Democratic Socialist Republic of Sri Lanka
Ministry of Agriculture (MoA)
Agriculture Sector Modernization Project (ASMP)

Assessment of Current Pest Management Strategies Implemented by the MoA & Preparation of a Pest Management Action Plan

FINAL REPORT - VOLUME 1

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Foreword

The increasing urbanization and declining extents of land for agriculture production have alarmed the authorities and created awareness of the urgent need to prioritize the national food production to secure safe and healthy food for national consumption. It is been made aware that national rice production has reached the self-sufficiency standard with the green revolution initiatives in the 60's. During the past few decades the vegetables/ fruits/ yams subsectors emerged as an important economic partner for rural small farm households. The tropical climate has been made affordable to cultivate a wide array of crops in different parts of the country.

The technology interventions over the decades have introduced and promoted innovative crop production systems and approaches for increased productivity and farm income. Though the productivity has increased, the heavy use of inorganic chemicals has negatively affected the unit land output due to continued degradation of soil characteristics and soil nutrient/ fertility level.

Evidence of the past studies shows that, overuse and misuse of chemical pesticides has widely been reported in this sector. The introduction of high yielding crop varieties have influenced farmers to use more high energy inputs especially chemical insecticides for control of pests in rice farming. In the long run the use of toxic chemicals resulted in increased health/ environmental hazards and proved to be a life threat for communities in farming areas due to toxic contamination. In order to mitigate these challenges, the global technology interventions for pest control/ management focused to promote Integrated Pest Management (IPM) practices especially in rice farming. Through the IPM technologies adopted for rice farming, the farmers gained skills and experience that was shared with farmers involved in vegetable growing in the provinces. However, the IPM practices have not adopted well towards other seasonal crop sectors due to many reasons.

During an era in which lots of discussions are being held regarding the negative impacts of the heavy use of inorganic chemicals on the environment and human health, it is crucial/important to understand/ ascertain the factors affecting the poor adoption of environmentally sound and safer techniques covering all stages from seed to harvest/post-harvest on select crops.

Accordingly this study report identified the factors affecting low adoption of monitoring and PM interventions for protecting the crop from pest/ disease infestations as against the high dependency and routine application of hazardous inorganic pesticides. The study will suggest strategies for promoting and identified PM tools in small farm agriculture productions. Thus, this study is timely and contains useful recommendations which could support in ASMP/ ATDP efforts of promoting environmentally friendly human safe PM practices in the small farm food crop sector in Sri Lanka- promoting enhanced economic and social status for small farm agriculture systems in the Provinces.

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Acknowledgment

The consultants team on behalf of S & P Holdings (Pvt) Ltd, wishes to express their gratitude to the Farmers of producer organizations, farming community, Agriculture Instructors, Provincial Directors of Agriculture, Directors of Regional Research Institutes, Director of CARP, Directors and sectional heads and relevant officers in SCPPC, PPS, ROP, NPQS, HORDI, Extension & Training, Divisional Officers, and Agricultural Instructors and the Project Director, Environmental and Social Safeguards Specialist and other Officers of ASMP/ PMU office, Deputy Project Directors, Agricultural Scientists, Monitoring & Evaluation Specialists, of ASMP/ PPMUs in project provinces, last but not least the Deputy Resident Project Managers (Agri), Agriculture officers, Unit Managers and Field Assistants, at MASL, Officials at Environmental Authorities, and MOH in the areas of ASMP project provinces in Central, UVA, North Central, Eastern and Northern for their uninterrupted support and cooperation extended during the course of the study.

The study would not be complete without the contribution from the private sector that plays a major part in rural agriculture production, facilitating the supply of inputs for plant growth and protection. We are thankful to General Manager (Agri) Cargills & Central province field operations Manager Cargills, Past president and vice President of LFVPPEA, Chairman of Ellawala horticulture, President & Secretary of Crop Life Sri Lanka, Director of CBL Natural, General Manager & Director of HJS Condiments, Marketing Director of CR Exports (Pvt) Ltd. Chairman/CEO AGCO/Green Farms Venture, Provincial level Agri-input dealers, for extending their support to share valuable experiences and information related to the objective of this study.

We would also like to thank Deputy Country Representative at FAO, District Representative of World Vision, and Enterprise Development Manager at SAPP, Certification officers of Control Union for their support extended to us in conducting this study.

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We are indebted to our field support team especially the Investigators for their dedicated efforts in data collection and analysis. Our sincere thanks are also due to the World Bank team guiding us on the right path to make the endeavor a success.

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Executive Summary

This report is established in line with the scope of work identified by Terms of Reference for the Assessment of Current Pest Management Strategies Implemented by the MoA and Preparation of a Pest Management Action Plan under the Sri Lanka Agriculture Sector Modernization Project (ASMP). The study focused on the ASMP Project Provinces of Central, UVA, North Central, Eastern and Northern from where primary data was collected from 197 farmers and 31 field officers in a survey. In addition, 13 Focused Group Discussions with district level officials of the Agriculture and Health sectors were also conducted.The survey covered farmers, extension officers and private sector individuals representing diverse agriculture investments that include production, input services, and marketing (local/ exports). The questionnaire for primary data collection focused on PM tools determined by Monitoring mechanisms *(such a pest identification, surveillance, Diagnostic, Scouting, ETL)*, Systems/ Interventions *(Agronomic, Mechanical, Physical, Biological, Genetical, Regulatory and Chemical)* and Practices *(land preparation to harvesting and level of farm management)* in assessing the status of PM at provincial level and identifying the inputs for recommendations and preparing an action plan for promotion and adoption of PM tools in ATDP provinces initially and to be promoted to the national level in future.

The problem of overuse and misuse of chemical pesticides has widely been reported from small farm vegetable cultivations in the provinces. Increasing negative consequences has prompted the necessity for developing safer and environmental friendly pest and disease control methods for small farm crop production in the provinces. Consequently, techniques/ practices such as Integrated Pest Management (IPM), Organic farming systems, Low Energy Input Sustainable Agriculture systems (LEISA), protected farming systems, have drawn significant attention around the World.

Sri Lanka initiated the IPM program for rice in 1980 with the technical support from FAO. The IPM technologies promoted and adopted in rural level farmer clusters established in selected major irrigation settlement areas including MASL. The program continued with FAO funding. At the end of the project in year 2002, a total number of 35,000 farmers were trained. It was these farmers and around 220 TOTs, half of them who are employees under MASL who were instrumental in spreading/ sharing the message to neighbouring farmers in the vicinity and outside areas. The FFS, a participatory method for promoting IPM has benefited the rice farmers to learn and understand the technologies and adoption of the same in the field level. The FFS in the IPM clusters have brought back the traditional and indigenous PM practices integrating Physical/ Mechanical/ Biological interventions and shown a reduced level of pesticides used in rice farming.

There were a few efforts taken in promoting IPM for the vegetable sector in Sri Lanka. However, farmers have not exhibited much interest to follow IPM or other non-chemical pest controlling methods in vegetable farming. Farmers in the provinces have indicated the chemical pesticides are best option for pest control as it kills instantly. However, they are aware that as per the DOA/ ROP regulatory notifications the pesticides available in the markets are less poisonous, in terms of instant killing of pest, and therefore they use more than recommended volumes or cocktail mixtures to see the pests are killed on-the-spot, even though the cost is increased.

On the other hand, FPOs reported that the non-chemical practices and pesticide management methods are not promoted or introduced properly and there are no demonstrations/ experiments with farmer participation. Therefore, even though they are trained for IPM they lack confidence to adopt IPM technologies and increasingly depend on chemical control measures. The findings indicate that, a majority of farmers in the provinces were able to acquire at least half of the total household income from other field crop/vegetable farming. Failure of extension services in serving farmers properly in providing pest management information (due to various constraints) was confirmed in instances where 57% of farmers in the study sample have resorted to the advice of sales agents and other informal sources when making decisions pertaining to pest management/ purchasing chemicals.

Farmers have been used to apply chemical pesticides before the pests and diseases appear in the field or as a routine practice. The ‘economic threshold level concept’ which is the base of PM tools was known by a few. However, 79% of the sample farmers in the project area are vigilant about pest/ diseases infestation and identification by monitoring the crop fields. But it was only a tool used for deciding to use chemical control measures.

In contrast, the increasing consumer demand for safe foods that are free from harmful contamination of heavy metals, pesticides, mycotoxins are emerging urban markets and international markets which have influenced the DOA to initiate and promote programs such as SL-GAP certification, where pesticide management is a key factor and making farmer awareness/ training through crop clinics, deploying crop doctors, empowering PHIs as pesticides authorized officers in addition to district level DOA officers, promoting Plant- wise app, with more focus towards reducing the use of chemical pesticides by adopting PM tools at farmer fields.

The GAP certification program initiated in 2006 progressed well but field implementation slowed down due to inadequate staff and diluting interest in communicating it in the field level. The SL-GAP has given priority for using non chemical PM practices. Assessing the field and including its information to a standard form by following a given process to certify the adoption of correct PM tools is one of the prerequisites to qualifying the farms for GAP certification.

The study observed the number of investments through public/ private/ donor initiatives of promoting productive technologies to increase yield while protecting the crops from pest/ disease infestations in the provinces. These include the interventions by the ASMP project in selected provinces and private sector cluster farm development programs in the proximities. The private sector interventions have shown successful technology adoption with yield/income increase while reducing the use of chemical inputs. Also private sector initiated organic farming cluster demonstrated best performance in controlling pest and disease with PM tools. It was observed that the key factor behind such a success was having a well-defined procedural set of agricultural technologies which are to be adopted from land preparation/ nursery periods to postharvest, followed by handing it over to the end market and close monitoring/ follow up of the program. The report recommends that the ASMP projects require the FPO to participate in these programs for more exposure on technical interventions adopted for conventional/ organic cultivation of vegetables/ moringa, etc.

The study noted that farmers are aware of PM technologies and their contribution to appropriate practices on reducing P&D infestations. However, they are yet to build confidence on those practices other than chemical measures. There is a positive trend as observed during the field visits where alternate farming practices are implemented in the provincial areas. Adoption of LEISA in the Eastern province is guided by World Vision, and a cluster of conventional farm operators converting to organic farming aiming to obtain the organic certification within a period of two years are few examples for identifying the opportunities for promoting PM tools in the provinces. The knowledge of farmers on PM techniques indicates the possibility of increasing the adoption level via awareness and training in future interventions. It was observed that dedication of a specific extension agent from awareness creation stage to final success plays an important role in this regard.

Proportionate income has a negative influence on IPM adoption as farmers' dependency on income from vegetables has increased; they try to minimize the risk factor associated with the techniques such as agronomical/ mechanical/ biological practices which allows crop damage to a certain extent during the process of PM. Reports on cost and benefits related to IPM are available for rice farming compared to vegetable cultivations which is yet to be adopted. The reports highlight that farmers using IPM technology in rice have achieved a higher yield compared to non IPM farmers. This is due to the implementation of timely cultivation, use of fertilizer as required by plants at different stages, monitoring of pest population/ incidences, and pest control measures determined based on surveillance and scouting. Studies also highlighted the cost saving medical treatments due to pesticide poisoning which indicated that IPM practices have achieved high profits compared to the control measure, using chemical control at ETL (usually two sprays during the season against the standard nine sprays) per season.

In addition, findings hint that, gaps in the existing policy and institutional set up, hindered the field level promotion of PM over years. It was reported that there is inadequate interaction/ corporation with provincial and inter provincial resources by private sector extension representatives and public extension services, capacity lags, widening communication gaps, poor attitudes of farmers and insufficient scientific knowledge of officers on PM tools, insufficient human resources in the current extension system were the major factors behind the low level of adoption of PM tools for determining the pest control method in farmer fields.

The study recommends PM tools as one of the priority areas to incorporate in the DOA extension programme at the national level by initiating measures to allocate sufficient human resources and enhance their capacities by empowering SCPPC for sustainable implementation. Filling the knowledge and attitudinal gaps of farmers and extension officers towards PM, tailor-made PM training programs for trainers and the extension officers and creating community awareness to purchase 'pesticide free farm produce/ products' are considered as a sustainable way forward. Establishment of 'participatory PM trials' and demonstrations to develop simplified PM packages for major pest and diseases also needs to be popularized PM tools in addition to obtaining the SL-GAP certification. These should be a primary focus of the FPOs in the project provinces.

Advocacy on policy issues across the country and making the agencies and policymakers to internalize the subject in the routine programmes is essential for effective promotion of PM tools. It was observed that enforcing the regulations of the pesticide act through the extension service is not functioning sufficiently and it is recommended that the regulatory enforcement comes directly under ROP and the required strengthening with a team of enforcement officers directly under the purview of ROP/ SCPPC to act on the misuse by unethical traders/ dealers/ users regarding the sales/ storage/ disposal/ application of pesticides; those considered detrimental for humans and the environment.

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CHAPTER ONE: INTRODUCTION

1.1 Introduction

The Ministry of Agriculture (MoA) commissioned S & P Holdings (Pvt) Ltd. (S&PHPL) to carry out an assessment of current pest management practices implemented by the MoA and preparation of a pest management action plan to be implemented through World Bank supported "Agriculture Sector Modernization Project (ASMP)". The S&PHPL initiated the field activities from June 2019, immediately after the green light to proceed was granted through ASMP/ Project Monitoring Unit (PMP) based on the proposed actions identified under the inception report and subsequent presentations/ discussions with relevant representatives of Provincial PMUs and WBG. The multi-disciplinary team of experts who conducted the study include, Dr. Anura Wijesekara – Team Leader (former ROP/ DOA), Mr. M.Z.M. Farhad - Pest Management Specialist (former Deputy Director /EDB), Mr. Edward De Mel - Agronomist-Former Director Agric-MASL, Prof. R. Nanthakumar - Senior Professor - University of Jaffna, Dr. Daham Jayawardana - GIS Specialist (Senior Lecturer, University of Sri Jayewardenepura). The data collection through farmer interviews, KIIs, group meetings, implemented with a team of four field assistants accompanied the experts in five provincial areas. The expert team commenced the program with field exposure visits to relevant ASMP/ PPMUs in the provinces and meeting with FPOs and representatives, and non ASMP farmers in the local areas. The preliminary visit covered all ASMP provinces and relevant officials at DOA to familiarize the regional network and programs linked to ASMP and pest management. The visit also introduced the team and established initial contacts with field level officers at DOA, MASL and private sector businesses and company representatives. Based on the information received from PPMUs, PDOAs and connected farmers leaders the field team carried out the detailed study according to a questionnaire prepared for farmers and key informants interviews.

The qualitative and quantitative information gathered was tabulated and analyzed to interpret detailed discussions, conclusions and recommendations and to develop and design a pest management action plan in line with the World Bank (Op 4.09) requirements to integrate to ASMP projects and subsequent expansion to other agriculture investments in the provinces. The action plan proposed to be implemented by DOA under the guidance of MOA.

1.2 Background

The Agriculture Sector Modernization Project (ASMP) funded by a World Bank Group (WBG) associate, International Development Association (IDA), to achieve required modernization in the Sri Lanka agriculture sector production through established strategies categories divided in to three major components;

a) Agriculture Value Chain Development – *[to promote commercial/ Export oriented Agriculture, Matching Grant Program]* – implemented by MOPI

b) Productivity Enhancement and Diversification Demonstrations *–[increase the capacity of small holder farmers to improve the ability to respond to market requirement – Farmer (individual/ groups/ organizations) training capacity building, Agro Technology Demonstration Parks (ATDP) promote innovative agro –technology based on value chain for selected crops, supports market infrastructure development, policy development support]*- implemented by MoA.
c) Project Management, Monitoring & Evaluation - *[to support the PMUs of MOPI and MOA in project management and coordination, technical supervision, financial management, procurement, social and environmental safeguards, improve the capacity of human resources and monitoring and evaluation (M&E)]* – PMU/PPMU of MOPI and MoA.

The project identified 20 ATDP pilot programs and established in five provincial areas and proposed to implement an expansion program to establish more ATDPs in the selected provincial areas. The clusters also identified as Farm Producer Organizations (FPO) and promoted the concept of ‘one- crop- one- village’ with modern technology interventions for achieving enhanced productivity and increased farm income for small farmers. Under pilot ATDP programs the FPOs established a range of selected crops such as fruits, vegetables and nuts as main items and supported with intercropping/ mixed cropping systems to promote year round income. The programs are monitored by PMU in coordination with PPMUs in the provincial areas.

Review of spatial data identifies that small holder Farmers are constrained to accessing the expanding market opportunities both locally and internationally due to numerous barriers encountered through the crop production/ availability of produce and stringent consumer protection controls/ strict monitoring mechanisms in diverse market systems. The international and local interventions promoting technologies for increased agricultural production has identified the need for more chemical inputs for better returns. However, the study revealed that at farm level these inputs were incorrectly used, in many cases it is over used to achieve more farm revenue. Use of chemicals for long periods in agricultural production has proven theaccumulation of toxic chemicals/ heavy metals in soil, water bodies, while contaminating crops supplied for human consumption.

According to the sources of EDB, DOC and the National Plant Quarantine Office and the EU Rapid Alert System for Food and Feed (RASFF), the border control authorities have sporadically notified/ alarmed/ warned and banned the import of vegetables/ fruits/ food products due to pesticides residues and chemicals contamination beyond the accepted levels. It is reported that the Sri Lanka Agriculture sector is the biggest consumer of pesticides.

There are a number of published reports/ research papers that document the pesticides use pattern, over use of pesticides, heavy dependency of pesticides by small farm producers, varied application/ practices due to regional conditions/ crop types, farmers attitudes, knowledge, extension support, indigenous pest management practices, IPM, hazards on the environment and humans, etc.

The study reports were reviewed and most of them are academic reports among a few which were identified as research reports which highlight the PM activities/ projects implemented in the past. Most of the documented evidence discussed the measures adopted to control the pesticides use in rice cultivation and programs implemented for promoting IPM in rice. There have not been any planned interventions/ programs introduced or implemented to control the increasing dependency of pesticides usage in vegetable farming during the past few decades. The results and recommendations reviewed are contained to particular villages/ Districts/ provinces and not extended/ promoted island wide. The review also noted that the published information/ data/ recommendations were not fully focused on crop growing cycles or the Plant Health Management (PHM) approach for diverse crops identified in particular areas.

The study also identifies the lack of strong cooperation/ cohesiveness among the private and public sector institutions especially in the provincial/ interprovincial level. It was observed that the private sector initiatives reach the farmers directly in providing technical and management information advises which in many instances the public sector extension officers are unaware of. In some cases the incorrect information and un-authorized crop inputs are penetrated into the farmer sites, which proves to be a challenge for sustainable crop production in the provinces.

Despite the emerging issues on over use and misuse of chemical pesticides, farmers have not been convinced much to move out from the conventional practices of pest control which they have practiced for years. The existing farming practices have increasingly depended on the usage of chemicals for plant growth and avoidance of pests/ disease damage. Farmers confirm that for the last few decades they have performed routine applications of pesticides as recommended by authorities/ companies/ dealers in the area (since the time pesticides were introduced and promoted in agriculture production). The small farmers are reluctant to implement non chemical control practices due to a fear psychosis created by the pesticide promoters and the risk they do not want to take if any loss of crops occurs due to pest damages. There is no proper awareness/ demonstration related to benefits and cost effectiveness of non-chemical practices. The study revealed that farmers in the provinces are aware of the hazards and market rejections due to toxic residues. Yet they use chemical control methods as the only remedy for controlling the pest incidence in the seasonal crops. Farmers noted many reasons as to why they are continuing to depend on chemical pesticides and the low level of acceptance of non–chemical methods.

It was made to understand that ongoing pilot projects implemented under ASMP/ATDP in the selected provinces are yet to use any form of technology packages for pest management. The selected farmers in diverse crop clusters were provided with improved seed and planting materials, machineries for land preparation/ seeding/ post-harvest processing, irrigation systems (Drip/ sprinkler), materials for semi protected cultivation, and training/ exposure visits. Yet, a total technology package is to be introduced. It was highlighted that the expert resources are scarce. The cluster meetings/discussions revealed that farmers carry decades of experience in crop cultivation practices such as soil/ land preparation, selection of planting materials, identifying irrigation intervals, benefits of weeding, hazards from pesticides, indigenous pest control methods, observation/surveillance for pest populations, according to the crops cultivated. However, they are not aware of the scientific values and its contribution towards managing or control of P&D. Hence they practice routine applications of pesticides irrespective of the threat of pests or the increase/ decrease of pests. In this regard the ATDP programs are an ideal opportunity and a potential to improving the existing technologies and identifying whether the farming practices already in place are capable of controlling the pest incidences since the begening of the crop cultivation program.

The study coordination with relevant institutional frameworks for ASMP/MOA, assessed the current status on pest management in Sri Lanka and based on the results and information a detailed action plan was established to be implemented through the ASMP program initially and extended to other provinces and producer clusters of the public and private sector intervention.

1.3 Overall objective of the ASMP project

The Project Development Objective is to improve agriculture productivity, farmer organizational arrangements and achieve the adoption of innovative agriculture technologies and marketing practices in selected provincial areas. The project will be implemented over a period of five years.

1.4 Objectives of the study

The main objective is to assess the pest management practices currently implemented/ ongoing under the guidance of the Ministry of Agriculture and based on the results formulating an action plan outlined on the following specific areas:

i. Strengthening pest forecasting
ii. Promotion of Agronomic Control
iii. Promotion of Physical Control
iv. Promotion of Biological Controls
v. Chemical Control

The action plan ensures the prioritized order to implement pest control measures to begin with Agricultural/ agronomical technologies, Physical and biological technologies and when the incidence exceeds threshold levels the chemical control adopted as a last option. The goal of the assignment is to develop an action plan to implement integrated pest/disease control emphasizing the actions to minimize the incidence of harmful creatures, while improving the safety level of crop production, protecting the ecological environment, enhanced farmers capacity/ knowledge / skills/ attitudes, keep farmers away from the use of chemical P/C.

1.5 Significance of the study

Pest management methods include Sanitary, Cultural, and Physical, Biological and Chemical practices / technologies. Controlling pests in the most effective, economical and safe manner requires much more than a “see and spray” approach. A good pest management system includes pest monitoring, identifying its habits/ lifestyles, forecasting pest build up, knowing different control methods, looking for cost effective/ least harmful alternatives, keeping records/evaluating results, offering pest resistant varieties, in combination failing with resorting to the application of pesticides as the last option. Sri Lanka depends on imported chemical pesticides, hormones, pheromones, insect, biological agents, insect repellants, growth regulators, etc., for the purpose of crop protection. The farmers increasingly use chemical inputs to obtain high growth performance and managing/ controlling P&D on high yielding improved crop varieties cultivated in their farms. Introduction of modern technologies, high yielding crop varieties, hybrid seed andplanting materials, high income potential of crop with inorganic inputs are demonstrated and promoted by importers, distributors in cooperation with public sector extension services have, influenced the farmers move out from the conventional/ traditional/ indigenous practices used over generations. The study identified that the authorities have neglected or not taken any efforts to promote/popularize or demonstrate to continue use of knowledge/ experiences /skills on available non-chemical technologies/ practices on pest/ disease control and its economic/ social benefits that have been practiced for generation. Over the decades the heavy use of inorganic inputs on agriculture production has polluted the natural environment due to accumulation of toxic residues, causing hazards for human health due to the consumption of contaminated food/ water, and loss of international market share due to high level of chemical residues detected in food items. The GOSL have identified the emerging issues and challenges and shown a commitment by recognizing the importance of implementing consumer safety, market oriented and environmental friendly pest management procedures as a critical measure in the draft of the national agricultural policy 2018.

The results of this study documents the current status of pest management and past experiences in the adoption of diverse technologies, drawbacks and recommendations for the development of national programs for promotion and implementation of sustainable pest management technologies mitigating the issues pertaining to the of use of chemical pesticides. The study accommodated the information/ inputs provided by WBG documents on the Pest Management Plan and Environmental Assessment Framework to be followed by investors supported under ASMP.

CHAPTER TWO: METHODOLOGY

The study team in coordination with the client determined the stakeholder network in project provinces and other relevant sources and initially carried out a preliminary visit to PPMUs covering five provincial areas where pilot ATDPs were established under the ASMP program. During this visit the team gathered a comprehensive knowledge about the ASMP pilot ATDPs and crops cultivated by the famer producer organization. The team in coordination with PPMUs gathered the required contact information of the farmers, officials at the provincial and district level DOA (Extension/ research/ ADC), input suppliers/ dealers and farmers not listed for ASMP support. The study team comprised of a Team leader and four sector specific experts supported by four field assistants for field/ farm data collection.

2.1 Study Location

The locations covered five provincial areas, Northern, North Central, Central, Uva and Eastern Provinces. The team, visited all provincial PPMUs established under ASMP and held introductory meetings with farmer leaders and representatives which were conducted at field level, covering individuals/ groups to understand the programs implemented under ASMP, offer assistance/ support for farmers, evaluate the technologies adopted and especially observed the contribution of these support support measures and technologies for minimizing the usage of chemical pesticides for P&D control.

The initial visit also covered the relevant divisions of DOA- HQ at Peradeniya and Gannoruwa. This covered meetings with key persons involved in pest management technology development and promotion in SCPPC, PP Division, Entomology Division at HORDI, ROP, E & T center, GAP Certification Division. Meetings were held with the relevant officials in the important public and private sector institutions, exporters, representatives of associations, certification bodies, Govt. Analyst Departments, representatives from FAO and chemical companies in Colombo and suburbs in which valuable data and information related to the study were discussed and obtained.

An extended survey based on the questionnaire was implemented in one week after the initial project exposure visit. The field data collection was designed with two types of questionnaires, i.e. 1-Farmers data and 2-Officers data, and the enumerators were deployed in fields at Central, North Central, UVA, Eastern and Northern provinces for collection of relevant information and data. The data was also collected from non ASMP beneficiaries in and around the vicinity of ATDP cluster regions.

The team, by visiting MASL areas have collected diverse information that would be useful for interpreting the results to match with national requirement of pest management. Informal meetings were held with company representatives, farmer leaders, protected agriculture farmers, and prior learner experienced farmers to collect information on crop management/ pest management and identify the available information on traditional pest management measures.

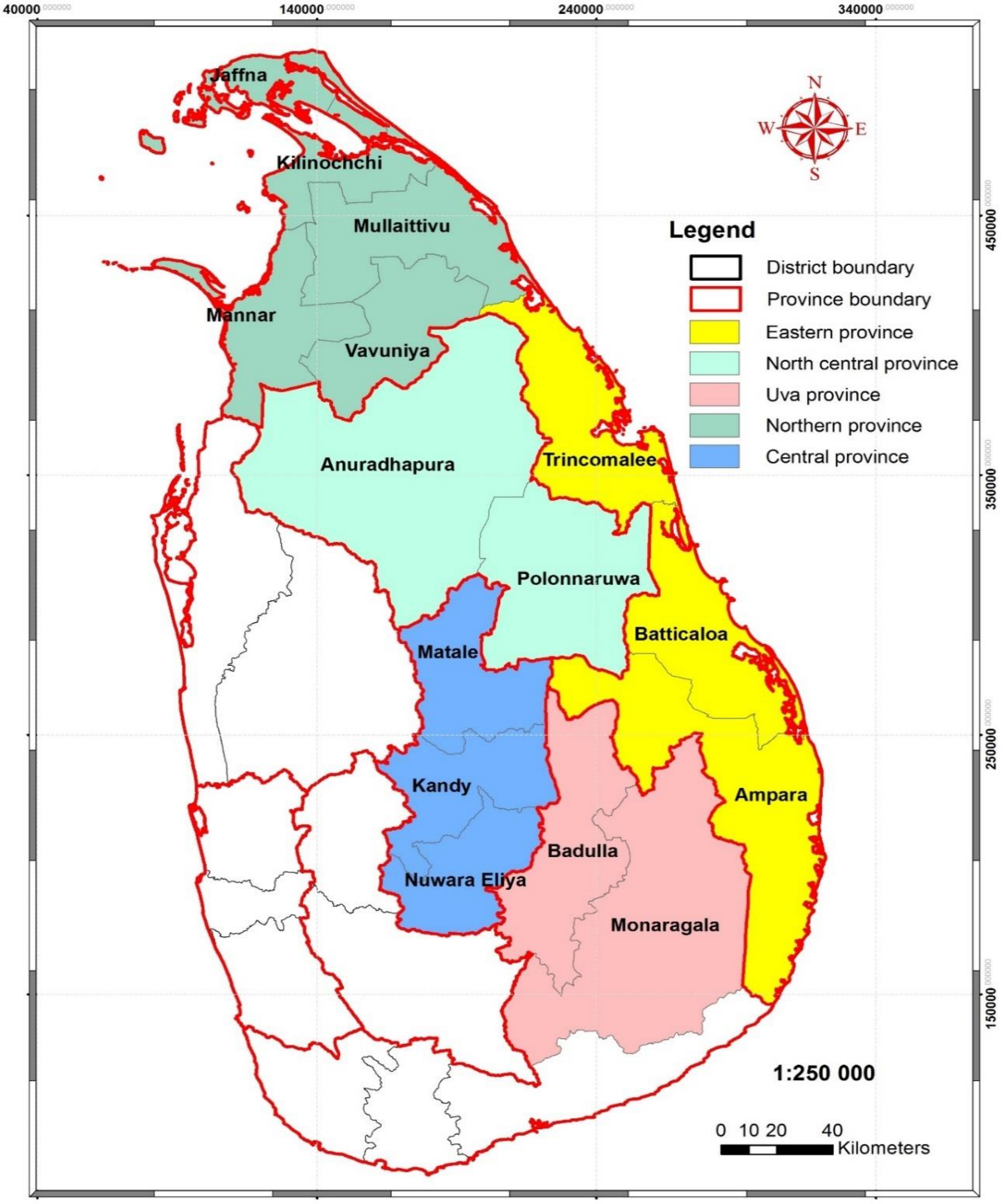


Figure 1.1: Map of Project Area

2.2 Sample selection & distribution

The samples for the study was selected in consultation with PPMUs in the ASMP provinces. The sampling covered five provincial areas identifying 10% of the total number of farmers registered under ASMP provincial pilot ATDP programs. The clusters covered around 11 types of fruits & vegetables. This number was determined according to the tasks identified by the client and the limited time period available to complete the task. However, the team had informally gathered data and information from farmers, other than the ASMP provinces and FPOs. The team also covered officials, private sector companies and donor agencies to obtain maximum possible information and data related to crop cultivation and pest management practices.

Table 2.1 Sample distribution

Province	District	Crop	No. villages	Acres	No.FPOs registered	Total No. of Beneficiaries	No. of Study sample	No. producers reached
North Central	Anuradhapura	Green Chili	41	40	2	80(11F)	35	28
		Bitter Gourd	29	20	2	40(4F)		
		Guava	14	47.5	1	60(4F)		
		Mushroom	01	--	1	30(23F)[c]		
	Polonnaruwa	Green chili	35	20	0	40(7F)		27
		Bitter Gourd	25	15	0	30(3F)		
		Papaya	04	25	0	25(5F)		
		Mushroom	02	--	0	40(37F)[d]		
Central	Matale	Mango	06	350	1	100(10F)	12	20
		B-Onion[f]	03	07.5	1	15(0F)		
		Vegetables	03	01	0	10(0F)		
UVA	Moneragala	Pineapple	05	37.5	1	75(23F)	19	26
		Passion fruit	06	37.5	1	75(11F)		
		Mango	03	40	0	40(12F)		
Eastern	Batticaloa	Ground nut	06	100	01	100(22F)	70	46
		Green Chili	06	50	01	100(23F)		
		G/ cucumber	10	500	04	500(123F)		
Northern	Mullativu	Ground nut	18	100	06	200(43F)	41	50
	Jaffna	Mango	12	100	04	200(51F)		
		Green chili	4	2.1	04	08(0F)		
Total							**176**	**197**

Accordingly the study extended to cover a higher number of farmers and relevant key informants, gathering a wide array of data and information related to tasks. A list of farmers, officials, representatives of private sector companies, input suppliers, dealers, donor agencies, NGOs is shown in **Annex-1.**

2.3 Data collection methods/tools

The study determined multiple methods to collect primary and secondary data required for analysis. The major data collection methods used are as follows:

2.3.1 Literature review

Further to the review and study during the inception phase the team carried out a comprehensive review of available literature to explore the development activities and programs and experience in implementing PM technologies in Sri Lanka and other countries. Based on the reviewed information, a questionnaire for primary data collection was developed. Guidelines for key informant interviews also developed with the help of secondary information gathered through the literature review.

2.3.2 Primary Data Collection

Considering the distribution of provinces /districts/ ATDPs under ASMP, the consultant undertook the task to plan and execute the field program within the given time period. The task was achieved with a team of enumerators in the field guided by Agriculture specialists, socio-economic experts, GIS experts, pest management specialists and the team leader. The team covered individual farmers/ leaders who are the members of the FPOs under pilot ATDP in five provinces cultivating over 12 different crops.

The following aspects were discussed during the primary data collection process. However, any additional information identified by the farmers was considered for discussion or elaborating the relevance with pest management on particular crop/s cultivated.

- Field maintenance- *hygienic practices, destruction of debris/ infected plant and parts*
- Land preparation practices – *soil treatment methods, soil conservation, and soil fertility*
- Cultivation practices – *crop rotation, intercropping, Agronomic practices, plant densities,*
- Pest surveillance – *field observations/ monitoring/ forecasting/ promoting natural enemies*
- Non chemical pest control techniques- p*hysical/ mechanical/ biological/ irradiation*
- Identification of the need for pest control and determination of method- *threshold levels*
- Availability of physical pest control for managing the pest incidence on crops.-*manual*
- Practices used to trap and control pests *–light traps/ sticky papers, baits,*
- Concerns about environment and control of pollutants – p*ost disposal/ storage/ time of application*
- Level of understanding of use of non-chemical methods-*knowledge/ skills/ education*
- Continued practice of traditional pest management methods.-*indigenous technologies*
- Following the published recommendation on pest management- c*hemical/ IPM*
- Protective actions on *pesticide handling, protective gears for pesticides spraying*

- Availability of promotional and technology transfer program – *training, demonstration, awareness*
- Small farmers' capacities on diverse pest control methods-*minimizing the use of chemicals*.
- Involvement of women in pest management practices in small farms.-*household support*
- Private sector extension services/ effectiveness -*pest management practices*.
- Regulatory mechanisms for control of pesticides –r*egistration, handling, packaging, marketing*,
- Cost/returns of pest management practices –*cost concern on pest management*

2.3.3 Focus Group Discussions (FGD)

FGDs used was one of the main qualitative data collection methods in this exercise. Focus Group meetings at provincial levels were conducted by the study team assessing the situation of available/ existing pest management practices, its effects on the environment, the cost benefits, legal/ regulatory empowerment, effectiveness of extension support, benefits accrued due to donor support programs with special reference to ASMP pilot programs, influence of private sector networks in five (05) provinces. The FGDs were conducted with the public/ private/ donor stakeholders, and farmer leaders.

2.3.4 Key Informant Interviews (KIIs)

Key informant interviews carried out with (i) officials involved in training and extension in the study areas (ii) policy-makers involved in decision making related to agricultural extension/pest management and control (iii) trainers, researchers and academics involved in pest management technology development/ promotion, in the provinces.

2.3.5 Integration of Different Information Gathering Processes

Findings of study was compered or cross checked with different data/information sources interviewed during the study. Evidence from secondary sources, stakeholder consultation and interviews are supplementary sources of information and will be used to support the findings gathered from the above key sources.

2.3.6 Data Analysis

Gathered data based on the questionnaire was compiled in to the data sheet and crop cycle activities assessed and the results interpreted to determine the status of pest management systems and issues/ challenges/ potentials to mitigating current hazards on environment and human health. Based on the collected information (qualitative/ quantitative) the relevant recommendations were established and guided to develop an action plan. A guideline on pest management best practices was developed and established.

CHAPTER THREE: OVERVIEW OF THE PROJECT

3.1 Project

On the initiative of the WBG funded ASMP implemented by the MOA, identified five provincial areas to promote ATDP to demonstrate the agro-technology for selected crop value chains focused to establish profitable farmer companies. The ATDP promote and mobilize farmer clusters in the provincial areas with technology packages disseminated via training, demonstration, crop production, post –harvest handling, and marketing. The project already established 20 provincial projects on pilot basis. The study team focused mainly on farmer clusters and crop sectors under these ATDPs and outside locations depending on the time available.

The provincial programs were organized and implemented through the PMU which was centrally located at the MoA office and regional PPMUs established in Jaffna, Batticaloa, Matale, Moneragala and Anuradhapura Districts covering respective provincial areas. The PPMUs in the regions managed by the Deputy Project Director is also supported by Agricultural Scientists, M & E Specialists and Program Officers working in concurrence with Project Directors and relevant technical staff at the PMU.

Diagnostic studies were carried out in provincial areas, for site selection, crop identification, farmer selection, cluster formation, training and technology transfer activities/ demonstration, and are closely coordinated with provincial and interprovincial Departments of Agriculture. Farmer clusters are selected within a particular ADC areas guided by the AI responsible. The particular AI covering the selected village is the contact point for cluster farmers and PPMU for promotion of ASMP/ ATDP technical interventions. Most of the clusters are identified in remote villages/ GND where poverty is higher compared to other GNDs in each province. The nature of terrain has identified the need for infrastructure especially the rehabilitation of sources of irrigation (Agro Well/ Deep Well,), establish road networks, shared service facilities, access roads to increase efficient transport to market entry points and input supply. The beneficiaries selected according to the list of criteria were established under ASMP/ PPMUs.

Ministry of Agriculture
Agricultural Modernization Project - North Central Province
Beneficiary Selection Criteria for Pilot Projects

- An Individual operating a Small scale producer involved full time farming and Experience in cultivation of selected crop.
- Gender and age.
- The farmer's willingness to grow the select crops on a commercial scale.
- Confirmation of ownership of the land expected to be cultivated by the beneficiary.
- The land and the soil should be certified as suitable for the selected crop.
- There should be a permanent water source for cultivation.
- Must have a water pump.
- There should be a proper security fence around the land.
- Should be willing to use soil conservation methods.
- Willingness to provide beneficiary contribution to the decision related to project.
- People who have the ability and willingness to use modern technology.
- Should enroll as a member of the established Farmers' Production Organization or the Farmer Company and would like to comply with its rules.
- To be willing to sell their products under forward trade agreements.
- An individual willing to contribute to the Value chain development activities.
- A person genuinely making an effort to transition from subsistence agriculture to commercial agriculture.
- Should be willing to participate in the training programs organized by the project.
- Should be a person who wants to follow Good Agricultural Practices

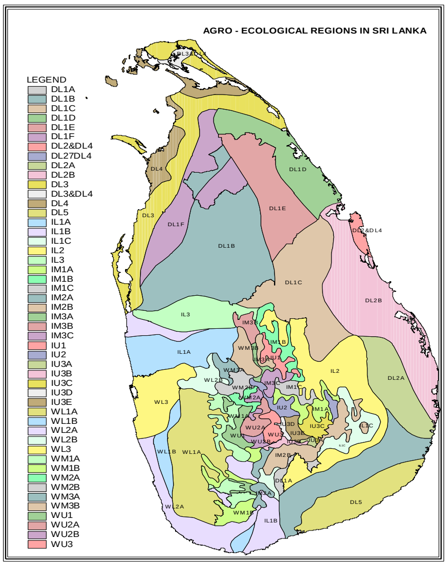
Source: Office of PPMU/NCP

3.2 Project location

The five provinces where the project is implemented covers all major Agro Ecological Zones of Sri Lanka. The altitudes, seasonal rainfall pattern, temperature regimes and soil characteristics of these zones distinguishes 46 Agro Ecological Regions around the Island. Considering the topography and the climate, bioclimatic zones are recognized to describe the distribution of natural vegetation in the country. In differentiating the climate, soils and terrain conditions that are uniform throughout an area for crop production are widely used in identifying agro-ecological regions. Environmental change, availability of more spatial and temporal data and advancement of GIS technology has led to provide more accurate information related to 46 Agro Ecological Zones in Sri Lanka.

With a long history of agriculture that stems from a unique hydraulic civilization, Sri Lanka is recognized for its rich agro-biodiversity, resulting from the selection and adaptation of crops and livestock through generations to match with varied ecological conditions that prevail in the country. Ancient Sri Lanka was a self-sufficient, thriving agricultural economy with the staple food, rice which was cultivated in extensive paddy fields, while vegetables, greens, grains and cereals were cultivated in rain-fed lands called 'Chenas' also known as shifting cultivation which is the most primitive type of agriculture known to man from the dawn of civilization.

Climatic Zone	No.of AE Regions	Land Extent (ha.)
Wet Zone UC	04	139,807
Wet Zone MC	06	315,534
Wet Zone LC	05	818,733
Intermediate UC	07	157,162
Intermediate MC	08	342,395
Intermediate LC	05	1,004,431
Dry Zone	11	3,562,616



3.3 Agro-Ecological Zones of Sri Lanka

Table 3.1: Characteristics of major ecological zones

Ecological Zone	Altitude Meters (MSL)	Land area	Annual Average Rainfall (mm}	Annual Average Temperature(^{0}C)	Humidity (RH)	Soil types	Project provinces covered
Wet	Above 1000	21%	2500-5100	10-25	73-93	Red yellow Podsolic, bog/Half Bog & Sandy regosols	Central, Uva
Intermediate	300-1000	23%	1750-2500	26-28	77-88	Immature Brown Loam, from RBE to red yellow podsolic & non calcic brown loam	Central, Uva
Dry	0-300m	56%	Less than 1750	29-32	75-90	Reddish Brown Earth, Humic Gley Alluvial & Red Yellow ,latasols/Calcic brown ,Sandy regosols, Alkaline & Saline	East, Northern, Uva

Source: Dept. of Census & statistics

3.4 Land Use

The land area under agriculture production is 2.2mn.ha, contributing to 33% of the total land mass of 6.44mn ha. (Excluding areas occupied by inland waters) of Sri Lanka. The agriculture land use pattern identifies that 44% of agriculture land is used for paddy cultivation while 32% is used for plantation crops (Tea/ Rubber/ Coconut) which are two major sectors that provide a livelihood for the rural population. The prosperity of the country depends on the rational land use, proper management of the natural resources soil, water and significantly on biodiversity with due consideration for environmental protection, human health for producing safe food for consumer segments. Sri Lanka is a country with a rich plant diversity. About 3368 plant species belonging to 1294 genera and 132 families have been identified in Sri Lanka. About 800 of these are endemic to Sri Lanka, while the rest of the species have been brought to Sri Lanka from the various regions at different times.

Reports identifies that 80,000 of edible plants were explored by man since civilization. Currently exploited around 150 species and less than 30% of these are utilized to meet about 90% of the food requirements of the population. The wealth of crop types built over thousands of years are being lost at an alarming rate, mainly due to the human factor in the name of global development.

Table 3.2: Agriculture land use in Sri Lanka

Agriculture system	Extent *(Ha)*
Rice cultivation	977,561
Plantation crops *(Tea,Rubber,coconut)*	716,320
Other field crops *(pulses,oilseed,other cereals)*	130,297
Minor Export Crops *(spices,herbs,medicinal plants)*	119,862
Vegetables *(includes roots and tubers)*	85.663
Fruit cultivation	85,066
Home Gardens	76,483
Chena *(slash and burn)* cultivation	NA

Source- Sector Vulnerability Profile: Biodiversity and Ecosystem Services/ Biodiversity –SVP Nov 16-2010-ADB/Climate change secretariat

Green Revolution launched in the 1960's had its motto, the increase in productivity using high yielding hybrid varieties and high inputs. The liberalized economy after the 80's allowed the import of high yielding seed materials of many vegetable varieties hindering the development or upgrading of local varieties. At present, there is a heavy inflow of hybrid seeds that give a higher crop yield with attractive quality/ characteristics which has over taken the use of local/ traditional seed varieties cultivated for generation. Existing traditional varieties were deemed unsuitable in the current open market environment for a diverse range of imported seeds. Only a few local varieties were bred and cultivated.

Mono-cropping is the accepted farming system in modern agriculture. Although it is argued that the introduction of new crops or Mono-cropping systems have enriched the crop diversity in Sri Lanka, the damage done to the traditional food plant diversity is greater due to increasing cultivation of exotic varieties introduced during the British rule.

Deforestation also had a serious impact on plant genetic erosion and food security of the local people. Some 200,000 square kilometers of forest cover is disappearing every year. In Sri Lanka, the land area under forest cover has decreased from about 70% at their turn of the century to about 22% today.

Though the study identifies that cultivation of selected varieties of a few cash or market oriented crops, thousands of food crops grown in farmers' fields have been seriously threatened.

3.5 Agro Technology Demonstration Parks (ATDP)

Based on the assessment on agricultural potential, poverty level, ecological diversity and representation of small farmers, the WBG in cooperation with MOA under ASMP, determined to expand the market oriented commercial agriculture production in five provinces covering the major ecological zones. It is learned that the focus is to promote Small Farmer Producer cluster Organizations to expand agribusinesses that demonstrate the modern/ high tech crop production systems owned by farmer communities in identified villages. The study covered five provinces assessing the pilot projects implemented as a way forward for future promotion/ expansion of Agro Technology Demonstration Parks (ADTP) on selected fruits/ vegetables.

Table 3.3: Agriculture potential of Provinces selected under ASMP

Province	Districts	Total GNDs	No. GND crop production	Population ’000	Agriculture holdings (Ha)	Major crops (‘000Ha) 1- Available in the province 2- ASMP –pilot project
Northern 1.12mn[a]	Jaffna	425	306	608	16,942	**1-Coconut(10.6),Paddy(41.1),Red onion, black gram, green chilli,maize,green gram, potato, Mango, Banana, Grapes, Papaya, Cashew, Guava, P/A, Moringa.** 2-Green Chili (traditional/PC-1/Vanni type) ,Ground nut (Tissa & Tissa-1) ,Mango(TJC) with intercrop-Ground nut/Chilli/vegetable
	Kilinochchi	94	86	124	15,939	
	Mannar	153	118	107	8,920	
	Vavuniya	102	100	184	13,840	
	Mullativu	136	127	96	16,293	
North Central 1.35mn[a]	Anuradhapura	694	666	918	151,941	**1-Coconut(14.2) Paddy (110),maize, red onion,b-onion,green chilli,black gram, green gram , Pumpkin, Mango, Papaya, P/A, Moringa** 2-Chilli(farmer selection),bitter gourd(hybrid),Guava intercropped with melon, ground nut,chilli,mushroom,papaya (green papaya),moringa,aloe Vera.
	Polonnaruwa	294	267	431	71,206	
UVA 1.35mn[a]	Badulla	567	534	864	106,738	**1-Tea, Rubber- Coconut(12.7), Paddy (46.2) ,Tomato, potato .beans,maize,ground nut, protected agriculture, Passion fruit, Mango, Papaya, Lime, Cashew, Orange, Pineapple, Rambutan, Avocado,Banana,woodapple,Beli, Melon, Sugar cane** 2-Mango, Passion fruit, P/A, Moringa (existing), intercrop groundnut.
	Moneragala	319	312	485	96,437	
Eastern 1.68mn[a]	Batticaloa	346	225	560	34,490	**1-Coconut(7.74), paddy(186),red onion, cowpea,maize,green chilli, vegetables, Mango, Cashew, Papaya,Banana,Sugar cane, Citrus** 2-Chilli,groundnut and Gherkin crop rotation vegetables, red onion, melon, pumpkin
	Ampara	404	503	705	73,180	
	Trincomalee	168	228	412	22,474	
Central 2.72mn[a]	Kandy	1187	945	1,45	94,674	**1-Tea, Rubber- Coconut(18.27),Paddy(26.4) Tomato ,beans, cabbage, potato, protected agriculture, Strawberry, Avocado, Anoda,Banana, Grapefruit, guava,** 2-Mango, guava, B-onion seed production, passion fruit, intercropping melon, vegetables, pumpkin.
	Matale	545	489	514	68,740	
	Nuwara-Eliya	491	464	756	86,761	

Source - CBSL annual report 2018Dept. of Census & Statistics & PPMU/ASMP; a- Provincial population; vegetables-bitter gourd, snake gourd, brinjal, long bean, Capsicum, Beet root

The majority GND in above provinces involved in agriculture production. A wide array of crops are cultivated in the region experiencing two crops per year. However the farmer/ key informant interviews revealed that the farmers linked to ASMP project carries years of experience on year round production of crops in rotational system. Most of the farmer clusters cultivating three crops per year.

The clusters at village level compromised to cultivate identified main crop during the Yala and Maha seasons and the rotational crop in mid seasons depending on availability of irrigation water. The FPOs traditionally begins the crop planting within a stipulated time frame according to climatic factors; rainfall, temperature. Irrigation availability, etc. Farmers by experience aware that timely planting will enable the crop to withstand/resist pest and diseases. Timely cultivation is a scientifically proven practice that enables the plant to utilize the maximum benefit of climatic factors essential for crop growth, flowering and harvesting.

3.5.1 Pilot projects on ATDP implemented under ASMP

The ASMP interventions with modern/improved technology package on selected crops initiated during the early 2018 was observed in farmers' field. It is learned that PMU in coordination with PPMUs, initiated interventions to promote technology packages to farmer clusters identified in seven districts in select provinces. The program established 20 pilot projects identifying a range of crops to be cultivated by selected farmer clusters in the district areas. It was understood that the PPMUs are proposed to extend the program with identified crops in assigned ASMP areas. The summary of these pilot programs are given in the table below.

Table 3.4: Pilot ATDP programs implemented in the provinces

Province	District	Crop	No.villages	Acres	No.FPOs registered	No. of Beneficiaries	Proposed crops
North Central	Anuradhapura	Green Chilli	41	40	2(of 3projects)	80(11Females)	Moringa, Aloe Vera, Papaya fruit
		Bitter Gourd	29	20	2(of 2p)	40(4F)	
		Guava[a]	14	47.5	1(of1p)	60(4F)	
		Mushroom[b]	01	--	1(of1p)	30(23F)[c]	
	Polonnaruwa	Green chilli	35	20	0(of2p)	40(7F)	
		Bitter Gourd	25	15	0(of2p)	30(3F)	
		Papaya(Green)	04	25	0(of1p)	25(5F)	
		Mushroom[b]	02	--	0(of1p)	40(37F)[d]	
Central	Matale	Mango[e]	06	350	1(of1p)	100(10F)	Passion Fruit, Guava
		B-Onion[f]	03	07.5	1(of1p)	15(0F)	
		Vigetables[g]	03	01	0(of1p)	10(0F)	
UVA	Moneragala	Pineapple[h]	05	37.5	1(of1p)	75(23F)	Guava, Wood apple (grafted),
		Passion fruit[h]	06	37.5	1(of1p)	75(11F)	
		Mango[e]	03	40	0(of2p)	40(12F)	

Province	District	Crop	No.villages	Acres	No.FPOs registered	No. of Beneficiaries	Proposed crops
							Sour sop, Moringa
Eastern	Batticaloa	Ground nut	06	100	01(of1p)	100(22F)	Mango, Vegetables
		Green Chilli	06	50	0(of1p)	100(23F)	
		Cucumber	10	500	4(of6p)	500(123F)	
Northern	Mullativu	Ground nut[i]	18	100	6(of6p)	200(43F)	Banana,Grapes, Passion fruit, Moringa, Papaya
	Jaffna	Mango[i]	12	100	4(of4p)	200(51F)	
		Green chilli	4	2.1	0(of4p)	08(0F)	

a-Common collecting provided; b-Plus a common unit; c- Out of the total 30 beneficiaries10 are attached to common unit; d-Out of the total 40 beneficiaries 10 are attached to common unit/Centre.; e-Mango cultivation/value addition; f-Seed production; g-including value; p-projects

The established FPOs were registered under DOA and member farmers granted with irrigation systems (sprinkler and drip with pump), planting materials (fruit-Mango/ PF, guava-Vegetables - Groundnut, Chilli, Cucumber, Mushroom), plastic crates for transporting farm produce; shared facilities such as land preparation machineries, post-harvest machineries, construction of farm access roads, buildings/ equipment for post-harvest and market operations, rehabilitation of irrigation resources, and training/ exposure visits to fruit farms. Apart from the technology transfer training the FPOs are required to attend the Farmer Business School (FBS) entrepreneurship training for 35 session of 1hour each to enhance their skills/ knowledge on farm enterprise development and doing business on farm produce. This training program was tied up to the package of assistance to FPOs. FBS program is conducted by AIs in the area who were the trainers trained by an expert team out sourced under ASMP. However, it was noted that the FBS program is focused on achieving the business skills for farmer communities to enable them to better communicate /negotiate for farm produce marketing. There is no strong integration with crop production technology/practices/ activities on select crops to make an effort to increase skills on cost analysis for different stages in crop cycle to increase the capacity on competitive marketing.

Harvesting passion fruit is continued and the average farmers in Moneragala area have done 5-6 harvests and are expected to continue up to 12-18 months. The marketing arrangements for passion fruit coordinated through the project and contract buyers include Lanka Canneries who collect the produce from collecting centers established for FPO. Most of the seasonal crops Ground nut, Cucumber, have progressed with 2-3 cycles. Green chillis are cultivated with traditional types where farmers continue to manage the plantation for a period of 6-8 months in which hybrid types are removed after five (05) months.

Ground nut, chilli and vegetables are marketed through the local area collector network. Cucumber is cultivated by a large number of small farmers linked to the leading processing and exporting company. Contract agreements are made where the purchasing company has determined the prices that was agreed by farmers according to the quality/ specifications. The inputs such as seed, fertilizer, pesticides are provided by the company with extensive support given in areas pertaining to technical advice and cultivation practices.

Mango producers in the provinces are devided in to two categories. The existing mango crop and new planting. The existing mango plantation produce fruits and are continue to harvest. The new plantations are still young and in growing stage where age varying 3-8 months. The existing plantations of Mango are already producing fruits and the harvest is linked to modern retailing companies and collectors for hotels and other retail outlets in the urban areas. Although these plantations use the technology interventions, such as fruit bagging the quality of fruit is not encouraging for urban markets.

The farmers who cultivated with conventional/ traditional systems are in transition with the introduction of technologies such as drip irrigation, sprinkler irrigation, semi protected netting, intercropping annuals with perennial crops, plant protection technology especially bagging of fruit, net covering of vegetables, etc.

However, it is envisaged that technology diffusion is still not practiced/ performed in an organized or coordinated manner. The technology introduced covered only certain areas or activities in the crop growing cycle/ value chain, causing a poor outcome and losing the farmer confidence. A comprehensive technical package is yet to be introduced or offered to FPOs.

The PPMUs pilot programs are considered a learning experience to improve and develop profiles on technical and farming practices for a range of crops suitable for provinces with market potential and expected to be shared with proposed expansion for ATDP within the project lifespan.

3.6 Demographic Characteristics of provincial population

The Sri Lankan society is predominantly agrarian. Although the country is moving towards industrialization, the agricultural sector still continues to be an important sector in the economy of the country and contributes substantially to foreign exchange earnings and to the GDP. The share of agriculture to the GDP is 7.7% in 2018. Economically, the active population employed in agriculture and related activities is estimated to be 26% in 2018 compared to 31% in 2012, *(Dept. of Census & Statistics/ bulletin 2018).* At provincial level the UVA province shows the highest number of people (56% of provincial population), North Central identified as second place with 43% and central province has 38% where Northern & Eastern have 28% each of the provincial population. It is also identified that a percentage of rural population in these provinces are high compared to urban or the estate population. In Central province it represented over 70% (highest in Matale & Kandy), the rural population in the Northern province account for more than 86 %, (highest in Mullativu and Kilinochchi), Eastern Province reported around 75% rural population, with the North Central Province amounting to 74% and UVA province recording 86% (highest in Moneragala) indicating the potential for development of agriculture resources for economic prosperity of the people in the area.

3.6.1 Age

The study covered the aspects related to the distribution of demographic characteristics of population to identify potential and existing capacities/ knowledge base of resources availabile to supporting agriculture productivity in the provincial areas.

Table 3.5: Distribution of Population in the ASMP Provinces by Age

District	Gender	Age (years)			
		0-19	20-59	60-74	75 & above
Kandy	Male	232,532	340755	66178	16326
	Female	228401	387661	78886	24643
Matale	Male	81671	125500	21454	5052
	Female	81643	136579	25280	7372
Nuwara Eliya	Male	133519	175906	31288	6085
	Female	133615	197109	38230	8353
Jaffna	Male	99171	138181	30306	7515
	Female	98611	164481	36560	10053
Mannar	Male	19587	26508	3333	643
	Female	19094	26147	3491	785
Vavuniya	Male	32528	45242	5645	1246
	Female	32521	46785	6503	1591
Mullativu	Male	18803	23377	3266	590
	Female	18392	23806	3411	593
Kilinochchi	Male	24106	26872	4066	739
	Female	18408	28521	4378	786
Ampara	Male	127558	162217	20459	4118
	Female	124764	182000	23275	5011
Batticaloa	Male	108441	124472	14854	2907
	Female	108109	145404	18282	4096
Trincomalee	Male	79553	94444	11221	2254
	Female	79061	98420	12690	2898
Anuradhapura	Male	149771	234498	29511	6320
	Female	149857	247629	33943	9046
Polonnaruwa	Male	69125	112799	15736	3120
	Female	68993	115234	16914	4167
Badulla	Male	141801	206666	34328	9151
	Female	143476	228021	40760	11146
Moneragala	Male	78957	124813	16566	3823
	Female	80134	125500	19599	4657

Source: Dept. of Census & Statistics -2018

The national level population by age groups indicates that age from 0-19 years contribute to 33% of the total population (Dept. of Census & Statistics 2017), equally shared by male and female numbers. The age group of 20-59 years contribute to 51% of the total population in which the female share was 52% which is indicative of being higher than the male share in this age group and the availability of the female workforce. At the national level the age group 60-75 & above, contribute only 12% to the total population of which the female share indicated 43%, which hint that the well experienced learned personnel with knowledge of Agriculture is reducing in numbers.

Table 3.6: Age group distribution of study sample

District	No of head farmers according to age group and (%) to district totals					
	20 to 30 Yrs.	31 to 50 Yrs.	51 to 60 Yrs.	60 to 70 Yrs.	71 Yrs. and more	District Total
Matale	1 (5)	11 (55)	6 (30)	2 (10)	0 (0)	20
Jaffna	2 (8)	8 (32)	6 (24)	7 (28)	2 (8)	25
Mullativu	3 (12)	12 (48)	4 (16)	5 (20)	1 (4)	25
Batticaloa	15 (33)	18 (39)	12 (26)	1 (2)	0 ()	46
Anuradhapura	1 (4)	18 (64)	7 (25)	2 (7)	0 ()	28
Polonnaruwa	1 (4)	21 (78)	5 (19)	0 ()	0 ()	27
Moneragala	2 (8)	13 (50)	7 (27)	4 (15)	0 ()	26
Total	25 (13)	101 (51)	47 (24)	21 (11)	3 (1)	197

Source; Expert team S&P Holdings 2019

Compared to provincial level statistic as discussed above, the study confirms that the majority of respondents (75% were between 31-60 years of age where the population of aging people (above70 years) is less than 2%. The study sample represented 13% of youth famers within the FPOs in the provinces. Batticaloa District indicated the largest number (33%) in this category. It was observed that the ASMP/ ATDP cluster concept encouraged the participation of youths through the introduction of modern agro-technologies with mechanized production practices and promoting market oriented small farm production.

3.6.2 Family labour

The contribution of family manpower for farming from in each household is constrained due to a wide array of income generating options within the local areas. This fact was well reflected by the income distribution pattern where the main source of income for rural households was wages and salaries. The infrastructure development activities and increasing investments on Agric and non agric businesses have created a demand for high wage employment options compared to family owned small farm units. The farmers highlighted that the family members mostly prefer to work in organizations that provide high income opportunities and therefore the family labour for own farming units becomes a part time involvement. This has resulted in the shortage of labour in the area with small farm units now looking for alternate ways such as mechanization/ outsource services and use of contract labour for farming.

The availability of the female workforce in the age group 20-59 years was highlighted during the field data gathering where organized women's groups ranging from 5 to10 individuals per group were employed as contract labourers for harvesting crops. This was observed in the chilli cultivation in the Eastern province. This relieves the farmers from the burden of finding labour and hiring on a daily basis which is not reliable and leads to loss of harvest due to delays. The women clusters were contracted with pre-determined tasks based on arrangement for which payment is based on the volume harvested. Usually it is 10% of the market price and if the market price is below LKR100 the farmer will pay 15%.

In Moneragala District, FPOs involved in pineapple cultivation implemented the traditional group labour exchange (Aththam) system for land preparation, timely planting, weeding, maintain/ operate irrigation systems, field monitoring for P&D, crop management, on pre-determined crop cultivation schedule. Such cohesive/ joint operations promoted under the ASMP/ ATDP program will enable them to achieve uniform plant growth in all farm units leading to fulfillment of the target volumes of fruits required by the contracted markets.

3.6.3 Education

The national statistics indicate that only 3.3% of the total population (over 5 years and above) in Sri Lanka has no schooling, 29.2% is qualified in at least the GCE O/L. Irrespective of the sector (Urban/ Rural/ Estate) over 40% of the population has passed Grade 6 to Grade 10 levels. The study specifically assessed the educational background of personnel involved actively in farming. The census & statistics data identified that the rural sector where ASMP provinces are concerned has accounted for 40-51% of households with grade 6-10 level of education. The study envisaged that the majority population has stayed in the village as a result of their lower educational background and this benefitted the rural sector to contribute towards agriculture production directly or indirectly engaged in full time or part time. This could be an indication that farming as a main income source is still recognized in these provinces. The current GOSL development strategies in corporation with donor supported programs focused to enhance the rural economy through modernized agricultural systems/ technologies which may attract the rural population that covers the educational level of Grade 6-10 to move in to more productive, and profitable agriculture involving small farm clusters.

Table 3.7: Percentage Distribution of population (aged 5 years & above) by level of Education

Sector/ Province/ District		No schooling	Up to Grade 05	Passed Grade 6 - 10	Passed G.C.E. O/L	Passed G.C.E. A/L	Passed degree & above	Other
	Sri Lanka	3.3	23.5	44.1	15.3	11.1	2.7	0.1
Sector	Urban	2.4	19.3	40.4	18.4	14.7	4.7	0.1
	Rural	3.1	23.5	45.0	15.1	10.8	2.4	0.1
	Estate	10.1	39.6	41.8	5.4	2.6	0.4	0.1
Province	Central	5.0	26.2	41.8	13.8	11.0	2.0	0.1
	Northern	1.9	25.6	51.0	10.8	8.4	2.3	–
	Eastern	3.9	32.0	40.6	14.9	6.7	1.8	0.1
	N/ Central	3.1	25.6	49.1	11.8	8.9	1.3	0.2
	Uva	5.1	25.6	45.4	13.9	8.2	1.7	–
District								
	Kandy	4.6	22.0	42.1	14.5	13.9	2.7	0.1
	Matale	4.0	27.0	42.1	14.0	11.1	1.8	–
	N/Eliya	6.5	33.6	41.1	12.5	5.5	0.9	–
	Jaffna	1.3	24.0	53.2	10.8	7.8	2.9	–
	Mannar	2.7	26.6	37.9	18.9	11.6	2.3	–
	Mullativu	2.1	30.1	50.8	11.8	4.2	1.0	0.1
	Vavuniya	3.4	25.0	49.1	8.5	11.6	2.3	–
	K/nochchi	2.1	30.2	53.9	5.8	7.2	0.7	0.1
	A/pura	3.2	25.6	48.7	11.6	9.5	1.3	0.1
	P/naruwa	3.0	25.5	49.9	12.3	7.8	1.3	0.3
	Batticaloa	4.5	33.7	40.4	13.1	5.5	2.8	0.2
	Trincomalee	3.7	32.2	41.3	16.0	5.6	1.2	–
	Ampara	3.5	30.5	40.5	15.8	8.3	1.5	–
	Badulla	5.3	24.3	44.8	14.7	9.0	1.9	–
	Moneragala	4.8	28.1	46.6	12.5	6.8	1.3	–

Source- Dept. of Census & Statistics

The study identified that on an average 50% of the represented farmer have a minimum qualification of GCE.O/L. Among the sample, only 1% reported as not having had any formal education. It is also noted that there are farmers with a higher level of qualification (A/L & above) which represent 19% compared to the other level of education in the provincial areas. It was reported that 28% of farmers had their education up to grade 8. Accordingly the total number of farmers who had a formal education accounted for 96%. The level of education identifies the ability of farmers to understand and implement new/integrated technologies for crop cultivation. However, it is necessary to implement and continue educational training/ demonstrations/ exposure programs to enhance the skills and knowledge on productive agricultural practices to achieve the goals identified by the ASMP.

Table 3.8: Assessment of Educational level of study sample

District	No of farmers and (%) to the District Total					
	No School Education	Up to Grade 8	Up to O/L	Up to A/L	Degree or Degree	District Total
Matale	00	8 (40)	8 (40)	4 (20)	00	20
Jaffna	00	3 (12)	4 (16)	14 (56)	4 (16)	25
Mullativu	00	20 (80)	5 (20)	00	00	25
A/pura	00	9 (32)	14 (50)	4 (14)	1 (4)	28
P/naruwa	00	8 (30)	17 (63)	2 (7)	00	27
Batticaloa	00	27 (59)	12 (26)	6 (13)	1 (2)	46
Moneragala	1 (4)	4 (15)	14 (54)	7 (27)	00	26
	1	79 (40)	74 (38)	37 (19)	6 (3)	197

Source; Expert Team- S& P Holdings, 2019

Farm Business School (FBS), an ongoing entrepreneurship training program implemented by the ASMP project is considered a timely action to enhance the business capacities of FPOs in the provinces. However, this program needs to be integrated with technology transfer interventions on crop production and market facilitation identifying the cost structures pertaining to the activities in the crop production cycle and farm management to enhance/ establish a business culture for competitive agribusiness negotiations in diverse markets.

3.6.4 Household Income & distribution

Household income varies depending on the sectors of population that are grouped as Urban, Rural and Estate. The urban household income (LKR 88,692) is higher than the average income in Sri Lanka which is LKR 62,237 and the where rural house hold income (LKR 58,137) is less than the national average. The estate sector income (LKR 34,804) is 56% of the national household income. Though there is disparity in household income among the provinces/ districts the only outlier is Colombo District that reported a high level of household (HH) income. The contribution of Agriculture sector varies among provinces and districts. On the national average, the contribution of Agricultural activities of HH income is around 8%. Wages and salaries accounts for the largest share of 38%. In the UVA province the average monthly HH income from Agricultural activities is the highest LKR 11,023 compared to other provinces. Poverty is relatively high in the rural population sector.

The representative samples of the study elaborate that the farming population in the provinces have identified income opportunities other than direct/ indirect agriculture activities, such as transport, input supplies, hiring farm machinery, Groceries/ farm produce trading and sales outlet/ wage labour/ dress making/ curd/ yoghurt/ etc., at provincial levels.

Table 3.9: Percentage of average monthly household income by main source of income 2016

Sector/ Province/District	**Wages/ Salaries**	**Agricultural activities**	**Nonagricultural activities**	**Other cash income**	**Income by chance/ adhoc gains**	**Non-monetary income**	**Income in-kind**	**Estimated rent value of own occupied housing unit**
Sri Lanka	**38.2**	**7.6**	**17.4**	**12.9**	**9.0**	**14.9**	**4.8**	**10.1**
Sector								
Urban	40.1	1.3	20.6	13.7	6.9	**17.4**	3.1	14.3
Rural	37.0	9.7	16.7	12.7	9.7	**14.2**	5.3	8.9
Estate	58.8	6.0	6.4	10.4	8.2	**10.2**	4.4	5.8
Province								
Central	36.0	6.9	18.0	16.0	8.0	**15.1**	4.6	10.5
Northern	40.6	6.7	14.0	15.2	13.3	**10.2**	6.0	4.1
Eastern	42.5	6.6	16.0	15.6	9.1	**10.2**	3.7	6.4
N/ Central	27.5	13.0	18.1	15.0	14.3	**12.0**	5.6	6.1
Uva	32.7	21.3	14.1	10.9	8.0	**12.8**	5.5	7.4
District								
Kandy	37.5	5.1	18.4	16.6	5.9	**16.6**	4.6	12.0
Matale	29.7	7.9	19.4	15.5	13.5	**14.0**	5.6	8.4
N/Eliya	38.4	10.4	15.7	15.0	8.0	**12.6**	3.7	8.9
Jaffna	40.6	3.8	14.6	16.5	14.9	**9.7**	6.1	3.6
Mannar	48.7	9.9	13.2	10.2	6.4	**11.7**	6.1	5.5
Mullativu	38.2	17.2	12.2	16.1	1.5	**14.9**	9.2	5.7
Vavuniya	31.7	9.7	16.1	15.7	17.3	**9.4**	5.6	3.8
K/nochchi	58.4	7.1	5.9	9.3	9.3	**10.2**	3.9	6.2
A/pura	28.3	12.9	16.2	14.9	14.9	**12.8**	5.7	7.1
P/naruwa	26.0	13.2	21.8	15.2	13.3	**10.4**	5.3	5.1
Batticaloa	44.7	4.8	18.9	17.5	6.1	**8.0**	2.4	5.6
Trincomalee	43.4	7.3	12.2	9.9	16.5	**10.8**	4.8	6.0
Ampara	40.4	7.6	16.0	17.5	6.9	**11.6**	4.0	7.6
Badulla	35.0	18.5	14.2	12.0	7.5	**12.8**	5.2	7.5
Moneragala	28.4	26.7	13.9	8.9	9.1	**13.0**	5.9	7.1

Source- Dept. of Census & Statistics

The representative sample assessed confirmed that the Agricultural activities considered their main source of HH income. The current development scenarios in the provinces have further enhanced revenue options by introducing improved/ modern agriculture production technologies.

However, it was noted, if agriculture is made attractive/ competitive with sustainable technologies and mechanization the households especially the future generations will stay in agriculture to contribute and cater to the increasing demand for food in the local and international trade. This phenomena was observed in farmers who are already reaping the benefits by participating in the ASMP pilot programs that helped them to stay in agriculture due to improved production technologies and mechanization while guaranteeing market access.

3.6.5 Farming Experience of rural households

The farming community in the rural sector carries decades of experience gained through generations in identifying a range of local seed and planting materials for its yield potentials, resistance to pest and diseases, tolerance for varied climatic conditions depending on the agro ecological regions. In some regions farmers continue to depend on these species by developing/ producing their own seed for planting in the next season. Irrespective of the educational level, the farmers through practice have accumulated a wealth of invaluable indigenous knowledge associated with cultivation, nutrition and storage of traditional food plants which can be incorporated in future agricultural programmes with or without modification. The majority of farmers are aware of the climatic changes and declining resources especially the water for irrigation. In this regard the farmers in the provinces increasingly adopt efficient irrigation methods such as drip/ sprinkler systems that enable to reduce cost of labour, saving water for an extended period, avoid water logging, soil erosion and spreading soil borne diseases. This phenomena was also observed with the farmer community in the ASMP identified provinces.

The farmers in the Northern and Eastern Provinces experiences long years of fallowing agricultural lands due to security situations that caused them to abandoned agricultural activities. The study identified that since late 2009 (post war) farmers in these regions are back in the field cultivating a range of vegetables and fruits with introduced technology packages made available through DOA, Private sector and programs implemented by various donor agencies. Farmers in other provinces continue to perform cultivation. Over a decade the introduction of improved varieties, high energy inputs, innovative agronomic practices have eroded the traditional and indigenous crop production and plant protection knowledge and experiences in agriculture. Over the years, farmers have increasingly been shifting cultivation methods becoming dependents for high responsive chemical inputs that lead to depletion of soil health, increased pest & disease incidences in the long run.

The study identified that traditional agriculture practices are integrated with modern technology such as improved irrigation systems, Organic farming systems, low input sustainable farming, protected agriculture systems, etc. Farmers have been increasingly using these technologies which helped them by increasing crop yield and income per unit land area compared to traditional farming practices. The farmers in the provinces reported that they continue the use of high response chemical inputs expecting a higher output. However, farmers reported that the optimum potential of these inputs were hindered due to inadequate awareness on correct practices for application according to different crop varieties, crop growth stages, soil type, and climate/ environmental conditions.

The majority of farmers in the representative sample, are well aware of the harmful effects of high response chemical inputs but yet they are ignorant on levels of toxicity and unacceptable residual contents/ contamination of produce supplied to consumer markets.

3.6.6 Exposure of farmers to the extension services

The exposure of farmers to extension services assessed through the availability of public and private sector extension services, frequency of farm visits by Extension Officers/ Service Providers, communication methods used for technology transfer, availability of farmer advisory services, and market facilitation.

Table 3.10: Farmers' exposure to various extension service providers

Service provider	1 or more farm visits	Training sessions	Crop clinic	Promotional events	FBS/ GAP	Farm development projects	Other
DOA (intra provincial)	√√√√√	√√√	√√√	-	√√√√√	√√√	1a
DOA (inter provincial)	√	√	√	√	√√√√	√√√	2,3
MASL	√√√√√√	√√√√	√√√	-	√	√√√	4,5
Cargills	√√√	√	-	√	-	√	1b,4
HJS	√√√√√	√	-	-	-	√	4
Agro input suppliers	√	√	-	√	-	-	5
NGOs/Donor programs	√√√√√√	√	-	-	-	√	1a,2,3,4
Other companies[b]	√√√√√√	√	-	-	-	√	-
Farmer organization	√√√	√	√√				

1-.Exposure tours (1a Local, 1b international) /2 experiments/3- demonstration /4-collecting centers/5-sales outlets /-b-Sehani-Moneragala/Dasini –Anuradhapura/CBL- Colombo/ Lanka Canneries-Colombo, David Gram-Jaffna

3.6.7 Level of knowledge, understanding and behavior of farmers in pest management

Despite the programs implemented by the ASMP project, the study found a number of interventions to promote cultivation of crops by using organic or chemical free production practices with identified small farm clusters in the project provinces. Farmer groups in the Eastern Province supported by World Vision-Vahare, (funded by KOTRA) are cultivating selected vegetables using organic farming practices. Further, farmer clusters are working in coordination with private sector companies such as Cargills, HJS, AGCO/ Green Agro, Sehani and Dasini, producing toxic free vegetables (N'Eliya), cultivation of vegetables using high tech crop protection & irrigation in UVA province, cultivation of cucumber for export processing in

Eastern Province (Vahare) and Moringa in UVA and NCP, facilitated by buy back of produce at predetermined farm gate price.

The interviews and discussions with farmers revealed that before introducing chemical pesticides/fertilizer, the pest control practices necessarily depended on the indigenous methods such as the use of plant extracts, sound gadgets, traps, rituals, timely planting, border crops, and pest surveillance for profitable farming. However, over the years these traditions are eroded. The respondents were aware of combined pest management systems which existed in Sri Lanka and have been practiced in agriculture production for many generations.

The farmers are experienced in using plant base extracts and traps to manage the pest incidences successfully. However, it was noted there are no prepared plant based or bio-pesticides available in the market and each time farmers need to prepare mixtures which are not attractive in the long run, it consumes an excess amount of time and energy that adds to the cost of cultivation.

Though it was proven that the indigenous/ traditional methods practiced for generations are still in use by small farm groups in remote areas, the majority of farmers interviewed indicated the traditional non –chemical methods/ recommendations are not attractive or not effective in the present day cultivation practices associated with improved crop varieties for increased production. It was reported that improved/ hybrid varieties are highly responsive for nutrients and sensitive for pest and diseases that require close monitoring and crop care to avoid any crop losses. This was reported as one of the reason that farmers have embarked on use of chemical inputs in small farmers fields ignoring the benefits of organic inputs and other non-chemical farming practices.

The farmers sharing the experiences indicated that timely cultivation still continued in crop production which helped the farmers immensely to mitigate the incidence of pests and take advantage of the climate conditions, time of flowering and harvesting. They also identified that delayed planting will not only attract more pest and diseases but it contributed to a drastic decline in yield. The FPOs in the provinces implement the timely planting in all fields for selected crops.

Some Farmers didn’t show a positive response for using traditional/ indigenous practices and informed it is mainly due to reasons such as inadequate knowledge/ skills, lack of training or demonstrations/ promotional programs.

The respondent commented that sticky traps and bait are still in use and in addition to popular non-chemical methods to trap and avoid major pest incidences. The discussions revealed that traditional methods, especially sticky traps are still in use in modern agriculture systems as a non-chemical pest management practice.

Organically cultivated vegetable farms in the Eastern Province in Vahare gradually shifted towards conventional farming systems due to the introduction of the export oriented crop cucumber as a high income earner with convenient market access. The adoption of more intensive cultivation practices for cucumber, influences the presence of pest & disease incidences that require greater reliance on chemicals. The routine chemical spraying has threatened the existence of organic farming in the vicinity and a few clusters have moved to distance locations to avoid any contamination.

The farmers cultivating cucumber informed that there is no option but to follow the technical guidelines by the contracted company which supply the seed, inputs for cultivation with extension and technical advises up to harvesting and delivery of produce. In this regard, farmers are forced to use chemicals under the companies' supervision. Farmers are not responsible for market delivery and any rejection from the international buyer due to residual contamination. HJS on the other hand is facing difficulties due to testing the residual contents as there are no high precision testing equipments available locally or in the region, especially India where the results of the same test using similar methods show significant differences in residue contents. Samples tested in Sri Lanka/ India and Germany (EU) were shown different results due to the level of precision of the equipment.

The vegetable growers FPO in Batticaloa district responded that they continue to grow traditional chilli type PC-1 for many generations as it's in high demand in local area consumer markets. The seed for continued planting is developed from the selected plants of farm land. It was indicated that the plant is resistant for leaf curl disease but in the recent past there were incidences of infestation of pest and diseases. It was believed that the emerging problem is due to deterioration of characteristics (especially reducing resistance to pests and diseases) seed produced from repeated cultivation and non-availability of certified seed from the DOA.

In NCP the farmers are cultivating hybrid /improved varieties those identified for resistant to pest and diseases, have a high yield potential with enhanced market opportunities and availability of seed.

The study also reached the high-tech farming clusters using protected systems. The support from extension services for this sector is limited and the knowledge and experience of extension staff at field level is inadequate for responding to the problems of farmers growing high value crops. The majority of farmers are trained at Bindunuwewa in-service training centers and establishtheir poly houses through contracting poly-house contract suppliers/companies like Hayley's, CIC, Jinasena, Citi Gardens, etc. Farmers are not aware about the Protected Agriculture Entrepreneurs Association (PAEA), a leading entity that provide extension and marketing support for the high-tech farmers. Since there is inadequate support from the public extension services the farmers mostly depend on companies involved in supplying poly house structures/ seed/ nutrients/ additives/ pesticides, exporter's and local market forces to find solutions for their problems and issues in protected cultivation systems.

3.6.8 Knowledge & concerns over environment & human safety on adopting diverse pest control practices

The farmers interviewed have responded that they are aware of possible pollution on the environment and hazards on human health due to continued use of pesticides. Farmers are aware that pesticide residues remain in the environment; atmosphere, soil surface and water sources. However they do not know the fact that only 20-30% of pesticides applied is absorbed to the plant and balance is left in the environment. According to farmers the pest incidence and associated crop damages are considered the main risk factor and due to the short gestation period of the seasonal crops a majority of farmers in the survey depend on chemical pesticides. Also they are aware of the harmful effect on beneficial organisms that were destroyed due to pesticides. Farmers in the provinces expressed that they are aware of agricultural practices, especially the use of chemical inputs which led to the pollution of water resources and soils due to accumulation of chemical residues/ heavy metals. The farmers are well aware of time of the day at which pesticides should be applied and the direction to be faced depending on the wind force and other factors. The farmers use hired labour for pesticides application and in order to take advantage of the high cost of labour, ignoring the safety practices recommended by the DOA. Further it was noted in order to cover the cost of labour, by reducing the number of application that disregarded recommended dosages causing greater impact on the environment and health. Though farmers are mindful of negative impacts on pesticides they are reluctant to reverse to non-chemical or reduced use of chemicals and still remain dependent due to economic advantages.

3.6.9 Presence and influence by the chemical pesticides

The convenient nature of pesticides in ready to use attractive packages are freely available in the market that can be easily procured by farmers as and when needed. The most common mode of pesticide application is revolved with the liquid formulations, widely marketed as concentrates that required to be diluted before or during the preparation for field application. Apart from the legally imported products there are illegal pesticides made available in the market that gives access to a number of banned chemicals into farmer's fields.

Pesticides are classified by different target organisms

Pesticides	Target organism	Pesticides	Target organism
Algaecide	Algae	Miticides	Mites
Avicide	Birds	Molluscicides	Molluscs

Bactericide	Bacteria	Nematicide	Nematodes
Defoliant	Crop foliage	Plant growth regulator	Crop plants
Desiccant	Crop plants	Rodenticide	Rodents
Fungicide	Fungi	Pesticide	Fish
Herbicide	Weeds	Wood preservative	Wood destroying pest
Insecticide	Insects		

Source; Pesticides used in PM- Chigoze Jesse Uneke

The meeting with representatives of Crop life Sri Lanka, a leading pesticides/ agrochemicals importers/ distributors and retailers association (represent over 90% of pesticides import/ distributing companies) highlighted, that the recent restrictions and interventions under GOSL created a monopoly situation for the import of glyphosate that paved the way to inflow of wide range of banned chemicals in to Sri Lanka, influencing the farmers to make use of high toxic class I type Chemicals like Monocrotophos, Carbofuran which is detrimental to the safety of humans and the environment.

It was evident that complaints made by exporters of fruits/ vegetables which are out sourced through GAP certified farmer clusters have detected higher levels of pesticides residues (e.g. Carbofuran and Monocrotophos) by food safety control authorities in importing countries causing rejection/ banning the import from Sri Lanka. Irrespective of the existence of legal control procedures and awareness programs, the farmers continue to hunt for high toxic chemicals even if it is banned. The farmers are aware that there are regulatory mechanisms at national level. However, it was reported that the procedures and legal empowerment system is not effectively performed due to inadequate human resources and lack of proper surveillance mechanism to detect irregular practices in the provinces.

The situation allowed a free inflow of illegal chemicals in the market causing damages to legally established business and increasing the risk of crop failure, environmental pollution and health hazards.

Knowing the fact that the short growth cycle of seasonal crops and possibility of losses due to P&D infestation, the farmers indicated it is not possible take any chances to lose their main income sources and prompted to use chemical pesticides to ensure instant killing of pests. This influenced the farmers to apply routine pesticides where related information/ instruction/ advice is disseminated via the pesticides dealer and field officers/ representatives attached to pesticides importers/ distributors/ retailers. It is aware that pesticides related advertisements, demonstrations, posters, introductory programs are not allowed as per the amended pesticides act. However, farmers in coordination with dealers/ representatives implement trials/ experiments on pesticides and identifying the effectiveness of the control of P&D.

The cocktails for pesticides are identified and experienced by farmers in the fields and through years of experimentation the farmers recognizes the dosages that is always above the recommendations. The study found that farmers in Nochchiyagama and Udunuwara Janapadaya informed that the cocktail mixture of Abamacting & marshal 20 or Abamacting & Actara is commonly used for the control of mites/ aphids in Chilli and bitter gourds. Further they identified that adding of Calcrone to the above mixture suppresses any weed infestation. However they are not aware of the chemical reaction by mixing these pesticides and its long term environmental and health related hazards.

It was also highlighted that since recommended input volumes and application methods are not updated to suit the new/ improved hybrid varieties of vegetables, the farmers were compelled to try and use an additional volume of inputs, without knowing the effect on growth and yield, to tolerating pests and diseases. They continue to use it if they see the success of these “try outs”. Therefore it is upto the farmers’ discretion to depend on chemical control methods without trying out non-chemical practices as they need quick results. It was also observed in all ASMP pilot project implemented programs with “high tech methods,” that only a certain component of the agronomical process was highlighted or implemented.

A “Total technology Solution Package” covering nursery to harvest/ post-harvest, (crop stage-wise) techniques to identify and introduce best practices that could lead to keeping away or delaying the chemical pest control mechanisms are yet to be recognized/ introduced by the PPMUs.

It was noted that the project has sponsored and installed insect proof netting surrounding the crop field with a 3 meter height to control insects’ infestation in chilli and bitter gourd cultivations together with a polythene mulch. But, farmers reported that they still encounter pest and disease problems. According to observations and discussions with field officers it was informed that the eye size of the given nets is larger and insects could pass through. Further it was identified that the same technical interventions by leading retail chains working with farmer clusters had achieved successful results by installing smaller eye nets counting more than 1400 eyes per square inch compared to nets supplied through the project which only had 1000 eyes per square inch. The particular situation was observed / experienced in Northern, & North Central provinces. AIs of respective areas were not well conversant about these technologies.

3.6.10 Economic importance of Pest Management

It is aware that the agricultural lands continued to decline but demand for food is increasing due to the ever growing population. In this regard it is necessary to take measures to increase crop production in order to secure safe food for all. It was identified that reducing the crop losses by controlling the occurrence of pest/weeds and diseases was one of the major tasks implemented to secure increased food crop production in the world. According to reports it was identified that there are around 9000 species of insects/ mites, 50,000 species of plant pathogens, and 8000 species of weeds (Zhang al, 2011) cause crop losses.

The estimates indicate that insects /pest caused around 14% loss, plant pathogens caused 13% loss and weeds 13% loss (Pimentel, 2009),urging the necessity for using pesticides. The studies (Liu et al., 2002; Zhang et al., 2011) indicated that nearly one-third of the agricultural products are produced by using pesticides. Without the use of pesticides, the loss of fruits, vegetables and cereals from pest injury may reach 78%, 54% and 32%, respectively (Cai, 2008). Crop loss from pest injury declined by 35% to 42% when pesticides were used (Pimentel, 1997). More than 40 categories of pesticides are used globally.

Table 3.11: Economically important categories of pesticides

Pesticides	**Categories**
Insecticides	Chlorinated hydrocarbons, organo-phosphates, carbamates insecticides, pyrethroids, botanic & biological products, seed treatment insecticides, organo-phospates/carbamates, pyrethroids,
Herbicides	Phenoxy hormone products, triazines, amides, carbamates herbicides, dinitroanilines, urea derivates, sulfonyl ureas, bipiridils, uracil, other herbicides
Fungicides & Bactericides	Inorganics, dithiocarbamates, benzimidazoles, triazoles / diazoles, diazines / morpholines, botanic & biological products, seed treatment fungicides, dithiocarbamates,benzimidazoles,Ttiazoles diazoles, others, disinfectants, other fungicides.
Rodenticides	Anticoagulants, cyanide generators, hypercalcaemics, narcotics, other rodenticides.
Plant Growth regulators	Hormones, micro elements/nutrients/foliar application for vegetative growth ,flower induction, fruit quality appearance
Mineral oils	kerosene oil
Other (nets)	Plant based extracts, plant parts, biological repellents

The report on analysis of Global Pesticides use (Wong Jun Zhang), indicated that the trend in pesticides (insecticides, herbicides, fungicides, bactericides and growth regulators) usage increased with time during 1990 and 2007. However, the trend has changed since 2007. The insecticides usage has significantly declined. Herbicides especially amides and other herbicides have continually increased while the fungicides and bactericides have shown a fluctuating pattern *(FAO stat)*

Table 3.12: Global pesticides use cost/ benefit since 1990

Year	Cost / Benefit (g pesticide use / kg crop production)					
	Insecticide	Herbicides	Fungicides & Bactericides	Rodenticides	Other growth regulators, etc.	Total (Pesticides use)
1990	0.0876	0.1334	0.0817	0.0038	0.0084	0.3427
1995	0.078	0.1262	0.0727	0.0036	0.3018	0.6117
2000	0.0766	0.1443	0.0899	0.003	0.3202	0.6685
2005	0.0831	0.1628	0.0864	0.0027	0.3302	0.6905
2010	0.0639	0.1753	0.0851	0.0003	0.3556	0.6891
2014	0.0448	0.1498	0.072	0.0002	0.3214	0.6081

Cost / benefit.; refers to the amount of pesticides used to produce a certain amount of crop in a year, which has the scientific units as g pesticide use / kg crop production, or kg pesticide use / tonne crop production. Based on the analysis it was reported that by 2020 the pesticides use will stay at 0.6081g pesticides per Kg crop production.

CHAPTER FOUR: PEST MANAGEMENT APPROACHES IN THE PROJECT PROVINCE

This chapter envisaged to identify the agricultural production systems and crop diversification patterns especially focused on existing pest management practices implemented by the farmer clusters in pilot project areas covered under ASMP project provinces.

4.1 Agriculture production systems

It was evident that with the gradual evolution of agriculture, the farming communities have invented or adopted varied crop production practices and farming systems according to the requirements of the selected food crops and knowledge gathered on the environmental responses of each plant cultivated in varied agro climatic conditions. Accordingly three distinct farming systems/ practices through many generations have been identified below.

1. ***Paddy cultivation system -*** Being the staple food, paddy has been cultivated from ancient times in the valleys of the Mahaweli Ganga and the Malvathu Oya. More areas were brought under cultivation with the construction of tanks and canal systems for irrigation. Short and long duration varieties of paddy were selected for cultivation in both Yala and Maha seasons, respectively.
2. ***Shifting cultivation system*** - "Chena" is regarded as the oldest form of cultivation in Sri Lanka. Coarse grains such as Kurakkan (finger millet), which was considered as the second staple, Meneri (millet), Thana Hal (Italian millet), Amu (Kodo millet), mustard, gingerly (sesame), green gram and black gram and vegetables such as luffa (ridge gourd), ladies fingers (okra), snake gourd, bitter gourd, ash pumpkin, yellow pumpkin, melons and brinjal (eggplant) were also cultivated as mixed crops in Chenas.
   It is well known that chena cultivation has resulted in the clearing of jungles and the shifting of cultivation areas year by year that abandoned the previous plot for fallowing. This shifting and fallowing process continues for 5 or 6 years and may come to the initial allotment again. But, under present situations, the number of squatters in chena land has been increased and the pressure for the protection of forest reservations has been aggravated. The Forest Department does not allow to clear the forest or state lands under their purview. At present the "Chena Farmer" has to squat and cultivate on the same land for an indefinite period which may even be for a life time. Therefore there is no fallow period. On the other hand, these lands are used for cultivating both in the Yala and Maha seasons using water pumps to irrigate during the dry spells. Many land owners do not adopt suitable soil conservation and soil fertility management measures, although they continue to cultivate season by season. As a result many of these lands are devoid of fertile soil and some lands have thus been abandoned. It was learned that chena cultivations in the villages have contributed towards the national agriculture production during the past. Therefore it

is important to pay more attention towards the development of existing or abandoned chena lands for promoting cultivation by introducing modern agriculture technologies.

3. ***Home garden system***- maintained by the Sri Lankans from early times. Traditional root and tuber crops, jack, coconut, arecanut, wine palm (kithul), banana, sugar cane, ginger and turmeric, citrus species and other important food and medicinal plants were commonly cultivated in home-gardens.

The above food production systems were supplemented through forests in the vicinity of villages which provided the source of carbohydrate, leafy vegetables and fruits during the lean seasons, with a wide array of crops such as wild yams *(Katuala (Dioscorea pentaphylla), Hiritala (D. oppositifolia), Gonala (D.spicata))* seed of *Hal (Vateria copallifera), Beraliya (Shorea megistophylla) and Madu (Cycus circinalis)* and the plant heart of Kithul, *(Caryota urens)*, fruits from *wood apple (Feronia limona), Indi (Phoenix Zeylanica), Weera (Antidesma bunius), Palu (Manilkara hexandra), Mora (Ephoria longan), velvet tamarind (Dialium ovoideum), tamarind (Tamarindus indica), Timbiri {Diospyros malabarica) and Ulkenda (Polyalthia korinti)* for food purpose.

The Sri Lanka farming systems, gaining the experience through ancient crop cultivation patterns and modern development assistance has changed/improved/developed more specific crop diversification approaches, identifying a wide array of crops based on environmental conditions of different agro ecological regions. The major focus was to increase production by expanding the cultivable land in the dry zone, facilitated by a variety of irrigation approaches.

Major Irrigation schemes have opened large extents of land for irrigated cropping, specifically the propogation of rice cultivation in the dry zone areas. The irrigation systems are designed with facilities for irrigation management for crop diversification, where rice and other field crops could be cultivated alternatively in the wet and dry seasons. Farmers are encouraged to grow non-rice crops as the margin of profit is attractive. It was noted that crops such as sugar cane, banana, papaw, chilli, onion, ground nut, vegetables, cereals and grains are commonly observed as intercrop or crop rotation under these systems.

Minor Irrigation schemes are predominantly rainfed reservoirs. Farmers grow non-rice crops in well drained parts of the land during the dry season. However, in the present economic development system the farmers are influenced to grow non-rice crops during rainy seasons as well due to high profit margins compared to rice crops. Wells are often dug in these schemes to tap the shallow ground water boosting availability of irrigation water during dry periods. Major highland crops observed in these schemes are banana, papaw, guava, lime and selected vegetables.

Anicut based schemes and rice fields are derived in areas where the landscape is rolling to hilly and undulating in upcountry mid- country and low- country intermediate zones. Rice and alternate crops are cultivated on terraced land during the wet season and dry seasons respectively. Main alternative crops include onions, and vegetables. Potato is cultivated extensively in upcountry intermediate zone with other crops such as tomato, beans, carrot, cabbage, beetroot, and leeks. Currently potato cultivations are replaced by other vegetables. Mid country intermediate zones are dominated by onion, tomato, cabbage, tobacco, beans, shallots and capsicum in this diversified pattern. Cucumber, gourds, long beans, okra and capsicum are the leading vegetables grown in the low country. Melon is the only fruit crop cultivated in this part of the diversification pattern.

Wetland rice field- found in the low country wet zone where 8700ha under major irrigation schemes 18100ha under minor irrigation schemes and 68,200ha under rainfed conditions are grown. It has become highly uneconomical to cultivate rice due to the high cost of production and increasing population density and rapid urbanization. It was also noted that these areas are receiving a low level of sunshine hours, causing low crop productivity. The crop selection in these zone is dependant on the availability of market options in the vicinity. Accordingly, the main crops observed in the area are leafy vegetables, root crops (manioc, Sweet potato, and innala), long beans, bitter gourd, okra and banana as the main fruit crop.

Mid country tea and rubber plantations are phasing out due to the increasing cost of production, unaffordable wage rates, decline market prices, soil erosion which are forcing the plantation industries/ small holders to withdraw from tea and rubber and invest in more sustainable export crops such as pineapple, anoda, pepper, cloves, cinnamon, cocoa and high tech agriculture investments (poly greenhouse crop cultivation).

Apart from the above, the home garden systems have diversified with increasing urbanization/ emergence of home gardens due to cunsumers preference to purchase chemical free food varieties, protection from increasing heat / carbon dioxide build up, surplus as a source of household income.

Recent evidence shows that successful initiatives investments and projects arise through innovative shifts/ changes in the factors of agricultural production (e.g., from use of fertilizers to nitrogen-fixing legumes; from pesticides to emphasis on natural enemies; from ploughing to zero-tillage). The development activities and planning for agriculture production has prioritized the promotional efforts that centers on intensification of resources, making better use of existing resources (e.g., land, water, and biodiversity) and technologies,than extensive/ conventional agriculture.

Protected Agriculture systems consider an emerging and rapidly developing sub-sector identifying perfect solutions for present day challenges/ issues/ constraints faced by the sector. In Sri Lanka the most popular form of greenhouses use poly covers with steel structures known as PGH. The market oriented subsector identified high value crops such as cucumber, bell pepper, salad leaves, strawberries and tomatoes are used for continuous production irrespective of whether fluctuation/ climate changes occurs . Relatively high plant densities and perishable nature of the plants are more vulnerable to intensive crop management and unfavorable environmental conditions. PGH farmers often encounter technology constraints agronomical practices/ planting methods/ input recommendations due to existing gaps in the local knowledge base.

Organic Farming, Promotional activities for organic farming in the project provinces/ pilot programs are yet to be introduced. In the study areas, immediate focus is towards promoting conventional farming. The study noted few interventions by the PPMUs and other agencies to promote organic moringa production in coordination with private sector participation. The farmer cluster in NCP who cultivate moringa in cooperation with a private company revealed that there are 100 farmers with one acre each strictly following non-chemical agriculture practices based on the instructions and techniques diffused through the company field representatives. It was assured that without using chemical inputs (fertilizer/ Pesticides) there are many practices implemented that in combination enable to sustain the organic production systems. Though the pest occurrence was present, the monitoring/ surveillance through traps/ farm visits indicates that the pest populations are below the level of crop damage. The farmers sharing their experience have indicated that though they are in the learning process the observations make them understand that there are more beneficial insects than pests roaming in the fields. It was noted that the cluster also uses traditional/indigenous plant based pest repellant methods that influence the equilibrium of pests and beneficial insect population leading to a damage free crop environment.

The farmers have attended more than five training programs since December 2018, and gained a knowledge of organic farming technologies integrating farmer’s expertise gathered during the past decades. The farmers show high level of confidence on chemical free combined farming methods for land preparation, planting, spacing, composting, preparation and using bio pesticides, (seed/ bark/ leaves of Neem + Burutha + wara + Lime + pomegranate + tobacco), pruning, harvesting, grading of leaves and delivery to the market. Each unit has a compost making structure. Irrigation is supported by agro wells in certain instances and some are through tube wells with sprinklers.

The study identified a moringa project in Uva province where meeting was held with representatives of a processing company which supplied dehydrated moringa leaves to leading organic produce exporters. Though the exporters are certified as organic, the supplier network for Moringa fresh leaves operates on trust basis where extension officers attached to buying companies visits the identified farms for inspection, crop observations and approving of the suitability of the produce. However, the farmers/ companies need to streamline the mechanisms to prove that the organic practices are implemented and there is no occurrence of contamination from surroundings.

CBL (Natural) is a leading company for organic supply chain development and export of processed fruit and vegetables such as papaya, passion fruit, mango, pineapple, banana (ambul/seeni). The CBL organic program is involved with over 1000 registered farmers monitored by company extension officers in the provinces. The PPMU reported that CBL was identified as one of the link market entities for FPOs producing pineapple and ground nut. The collaboration project on organic fruit and vegetable farming by Cargills/ Shanthi Pura Women farmers group in Nuwara-Eliya was identified during the study mission. The cluster farmers with the support of Cargills technology interventions is in the process of implementing preliminary activities for processing of certifications from the Control Union. It was reported that the observation procedures will take 2-3 years before being certified as Organic. Cargills is also actively involved with the promotion of GAP certification for farmer clusters in other regions (UVA/ NCP/ Central/ North) under its Sarubima small farmer development program.

Nawarathna Hettiarachchi, Chairman of AGCO/ Green Farms an organization identified as the “All Island Agricultural Cooperative Society” has already obtained the Certification from the Control Union and SLSI had discussed the current trend in nature friendly farming approaches and its contribution towards the the suppression of P&D infestations in vegetable farming. This is a leading Cooperative society in the island dealing with “Organic Cultivations”. The Chairman who is the key farmer of this organization cultivate about 48 acres under the organic base. Buwenaka, a member of this society who manages a smaller organic plot said that he gets about three folds higher the price than the common market price.

Organic farming stipulates conditions regulating the cultivation practices and avoiding chemical inputs especially toxic substances. The Organic certification system has established procedures that maintain the reliability/ sustainability by periodical farmer training, farm visits, monitoring records, and regular audits. The final produce is always tested for residue contents by monitoring for toxic contaminations. Also the price of produce is high compared to conventional types due to increasing demand in the health conscious urban consumer markets.

Organic agriculture provides a holistic crop production approach that promotes agronomic, biological and mechanical methods as opposed to using synthetic materials for crop production and processing. The practices under this system could be integrated to develop the conventional farming systems to make more responsible farming by controlling the use of synthetic crop inputs that is hazardous to the environment and humans.

Low External Input Sustainable Agriculture (LEISA)

It was revealed that within the project provinces small farmer clusters with the support of NGOs, practice traditional agriculture methods using very little or no chemical inputs that require less financial commitments while placing more reliance on natural and human resources, towards more sustainable agricultural production. It was reported that introducing innovative agricultural based production systems especially in resource constrained areas and providing market access is considered a key to the mass reduction of income disparities of regional/ rural households.

The program implemented in Vahare, & Koralai Pattu DS divisions, Batticaloa, cultivating vegetables such as pumpkin, brinjal, okra, long bean, snake gourd, chilli are aiming at urban consumer segments in the district areas. The farmers in the area are experienced in the use of biological/ mechanical/ physical/ agronomical technologies for control of pests and diseases as guided by World Vision (WV), INGO (funded by KOTRA), interventions. Farmers are well aware that LEISA technologies help to reduce the cost of production as chemical inputs are substituted by locally available/low cost organic inputs (plant extracts/ plant parts/traps) which are indigenous to the area and also it lowers the need of credit which is often expensive and out of reach for micro/ small farmers. According to WV District Officer there are around 1000 farmers in the area following this crop production system. The farming is considered a part time income activity where the beneficiaries are mainly involved in fishing as a form of employment. The farmers were trained on land preparation, use of organic matter (cattle dung/ poultry liter/ compost), practices of mulching, preparation of liquid fertilizer from plant extracts and fermented fish waste (fish tonic), pesticides from ginger and garlic, etc.

However, due to inadequate market opportunities in the vicinity and the cost of transport and travel time to the only available market/sales point (an open shed near Kalladi Bridge) in Batticaloa city, some farmers have switched in to cucumber cultivation, introduced through HJS/ DOA/ PPMU. Farmer clusters are attracted to contract growing of cucumber that provide market access in the vicinity and are facilitated with technology and inputs ensuring high returns per unit land area compared to other vegetables.

The farmers indicated that irrespective of the new development in the area, still there are farmer clusters which continue to produce under LEISA technologies, due to the low cost of production and higher profit margins integrated with human and environmental safety measures. As well, they could maintain the traditional varieties of planting materials which are typically resistant for pest & diseases and with time developing own seed with selective/ breeding process will gradually increase the resistant.

Crop diversity

Since achieving self-sufficiency in rice, the focus on the agriculture sector development programs in Sri Lanka have opened the paths to promote non-rice food crops (vegetables, yams, fruits) to enhance the small farm economy and promote exports. The development initiative in the past 50 years have seen the farmers increasingly dependent on inorganic inputs for agricultural production and less concentrated on the importance of the use of agronomic practices integrating the use of non-chemical inputs and its contribution for cost effective, high productive small farm agriculture. It is observed that trends in current agriculture research and technology interventions have further influenced the dependency on chemical and high energy inputs. This has paved the way for the rapid deterioration of indigenous farming practices and knowledge experienced from the ancient farming systems.

Rice farming

Rice farming systems during the past implemented eco-friendly agronomic practices/ technologies promoting farmers to adopt and manage their crop cultivations with minimum use of chemical inputs/ toxin substances. In the circumstances the national level programs in coordinating with international agencies like FAO/ UNDP/ WB designed and implemented integrated production approaches focused on rice cultivation.

Rice farming systems in provinces, most specifically the dry zone areas have increasingly mechanized the land preparation and follow harvesting activities minimizing the cost of labour and saving the produce from weather changes. The seasonal cultivation and timely planting with the schedule of cultivation practices (*age of crop, variety, transplanting/ sowing, fertilizer application weeding, pest control, irrigation intervals and harvesting)* implemented under a particular irrigation system as determined at pre -seasonal farmer meetings. Farmers indicated that organized/ collective cultivation practices and timely implementation has benefited the farmers on better crop growth, optimum response for fertilizer, low incidence of pest/ diseases, avoid routine spraying leading to reduced cost and increasing yield. Farmer interviews and key person interviews highlighted that indigenous methods are still considered and integrated in cultivation practices for rice farming. The study identified that rice is the major field crop in all ASMP project provinces.

Vegetable farming

The variety of vegetable cultivated, varied according to ecological area and soil and climatic conditions. It shows wide variations compared to rice mono crop system that utilize the lands with capacity to hold high moisture/ water logging conditions most of the time during cropping season. The vegetable sector is constrained by low productivity at present. Increasing the extent under cultivation is impossible due to lack of availability of land for agriculture and the only option is to increasing production per unit area. In this regard the constraints in the production process is required to be rectified/mitigated to achieve sustainable income for small farmers. Accordingly the small farm vegetable production in the rural areas are yet to receive national focus especially on technological improvement leading to increased productivity and farm income.

Unlike the rice crop the global demand for safe/ non-toxic vegetables are increasing and it is required to adhere to the strict controls and standards of international trading. Although pesticides and chemical input applications for seasonal crops especially vegetables are restricted or legislatively controlled, Sri Lanka is yet to perform integrated technology packages towards P&D management.

The ASMP has implemented a pilot scale cluster development project for cultivation of select seasonal crops such as ground nut, cucumber, green chilli, B-onion (seed production), red-onion, bitter gourd, king yam, long bean, and other vegetables) are provided with modern technology and equipment packaging.

Fruit Farming

Fruit cultivation in Sri Lanka still revolves around home gardens and small farm allotments. Availability of large scale cultivations are restricted due to limited land available for commercial fruit farming. Sri Lanka identifies 50 common fruits categorized as tropical, sub-tropical and temperate types and 90% of these are available in home gardens under diverse agro Ecological regions. However, the study revealed that only a limited number of fruits are exploited and popularized in the consumer markets. According to the DOA information, fruit cultivation in Sri Lanka is expanding and the trend for cultivation of selected fruits under small clusters and uprooted plantations are increasing due to the emerging demand for export and local food markets. The potential for year round production of fruits is identified and promoted under diverse AEZ. However, the correct technological/ agronomical practices are yet to be adopted by farmers. There is scarcity of technically qualified/ experienced personnel for guiding farmers on crop management, pruning, pre-harvest treatments, harvesting, storing, and delivery of a hygienically produced safe product for consumers.

Tree rehabilitation/ rejuvenation, control of insect pest are not practiced under home garden production. Also the time of harvesting, poor harvesting methods and post-harvest handling by trading partners has created a negative/ low preference among the consumers due to post market infestation of insects and diseases.

Further, the Ministry of Agriculture has identified a range of vegetables and fruits for intensive cultivation in order to ensure the availability of food throughout the year.

Table 4.1: List of Vegetable & fruits for intensive cultivation in Sri Lanka

Vegetable	Fruits
Ash plantain	Pineapple
Silver Melon (Ash Melon)	Passion fruit
Bitter Gourd	Mango
Carrot	Banana
Tomato	Rambutan

Vegetable	**Fruits**
Winged Bean	Sweet Citrus (B-Orange)
Grains –(GG,BG,cowpea,horse grain)	Pomegranate
Cereals-(Maize, Millet,)	Wood apple
Yams –(Manioc,S/potato, cocoyam)	Lime,
Okra	Guava
Cucumber (gherkin,green,salad)	Durian
Brinjal	Jack
Mushroom	Wax apple
Beet root	Sapota
Chili (capsicum, green)	Nelli
Leeks	Beli
Pumpkin	Soursop
Ridged gourd	Avocado
Beans (G/bean, Long bean)	Melon
Raddish	Mangosteen
Drumstick(pods, leaves)	Ambarella

Source; DOA-HMS Heenkenda 2017 & Traditional Food Plants in Sri Lanka, Udaya Rajapaksha 1998

Most of the fruits and vegetables listed above are considered "traditional" by the Sri Lankans. This reflects that there is a large array of underexploited fruit crops available in Sri Lanka to satisfy the demand for healthy/ nutritional conscious consumer markets locally/ internationally.

The Traditional agriculture/ farming practices, food systems and food culture were challenged/ diversified with the invasion of the Portuguese, the Dutch, and the British who introduced crops of the New World such as chillies, sweet potato, tobacco and vegetables such as cabbage, potato, carrot, beans, beet root and leeks which were incorporated into our food systems and further promoted/ established export oriented commercial plantations producing Tea, Rubber and Coconut by clearing vast areas of forest cover in upcountry, Mid country and Low country wet zones.

The Post-independence policies of successive governments focused to expand the extent under rice production to make Sri Lanka self-sufficient by promoting and adopting innovative technology, integrating the research and development identifying/ diffusing high yielding varieties, pest and disease resistant varieties, mechanization, that revolutionized the rice industry in Sri Lanka. Also the government policy of converting the highlands, where the coarse grains were cultivated, to paddy fields under various irrigation schemes in the dry zone had a negative impact on vegetables, other cereals such as finger millet and other millets, oil seeds, condiments and pulses.

The study observed increasing diversification of agriculture production systems covering AER and socio-economic conditions in Sri Lanka, promoting small farm cluster investments such as *one- crop- one -village*, Agro Technology Demonstration Parks, Protected Agriculture systems, facilitating small farmers cluster formation to implement uniform agriculture practices recognizing market access with safe food for consumers while preserving the environment. However, still the paddy is the main crop cultivated in all provincial areas due its importance in providing the staple food of the populace. The highland areas increasingly diversified with perennial crops especially a range of tropical fruits like banana, mango, guava, dragon fruit, rambutan, durian, and passion fruit with multiple market options.

The innovative agro- technology and systems are promoted by interventions through public, private and international donor projects working with small farmer clusters in regional areas. Such development programs include Agriculture Sector Modernization Project (ASMP) under MoA and MOPI with World Bank, Small Agribusiness Partnership Project (SAPP) under the Presidential Secretariat with IFAD, Private sector agribusiness programs supported by Public and donor agencies (USAID, OXFAM, World Vision, AUS-AID, ILO,) link with small farmer producer clusters, Protected/ soil-less producer clusters(PAEA), contract farming systems with private sector interventions for technology/ inputs and buy back support (Cargills, HJS, CBL, Agri produce exporters, etc.).

The ASMP under the pilot programs have implemented fruit cultivation with selected fruits suitable for different project locations. The interventions of ASMP/PPMUs have identified and established farmer clusters promoted to cultivate selected crops such as passion fruit, guava, and mango, pineapple guided with technology packages including intercropping options for short term crops such as ground nut, cucumber, chilli, onion, long bean and green gram, for income generation purposes.

Table 4.2: Crops identified in study areas

Crop	Project Provinces					
	Central	N-Central	Northern	Eastern	Uva	Other[1]
Maize	*N*	*Y*	-	*Y*	*Y*	*Y*
G-Gram	*N*	*N*	*Y*	*Y*	*Y*	*N*
Gingelly	*N*	*Y*	*Y*	*Y*	*Y*	*Y*
G-Nut	*N*	*Y*	*Y*	*Y*	*Y*	*N*
Chilli	*Y(GH)*	*Y*	*Y*	*Y*	*N*	*Y*
B-Onion	*Y*	*Y*	*N*	*N*	*N*	*N*
R-Onion	*N*	*N*	*Y*	*Y*	*Y*	*N*
K-yam	*N*	*N*	*Y*	*N*	*Y*	*N*
Cocoyam	*Y*	*Y*	*N*	*N*	*Y*	*Y*
Manioc	*Y*	*N*	*Y*	*N*	*N*	*Y*
S-Potato	*Y*	*N*	*Y*	*N*	*Y*	*Y*

Crop	**Project Provinces**					
	Central	**N-Central**	**Northern**	**Eastern**	**Uva**	**Other[1]**
B-Gourd	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*
L-Bean	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*
Capsicum	*Y*	*Y*	*Y*	*N*	*Y*	*Y*
Brinjal	*Y*	*N*	*Y*	*Y*	*Y*	*Y*
Okra	*Y*	*Y*	*Y*	*N*	*Y*	*Y*
Moringa	*N*	*Y*	*Y*	*Y*	*Y*	*Y*
Aloe Vera	*N*	*Y*	*N*	*N*	*N*	*Y*
Cucumber(gherkin)	*N*	*N*	*N*	*Y*	*N*	*Y*
Melon	*Y*	*Y*	*N*	*Y*	*Y*	*Y*
Mushroom	*Y*	*Y*	*N*	*N*	*N*	*Y*
Mango	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*
P-Fruit	*N*	*N*	*Y*	*N*	*Y*	*N*
Guava	*N*	*Y*	*N*	*N*	*Y*	*Y*
Pineapple	*N*	*N*	*Y*	*N*	*Y*	*N*
Grapes	*N*	*N*	*Y*	*N*	*N*	*N*
Papaya	*Y*	*Y*	*Y*	*N*	*Y*	*Y*
Banana	*Y*	*n*	*Y*	*Y*	*Y*	*Y*
Rambutan	*Y*	*N*	*N*	*N*	*Y*	*N*
Anoda	Y	N	N	N	N	Y
S-orange	Y	Y	N	N	Y	Y
Lime	Y	Y	Y	Y	Y	Y
Pomegranate	N	N	Y	Y	Y	Y

Y= cultivated crop in the province; N= not cultivated in the province PGH=Poly green house. 1-MASL

4.2 List of pests & diseases in varied project provinces

The intensive agriculture systems that use the high yielding varieties with narrow genetic characteristics are more vulnerable to occurrences of pests and diseases. The study identifies that the tropical climatic conditions associated with diverse ecological regions create advantages for the diversity of crops, mainly cultivated in small farm lands. The increasing monoculture cropping approach and the tropical climatic conditions prevailing in the majority of provinces provide a conducive nature for pest/ disease occurrence. The study revealed the wide array of pests and diseases in farmers’ fields under diverse varieties of fruits/ vegetables/ root crops/ leafy crops.

Table 4.3: Pests & diseases found in the Provinces

Crops	Major Pests	Diseases	Project Provinces					
			Central	**N-Central**	**Northern**	**Eastern**	**Uva**	**Other**
Maize	*Stem borer (Chilo partellus), White fly (Bemisia tabacai). FAW (Spodoptera frugiperda)*	*Bacterial stalk rot(Erwinia chysanthemi), Maize wilt Pantoea stewartii*	*N*	*Y*	-	*Y*	*Y*	
G-Gram	*Whitefly: Bemisia tabaci (Gennadius) (Hemiptera: Aleyrodidae), Thrips: Megalurothrips usitatus (Bagnall) (Thysanoptera: Thripidae)* *Blister beetle: Mylabris spp (Coleoptera: Meloidae), Pod borer: Helicoverpa armigera Hubner (Lepidoptera: Noctuidae)*	*Ashy stem blight (Macropho mina phaseolina (Rhizoctonia bataticola), Yellow mosaic disease: Mungbean yellow mosaic virus* *Leaf crinkle disease: Leaf crinkle virus, Cercospora leaf spot: Cercospora canescens* *Powdery mildew: Erysiphe polygoni* *Root rot and leaf blight: Rhizoctonia solani J.G. Kühn*	*N*	*N*	*Y*	*Y*	*Y*	
Gingelly	*Leaf eating caterpillar,Gall fly,Leaf hopper,Sphinx moth*	*Powdery mildew, Leaf spot, Bacterial blight: Xanthomonas campestris pv. Sesame. Cercospora leaf spot / White spot: Cercospora sesami, C. sesamicola. Damping off / Root Rot: Macrophomina phaseolina,. Sesamum phyllody: Phytoplasma.6.Root rot: Fusarium oxysporum f.sp.sesami*	*N*	*Y*	*Y*	*Y*	*Y*	
G-Nut	*White fly (Bemisia tabacai). Armyworms Spodoptera spp, Thrips (Tobacco thrips)* *Frankliniella fusca* *Frankliniella occidentalis*	*Botrytis blight Botrytis cinerea, Charcoal rot Macrophomina phaseolina, Bud necrosis(Tomato spotted wilt virus-vector Thrips palmi), Early & late leaf*	*N*	*Y*	*Y*	*Y*	*Y*	

Crops	Major Pests	Diseases	Project Provinces					
			Central	N-Central	Northern	Eastern	Uva	Other
	Thrips palmi, Velvetbean Caterpillar Anticarsia gemmatalis, Root knot nematode Meloidogyne spp, Two-spotted spider mite Tetranychus urticae	*spot(Cercospora arachidicola & Phaeeoisariopsis personata),Collar rot (Sclerotium rolfsii*						
Chili/Capsicum/Bell Pepper	*Thrips (Scirtothrips dorsalis), Mites (Polyphagotarsonemus latus, Hemitarsonemus latus), Leaf curl complex-CCC-(Thrips-Sd-/mite-Hl-/Aphids-Aphis gossypii, Myzus persicae, White fly Bemisia tabacai. Root knot nematodes (Meloidogyne spp) Pod borers(spodoptera litura,helicoverpa armigera)*	*Collar rot- (Scleritium rolfsii, Phytohthera Spp,Fusarium Solanai), Anthracnose (colletotricum gloesoporiodes, c.capsici), Bacterial wilt (Ralstonia solanacearum), Leaf mold (Fulvia fulva), Powdery mildew (Laveillula taurica – Axeual stage: Oidiopsissicula), Phytophthora blight (Phytophthora capsoci), Blossom blight (Choanep hora spp)*	*Y(GH)*	*Y*	*Y*	*Y*	*N*	
B-Onion	*Thrips (Thrips tabacai), Catarpillars (Spodoptera litura, S.exigua), White fly (Bemisia tabacai)*	*Bulb rot(Fusarium oxysporum, F.solani, Sclerotium rolfsii, Phythium spp, Rhizoctonia solani), Anthracnose (colletotricum gloesoporiodes), Purple blotch (Alternaria pori), Bacterial bulb rot (Ralstonia spp, Erwinia spp)*	*Y*	*Y*	*N*	*N*	*N*	
R-Onion	*Thrips(Thrips tabacai), Catarpillars(Spodoptera litura,S.exigua), White fly (Bemisia tabacai)*	*Bulb rot(Fusarium oxysporum, F.solani, Scleritium rolfsi, Phythium spp, Rhizoctonia solani), Anthracnose (colletotricum gloesoporiodes), Purple blotch (Alternaria*	*N*	*N*	*Y*	*Y*	*Y*	

Crops	**Major Pests**	**Diseases**	**Project Provinces**					
			Central	**N-Central**	**Northern**	**Eastern**	**Uva**	**Other**
		pori), Bacterial bulb rot (Ralstonia spp, Erwinia spp)						
Manioc	*African root and tuber scale Strictococcus vayssierrei, Cassava scale Aonidomytilus albus Cassava whitefly Bemisia tabaci, Cassava Green Mite Mononychellus tanajoa Root knot nematode Meloidogyne spp.*	*Anthracnose Colletotrichum gloeosporioides, Cassava Brown Leaf Spot Cercosporidium henningsii, Cassava mosaic & brown streak disease (Virus;Vector-White fly- Bemisia tabacai)*	*Y*	*N*	*Y*	*N*	*N*	
B-Gourd	*Aulocaphora beetle (Aulocaphora forveicollis, A.cincta, A.cruenta, A.lewisii), Melon fly (Bactrocera cucurbitae, B.tau, B,diversa White fly (Bemisia tabacai), Epilachna spp, Gall fly (Lasioptera spp)*	*Downey mildew (Pseudoperonospora cubensis), Bacterial wilt (Erwinia tracheiphila), Alternaria blight (Alternari a spp.)*	*Y*	*Y*	*Y*	*Y*	*Y*	
L-Bean	*B/fly,(Ophiomyia phaseoli), L-miner (Liriomyza sativea), Pod borer (Maruca vitrata), Pod sucking bug (Nezara viriduala, Anaplocnemis spp, Riptrortus spp,) Aphids, Thrips, White flies Spiraling WF (Aleurodicus dispersus), Leaf hoppers (Amrasca spp)*	*Bean root rot (Fusarium oxysporum, F.solani), Anthracnose (Colletotricum lindemuthianum) Angular leaf spot (Phaeoisariosis gresiola-Isariopsis gresiola), Bean rust (Uromyces appendiculatus)*	*Y*	*Y*	*Y*	*Y*	*Y*	
Brinjal	*Shoot & Fruit borer (Leucinodes orbonalis), Red spider mite (Tetranychus spp), Leaf hoppers (Amrasca spp), White fly (Bemisia tabacai)*	*Little leaf (Virus ;vectored by Empoasca devastans), Bacterial wilt (Ralstonia solanacearum)*	*Y*	*N*	*Y*	*Y*	*Y*	
Okra	*Red cotton bug (Dysdercus cingulatus), Shoot & Fruit borer (Earias vittella),*	*Yellow vein mosaic (virus; White fly-Bemisia tabacai)*	*Y*	*Y*	*Y*	*N*	*Y*	

Crops	Major Pests	Diseases	Project Provinces					
			Central	N-Central	Northern	Eastern	Uva	Other
	Leaf hoppers(Amrasca spp)							
Moringa	*Moringa hairy caterpillar: Eupterote mollifera Walker (Lepidoptera: Eupterotidae)Moringa budworm: Noorda moringae Walker (Lepidoptera: Pyraustidae) Leaf caterpillar: Noorda blitealis Walker (Lepidoptera: Pyraustidae)* *Pod fly: Gitona distigma Meigen (Diptera: Drosophilidae)* *Bark eating caterpillar: Indarbela tetraonis Moore (Lepidoptera: Cossidae)*	*Spot Damping off: Pythium aphanidermatum (Edson) Fitzp, P. debaryanum R. Hesse, and Rhizoctonia solani J.G. Kühn* *Twig canker: Fusarium pallidoroseum (Cooke) Sacc*	*N*	*Y*	*Y*	*Y*	*Y*	
Cucumber	*Aulocaphora beetle(Aulocaphora forveicollis,A.cincta,A.cruenta,A.lewisii), Melon fly(Bactrocera cucurbitae,B.tau,B,diversa*	*Downey mildew(Pseudoperonospora cubensis),Bacterial wilt(Erwinia tracheiphila),*						
Melon	*Aulocaphora beetle(Aulocaphora forveicollis,A.cincta,A.cruenta,A.lewisii), Melon fly(Bactrocera cucurbitae,B.tau,B,diversa*	*Downey mildew(Pseudoperonospora cubensis),Bacterial wilt(Erwinia tracheiphila),*	*Y*	*Y*	*N*	*Y*	*Y*	
Mushroom	*Mushroom maggots*	*Green Moulds*	*Y*	*Y*	*N*	*N*	*N*	
Mango	*Fruit fly(Bactrocera dorsalis,B.kandiensis, B.correcta, B.tau,B.zonata), Leafhoppers (Idioscordpus clypealis,I.nagpurensis,Amiritodus brevistylus, Waxy scale insect(Gascardia*	*Stem end rot (Lasiodiplodia theobtomae,Dothiorella spp,Phomopsis mangifera)*	*Y*	*Y*	*Y*	*Y*	*Y*	

Crops	**Major Pests**	**Diseases**	**Project Provinces**					
			Central	**N-Central**	**Northern**	**Eastern**	**Uva**	**Other**
	brevicauda, Ceroplastes destructer) Stem borer(Batocera rufomaculata,Xyleborus spp),							
P-Fruit	*Waxy scale insect(Gascardia brevicauda, Ceroplastes destructer),Beetle-Vine girdler-(*	*mosaic virus,anthracnose,mildew*	*N*	*N*	*Y*	*N*	*Y*	
Guava	*Root knot nematodes(Meloidogyne spp),Fruit fly(Bactrocera dorsalis,B.kandiensis, B.correcta, B.tau,B.zonata)*	*Fruit rot, anthracnose*	*N*	*Y*	*N*	*N*	*Y*	
Pineapple	*Mealy bug (Dysmicoccus brevipes- syn; Pseudococcus brevipes)*	*Leaf virus*	*N*	*N*	*Y*	*N*	*Y*	
Grapes	*Thrips(selenothrips rubrocinctus)*	*Powdery mildew*	*N*	*N*	*Y*	*N*	*N*	
Papaya	*Mealy bug (Paracoccus marginatus)*	*Foot rot (Phythium spp,Phytophtera spp,fusarium spp),ring spot virus potyvirues(*	*Y*	*Y*	*Y*	*N*	*Y*	
Banana	*Rhizome weevil (cosmopolites sordidus), Mealy bug (dysmicoccus neobrevipes), Fruit fly (Bactrocera dorsalis, B.kandiensis, B.correcta, B.tau, B.zonata), Banana Skipper (Erionota sp.)*	*Yellow sigatoka (Mycosphaerella musicola), Panama wilt, (Fusarium oxysporum, F.spp, cubense) Bacterial rhizome rot (Erwinia spp).)*	*Y*	*n*	*Y*	*Y*	*Y*	
Rambutan	*Waxy scale insect (Gascardia brevicauda, Ceroplastes destructer), Stem borer(Batocera rufomaculata,Xyleborus spp)*	*Powdery mildew (Oidium nephelli*	*Y*	*N*	*N*	*N*	*Y*	
Anoda	*Waxy scale insect(Gascardia brevicauda, Ceroplastes destructer),Stem borer(Batocera rufomaculata,Xyleborus spp)*	*Anthracnose,mildew*	y	N	N	N	N	
S-orange	*Leaf miner(Phyllocnistis citrella)*	*Mosaic virus,fruit rot*	Y	N	N	N	Y	

Crops	**Major Pests**	**Diseases**	**Project Provinces**					
			Central	**N-Central**	**Northern**	**Eastern**	**Uva**	**Other**
	Orange dog (Papilio demoleus)							
Lime	*Leaf miner(Phyllocnistis citrella)* *Orang*	*Mosaic virus,fruit rot*	Y	Y	Y	Y	y	
Pomegranate	*Fruit borer (Virachola isocrates)*	Anthracnose	N	N	Y	Y	Y	

Despite the awareness on occurrence of pests/ diseases on crops cultivated, the majority of farmers were ignorant on implementing any early detection methods to determine any potential economic damages or identifying symptoms on possible emergence of diseases. The farmers based onexperience are aware of a few types of pests identified as white fly,thrips, aphids,fruit fly, pod borer, mealy bug and diseases such as wilt, foot rot, powdery mildew, damping off and leaf curl complex.

Table 4.4: Farmers' knowledge on pests/ diseases detection

Crop	**Pests identified**	**Disease identified**	**Province wise Knowledge** 1-poor 2-Little, 3-Average 4 –Good 5- Very good				
			Central	**Uva**	**East**	**North**	**N/C**
Chilli	White Fly		4	4	4	4	4
	Aphids		3	3	3	3	3
	Thrips		3	3	3	3	3
	Mites		3	3	3	3	3
	Pod borer		5	5	5	5	5
		Leaf Curl Complex	5	5	5	5	5
		Anthracnose	3	3	3	3	3
Big Onion	Thrips - leaf/bulb		4				4
	Leaf Hoppers		2				1
	Leaf Eating Caterpillars		4				4
		Anthracnose	5				5
		Purple Blotch	5				5
Bitter Gourds	Melon Fly		5	5	5	5	5
	White fly		4	4	4	4	4
	Aphids		3	3	3	3	4
	Mites		3	3	3	3	3
		Fungal	4	3	3	4	4
Groundnut	Aphids/ Thrips				3	3	
	Termites				5	5	
	Fusarium Rot				3	3	
		Virus			3	3	
		Anthracnose			3	3	
Mango	*Fruit Fly*		5	5	5	5	5
	Mealy Bug		4	4	4	4	4
	Mango Hoppers		4	4	4	4	4
		Mango Fungal	3	3	3	3	3
Passion Fruit	*VTI*			5			
		Collar Rot		5			
Pineapple	*Mealy Bug*			5			
		Dieback		3			
Papaya	*Mealy Bug*		4	4			3

Crop	Pests identified	Disease identified	Province wise Knowledge 1-poor 2-Little, 3-Average 4 –Good 5- Very good				
			Central	Uva	East	North	N/C
		Virus	4	4			1
Guava	*Fruit Fly*		4			4	4
	Fruit borer		4			4	4
	Mealy bug		4			4	4
		Fungal Disease	5			2	5

Source: Expert team S&P Holdings 2019

The study found that farmers have continued to implement the cultivation based on their past experience and the P & D control method is determined on their own. It was observed that the scientific identification of pests and any notable variation of pest development during the seasons are rarely carried out, as majority of farmers rely on routine application of chemical pesticides as a precautionary measure, irrespective of pest & disease occurrence.

4.3 Contribution of diversified technologies for Pest management

In the current context of global up rise and demand for nontoxic, safe food for human consumption which has influenced the necessity of promotion and adoption of economically accepted, ecologically sound, socially responsible, environmentally sustainable alternatives and legislatively empowered pest management practices to minimize the use of chemicals in crop production.

In this regard global thrust was initiated and implemented to promote alternative pest control/ management methods especially combined approaches on Cultural, Physical, Biological, Mechanical, Legislative, and Chemical technologies which are primarily focused in rice farming in Sri Lanka. The current agro-technology interventions, have identified the importance of promoting combined pest management practices integrating the traditional methods to reducing the use of poisonous inputs for agricultural production. It was observed that, though the trend is developing towards combined agro technology practices, the small farmers are yet to gather required knowledge and skills with attitudinal change.

4.3.1 Pest Management in the ancient Agriculture systems

Historically, pest management technologies used non chemical ingredients and devices. Ancient farming systems in Sri Lanka have identified appropriate crops according to their wish and suitability for the AERs. Based on the data gathered, it was revealed that Paddy is the main seasonal crop in Sri Lanka, which contributes to 44 % of the total cultivable land and other field crops which covered around 10% of the total cultivable land in provincial areas. Farmers engaged in cultivation of a variety of crops, had to struggle hard in protecting/ managing/ controlling the pest and diseases afflicted. There are many non-chemical methods adopted by farmers on successfully managing their fields free from the pest/diseases without harming the environment, and resulting in a wholesome and bountiful harvest. Though the indigenous or traditional pest management technologies continued to be practiced is rural areas, the results of study identify that the FPOs in project areas are rarely dependant on those methods for controlling pests & diseases. Further it was informed that there are clusters still making use of indigenous practices of pest management by organized market linkages promoted through NGOs and development agencies. However, the practices identified below are proven successful in ancient farming systems. It was noted these technologies were modified and used by LEISA and Organic farming clusters contacted by the study team.

i. **Torches** & **Light traps**

Torches are prepared by wrapping rags, dipped in Mee (Madhuca), Kohomba-Neem (Margosa) or coconut oil at the end of a stick which was lit and planted near the water inlet to the field. Farmers during the night walk through the field clapping to divert the attention of the insects towards the light which will eventually trap or burn them.

The light trap is another method of using bright light with a water source below the light to get the reflection to attract insects who eventually get trapped in the water. The method is used by the provincial farmers, mostly with little modification to the traditional methods which are followed. (Moringa Farmers, vegetable Farmers in Cargills network, and farmers growing rice in provincial areas. Madhuca oil poonack mixed with mucilage of **Kekuna** (*Canarium zylanicum*) burnt as incense at corners of the field and lamps lit with Madhuca oil chase away the pests.

ii. **Plant parts**

Raw papaw is chopped and scatter in the field specially to control the rat menace on rice crops during the milky stage. By eating the the raw papaw, the rat damages its gums, which causes soreness in its mouth and prevents it from further attacking the rice, giving the farmer ample time to harvest the crop. ***(An option for rat attack in ground nut)***

Coconut stalks- planted in rice fields for resting birds that prey on the insects that run over or fly over the field. This is a common practice currently observed in rice fields.

Madhuca roots buried randomly in the field and water flowing areas. The roots rot and liquids/essences emanated mixed with water will destroy the larvae and Pupae of pests. This is proven scientifically as the madhuca root contains a chemical compound identified as “Saponin” that has properties of pesticides. *(An option for introducing as a border crop initially among the FPOs in the project provinces.)*

Extracts from chopping/ crushing of plants such as **Kalawel** (*Derris scanders*), **Thiththa wel** (*Lypersion esculentium* **Daluk** (*Eupholsia antignomum*) and leaves of **pineapple** mixed with water and sprayed around field to get rid of the damages caused by Kandan messa and Gok Messa *(Gold midge).*

Leaves of **Cinnamon** (*Cinnamomum zeylanicum*) and/ or **Keppetiya** (*Croton lexifenio*) mixed to the soil when the land is prepared for cultivation. Farmers use this leaves to get rid of worm attacks during the early stages of plant growth. (A handful of farmers were aware of this and some practice this method in an adhoc manner. *(A program is necessary to promote cultivation of these crops especially in the home gardens or boundaries of the crops.).*

Kohomba (Margosa/ Neem) – (*Azadaricta indica*) Since ancient farming times it has been continuously used as a common plant based non-chemical pesticide for a wide array of crops cultivated in farmers' fields that include conventional and organic farming. The extracts of seed/ leaves/ bark etc., are popularly used to control pest on a variety of vegetables grown in small farm fields.

iii. **Use of living species** (biological methods)

Small fish Thiththaya (*Barbus uneya*), Innala handaya (*Aptocheitus dayi*), frog and monitorlizards/monitor snakes are observed as living species of fauna that contribute to natural pest control in the rice fields.

Micro-organisms species of fungus such as Nomureae releyi is used to control rice caterpillars (spodoptera mauritia) and pink borer (*Sesamia infereus*). The fungus known as Mettarhihzium anisopliae is used for controlling the Pentatoid bug (Seotinophera lurida) infestation and the Euboralia stalli which feeds on rice caterpillars are reported to be often used for control of pests (Vidurava Vol.18 No.3/4).

Live plants species such as "Mee" (*Madhuca longifolia*) planted on the border of paddy fields and bare areas. The fragrance emanated in the air attracts the bees and insects which prey on the pests of paddy. The attraction of birds also helps to improve the pollination of flowers. ***(This tree could be an option for passion fruit farmers to enable them to save the cost of man power resource on artificial pollination.)***

Madu-(*Cycus citratus*) planted in vacant areas and borders of the cultivated lands cause pests to be repelled by which is emanated from the plant. This is considered a successful ancient control mechanism where the smell of the plant is highly repulsive to the pests.

iv. **Sprinkling of Ash-** Wood ash is collected into a cloth bundle hung on a stick and it is beaten with another stick to spread/ scatter the ash over the cultivated area. According to farmers it contributes to minimizing the pest/ diseases incidences.

v. **Winnowing method *(kulugema)*** - at the back of the winnowing basket, mucilage (koholla) from the jack fruit is applied and fanned across across the field, which disturbs the insects on the crop to fly and get stuck on the mucilage. This is done twice a day when the rice sprouts into ears.

vi. **Water Ghost (diya holmana) -** Method used to protect paddy from beasts. A 02 segment long piece of bamboo placed on the point where water flows down from one liyadda to the other. When water flows down the stick rises and falls, subsequently hitting a stone which is placed underneath, causing a noise which scares the beasts away.

vii. **Wind Ghost (hoolang holmana)**- A commonly used method where farmers place long nails/ pieces of iron rod with bottles/ tin (large size) hung on a tree or arranged along the wire/ coir lines tied between trees/ border fences that creates a ghostly sound when the wind blows.

viii. **Planting time**- Farmers are well aware of the fact that the time of planting and time of harvesting has a strong impact on pests and disease occurrence and strive to keep it below the level of crop damage. At the time of planting one may avoid the egg laying period of the pests. Through experience and instinct the farmers are aware of the exact time to plant and this is not by implementing surveillance/ monitoring. This was proven with ground nut, chilli and other vegetable growers in the study area and also identified through the review of reports.

A learning experience of farmers' shared by AIs and other officers of Kodayana of Athimale ASC center of Siyambalanduwa reported that severe outbreak/damage from FAW occurred only in the fields where maize had been established after October 31st. (delayed planting) caused an unexpected outbreak of Fall Army Worm (FAW) damaging maize. The incident had alarmed the farmers in the area to understand the importance of adhering to timely cultivation and all farmers' plant together in an agreed period of time or Yaya cultivation. This has been stressed in traditional farming by an adage, "It is not a major problem to delay in season but do not delay in "Yaya" or geographical area of the cultivation in other words do the work all together".

ix. **Crop rotation-** is another technique that farmers continued through decades of farming and observed in every province.

x. **Water management-** flood method allows water to be retained for a period of 4-5 days, which is considered common in paddy cultivation and this enables the farmers to control many pest/ organisms/ weeds to die in the stagnant water and the removal of dead or decayed parts when releasing the water. However, vegetable farmers through their experience have identified micro irrigation technologies especially sprinklers that keep the pest incidence at low level. Additonally, the Plant Wise App of CABI promoted under PPS of SCPPCC/ DOA has confirmed the importance of this practice by recommending to use the sprinkling irrigation between 0600 to 0700 hrs. and 1300 to 1400hrs.

The results identified that farmers are ignorant of the fact that ancient pest control techniques are still made use of or integrated to different cop growth stages. However, the influence of high energy inputs have forced the gradual withdrawal of ancient pest control methods from the small farm agriculture.

4.3.2 Pest management under modernized agriculture systems

Sri Lanka is increasingly utilizing the intensive/ modern agricultural technologies in order to capture a share of the demand in the local and international markets. Traditional farming is rapidly changing/ modifying due to the increasing labour cost and low productivity compared to the efficient technology interventions under modern farming methods. The introduction of Green revolution in Sri Lanka, coupled with the establishment of major irrigation and settlement programs, subsidized inorganic fertilizer/ pesticides/ weedicides, and extension of service packages, was oriented towards increased production of rice, securing the national staple food supply and lately penetrated to vegetable farming prompting the increasing demand for high energy inputs derived from inorganic chemical compounds. It was evident that most of the high yielding varieties with narrow genetic base are inherently vulnerable to major pests and thus brought about a marked change in the pest status.

The result has been a heavy and extensive use of pesticides for the control of insect pests, diseases and weeds which are considered as an integral anxious component of modern agriculture. It was reported that around 25-30% crop loss was observed due to insect/ pest diseases and weeds. Reports indicate that 35% farmers used higher concentrations/ dosages ignoring the recommendations leading to indiscriminate applications causing severe challenges for environment and human health.

4.3.3 Conventional Pest Management systems

Though the seasonal farming is a potential area for providing a high farm income, the farmers in the provinces reported that there are threats of occurrence of P&D. The crops cultivated have a short gestation period and is aimed at market demands with high values and the farmers are influenced to implement protective action rather having preventive options. It was observed, in some provinces in the North Central, parts of Uva North and in East, the trend for continuous crop production is in small allotments. This pattern further aggravated the use of inorganic inputs, mainly a variety of fertilizers, micro nutrients, hormones, and pesticides. According to farmers it was noted that since the green revolution the use of chemical pesticides for pest control tends to ignore the causes/ symptoms of pest/ disease/ weeds and rely on a routine, or calendar based scheduled application, or application of pesticides immediately after detecting pests but without considering the damage levels. It was stated that P&D problems in the vegetable cultivation is increasing and use of pesticides have become ineffective due to limitations for the import of high strength (Grade 1 type) pesticides. However, farmers insisted they continue to depend on the precautionary use of chemical pesticides to protect the final yield. The study identified that the level of the farmers' knowledge is related to the proper usage and practices of pesticides are limited but they are maintaining a positive attitude towards the use of chemical pesticides irrespective of risk/ hazards for humans/ environment. According to farmers, it was highlighted that the non-chemical methods proposed are not demonstrated to show the convincing results as opposed to chemical control methods.

Though the efforts have shown some success in promoting technologies to reduce the use of pesticides in rice farming at national level, the vegetable farming sector continues to use chemical pest control technology, causing heavy damages on human health and environment.

Table 4.5: Comparison of traditional VS modern pest management methods

Traditional sector	**Modern industrial sector**
Cultivate traditional/native varieties	Using new/improved high yielding varieties
Crops are protected from pests using traditional and biological methods	Highly dependent on the usage of chemical application
Depends on indigenous bio-dynamic formulas, traditional rituals, and bio-diversity which are used to ensure a healthy harvest.	There is some growing interest to cultivate traditional rice varieties for family consumption
Plant parts/extracts/live plants used for PM	Use of crop management practices to mitigate pest damages.
Mainly for family consumption and target groups	Bulk market demand local /overseas

Source: Traditional pest & disease control methods

4.3.4 Combined Pest Management (IPM/IVM) Practices

Over the last 60 years, the dominance of chemical control practices by rice and vegetables growers, stifled the development and application of non-chemical approaches particularly biological technologies and demotivating the use of hazard free indigenous practices. Over the decades, farmers have lost the indigenous pest management practices which have been successfully implemented for generations including the traditional art and technologies that rapidly eroded with the introduction of modern high energy inputs which led to attractive growth and yield. The farmers in the study area responded that there are clusters still making use of indigenous practices of pest management by organized market linkages through NGOs and development agencies. It was evident that increasing global concern on sustainable agriculture emphasizes the importance of environmentally sound farming, healthy food production and better income with welfare of farmer family. The study revealed that diverse pest management strategies/ technologies are promoted worldwide with increased efficiency to attract the small farmers to adopt more non-chemical methods for controlling P&D.

Accordingly, the concept of Integrated Pest Management (IPM) has evolved as the alternative to mitigating the adverse effects experienced due to increasing dependency on chemical pesticides in agriculture production. Observing the emerging trends for use of high level pesticides, increasing costs of production and spread of poverty has caused the GOSL to promulgate the IPM technologies which are used to play a key role in increasing the yield of rice as the national priority.

It is made aware that IPM is considered a part of the Pest Management (PM) program ***(A broader program of Monitoring, intervention and Prevention)*** that includes an array of definitions and descriptions which are noted in the published reports and other documents reviewed. All definitions focused on managing/application/practice by a combination of technologies to keep the pest incidents below the economic threshold level that avoids the killing of pests by keeping the chemical control option as a final option.

> *In 1967, FAO defined IPM as "a pest management system that is in the context of the associated environment and the population dynamics of the pest species, which utilizes all suitable techniques and methods in a compatible manner as possible, and maintains the pest population at levels below those causing economic injury".*
> *The requirement for adoption of IPM in farming systems is also emphasized in the World Bank OP 4.09 on Pest Management, which supports safe, effective, and environmentally sound pest management aspects, such as the use of biological and environmental friendly control methods.*

IPM technologies were promoted/demonstrated/adopted for rice farming in Sri Lanka since 1984. Participatory IPM in Sri Lanka was first introduced by technology transfer models identified as Training & Visit (T&V) with contact farmers, demonstration plots, and regular meetings. (C*ommunity IPM in Asia (GCP/RAS/172/NOR) FAO-2002*) The effect was limited. The concept was replaced with a group approach named as Block demonstration or tract cultivation/Yaya demonstration. The farmers in a particular tract follow periodic training over a period and apply technology uniformly in the tract covering a minimum extent of 10 ha. Initial results showed positive outcome and the program scaled up with 2300 extension

Historic evolution of IPM rice program in Sri Lanka.
1984 Start Transfer of Technology IPM
1992 End Transfer of Technology IPM
1995 Introduction of Participatory IPM
1999 Expansion of Participatory IPM

officers training 35000 farmers by 1987. Block demonstration continued until 1992. In 1995 the program on participatory IPM/ Farmer Field Schools (FFS) was initiated.

Currently there are 210 IPM master trainers (around 50% from MASL), which also comprised of a number of trainers from farmer clusters capable of providing participatory training in diverse locations.

The FFS concept evolved in 1980 in Indonesia and Philippines as a measure to mitigate the complexity and variability of rice ecosystems that demanded a practical/ educational approach, replacing the message based extension approach. FFS is a weekly gathering of a group of farmers with their facilitator (mainly the Extension service provider for the area) to learn, observe and understand the dynamics of their crops, ecosystem. The facilitator avoids instructions/ lectures but provides the opportunity for the participants to build skills by learning in the field by introducing activity, explaining the process and setting the platform for farmers to actively participate. The training is participatory and farmers make observations, analyse and draw conclusions on how to manage the crop over the next week. The facilitator will induce the farmers to communicate more through a number of questions rather than merely giving solutions.

The purpose of the FFS (the principle activity of the program identifying several follow-up activities) training model is to develop the local farmer driven programs. Several types of follow-up activities were carried out to strengthen specific skills of experimentation and organization or to encourage networking between farmer groups.

Box-1 **Farmer Field School** ADULTS LEARN best from experience, which in the case of farmers means: from observations in the field. Firsthand knowledge is superior to information received from others. The term ‘field school’ implicates that the field is a learning ground. The farmer field school is a weekly gathering of a group of farmers and their facilitator to learn to observe and understand the dynamics of their crop’s ecosystem. In an exercise called ‘agro ecosystem analysis’ participants depict their observed field variables and make comprehensive decisions on how to manage the crop over the next week. Additional hands-on experimentation stresses the strong tolerance of rice plants to leaf or stem damage, which normally triggers much unnecessary spraying by farmers, and the importance of conserving beneficial organisms in rice. The training is participatory in that farmers make observations, do analysis and draw conclusions. Moreover, group dynamics exercises encourage learning from peers, and strengthen communicative skills and group building. The facilitator avoids instructions or lectures but provides the opportunities for first-hand experience by the participants. He introduces an activity, explains the process and sets the farmers to work. Shortcuts to the learning process are seen as missed opportunities. During group discussions the facilitator fills in with questions rather than solutions.

Table 4.6: Activities of the IPM program through FFS

Activity	Purpose	Duration
FFS	Agro ecosystem management & group building	Weekly for one season
Participatory Planning	Problem analysis and community planning	4 days
Farmer studies	Training & practice Field experimentation	Weekly for one season
Cross visits	Exchange between two farmer groups	1-2 days
Farmer Congress	Forum for farmer groups	1 day
Farmer TOT	Training for farmers to become FFS facilitators	10-15 days
Season long TOT	Training for officers to become FFS facilitators	4months

Source-Participatory IPM in Sri Lanka: A Broad-Scale and an In-Depth Impact Analysis Henk van den Berga, Hector Senerath & Laksman Amarasinghe
A Report prepared for the FAO Programme for Community IPM in Asia (GCP/RAS/172/NOR), 1 August 2002, Wageningen, the Netherlands

It was reported *(Henk, et.al.)* a 23% increase in yield and a 41% increase in profits from rice cultivation. Insecticide use was reduced by 81% causing savings in agrochemical inputs but the herbicide use was not affected. The agronomic variable most promoted/adopted due to FFS training was the incorporation of rice straw (used by 31% of non-IPM farmers but by 84% of IPM farmers), which improves physical and biological soil properties. Moreover, IPM farmers used nitrogen fertilizer better in line with plant requirements. They used more potash, and improved their land preparation methods. IPM farmers visited their fields at shorter intervals, allowing for timelier crop management.

It is proven that participatory IPM to be decidedly a cost-effective, durable, pest management system that encourage motivation, cooperation and a sense of program ownership for farming communities. The learnt principles and skills influenced farmers to embark on new initiatives or programs.

It was also reported that the IPM practices adopted through FFS programs especially the usage of insecticides , incorporating straw to the soil were only sustained for limited period such as 6.5 years and is gradually eroding/fading away due to changing technologies and opportunities for increased farm income. The diffusion of technologies was further hindered due to inadequate availability of technically qualified/ experienced staff to implement/ promote/ facilitate training/ farm development activities/ IPM strategies at field level. It was noted that extension officials who trained under FFS programs are now transferred or retired and the programs implemented are not progressed due to scarcity of funding resources and policy support from relevant institutions to continue the program at national level.

The study finds that the ASMP program which is promoting and implementing ATDP/ one crop one village concept, has intervened on farmer entrepreneurship development initiatives in the provinces. The program identifies as Farmer Business School (FBS) and training programs are in progress and aimed to develop the entrepreneurship skills/ knowledge and changing attitudes towards commercial agribusiness farming through an established curriculum. The farm business school was inspired by the FAO experience with Farmer Field Schools (FFS) and used as an experiential learning framework. It focuses on content by providing practical exercises to facilitate learning of specific knowledge and skills – exercises can be organized into unique learning programmes. It involves farmer learning led by a trained facilitator. It is designed around a selected farm enterprise that can be produced locally. It covers the production cycle from planting to marketing.

FBS is;

A learning programme of learning designed to help smallholder farmers produce for the market and to make their farms work profitably.

A platform that brings farmers together to carry out collective and collaborative action to address business and marketing problems and opportunities.

A forum for sharing knowledge between farmers through discussion, practical exercises and self-study.

In the provinces the farmer participation was observed during the study mission. The program is different from FFS.The FBS strategies are mainly focused to enhance the business attitudes with improved negotiation and marketing abilities. It identifies the cost effective management of resources (internal/ external) contributing towards the increase in profit. Though the FBS includes the farming practices, it is not intended to teach farmers on how to produce/ manage crops, but it is assumed that they will have this knowledge. However, the study identifies that farmers in the provinces still need the guidance/ training on technical and scientific aspects on crop production and management to capture the innovative intervention under FBS.

The provincial level FBS programs for FPO under ATDPs are implemented by the area based AI in coordination with relevant PPMUs. It is the responsibility of the AI who undergone TOT programs on implementing FBS for farmer clusters FBS training programs under ASMP is scheduled for 35 sessions of 01hr each. It was noted that farmers were encouraged or influenced to attend this program regularly to gather the new experience for becoming best decision makers/ best competitors by taking advantage of new opportunities in the emerging business environment. It is not a concern of the FBS module to integrate the practices that contribute to pest management technologies/strategies. Accordingly, there is a possibility to build negative attitudes towards the holistic approach for pest management and farming practices. In this regard it is important that ASMP /ATDP is used to integrate crop stage-wise management strategies and farming practices to build a holistic approach on market-oriented profitable farming.

Farmers who participated in the discussions are aware of the combined/integrated pest management practices through trainings/ demonstration and exposure visits carried out in the past by DOA and other donor agencies. The organic cultivation practices promoted by private sector companies and NGOs have attracted the small farm clusters in the provinces. It is evident that farmers carry skills and knowledge through experience from indigenous farming systems and through a learning process. However, the majority of farmers indicated that they are not very clear about the non-chemical technical approaches in term of effectiveness of pest control compared to chemical methods that bring instant results.

The cultivation of practices used in diverse crop cycles essentially contribute positively or negatively to managing the P&D in the fields. This indicates that farmers intentionally or unintentionally implement combined technologies that complement the pest control mechanisms in farms. However, the study identifies that the technologies are in-built/automatically integrated to the crop cycle where all cultivation practices are connected to achieve a better/ vigorous crop growth that enables the plant to withstand any pest or disease occurrence to a level below the threshold. It was observed that the farmers were ignorant about this and did not perceive it as a component that contributes towards controlling P&D. On the other hand the farmers are not willing to take any risks on their crop and therefore they strongly believe inorganic compounds are the best option.

In view of this it is necessary to influence the farmers to adopt correct practices from (Crop growth stage-wise management such as soil/ land preparation, nursery, planting, vegetative growth, flowering maturing and harvesting while monitoring the behaviour and population changes of pests and beneficial organisms as a measure of preventing infestation. Among the clusters, the farmers informed that there is no proper methodology used to demonstrate/ diffuse the technical interventions to convince the farmers by observing and identifying the benefits of innovative technologies for small farm vegetable production. Farmers are ready to welcome the PM technologies if they are suitable for their socioeconomic situations.

4.4 Sources of information on pest managements

According to the farmers, the main information source in the field are the extension officers in the vicinity. Apart from the public sector involvement the increasing private sector agri business projects in the rural provinces and contract farming systems have opened the door for farmers to learn the latest technologies and production systems through training. The farmers have not forgotten the services of international donors who have supported development programs leading the small farmers to adopt global technology initiatives for increased farm income. Further, the initiatives of leading agro input producers, importers and suppliers were also highlighted by the farmers for their contribution for diffusion of information and advice on inorganic/organic input management for better crop production.

Table 4.7: Source of information for selecting the method of Pest Management

Source of Information	Province *(No.of Farmers & %)*					
	Central	East	N/C	North	Uva	% of Total
By farmer experience	4	1	7	3	00	**08**
Dealer	5	15	8	27	2	**30**
Extension officer (AI)	1	5	7	10	22	**24**
Company Extension	00	12	00	00	00	**06**
Label introduction	5	10	25	4	2	**24**
Leaflets and other media	4	00	1	00	00	**03**
Neighbour farmers	1	3	00	4	00	**04**
Total no. of Farmers	**20**	**46**	**48**	**48**	**26**	**188**

Source: Expert team S&P Holdings 2019

Training and awareness programs play a key role in the diffusion of technical knowhow and building farmer capacities. However, there is no regular programs aimed to build farmer capacity to adopt best practices for pest control and reduce the over dependency on pesticides. It was found that private sector initiatives focused on capacity building/skills development training on safe use/ handling/ storage pesticides at farm level, protecting consumer safety and, mitigating the environmental pollution completing the national plant protection programs/ activities. Accordingly, the pesticides companies ("Crop life Sri Lanka") in coordination with DOA have trained 300 field officers employed under their member companies, by enhancing the skills and knowledge on GAP procedures providing the opportunity to disseminate/ communicate with farmers in the rural provinces, under one platform.

The farmers are aware of this as the company representatives are in contact with them directly or indirectly through dealer networks. Though it is frequently said that farmers are unable get in touch with any extension officers in the field to get advice and directions to their ongoing and future farming activities, they are not aware that their representatives/ resource persons are available in the field level and can be contacted by the farmer in order to obtain information. However, it was observed the farmer awareness on these vast resources and opportunities are yet to be promoted and coordinated. During the study it was found that number of public and private institutions deployed their employees in working with farmer clusters/ FPOs, but operate separately in an isolated manner. There is no established regulating system to monitor each of their activities and its effect on the environment and the farmer community.

It is understood that although organized approach for promotion of market driven crop production programs are implemented the, concerns over the controlled use of chemicals (inorganic fertilizer/ toxic pesticides) are not very much emphasized in the ongoing cluster promotional programs. The results of the study is indicative of the fact that the usage of pesticides and its harmful effects to the environment/ humans is poorly perceived among the FPOs in the project provinces. Further it was reported that intense training is necessary to mitigate the knowledge gap of extension service providers and FPOs. Also it is important to implement effective surveillance and monitoring of regional pesticides sales/stocks and uses for mitigating the issues/ challenges related to farmer practices on usage and application of pesticides.

In this regard, MoA has already lined up programs linked to markets (local/ export) such as Sri Lanka Good Agricultural Practices (SL-GAP) certifying farms that produce safe food crops for consumer markets. However, as in the case of IPM the basic problems have hindered the promotion across the farming community.

Table 4.8: Farmer attitudes towards Combined Pest management practices

Description	**Province *(No.of Farmers & %)***					
	Central	**UVA**	**East**	**North**	**N/C**	**% of Total**
Do not know about IPM technologies/practices	1	0	25	23	7	28
IPM is a time-consuming method of pest control	11	8	13	9	21	32
IPM is unable to control all the pests and diseases	2	3	4	9	8	13
IPM is a risky strategy to adopt	7	6	3	14	11	21
IPM is a costly method of pest control	9	0	2	0	1	12
Total	20	26	46	50	55	196

Source: Expert team S&P Holdings 2019

4.5 Adoption of diverse Pest Management technologies

It is aware that the control of insect pest population is a function of the ecosystem itself by means of natural enemies and other factors. It is essential to make an understanding of population phenomenon to implement effective management or control mechanisms. The most effective system for controlling pests can be derived only after understanding the principles/ interventions responsible for the population fluctuation in the ecosystem. The study assessed the influence of farmers adopting pest monitoring and alternative control methods using diverse pest management tools indicated below. The tools for pest management categorized in ascending order of complexity.

Table 4.9: Pest Management tools

Monitoring/observation	Category/Interventions	Description/Practices/Prevention
1. Identification 2. Surveillance/ Forecasting 3. Diagnostic 4. Scouting	1..Cultural methods or agronomic practices	a. Use of resistant varieties b. Crop rotation c. Crop refuse destruction d. Tillage of soil e. Variation in time of planting or harvesting f. Pruning or thinning and proper spacing g. Judicious and balanced use of fertilizers h. Crop sanitation i. Water management j. Planting of trap crops
5. Economic Threshold Level (ETL)	2. Mechanical methods	a. Hand destruction b. Exclusion by barriers c. Use of traps
6. Pheromones	3. Physical methods	a. Application of heat - Hot water treatment/- Exposing of infested grain to sun/- Super heating of empty go downs at 50 ^{0}C to kill hibernating stored grain pests. b. Manipulation of moisture - Reduction of moisture content of grains to prevent from the attack of stored grain pests. c. Energy - Light traps
	4. Biological control	a. Protection and encouragement of natural enemies b. Introduction, artificial increase and colonization of specific parasitoids and predators.- conservation of natural enemies/Parasites and Parasitoids/Egg Parasitoids/Larval Parasitoids/Pupal Parasitoids c. Propagation and dissemination of specific bacterial, viral, fungal and protozoan diseases.

Monitoring/observation	Category/Interventions	Description/Practices/Prevention
	5. Genetic	Use of sterile male technique
	6. Regulatory	SCPPC-Plant Protection/ROP/ Quarantine Border control –Export/import Residue control
	7. Chemical	- Use of attractants - Use of repellants - Use of growth inhibitors - Use of insecticides ***(Chemicals that kill or paralyses)***

4.5.1 Monitoring (observation)

i. Identification:

Identification of pests and beneficial organisms in the cropping system is of prime importance before any pest management strategy is executed. Proper education at farmers' level by all extension agencies is extremely essential so that farmers can readily identify the pests and beneficial organisms to take up appropriate measures in time. Though the farmers in the study area aware of the common pests and diseases on crops cultivated, there are a range of unidentified pests where farmers have no proper awareness/ information/ guidance to determine the species/ family and type of damage it can cause to the crop.

The most common pests indicated include Thrips, Aphids, fruit fly, white fly, mealy bug pod borer, stem borer, leaf miner Nematodes and mites. The farmers were well aware of FAW due to the heavy damage caused and wide publicity in all media regarding its damages and remedial action proposed by relevant GOSL agencies. Diseases noted as anthracnose, wilt, damping off, root rot, ring spot, leaf curl, and leaf mosaic.

Lack of proper knowledge/ skills, hindered the farmers making detailed identification such as differentiating pests, beneficial insects, symptoms for occurrence of diseases. The FPO noticed incidences of pests which the farmers of certain provinces are not familiar with, yet cause much damage to plants. The delay in obtaining responses from the relevant authorities and the time time taken to communicate and obtain remedial solutions have caused crop losses and loss of income.

The results of the study indicated that farmers do not show any excessive desire to identify the pest/ diseases by characteristics/ symptoms as such but only by observing the field for any occurrence of pests or diseases. It is then that farmers decide on the control measures.

It was noticed that the farmers are aware of the availability of extension support programs on plant protection technologies disseminated through trained AIs named as plant doctors, responsible for disseminating information and solutions to farmer problems related to pest/diseases and other activities related to crop protection in farmers' fields. Though the plant doctors are required to carry out regular crop clinics at field level they are unable to implement scheduled programs due to other commitments/ tasks which strictly adhere to provincial development programs based on annual planning.

Though the information on P&D and related characteristics/ life cycle/ symptoms/ damages is made avaialble by the DOA, at the farmer level it is not effectively introduced/ demonstrated and therefore the knowledge and skills of farmers continued to be traditional.

Table 4.10: Farmers level of participation of pest monitoring activities

Description	**Province** *(No.of Farmers & %)*					
	Central	**Uva**	**East**	**North**	**N/C**	**% of Total**
Pest Identification	20	26	42	45	45	90
Surveillance and Forecasting	20	26	42	45	45	90
Diagnostic	00	00	00	00	00	00
Scouting	00	00	00	00	00	00
ETL	00	00	00	00	00	00
Pheromone/traps	10	08	07	10	12	24
Use of App- Crop wise/FAWMEWS	00	00	00	00	00	00
Total No. of Farmers	20	26	46	50	55	197

Source: S&P Holdings Pvt Ltd.

ii. Surveillance and forecasting:

Periodical studies on climatological changes are made in relation to pest dynamics of each agro ecological region. Long term observations on pest dynamics are initially made from light traps, sticky traps, spore traps, pheromone traps etc., and could be used to analyze and make appropriate forecasts on pest/ disease occurrence. Scientific surveillance and forecasting will enable extension workers to pass on proper recommendations to farmers for timely and appropriate crop protection measures.

In the study area, farmers make their own observations for any pest/disease occurrence. Almost all farmers responded positively that they do surveillance and field observation while attending to the field activities but it is not connected to a proper/scientific surveillance activity for determining or forecasting the potential infestation and making the decision on methods of control. It is only a laymen activity that is carried out while working on the field. The farmers through experience, notice that they know insects/ pests but do not concentrate on the level of pest incidence and availability of beneficial insects in the field. There is no record keeping method followed by farmers to track the potential pest occurrence, identify the development stages of pests (Egg/ Larvae, Pupae/ Adult) type of damage, as a measure of pest incidence and determine the method of control.

The FPOs in the project area are guided with record keeping systems and it is observed an initiative for promoting pest surveillance and forecasting. However, farmers are yet to understand the biology/ characteristics of pests based on their crops. It was made to understand that the farmers growing mango observed leaf roller incidence where they are unable to detect in the early stage when an adult pest roams on the crop before the egss are laid causing severe damage due to the lack of knowledge and awareness. Similarly, the chilli infected by Chilli LCC where the discussion with particular farmers revealed that the application of insecticides didn't effectively control the disease due to heavy insect occurrence at the time of spraying. This indicates that the farmer has no idea about the level of insect infestation and economic damages caused by the vector carried disease.

As well it was brought to our notice that the passion fruit FPO identifying the collar rot/ collar damages during the crop cycle was causing economic loss due to plant die back. However, the farmers are yet unable to diagnose the early stages of the damage and pattern of life cycle/ development stages identifying the adults, its numbers, time of laying eggs, formation of pupae and larvae.

Further it was found that installation of light trap boxes in farmer fields cultivating Moringa are being used as part of the organic crop cultivation practices. The farmers gained a knowledge about a large amount of pests belonging to a variety of species and types which may either be harmful or beneficial are trapped but they are not aware of their next step, which requires the identification and differentiation of insects and forecasts the potential incidences and determines the remedial action. Though it is a good practice to reduce the pest populations' number traps used is less than the recommended.

The finding indicated that IPM practices and the GAP program introduced the surveillance and forecasting practices by maintaining crop records. IPM on rice was the lead program that promoted surveillance and forecasting by the FFS method implemented in the later stages. However, as at present there is no evidence for voluntary implementation of pest surveillance practices under small farmer production in the provinces.Inadequate follow-up action and promotional programs on IPM for rice and other crop have caused the gradual erosion of IPM over time.

GAP the latest promotional effort to mitigating the problem related to inorganic input identified as an alternate option. However, the progress is slow due to inadequate staff at field level. The study found that more effort from the project promoters/ implementers is required to build farmer capacity to sustain the better monitoring practices in the long run.

iii. Diagnostics:

Symptoms and signs manifested on crops due to pest infestation and disease infection are to be correctly and timely identified for planning of all possible preventive and curative measures. Farmers in the provinces, through years of experience shared their knowledge regarding identified diseases on crops cultivated. However, they are ignorant on detecting early symptoms, but take precautionary measures by using chemical pesticides.

Lack of knowledge on identifying the plant nutrient disorders, monitoring the climatic changes (temperature/ Rain fall/ status cloud/ relative /humidity), hindered the abilities for early diagnosis and mitigation of issues. It was revealed that the majority of farmers identified diseases during the latter stage where most of the time the damage has already occurred. The farmers cultivating chilli are well aware of the damping off disease, but it was noted there is no early diagnostic practice adopted by FPOs.

Bacterial wilt, root rot, necrosis ,powdery mildew are common diseases known to farmers but the only precautionary method they practiced is application of chemical spraying, as there is no adequate skills for the farmers to make early diagnosis. It was noted that during the training sessions farmers were informed the early symptoms and possible cultural practices to minimize the occurrence. Across the provinces the farmers have not shown confidence in non-chemical preventive measures and therefore the practice of diagnosis was not recognized as an alternative option. It was noted that the lack of proper diagnostic skills/ knowledge had misleading conclusions by farmers. (Eg. incorrectly diagnosing the ring spot disease in Papaya.)

iv. Scouting:

This includes regular site inspections and trapping to determine the types and infestation levels of pests at each site. Thus, frequent scout for pests, diseases and beneficial organisms in and around the crop will enable farmers to plan for strategic measures in pests and disease management. In cases where beneficial insects are in abundance and pests incidences are below the thresholds, farmer need not go for chemical control measures.

The majority of farmers visited are involved full time in farming activities as the main source of income. They regularly attend the cultivation activities to achieve the maximum possible yield pertaining to different crops. Though they are fully aware of major pests/ diseases infested for the crops there is no assessment process carried out to identify the level of various pests/ symptoms of diseases and beneficial insects. During the field visits it was observed that pests and beneficial insects such as lady bird beetles were moving around the cultivation, indicating the balance in potential harmful and beneficial insect populations. But it was not recorded and studied to determine the level of population build up.

There are farmers in the project area who practice the manual method by rubbing the underside of the apex with wet fingers to observe the presence of thrips, aphids and to make their decision on control measures.

Farm records introduced and implemented under ASMP projects could influence the farmers to use the information/data to identify the incidences by assessing the levels of beneficiary insects and harmful pests by monitoring the pattern if recorded. According to farmers the record keeping practice is mostly focused on farm development, input application, costs and benefits related to crop yield and performance. Also the organic project implemented in NCP identifies the similar program but the farmers were guided from the beginning where a package of practices promoted the integration of non-chemical pest management methods but pest scouting is not implemented though it happens unintentionally.

Best practices on the pesticides control package is promoted under Cargills Sarubima program in Thanamalwila and Nuwara Eliya working with farmer clusters that promote combined practices (Deep ploughing, protective nets (7ft high), poly mulch, quality seed/ planting materials, micro irrigation, extension support) for control of pests and disease and for the purpose of monitoring through traps/ scouting before making the decision for the use of pesticides. This project promotes and adopts stage-wise crop management practices for small farms achieving successful results by reducing COP and gaining in productivity.

It was observed that in some of the ASMP pilot projects, the FPOs were introduced to practice combined technologies similar to the Cargills project but farmers continue their own/traditions practices due to inadequate knowledge transfer, training and lack of close supervision/follow up action by technical experts. The discussions revealed that farmers tend to make their own conclusions based on the experience and knowledge that may not have any scientific base or proof and give negative signals to member farmers that the technology package is not feasible. This fact was observed in NCP where farmers require more attention/ follow up to make the ASMP technology initiative a success as in the case of Cargills/ SAPP.

v. Economic Threshold Levels (ETL):

Pests are virtually never eradicated. Pest populations must be maintained below a certain level. ETL can be defined as the population density of pest/ disease/ weeds which can cause sufficient loss to justify the cost of control. ETL for major plant protection concerns should be standardized and made available to farmers for them to initiate proper management operations. It is aware that many published documents/reports carry the ETL data for different pests in a variety of crops cultivated by farmers. However, it was observed at the field level the farmers are still not very concerned about the ETLs due to inadequate awareness and non-availability of farmer friendly ETL guides.

The provincial areas under the study reported that farmers who participated in IPM programs a few decades ago are remember their interaction with farmer clusters/technical experts to determine the pest levels to identify the necessity of control using ETL especially in rice fields. It was noted that IPM was not continued since the end of the donor facilitated project in the villages.

The FPOs in provincial areas are not familiar about the ETL and making the decision accordingly. However, they continue to keep track of pest emergence and irrespective of ETL, farmers use chemical pesticides intended to kill all pests including beneficiary insects. It was observed that the widening gap between AI and farmers have influenced dependency on increased chemical control methods.

Farmers understand that if proper guidelines and technical information is communicated to convince the benefits of ETLs and its contribution for reducing the cost of production by avoiding excessive use of pesticides, it can be implemented.

Table 4.11: Economic Threshold Levels (ETL)

Insect pest	Crops	ETL
Rice Thrips	Rice	50% leaves show damage symptoms
Gall midge	Rice	5% Gall
Leaf folder	Rice, Brinjal, Okra, Mango	10 live larvae in 10 random hills of rice or mango trees or 25% leaves show 50% damage/ Preventive measure for mango - spray to colonized areas on the trunk and foliage as spot applications. If necessary, apply at flower initiation and new flush growth. Other crops wet both sides of the leaves
Stem borer	Rice	Damage exceeds 10% dead hearts or 05% white heads
BPH	Rice	Nymphs/Adults exceeds 5-8/hill @ Tillering or 8-10/hill @ maturity.
Paddy bug	Rice	Bug density of 1 per 10hills
Case worm	Rice	10 live larvae in 10 random hills of rice or mango trees or 25% leaves show 50% damage
Rats	Rice/Ground nut	No ETL-Prevention--Baiting from planting to crop maturity-40 baiting places per ha. **ETL Ground nut 15 live burrows/ha**

Insect pest	**Crops**	**ETL**
Bean fly	Beans	No-ETL- Prevention-Seed treatment – 7 & 14 days after planting.
Bean pod borer	Beans,Capsicum,chili	No ETL –prevention- at flowering and repeat at 10-14 days intervals 3 sprayings for pulses.
White fly *(v/vector)*	Beans, tomato, brinjal, capsicum,chili,okra/Citrus	No-ETL-preventive or cure when signs of damage appear.- Chili Leaf curl complex (CLCC)/spray early morning when the activity of white flies are low & for thrips it is in the morning a wet spray/**Citrus WF -5-10 nymphs/leaf/Citrus Aphids –ETL 5-10% infested shoots./Melon Aphids 25% infested shoots. ETL ground nut5-10 aphids or thrips terminal buds/shoots @ seedling stage**
Aphids*(v/vector)*	Beans, tomato, brinjal, capsicum, chili/Citrus/Melon	
Thrips*(v/vector)*	Beans, tomato, brinjal, capsicum,chili,onion	
Mites Two spotted spider mites	Brinjal, Chili Citrus	No-ETL-preventive treatment-Spray underside of the leaves @ early infestation period./**Citrus 2% infested fruits or 10% infested leaves**
L/Eating Caterpillars	Cabbage	8 adult/12 plant or 4 larvae/12plants. At 1st sight of damage use P/C & 2Wk intervals. **ETL Ground nut 10% foliage damage**
Fruit borer	Tomato	No-ETL-preventive treatment
Leaf miner	Beet root	No-ETL-preventive treatment/remove mature leaves with pupae. **ETL Ground nut 2-3 larvae/plant**
Shoot/Fruit borer	Brinjal/Pea Aubergine, Okra	No-ETL-preventive treatment-destroy all damaged shoots/fruits-clean surrounding
Gal fly	Cucurbits	No-ETL-preventive recommended chemical treatment
Melon fly	Cucurbits	Apply bait underside the leaves-10-15ft apart, damaged plant parts pack in to black poly bag and keep under sunlight, follow preventive spraying
Fruit fly	Mango	Apply bait underside the leaves of lower branches-10-15ft apart, damaged plant parts pack in to black poly bag and keep under sunlight, follow recommended

Insect pest	Crops	ETL
		preventive spraying/**Mediterranean fruit fly 20 adults/trap/week**
Mealy bug/Scale insects	Pineapple, Papaya, citrus	No-ETL- for P/A-Only recommended preventive pre-planting treatment/monitor after 1st harvest & repeat if any incidence.-for Papaya- recommended non-chemical methods, if infestation prevails spray mineral oils/ Remove & destroy damaged plant parts & spray to wet the infested area/**Citrus – 5-10% infested fruits.**
Stem & Cob borer	Maize	No –ETL- Preventive -Direct spray to central whorl' at 25-35 & at 45-55 days after planting.
Caterpillar	Onion	No-ETL recommended chemical treatment
Pod sucking bug	Grain legumes	No-ETL recommended chemical treatment
Sesame leaf weber	Grain legumes	No-ETL recommended chemical treatment
Black cutworm	Veg/legumes/fruits	No-ETL Drench soil around the base of the plants late evening as the damage is observed
Root eating ants	Vegetables	No-ETL recommended chemical treatment; Apply chemicals to soil around plants
Root knot nematodes	Vegetables	
Damping off/foot rot/root rot	All crops other than rice	No-ETL –Preventive-seed treatment/soil treatment-no chemical (burning/solarization/ sterilization of nursery beds.
Anthracnose	Vegetables,legumse,cereals	No-ETL-recommended chemical use.
Downey mildew	Cucurbits	No-ETL –Preventive measure recommended
Powdery mildew	Cucurbits	No-ETL –Preventive measures recommended with warning; Sulphur containing fungicide are not

Insect pest	Crops	ETL
		recommended for cucurbits and can be phytotoxic during hot weather
Stem weevil	Banana	5% infested plants
Root weevil		

Source; DOA-pesticide Recommendation 2015

As per above table there is documented information on ETL, available for the use of farming communities in the provinces. However, the results of the study indicated the farmers' knowledge on ETL is not satisfactory due to lack of diffusion of information through farm level experimentation and demonstration.

It was noted that ETLs are established for most of the rice pests and for vegetables it is not adequately considered. The farmers identify that having ETLs for diverse pests for crops in respective provinces are important for them to guide their decision and initiate or select proper control technology.

It was made to understand that farmers are getting rid of using insect traps (light/sticky) as they believed it kills all pests in the field and they are not aware of the next step for separating/differentiating/identification of those insects to determine the level of pest occurrence and potential damage.

vi. Pheromones:

Erecting pheromone traps in fields helps in pest monitoring. It can also be used to "attract and destroy." This method of pest control which indirectly helps in reducing mating, egg laying and pest proliferation on crop. In the rural farming areas the use of pheromones is a popular activity especially among the farmer cultivating Cucurbits, Guava, Mango. Based on the farmers' information the pheromone is mainly used for control of fruit fly and they are not concerned to monitor or judge or assess the number of insects/different types of insect that were caught in the trap.

Case study

The recent pest occurrence, FAW caused a rapid devastation of maize cultivations in the provinces and made Sri Lanka learn a bitter lesson, while inculcating good remedial procedures that could be replicated to crops other than maize as well. It is learnt that use of pesticides alone or non-chemical technologies cannot completely eradicate any pest or disease infestations. However, there is the ability to control the economic losses or economic injury to the crops with effective and sustainable management through actions on pest monitoring, prevention and interventions.

It has become the turning point for farmers to re-think about the unlimited use of pesticides as an ultimate solution for pest and diseases problems. Though farmers have understood that using chemicals is not the best option, they continue to do so due to the inability to perceive a better option.

Raising awareness about the FAW and understanding lessons learned from other parts of the world, including available management options identifying the lifecycle and population characteristics of the FAW, the DOA with the support of FAO developed procedures on how to scout the pest among management strategies. The information includes a range of options available apart from using hazardous pesticides, minimizing the use of chemical pesticides, and educating policy makers and farmers about agro-ecological approaches.

The study also identifies that there is a growing concern about FAW affecting the crops other than maize, especially the rice cultivation and sugar cane in the provinces. The interventions of FAO has shared international experience to successfully determine the FAW population levels by field scouting and use of pheromone traps. Introducing the technology for Fall Armyworm Monitoring and Early Warning system mobile app the FAO supports the MOA extension services in the field to manage /identify all stages of FAW; to detect the pest, monitor the level of infestation, to map its spread to make decisions, as well as to learn about the important natural enemies and the measures that are most effective in managing it.

The farmers in maize growing areas have informed about the use of plant extracts (Neem poonack and Neem bark mixed with cow dung applied during early growing stage has effectively managed the crops that repelled or controlled the incidence of FAW during the recent season Maha 2018/19.

The e.g. shown below identifies the adoption of a monitoring method established by TRI for decision making for control measures through three (03) infestation levels of Tea-tortrix. The threshold levels are categorized in to three groups based on three stages of the life cycle

Group 1: All larvae (caterpillars) –

A: Healthy larvae less than 2.5 cm length –***if this is above 50% P/C spraying is recommended***
B: Healthy larvae more than 2.5 cm length – ***P/C spraying not necessary***
C: Diseased and dead larvae – ***P/C spraying not necessary***

Group 2: Healthy pupae and fresh egg masses. ***If seen as a majority keep vigilant for new pest generations***

Group 3: Empty nests, Macrocentrus cocoons, empty pupae – ***if seen as a majority spraying is not necessary***

In view of the above, monitoring is one of the essential tools for pest management at field level and though the farmer is knowledgeable, the skills are very low and attitudes towards implementing effective monitoring mechanisms needs to be screened urgently while mitigating the knowledge gaps.

4.5.2 Interventions & Prevention practices for Pest management

4.5.2.1 Cultural methods or agronomic practices:

The Agro Ecological conditions in the five provincial areas identify similarities in climate, soil and environmental factors. It was clear from the majority of the identified crops which are cultivated through the provinces. However, there is clear differences in the cultivation pattern in small farm allotments. The rice cultivation shows a definite pattern on two seasonal investments depending on the availability of irrigation supplement and rain fall pattern. Vegetable farming observed mainly in the highland areas and in the paddy cultivated areas especially during (Yala) dry periods.

The recent development of PGH agribusinesses have contributed towards the regular supply of produce by changing the cropping systems seasonally to year round cultivation capturing emerging consumer markets including export and modern retailing trade. It was also noted that PGH became the model for farmers to think about innovative developments in the agriculture production that promoted irrigation technology, introducing high energy input in to the open field farming.

The study observed that open field crop production systems in the area are moving towards commercial agriculture production with increasing interactions with market entities that helped to change their attitudes on seasonal production to year round production with irrigation technology interventions especially tapping the ground water sources with modern irrigation methods.

It was noted that the rural farmers have increasingly embarked to invest on long term crops especially selected fruit cultivation, identifying increasing consumer demand locally and overseas. Identifying the change the ASMP provincial program has focused on expanding fruit production as a sustainable income option for farmers. Accordingly, the fruit cultivation that revolved around the home gardens, became a commercial operation through FPO in project provinces. Under FPO each farmer cultivated fruits covering an extent more than 0.5acs is supported with modern irrigation systems, production technologies and high yielding planting materials.

Table 4.12: Pattern of farming in the provincial areas

Pattern of cultivation	Province *(No.of Farmers & %)*					
	Central	UVA	East	North	N/C	% of total
Yala season only	00	00	00	00	00	00
Yala & Maha season	16	19	36	42	45	80
Maha only	00	00	00	00	00	00
Yala & Mid-season	00	00	00	00	00	00
Yala,Mid & Maha	4	07	10	08	10	20
Continuous	00	00	00	00	00	00
	20	26	46	50	55	197

Source; Expert team S&P Holdings 2019

Table 4.13: Adoption of different Agronomic practices in study area

Description	Province *(No.of Farmers & %)*					
	Central	UVA	East	North	N/C	% of total
Crop residue disposal ; burying, composting, recycling	7(35)	19(73)	44(96)	31(62)	39(71)	141(72)
Land preparation Ploughing/Tillering/ harrowing/	20(100)	26(100)	46(100)	50(100)	55(100)	197(100)
Soil treatment-soil testing, sterilization	13(65)	24(93)	7(15)	24(48)	15(27)	83(42)
Plant Spacing-recommended density	16(80)	25(96)	30(65)	44(88)	26(42)	141(72)
Nutrients use on Recommendations or above	20(100)	23(88)	44(96)	42(84)	41(71)	170(86)
Irrigation (Flood/Drip/sprinkler/furrow)	20(100)	26(100)	46(100)	50(100)	55(100)	197(100)
Traps-baits, sticky traps, light traps, pheromones.	6(30)	3(11)	5(11)	10(20)	17(31)	41(21)
Total	20	26	46	50	55	197

Source; Expert team S&P Holdings 2019

Although the farmers' responded positively on adoption of agronomic practices, the methods implemented are not effectively contributed for the optimum growth of the crop and thereby reducing the infestation. It was observed though they are ploughing, the practice of deep ploughing is implemented by very few farmers. Similarly every farmer uses some form of irrigation but most of them used surface water flowing methods contributing towards the wastage of scarce water resources while few implemented with modern irrigation techniques but yet there is need for more technical improvements for increasing efficiency. The cultivation practices themselves on crops could be modified without affecting the productivity, in order to bring down pest population below the economic injury level. Also, the different cultural practices helps to create a micro-environment conducive to better crop growth; they do not demand supplementary input materials other than a few more labour hours. Community participation is essential to find a long-term sustainable solution for issues related to weeds, pests & disease infestation in food crop cultivation under small farm fields.Continuous education and monitoring will play a crucial role at all times to protect our agriculture and ensure food security.

i. Crop rotation

Farmers with their own experience is aware of the effectiveness of crop rotation in terms of managing pest incidences in the crop growing fields. The farmers indicated the rotational planting of different crop varieties will enhance the soil fertility and productivity of small farm lands.

Table 4.14: Implementation of cropping practices

Crop Model	No of Famers and %					
	Central	Eastern	North Central	Northern	Uva	% of Total
Crop rotation	7(35)	27(60)	20(41)	13(28)	5(20)	72(37)
Inter cropping	2(10)		1(2)	1(2)		4(2)
Mix cropping	1(5)	10(22)	9(18)	19(40)	7(28)	46(23)
Mono cropping	10(50)	8(18)	19(39)	14(30)	13(52)	64(33)
Total (No Reported)	**20**	**45**	**49**	**47**	**25**	**197**

Source; Expert team S&P Holdings 2019

The clusters cultivating seasonal crops such as ground nut, chilli, B-onion, and bitter gourd have shown decades of experience on crop rotation with different types of crops. The selection of crops varies according to the provincial agro ecology pattern.

Eastern Province ATDP

Farmer FPO in Vahare DS division, Kathirveli in the East cultivate maize, green gram, cowpea, as alternate crops for ground nut. The particular FPO cultivates maize during the Maha season and have successfully experimented a bio method for control of FAW by applying Neem poonack and Neem bark mixed with cow dung during early growing stage. This envisaged that though the farmers show a negative attitude towards non chemical pest management technologies it is still valid among them and used as and when needed. This may be a window of opportunity to demonstrate and promote among the provincial FPOs.

The Cucumber FPO is an exceptional cluster that implements cultivation based on the training/ guidance, technology and inputs provided by the link company. In coordination with the relevant company, the FPOs repeatedly cultivated three crops within a year (Feb-May-Aug). Only during heavy rain season where Cucumber is not cultivated due to poor drainage an alternate crop; rice is cultivated. Also the company with the concurrence of farmers decide on the cultivation of selected crops with due consideration for any potential threat from pests and disease incidences using monitoring tools to avoid any crop losses. The FPOs are not aware of such forecasting. After two or three crops of Cucumber an alternate crop (Red Onion, long bean, Green Gram, Cowpea, green cucumber and melon for the local market) is cultivated by FPO to reduce the infestation of P&D.

The Kaluthaweli FPO main crop was traditional chilli type PC-1 is rotated with Red onion, brinjal, beet root and rice. Red Onion is a popular alternate for Chilli. Recently the farmers have introduced beet root as alternate crop after chilli and yet to be popularized among the majority farmers. It was observed that many chili field are cultivated with marigold flower plants along the border of the land as a traditional pest repellant crop. Based on the farmers experience it was identified as a success but needs more technical inputs on growing/ managing companion crops for insect repellant.

Northern Province ATDP

The farmer FPOs in Jaffna in the Northern area are cultivating Ground nut for the first time with a major crop introduced by the ASMP, which is TJC Mango. The ground nut production is a new experience for the farmers in Jaffna. Ground nut is the major intercrop until mango trees reaches the age of 4-5 years. The farmers based on their experience, practice crop rotation with red onion, king yam, chilli (Vanni type) Bitter gourd, snake gourd, Brinjal, Long bean, Okra, Cow pea, Black Gram, Green Gram and Paddy. Beneficiaries of same FPO establish border crops such as maize, Sorghum, marigold flower plants, sun hemp between beds and outer border of the field as a measure in managing the pest incidence and soil rehabilitation for better plant growth.

The farmers in Jaffna area revealed the experience of mix cropping of Chilli and red-Onion, an ideal crop combination brought over for many generations due to successes in the reduced pesticides use. Chilli is planted 30 days after planting the onions. It effectively reduces the burden of labour for weeding.

Farmer fields in Oddususdan/ Mullativu identified major crop in Ground nut which is cultivated all year round and harvested in Jan, April, and October each year. During heavy rains most of the lands are cultivated with rice under rain fed or irrigatedsystems. A majority of farmers indicated that the alternate crop is rice during the rainy season where lands are not conducive for highland crops. The study found that changing farming practices with the introduction of innovative technology leading to development of the year round cultivation of selected highland crops by facilitating the soil drainage even during rainy periods. This was evident where crop rotation is practiced with red onion, brinjal, green Gram, Kurakkan, sun hemp and rice; allowing the farmer to generate an income throughout the year with minimum pest occurrences. However, farmers with or without understanding prompted to use chemical pesticides to avoid any risk of pests.

UVA Province ATDP

ATDP pilot projects for cultivation of passion fruit, mango, pineapple, promoted with established farmer clusters in identified GN divisions in Buttala, Wellawaya, Medagama, Bibile, Kodayana, Siyambalanduwa area. Intercropping of ground nut, green gram is observed under at the new mango cultivations and the pineapple farmer cluster proposed to plant bananas as an intercrop which is yet to be implement. The passion fruit cultivations are presently at a harvesting stage and intercropping was not emphasized as vines are grown and farmers' involvement in crop management activities. Further the PPMU proposed to promote maize, ground nut, red onion, black gram, green gram, capsicum, melon and pumpkins under the new FPOs.

Apart from the ASMP interventions, it was reported that a modernized agriculture cluster farmer program has been successfully implemented in the province. The company has extended support to technology transfer through training/ exposure visits/ TOTs and promoting small farmers to adopt improved technology/ inputs guided by local and internationally renowned experts. The particular project essentially addressed technologies for managing pest incidence and reduced use of pesticides.

North Central Province ATDP

The NCP /PPMU implements pilot scale ATDPs for chilli, bitter gourd, guava, papaya, and mushrooms. The observations in the field ascertained that though the farmers are aware of the benefits of intercropping, border planting of crops like maize, sorghum, sesame, Kurakkan, etc., are not cultivated. The members of FPOs are granted with insect proof nets, drip irrigation systems and polymulch. The scattered cultivations are observed within large cleared areas. Based on the farmer information, the cultivated farms are highly prone to wind damages, climate change effects, and increased temperature due to a high amount of sunlight that could lead to poor plant growth. Further the nets/polymulch and drip irrigation systems are not properly installed and the farmers are not convinced about the performance. It was reported that farmers are new to this technology and inadequate follow up programs after installation have hindered the effectives of the interventions. The new guava cultivated fields are intercropped with melon/ cucumber/ pea aubergine according to the past experiences in farming.

Central province ATDP

PPMU central province have implemented two pilot projects on B-onion seed production and mango TJC cultivation. Guava cultivation was observed to be well suited for the provincial agro ecological zones. It is planned to promote passion fruit in select districts in the province. B-onion farmers informed that they do year round cultivation and after B-onion, that land is used for growing gourds and then in the rainy season its paddy. The Vegetables such as thumba, peas, aubergine, long beans, green gram, oil crops (sesame), maize, kurakkan, are considered for intercropping/ mixed cropping and crop rotation practices in the area.

The crop rotation practices in the provinces ascertained that farmers are well aware of the practices and have better idea for crop combinations depending on the season. Though different crops are cultivated alternatively, some farmers use crop varieties of same family envisaging the market potential but causing negative effects on soil fertility/ nutrients and continued damages of pests & diseases. Also it is noted that crop rotation and intercropping practices require to be strengthened through awareness, experiments and demonstration by bringing in the results of research & development findings in to farmers' door step.

Repeated cultivation of a single crop results in the progressive buildup of soil-borne insect pests and pathogens, which are injurious to the crop. Furthermore, certain pests are associated with specific crop types which feed voraciously and multiply rapidly with the presence of the same crop. In addition, the progressive cultivation of the same crop (eg-cucumber in Vahare) favours the increase in uncontrolled growth of weeds which could be checked by the adoption of a different crop (farmers grew sweet potato as alternative crop aiming to suppress the weed infestation) in the successive season. Hence, crop rotation would be an effective and profitable method of reducing insect pests, diseases and even some weeds.

Pests which feed on crop plants transfer themselves to alternate hosts during the off season. The growth and multiplication of pests during the off season becomes low because the alternate host plants do not provide the ideal source of food for the insects. However, an increase in the extent of staggered planting techniques, combined with cultivation of varieties in different age classes, provides a continuous source of food for insect pests throughout the year. This leads to the rapid proliferation of the pest and disease population.

ii. Use of resistant varieties

The globalization developments has influenced the diversification of Sri Lanka's agriculture sector to establish more market oriented production systems with improved technology/inputs to cater to the increasing demands in diverse consumer segments locally and globally. The interventions promoted the use of high yielding crop varieties with in-built characteristics to resist P&D with uniform size shape and colour of produce attracting the consumers.

However, Sri Lanka has a long experience for producing seed and panting materials of native varieties certified for their resistance for P&D and yield performances. In the context of expanding Agriculture investments/ adoption of modern technologies, especially in the vegetable farming sector has increased the demand for high yielding seed and planting materials. However, the limitations for production of seed/ planting materials locally have forced to open the doors for import and fill the gap. The imported seed becames popular among the farmers due to its availability, characteristics and performance coupled with market preferences compared to local seed varieties.

Identifying the demand for seed and influenced by the liberalized seed and planting material, import and distribution, the private sector Agri Input companies responded with import and supply of high quality high yielding hybrid varieties of vegetables and fruits.

It was made aware that the papaya variety Red lady became the number one type in Sri Lanka due to its resistance to the Papaya Mosaic Virus. It was observed that at present the farmers in all provinces cultivate red lady type and the local varieties are rapidly extinct over the past few decades.

Maize is mainly cultivated using imported hybrid seeds and the demand for OPV maize seeds in Sri Lanka is less than 5% of the total requirement. Production hybrid vegetable seeds in the local farms are limited to brinjal, capsicum, tomato, okra and cucumber varieties that were produced successfully in Aluttarama, Kundasale, Maha-Illuppallama and Ambepussa seed farms.

Table 4.15: Types of seed/ planting materials used in the provinces

	Crop Classification	Crop	Varieties
1	Vegetables	Chilli	MI 01, MI2,,KA02, CP1, MICP2, MICH3, MICH2, Galkiriyagama, Jaffna variety, Pioneer, Spartacus, Raj Hot, Super indum
2		Capsicum (Malu Miris)	Hangarian Yellow Wax, CA8, Bulnose, Muriya, Mcmillan, Thai Hot, Veena, Sanjana, Kashmeer,
3		Bitter Gourds	Tjinnaweli, Pali, Matale Green, Kalu Karawila, Maduri, Maya,
4		Ridge Gourds	Naga, Cleo, LA33, Mallika, Nadee, Royal Clio, Mayuri, Rupi, Kisalka, Kaki Maro
5		Snake Gourds	MI0l, MI Short, TA3
6		Cucumber	Shivani, LY58, Sayali, Shivani, Akila, M.C.R.X 33
7		Kakiri	Local, Hen Kakiri, Monika, Malee
8		Bean	Pokuru Shetti, Black Kora, Bushitha, Nayaru, A9,
9		Long Bean (Maae)	Mash Maee, Hawari Maee, Polon Maee, Sukumita
10		Pumpkin	Moragollagama, Lara, Malinga, Suprima, Arjuna, Pragathi
11		Dubai Wattakka	malborrow, Mimini, Royal, Best American, Peacock, Bingo
12		Brinjal	Lenairi, Padagoda, Raveena, Jaffna, Isakek, Macco,
13		Egg Plant (Thalana Batu)	Local, Cremit,
14		Cauliflower	Chamin snow, Mareet, CIC
15		Cabbage	Green Midori, Green Konet
16		Carrot	Inca
17		Rabi (Raddish)	Beeralu, Diga Raabu, Snow White, Urul, Red Radish
18		Knol Khol	Early white viana, Takeshi, Toku, CIC
19		Pumpkin	Suprima, Arjun, Lara, Baddy, Gajaba, Leela

	Crop Classification	**Crop**	**Varieties**
20		Beet	Onesh best red, Supreem Red
21		Tomato	Thilina, Padma, Platinum, Makish, Abiman, Kumari
22		Okra	MI5, Haritha, Shakthi, Athdala, Shanthi, Sukesha
23		Ash Plantain	Prasad
24		Mushroom	american oyster
25	Fruits	Melon	Rokee 375, Rokee 475, Strong, Kinari, Sugar Baby, Yuwaraj
26		Guava	Horana White, Lanka jayant, Kilo Pera, Apple Pera,
27		Papaya	Sinta, Red Lady, Tanin,
28		Promogranade	Nimali, Nayana,
29		Dragon Fruits	White, Purple
30		Passionfruit	Yellow, Purple, Horana
31		Mango	Kartha Colomban, Willad, Tom EJC, Rata Amba, Malvana
32	Oil Crops	Soya	PB01, MISB1, PM13
33		Groundnut	MI1, Tissa, Indi, Walawa, Lanka Jambo
34	Grains	Maize	Pacific 1 MIHY1, MIHY2, CIC 998
35	Condiments	Big Onions	MIBO1, Rampoor Red, Rampoor Rose, Galewela,
36	Other	Moringa	PKM1 (for leaves)

Source; S&P Holdings PL, 2019

The farmers are aware that all (imported/ local) seeds and planting materials available have been tested and certified under SCPPC/ DOA for its characteristics especially on yield potential and pest & disease resistance. In view of the attractive product characteristics farmers have shown interest to cultivate, hybrid or improved varieties of vegetables such as bitter gourd, ridged gourd, tomato, eggplant, cucumber, okra, onion, melon, long bean and pumpkin capturing a wide array of consumer markets. The study revealed that there is no nutrient recommendation published for hybrid/ improved seed and planting materials. Farmers on their own use different doses of fertilizer/ hormones/ additives, not knowing the negative impacts. There is a need to develop/ improve and establish input recommendations for high yielding varieties to reap the maximum benefits for the farmers.

An exception is found in the East and among some farmers in the North who have continuously grown a specialty chilli, native to the Kaluthaweli area known as PC-1 which resistant to common pests and diseases which occur in the area.

The FPOs under central province PPMU in coordination with the farmers implemented a cluster development program on producing B-Onion seed for select high yielding varieties has proven to be successful compared to imported types. It was reported that the quality of imported seed are poor due to low germination characteristics, susceptibility to pests/ diseases and importantly the lack of certification from a recognized authority in the country from which it is imported. The high tech methods with structures for seed production are developed under the ASMP interventions. As well, the establishment of the seed certification protocol is in progress.

It was observed that nurseries for raising seedlings have continued to be traditional. There is high potential that seedlings raised in the field using soil beds are prone to infestations due to soil borne illnesses, occurrence of pests, leading to poor growing conditions. The vigour of seedlings is further declined due to damaging of roots when uprooted for planting, causing uneven growth conditions after transplanting. It was noted that especially PGH growers use pelleted transplanting seed trays for raising vigorous seedlings under hygienically managed conditions. The use of sound nursery technology with sterilized pellets raises the quality and the vigorous planting material contributes to increased tolerance level towards the occurrence of pests/ diseases at the initial vegetative growth.

Farmers have developed a built in attitude, and believes that high yielding varieties essentially require the high energy inputs and dependence of pesticides. Accordingly it was observed that, irrespective of positive/ proven characteristics of the improved or native seed materials the farmers tend to implement routine application of pesticides though there are no symptoms of pests/ disease. They are not concerned about the increased cost of production and negative impact towards humans and the environment due to toxic residues. The results indicated that the level of knowledge and skills of farmers, is not adequate to make them understand about the proven resistance for pests and disease characteristics.

The selection and breeding of crop varieties resistant to insect pests and diseases have demonstrated the enormous potential of this method in the reduction of pests and diseases. In certain cases there are no effective methods of control of certain plant diseases, particularly those caused by viruses; here the only available alternative would be the cultivation of resistant varieties.

Some crops, when planted in an area where the environmental factors are optimum for its development, perform well and give an early harvest. On the other hand when the same crop is planted on land where the factors of crop growth are below the optimum requirement, the growing period is substantially lengthened and as a result the incidence, of pest attack may be high. Still the crops become more susceptible to particular P&D when planted in an area where the incidence of attack is reported to be high. Similarly short-aged crops are preferred to long-aged crops; in the latter case the period of crop exposure to natural calamities such as climate change, pest and disease outbreaks, is high and is subjected to a greater risk of pest attacks. Therefore, careful attention should be given to the selection of crops/ seed/ planting materials with particular reference to the climate of the area, where it is expected to be planted as it is a good strategy to minimize pest outbreaks.

iii. Crop refuse disposal

A majority of farmers in the study area have not thought about the seriousness of accumulating plant debris in the farm land. The study noted that heaps of crop waste and household garbage is dumped in the vicinity of farms and the surrounding areas especially around the borders which was also infested with high grown weeds and semi dried/dried plant debris. The accumulation of waste provides an ideal source of alternate host for the pest & disease organisms to continue their life cycle making it difficult to control the incidence/epidemic. The study identified that vegetable cultivations under a semi protected net covering was infected and farmers continued chemical spraying. Even after spraying several rounds of chemical pesticides including the use of baits/pheromones, the pest infestation persisted due to the unhygienic status of the farming area and its environs.

The farmers have not shown any interest to recycle the crop waste in order to make compost but as a practice, the waste is burned sporadically in order to reduce the volume of waste. The farmers themselves do not possess an understanding on the impact of pest and disease controlling. Also the farmers have no clear perception of the economical advantage in adding self-made compost to the cultivation area.

According to the farmers in the project area and outside areas indicated the need for adding compost to enhance soil fertility. It is reported that 5-8 tons of compost per acre is added during the land preparation and the cost incurred is LKR 12000 to LKR 15000 per acre. The price per ton is varied from LKR 1900 to LKR 2400 depending on the type of compost and distance to farm from the source. Farmers in the study area are well aware that adding compost is beneficial for increasing the soil fertility and vigorous plant growth.

The study found an enthusiastic farmer cluster counting over 100 members growing a selected variety of moringa for leaf harvesting on contract supply basis. The private company contracted with farmers have established the A-Z production and harvesting package for farmers covering all activities under the crop cycle. The farms are well managed to maintain the hygienic conditions. Every farmer has their own compost unit collecting crop waste, household food waste for recycling purpose. Farmers informed that the compost is ready within 3-4 weeks and it is added to soil at the rate of 2Kg per plant every two months, saving on cost for inorganic fertilizer while improve the soil nutrient and moisture holding capacities for healthy growing of plants.

The study results indicated that a majority of farmers in the Northern and Eastern province have integrated the used compost as an important/ necessary practice for seasonal crop cultivation as it is proven for generations.

Since the occurrence of FAW damages on maize, the farmers are now showing an interest to keeping the surrounding of the farm and crop area clean and hygienic to avoid any possible infestations. They are aware that though FAW preferrs to feed on maize they are able to live comfortably in about 100 plant species that cover rice and vegetables. It is important to clear the field as soon as harvesting is over. The stubble should be burnt, soil should be ploughed/tilled, and weeds should be controlled to make sure the growth stages of the pest will not transform into an adult.

The study found that a major mistake in the recent past was to transport fresh parts of the maize plant that may have been collected from infected fields as well, to be used as animal feed. This contributed to further aggravating the spread of the pest in distant places. On-site silage making (poly-silage or silage bales) would be better options. Government departments such as the NLDB should be provided with facilities to do so while obtaining the services of the private sector.

iv. Tillage of soil

The appropriate land management includes a combination of mechanical, biological and cultural practices as recommended by the DOA. Although the recommended practices for soil conservation in farming in different AER is communicated to farmers the problem of land degradation continued over time is largely due to inadequate understanding, farmers' attitudes influenced by area based socio – economic status and continued traditional practices. The traditional practices of "Chena cultivation" is carried forward through generations, where land clearing and burning that influence the pest incidences due to destabilization of the natural habitat and equilibrium of the living environment.

The increasing trend for mechanization of farm activities in all provinces was observed and almost all farmers use two wheel or four wheel tractors. Tine tiller is the common equipment used in land preparation for seasonal crops such as chilli, ground nut, bitter gourd, B-onion, red onion, maize, cucumber, melon. According to farmers, the land is loosened with tiller and levelled by rotavator. Sunken beds is a common land practice to enable the flood to soak the planting area where farmers' experiences indicate that in the dry zone farming it is an essential cultivation practice. This also helps the farmer to control soil erosion. The cultivation of vegetables under sunken individual plant beds was another popular practice in Northern farming areas. It was made to understand that the farmers are not willing to take any risks by changing the pattern on which they are experienced though the new methods are technically productive. The clusters studied, informed that there are no experiments/ demonstrations for new technical systems to make aware and convince the farmers for its benefits over the traditional farming methods.

Except for a few the majority of farmers in the study sample have not practiced any deep ploughing to enable/ facilitate the drainage and improved aeration of the soil. Field observations revealed that poor soil aeration and excessive water application have caused uneven crop growth effecting the yield due to occurrence of P&D and nutrient deficiencies.

The fruit farming in the project area have used different practices for planting such as deep ploughing levelling and planting in holes of 2'x2'x'2, where in some areas the land is not ploughed/ harrowed/ tilled it is planted spot holes at recommended spacing. These planting areas are demarcated/ separated by sunken beds for intercropping vegetables, Ground nuts and melon until fruit trees are fully grown. The intercropping keep disturbing the soil during each crop cycle as required for weeding through tillage. However, under B-onion it was restricted using machines as it damages the crop and therefore only chemical weeding is practiced.

The differences of growing conditions was observed in farmers' fields that used recommended land and soil preparation practices such as deep ploughing, preparation of ridge/beds and furrows as part of the integrated vegetable growing clusters that uses modern agro technology as guided by the leading modern retailing chain in Sri Lanka. The farmers highlighted that the use of right technology for the preparation of soil/ land development was the basis that created favorable conditions for the initial vegetative growth. It was pointed out that facilitating the vigorous plant growth will strengthen the ability to withstand/ tolerate any P&D occurrence without chemical usage.

It is further proven that the land preparation technology introduced to the moringa cluster in NCP, achieved best growing conditions that kept the pest and disease occurrence at levels which are not harmful. It is learned that farmers are not very attentive for soil testing practices due to poor awareness and knowledge. Also it is required to test the soil for its pH, fertility levels, moisture holding capacity, nutrients composition, etc., for proper management of soil, fertility, P&D.

The FPOs under ASMP programs are yet to familiarize themselves with equipments/ machineries provided through the project. It was reported that farmers lack the capacity and exposure for technical aspects related to operation and maintenance of new equipment/ machineries.

During the tillage the soil borne infections, pests and micro-organisms are disturbed and exposed to sunlight. Also it will attract birds and other small insects that will feed on creatures emerged on the surface and destroy a fair amount of pests/ micro –organisms which maybe harmful or not. Farmers are aware of the advantages of soil and land preparation and its contribution to reducing the incidence of pests during the initial crop growth.

The research information shows that the soil conditions are improved greatly by using Bio-Fertilizers (group of beneficial micro-organisms or specific micro-organisms) that would stimulate plant growth, restore natural soil fertility, enhance soil biological factors and, increase protection against drought/ soil borne diseases and replace inorganic N and P by 25%, accruing increased crop yield by 20-30%.

The discussions revealed that farmers use compost as a practice carried over for generations and aware that will contribute to improve the soil nutrients level and water holding capacity. However, they are not familiar with bio fertilizers. It was noted that the heavy use of compost in East and North is used to improve the fertility level, especially for the sandy soils. However, there is no testing of soil to identify the levels of the variety of available nutrients, soil acidity, availability of harmful residues, soil borne pests/ diseases, etc., making decisions for management practices for optimum plant growth to mitigate any pest and disease incidences. The FPO in the project provinces expressed the fact that they are not aware of the testing process though they were informed of the value and importance, through DOA and other training programs. Also it was highlighted that soil testing is limited to identifying few parameters where farmers seek more information about contents for micro nutrients, level of pests and disease occurrence, level of residues, etc.

Adoption of proper land preparation practices contributes towards the reduction inthe P&D incidences by exposing the different growth stages of pests and organisms which are naturally controlled by environmental factors and predatory/ parasitic action. Land preparation is also important for the control of weeds.

The need for better soil preparation and management practices was further highlighted during the recent FAW attack on maize. It was identified that FAW pupae lives in the soil before giving birth to the moth, which usually emerges in the night to start its flight to lay eggs again at a distance. This alert the farmers to be informed that good soil management practices automatically reduces the incidences of pest and disease infestation.

v. Time of Planting/harvesting

Farmers are aware of the two distinct seasonal variations in diverse ecological regions within the study area. Traditionally, the time of planting is determined through generations in various agricultural system and experience the contribution for reduced occurrence of pest & diseases during crop growth especially at the initial vegetative stage. Even though the farmers are knowledgeable, still practice the traditional methods ignoring the potentials benefits of timely planting.

Farmers experienced mixed results especially when the planting time is deviated where they faced increased crop damages due to pests and diseases, loss of yield due to prolonged rainy/ drought conditions during / flowering / harvesting. The project related FPOs noted that they implement timely planting and harvesting according to a crop cultivation schedule determined and agreed by all.

The FPOs cultivating ground nut emphasized that due to delay in planting time the crop had suffered white fly thrips/ aphids, and increased infestation of bud necrosis during the early crop growth where it was indicated that timely planted fields are not affected. The farmers in

East & North identified that ground nut requires timely harvesting where delay in 4-5days will cause loss of yield due to pod detachment during uprooting. This also incurs an additional cost for labour to unearth and collect the detached pods.

The farmers in the NCP moringa cluster, have invented the best practices and timing of different activities within the crop cycle. In this regard the cluster has determined that the leaves should be harvested during the day time to protect the plant from infections and occurrence of pests that are influenced by harvesting the crop since sunset.

Further the farmer cluster in Kathirveli informed that the FAW incidence on maize was negligible in the area due to timely planting and harvesting at a correct maturity stage that further confirmed timely cultivation which is still a valid option for minimizing the crop damages. The statistical information on climatic conditions in the study provinces identified are almost stable over the decades though many forums discuss the climate change and seasonal variations. It was observed the farming in the provinces continue to cultivate with the Yala & Maha seasonal rainfall pattern. In some farming areas an increasing trend is observed on mid seasonal cropping with the adoption of modern irrigation methods coupled with improved seed high tolerance to deviations of climatic conditions and responsive for high energy plant nutrients/ hormones/ growth regulators.

Table 4.16: Climatic status during 2008 to 2017

Description	**Average of 10year (2008-2017) data for all districts in each province**									
	Central		**UVA**		**East**		**North**		**N/C**	
Annual mean temperature (^{0}C)	20.75		22.19		28.58		28.32		28.12	
Annual rainfall (mm)	1743.23		1814.20		1800.03		1976.54		1577.71	
Annual rainy days	2008	2017	2008	2017	2008	2017	2008	2017	2008	2017
	184	170	174	146.5	108	96	86	82	123	102
Humidity % (day)	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
January	71	71	75	72	76	76	75	76	73	73
December	71	79	71	82	76	78	77	77	72	76

Source; Dept. of Census & Statistics

The statistics indicates that over the last decade there is no significant variations in the climate with regard to temperature, rain fall and humidity. However, the rainfall intensity is varied or in most provinces the rain fall distribution over a number of daysdecreased. This pattern may cause effects on plant growth and productivity, especially in short term crops. Despite the climate changing effects on crop growth farmers continue the traditional practices. Determining the time of planting/ harvesting is therefore considered a priority area for suppressing the occurrence of P&D. It was identified that the increasing day temperature in some provinces caused detrimental effects to the crop growth especially during vegetative and flowering stages. The P/F FPO in UVA PPMU discussed the effect of temperature for crop growth. There is emerging climate challenges due to lack of well distributed rain fall and increased temperature. Though the farms were installed with modern irrigation systems the plants growth is not uniform. The climatic status is changing and there is possibility for increasing temperature during the daytime and it may continue for a number of days. A varied level of plant growth in the same fields could aggravate the conditions for pest build up and survival. In view of this it is noted that considering scheduled planting programs covering timing for the entire crop cycle is important to keep the pests and diseases at low levels.

The time of cultivation can influence the rapid development and multiplication of pests. Some insect pests, multiply swiftly and reach very high levels during certain time periods during seasons, while the pest population is less throughout the rest of the season. The time of planting can therefore be adjusted in such a way to plant the crop by the time when the number increases, either the crop may be ready to harvest or may not be there in the field, thus ensuring the protection of crop from P&D infestation.

vi. Plant spacing/ Thinning and Pruning

Adoption of recommended planting practices at field level varies according to the AER and socio economic status of the farmer clusters established in the provinces. It was revealed that the increasing technology interventions in the rural farming systems, influenced to deviate from traditional/recommended methods achieving better control over pest and diseases and crop yield. Experienced chili farmers in the Northern area plant 4-5 seedling per hill continuing the traditional method envisaging a micro climatic conditions below crop canopy and helping the plant to perform at its optimum level. Farmers reported that planting more plants per hill enables to perform continued harvesting even during adverse conditions. However, it was identified that there is a high risk of pest and disease infestation such as LCC of chilli, thrips, leaf- eating caterpillars/ pod borers, anthracnose leading to crop losses. In Mullativu area it was found that farmers use a high rate of seed per unit land area for planting ground nut.

The farmers cultivating improved and high value seed and planting material are following the guidelines as recommended/ direction provided by dealers, extension officers in the area. It is noted that PGH crop producers perform regular pruning/thinning of fruits as specified according to the variety for achieving optimum yield and control of branching to prevent shading and P&D infestations.

Except few growers of pumpkin, melon, chili, pea-Aubergine, cucumber, a majority of farmers have not paid attention to practices for pruning/ thinning/ training of plants under open field cultivation due to lack of awareness and knowledge. The FPOs under ASMP interventions have adopted pruning practices for passion fruit, mango and guava as guided by training and demonstrations. According to farmers this is considered a new practice as most of the producers involved in home garden cultivation have not experienced and reported that further follow up of technology transfer interventions are important for increase skills.

It was observed that there is a high density of mango cultivations in the study area. Such plantations developed high shade conditions due to poor attention for pruning of trees and lack of post harvest cleaning of branches.

Pruning operations for Guava and Mango are yet to be performed efficiently to achieve the optimum results as determined by the project objectives. It was learned that farmers are not fully aware of the pruning practices. The tree branches hanging low with fruits though bagged are touching the moist soil surface.

The moringa leaf producing cluster was guided from the initial stages of plant growth and every stage of pruning with crop age and branching pattern through extension officer visiting the farmers. The guidance and in-field training and demonstration have been shared with farmers along with enhanced skills.

In the UVA provincial area a well-managed rambuttan cultivation field was observed. The crop was maintained at a height of 12ft where it allowed the farmer to comfortably, move around the plantation as there is no low lying branches. This may also keep insects incidences at a low level as the surrounding of the trees are hygienically maintained and facilitated by the monitoring of insect movements/ population levels.

Proper technology transfer methods such as training, demonstrations, and practice through extension services would enhance the knowledge skills and expertise of the farmers, to establish a healthy and vigorous crop with enhanced tolerance for pest and diseases and high response for inputs.

The dense type of planting methods favours the development of P&D in many cases. The adjustment of plant spacing to the recommended level should therefore be employed in order to lower pest and disease attacks. It has now been suggested that the devastating incidence of Brown Plant Hopper attack at rice fields at Ampara is partly attributed to the high plant density. Experience also indicates a positive relationship between the rice plant density and the occurrence of fungi diseases which could be an example to be considered when determining the plant spacing.

vii. Crop sanitation

Although the farmers are well aware of crop cultivation and management it was made to understand that crop sanitation/field sanitation was poorly practiced. It was revealed that the extension services operated in the provinces continue to diffuse the information and technical advice through training sessions and published materials.

DOA instrumented GAP procedures elaborates the need for maintaining crop sanitation at farmers' fields. GAP certification assures that the sanitary and hygienic practices of particular farm/cultivation is maintained according to the required standards and specifications. The pilot projects in the provinces have initiated action to promote GAP certification for crops cultivated by the farmers. It is still at an introductory stage and training/auditing and registration procedures are continued. The current status of crop sanitation under FPOs are not encouraging. However, the farmers understand that clean and hygienic fields help to get away with the P&D incidences.

The project interventions introduced the bagging for fruits such as mango and guava that protects the fruit from insect damages/ bird attacks, sunburn, blemishes, etc. The farmers have observed the scale of insect attacks on fruits even after bagging and it was evident that pest incidence prevails due to poor attention to keep the crop and its surroundings clean and hygienic. However, irrespective of hygienic/ sanitary conditions of the fields, farmers use chemical pesticides as immediate solution.

The leading association of pesticides importers and distributors "Crop life" intervened to promote the training of 300 field representatives of the member companies to enhance the knowledge and skills on GAP procedures to enable them to facilitate agric, extension and communication in line with DOA farmer development activities at provincial levels.

These private sector extension representatives in the provinces could jointly work towards increased farmer awareness and promote adoption of GAP procedures for improved crop production with assured crop sanitation/ hygienic standards.

FPOs identified that scarcity of labour and high cost has led to poor maintenance of fields. They realize the increased expenditure incurred on pesticides due to unhygienic conditions. It was observed that the burning of farm waste/ debris is a common practice in a majority of FPOs. Farmers are aware of the importance of weed free conditions that help in reducing the pest population and densities. Yet, the farmer fields are surrounded by weeds that provides an ideal opportunity for nurturing harmful pests during the off season/ season to continue the pest life cycle.

Pests and disease infested plants, fruits, crop residue etc., would serve as a potential source of re-infection. Collecting and destroying them and in general, the maintenance of a good sanitary standard in crop production field would bring down the pathogens to a level that could avoid re-infection. Consequently the P&D populations are lessened, followed by a low incidence of crop loss by their attack.

It was noted that FAW incidence set the example to inform the farmers that crop sanitation is highly important, in which the rapid spread of insects is possible due to the diversity of host plants that FAW is feeding. Each adult pest will lay around 2000 eggs which is an indication that the potential for increased damage is due to an increasing population of pests. Destroying one pest by mechanical way in the field would stop the infestation of 2000 adults.

viii. Use of fertilizers

It has been made aware that high yielding plant varieties are imported under license of the SCPPC/DOA, subject to screening trials to determine performance for yield capacities and resistance to P&D occurrence. The study identifies that there is a gap in availability of recommended fertilizer/ Plant Nutrient Management (PNM) practices for new improved/ hybrid crops. The farmers informed that the improved and hybrid plants require more attention and care to obtain the optimum productivity. In this regard it was found that the inputs especially nutrient recommendations are yet to establish. Based on the experience, farmers use available recommendations for similar crop varieties with additional nutrients and hormones to achieve optimum plant growth and yield. However, the correct nutrient requirement for improved varieties is yet to be ascertained and recommended. The field observation confirmed that the nutrient use varies in efficiency and plant growth as it depends on the soil, climate and farming practices in diverse AERs. Further, it was reported that the fields are eroded and the level of soil nutrients/ fertility depleted over the years. The farmers noted that they are less familiar with recommendations and are even unaware of any new recommendations published. However, it was learned that majority of farmers have an awareness about availability of modern varieties of fertilizers, nutrients, hormones, growth regulators and its uses for different crops at different levels. Farmers in the rural provinces are yet to understand the available soil fertility and crop input requirement based on the crops cultivated. Though there are modern/ improved farming practices introduced for small farm production, the crop nutrient management is still at a transit stage where farmers seekthe technical support of Extension service providers.

Farmers who have identified the high response for nutrients and plant growth regulators use foliar fertilizers and hormones (Gibberellin Acid) which are introduced through seed/ fertilizer distributors, dealers and their representatives in contact with farmers.

It was observed that FAW incidence and its rapid increase may have been cause due to heavy use of nitrogen in maize cultivation that makes the plant succulent and juicy to attract more pests.The farmers do suspect that the above may have been a probable cause or one of the factors that may have influenced the incidence which they had not perceived beforehand due to ignorance and lack of awareness.

A majority of vegetable growers depend on heavy use of chemical inputs due to visual response in plant growth compared to organic fertilizer. However, farmers have not perceived the importance of integrating organic matter and its effectiveness/ contribution of the well managed fertile soils for healthy crop cycles. The study revealed that heavy use of inorganic plant food materials lead to increasing pest incidences. It was observed that introduction of micro nutrients has prompted the farmers to adopt more foliar applications that increased the yield performance and attractive physical appearance of produce. However, there is no proper understanding on the necessity/ recommended practices related to the application of these foliar nutrients.

There is an increasing trend towards the use of organic farming practices in which identified farmer clusters growing vegetables with organic inputs such as compost made from plant parts, cattle dung, poultry manure, and plant extract base pest repellents, plant food, for vegetative growth, flower initiation, experimented and resulted in success as revealed by farmers interviewed during the study. It was also observed that innovative natural farming approach by a leading small farm cluster in the Central province continued for the past 7-8years with a proven record for success. According to the KII observations, it was noted that the buildup of soil fertility and micro-organisms in the long run is creating a favorable growing conditions for crops while enhancing the moisture holding capacity and beneficial insects' population that naturally keep the P&D population below the threshold levels.

When all required nutrients are available in a balanced form, it has been observed that crop, growth is steadier while pest and disease attacks are also at minimum. On the other hand, indiscriminate use of plant nutrients/ fertilizer, for example excess nitrogen, favours a luxurious growth of plants causing an increase in the degree of susceptibility to P&D.

Case studies highlighted that; high incidence of Rice Blast disease associated with more nitrogenous fertilizer and the greater degree of paddy leaf folder attack due to the practice of 'unbalanced nutrient supply. 'Hence, by ensuring the application of correct fertilizer/ nutrients with optimum dosages at the right time, will help to improve the resistant for P&D.

ix. Water management

With the introduction of modern agro technology, the traditional art of flood irrigation is increasingly replaced by micro irrigation systems among the small farm producers in the provinces. Rapid expansion of farm irrigation systems under small land agriculture has enabled the FPOs in the rural sector to implement year round production of seasonal crops. It was evident that remote agriculture including chena cultivation that depended on seasonal rainfall patterns are now supplemented with modern irrigation through rainwater harvesting/ tapping ground water/ installation of micro irrigation and creating an enabling environment for seasonal crop production.

The UVA passion fruit crops had a drip irrigation system istalled by the FPO as part of a novel technological venture initiated by the project which identified the benefits of crop growth and yield performances compared to previous cultivations that used flood irrigation. Farmers sharing their experience, indicated that flood irrigation increases the cost of production as it requires more labour/ man power to operate the water supply to fields and also effects the health of the person who is exposed to the heat of the sun and erratic field temperature conditions. The farmers expressed their concern about the the stagnant/ declining yield patterns as a result of flood irrigation methods which have been practiced for a long period of time.

However, it was observed that the installation of sprinklers/drippers have not reached its maximum water use efficiency as every plant in the field is not getting equal volumes/ pressure and therefore the plant growth is not uniform as expected. This was observed in all provinces, especially in fields cultivated with chilli, groundnut, B-Onion, mango, passion fruit, guava and Papaya. It was further proven that irrigation systems around the base of the plant alone will not provide an effective solution for plant growth, especially during prolonged climate change effects of increasing day temperatures during the life cycle of the crop. In some crops in which high tech methods are practiced (poly-mulch with drip) it was observed that a buildup of high temperature around the base of plant effects the growth. Varied levels of plant growth with conducive micro climatic conditions within the same fields will provide a better platform for pest build up and survival.

Although irrigation technology is popular and expanded in the provinces, the promotional and installation approach created a negative mind set among the farmers due to poor performance and lack of post installation technical support/ services. The negative mind set could cause the farmers to revert to the methods practiced traditionally i.e. flood irrigation.

In contrast to the above, the right approach towards the promotion and demonstration of irrigation technology, use of poly-mulch in selected farmer fields in rural provinces have achieved best performance, convincing the small farm clusters with better income and profits. The FPO in Thanamalwila under the guidance of the Cargills “Sarubima” program which saw 80 farmers involved in a modern technology agriculture program being convinced by the achievement of increased yield with low pest incidence through irrigation systems integrated with diverse non-chemical technologies.

Sharing their experience, the farmers indicated the white fly and aphids infestation is kept low with the sprinkler system. This confirms that farmers are monitoring the pest population in the field not purposively but unintentionally. However, irrespective of the level of pest infestation they continue to apply chemicals as a routine practice.

Farmers in provinces also gained an experience in using sprinklers which could keep the pest population at low levels especially in chilli, ground nut and vegetables. However, they are still not aware of the correct specification for field designs, area covered and pressure, etc. It was confirmed that there are no technical advisory services at the farm level and the only advice they could receive is from the companies or dealers in the vicinity. It is made aware that modern irrigation is advantageous for controlling the incidence of soil borne diseases, infestation of nematodes, as the crops are irrigated individually at canopy levels.

It was reported that farmers are using varied water sources such as reservoirs, irrigation channels, ponds, rivers, streams, agro –wells, household wells, ground water, etc., having varied characteristics in terms of salinity, pH., microorganism, nematodes, heavy metals, chemical residues that could affect the level of crop growth/ production unless carefully managed. Therefore it is required to consider mitigation measures for all potential challenges which may occur due to hazardous substances.

x. Planting of trap crops

Crop combination is a common agronomic practice in agriculture production. Many plant species possess a natural component which repels or attracts pests or beneficial insects. Pest control other than insecticides rely on pest avoidance, exclusion and trapping. Scientific reports of research in this regard highlighted that tomato intercropped with okra, leeks, mint, and carrot will contribute to reduce the incidence of white fly attack and Virus disease. Also the research findings indicate that mixed cropping of legumes with curry chilli or tomato or okra are more beneficial for reducing the P&D occurrence on legumes and vegetable.

It was evident that in the farmers in the provinces have traditionally cultivated chilli and red onion that benefitted both crops in reducing the pest damages and controlling weed. In some fields which were visited there were border crops such as marigolds and sunflowers which are natural for insect repellants that could repel the vector insects in chilli. Crops such as maize and sorghum, are planted as barriers for insect infestation in chilli, bitter gourd, etc. It was noted in some fields sun hemp is intercropped with oil seeds and vegetables contributing to reduced pest incidence and as a measure of improving soil fertility. Gliricidia was planted around the boundaries for wind break.

Farmers in the provinces confirmed that the ancient practice of growing “Mee” tree (Madhuca longifera) along the border of paddy fields/ bare areas in the centre. The fragrance which emanates from the flowers attract bees/ birds aids in the control of insects/ pest. Also bees contribute towards the pollination process. The Cycas citratus (Madu) is another border crop used in ancient farming, still observed in and around rural farming areas (Medagama/ pineapple-FPO) where pest nearing the plants will be repelled by cthe haracteristic odor emanated by the plant.

Insect pests are not attracted towards some crop varieties such as marigolds, wild sunflowers, Madu-(Cycus citratus), Kalawel (Derris scanders), Thiththa-wel (Lypersion esculentium) Daluk (Eupholsia antignomum), Cinnamon (*Cinnamomum zeylanicum*) and Keppetiya (*Croton lexifenio*), Kohomba, (Margosa), (suggest-Bandura nepenthaceae) as border crops.

4.5.2.2 Mechanical methods

Mechanical Control is a method whereby machinery, force or combination of force and machinery is employed to control pests. The machines may either be power operated, high technology types or manually operated simple tools. The techniques may vary according to the requirement.

i. Mechanical methods used for Weed control

This method is effectively practiced for weed control in small farm crop productions in the provinces. It was observed the power or manually operated movers, slashes, weeders, hoes, and intercultivators are commonly used tools and machineries for controlling weeds in small farm lands. The repeated use of tools for slashing, turning soil, will reduce the incidence of weeds by severing green aerial parts and causing the plants to starve to death.

The weeder is identified by the farmers as a successful method of uprooting weeds especially with wet paddy. Also informed that farmers growing maize have used hand weeders for weeding the highland fields during the early growing stages of the crop especially after irrigation. Flooding is still a popular practice of managing weeds in paddy.

Weeds are also hand pulled, removed and tread under soil surfaces/trenches between the crop spacing. Except in few small farm allotments where women are employed, weeding by hand is restricted or not implemented by a majority of farmers due to the high cost of labour and the extended duration required.

Burning is gainfully employed in the control of weeds in chena cultivation. It was observed that seasonal farming in highland areas is similar to a chena operation but it also has marked differences from traditional burning methods in which farmers use chemical weedicides at the initial stage while resorting to burning and land preparation as the subsequent process. It was revealed that similar operations were implemented by FPOs in the provinces cultivating perennial crops such as mango, passion fruit, pineapple and guava.

As a technology initiative the ASMP has provided inter-cultivators for FPO in the provinces for weeding and earthening activities among the spacing of plants. However, in the case of B-onion cultivation, the farmers depend on pre-emergence weedicides due to the lack of any tools identified for implementing mechanical weeding.

ii. Mechanical methods used for Pests & diseases

Food traps and torches/ light traps are useful techniques for pest control. Rodents which damage paddy and yam cultivations in particular are controlled by the use of food traps while insect pests are caught in light traps.

Torches are a practice that was used by ancient farmers and still viewed as a method for trapping insects and chasing away wild animals in provincial areas. Wrapping rags, dipped in Mee (Madhuca), Kohomba-Neem (Margosa) or coconut oil at the end of a stick was an indigenous method used by farmers. An alternative practice was observed in FPOs by placing the wrapping rags in a one side open large tin and lit with fossil oil (Kerosene). Insects attracted to the light are killed due to heat.

A light trap consists of an element producing a bright light which is installed above a container of water, placed out in the field and lit during the night. Insects attracted by the light get traped in water underneath the source of light. In an experiment carried out in India with the use of different lights, it was revealed that the white light trap was the most effective, in comparison to the other colours such as yellow, blue, green and red which were used. (Economic review –January 1983). Though the farmers are aware of the light trap method for managing pests in the field, only a few have thought of implementing it without the water source. This was observed in all moringa farmers' fields but only the light box using yellow polythene applied with grease was installed. A variety of insects (harmful and beneficial) were stuck on the polythene and dead due to heat. This could be an opportunity to promote and influence farmers to initiate the next step to keeping water sources and scouting the population movement of harmful/beneficial insects to ascertain the level of infestation.

Hand picking and destroying insects at different growth stages-egg, larva, cocoon and adults have proven to be an effective control method used in groundnut cultivation fields which are infested with caterpillars, pod caterpillars and blister beetles.

The destruction of infested plant/ parts such as leaf webbs, borer affected fruits, pods/fruits damaged by fruit flies and twigs infested by leaf miner are some examples of mechanical control measures observed in the provincial areas. The moringa cluster through their daily crop supervision and while attending irrigation, harvesting and composting operations have purposively practiced hand picking of insect and pests.

Similarly disease infested crop parts could be removed. In the case of infestation of viruses, entire plants could be uprooted and destroyed.

When the pest infestation is high, the sweep net method was employed by ancient farmers to catch and destroy. This method was observed in paddy cultivations in which farmers employed the winnowing method called **"Kulugema".** The back of a traditional winnowing basket ***(Kulla)*** was daubed with mucilage (koholla) from the jack fruit and slowly fanned across the field which caused the insects on the crop to get stuck on the mucilage. This method is applied twice a day when the rice sprout into ears.

The Water Ghost (diya holmana) is used to protect paddy from beasts. A two (nodes) segment long piece of bamboo is placed on the point where water flows down from one block to (liyadda) to another. When water flows down the stick rises and falls hitting a stone is placed underneath, causing a sound which keeps beasts at bay.

The Wind Ghost (holang holmana) is a commonly used method in which farmers place long nails/ pieces of iron rod with bottles/ tin (large size) hung on a tree or arranged along the wire/ coir lines tied between trees/border fences that creates a sound when the wind blows.

Most of the above practices are in the verge of disappearing due to farmers' dependence on chemical inputs. Although the importance of reducing the use of pesticides were debated at the highest level, there is no due recognition/interventions for promoting and diffusing the established and proven traditional mechanical practices for the small agriculture farms.

The cultivation of live barriers is considered a method of reducing the pest and disease infestation in seasonal crops. It is an ancient farming practice in Sri Lanka where farmers cultivated plants such as "Mee" (*Madhuca longifolia*), Madu- (*Cycus citratus*), Wild sunflower, marigold, glyricidiea, etc., on the border of paddy fields and bare areas. The fragrance emanated in the air attract the bees and insects that prey on the pests of paddy. These plants grow in highland areas and therefore introducing as a border crop for seasonal vegetables and other crops will reduce the incidence of pests and diseases.

Also noted that protected poly houses in which crops are cultivated under modified/ controlled climatic conditions contributed towards reduced incidences of pests and diseases. It is becoming popular among the small farmer clusters identifying the potential for increased income through achieving an uninterrupted production and attractive product quality. The majority of PGH growers indicate that pest and disease incidences inside the structure is low and they use hand picking of pests (adults, larvae, pupae, eggs) while attending the crop care practices during training/ pruning/ thinning out operations. However, it is required to maintain the hygienic conditions and clean surroundings, and structure to avoid the infestations.

4.5.2.3 Physical methods

The physical environment of the pest is modified in such a way that the insects no longer pose a threat to the agricultural crops. This can be achieved by creating stress conditions or using devices such as physical barriers that protect the crop or produce from infestation. Though the physical pest management methods protect the crops from emergence to postharvest, it is identified as being more effective and better suited for pest control during the postharvest stage such as storage, transport, and marketing. The frequent use of insecticides are unlawful or inappropriate especially after harvesting.

i. Trenches-furrows

Trenches and barriers can be used to reduce movement of flightless insects between fields, or limit access by insect to individual plants (e.g., trenches for migrating caterpillars).It was reported that a “V” shaped trench lined with plastic film has effectively contributed towards the control of 95% of the Colorado potato beetle. The furrows (trenches) are 25cm deep with sides sloping at angles of 45^0. The adult beetles that walk along the ground will fall in and be covered with dust/particles with little chance of escaping. The study team has not found such interventions in the farmers’ fields or any research programs in this regard. Though the farmers implement practices such as ridge and furrows and planting methods, there is no trace of information to confirm that the method is used to reduce any incidences related to pests/diseases.

ii. Barrier Fence

This practice is important to exclude the low flying insects from annuals crops. The research data indicated that height of the fence is critical for managing the pest. It is also limited by cost to be incurred and resistant to wind. The small farmers cultivating red-onion in Northern Province traditionally make fence with used cotton fabrics clothing material as a plant protection practice in remote areas.

Further it was observed that the installation of insect proof nets on the periphery of the planting area up to a height of 7ft is aimed to exclude insects of chilli. Reports indicate that a one metre high barrier netting/ fabric is used for the control of cabbage flies (Delia radicum).

This technology was successfully implemented by a cluster of 80 farmers in the Thanamalwila areawhich is a project promoted under the Cargills, Sarubima initiative. The similar initiatives under ASMP were also observed in the provinces and noted that more interventions and close coordination is necessary to achieve the benefits in this regards.

Individual plant netting was experimented in farmers’ fields to ascertain the feasibility of controlling insect infestations during the early growth period in bitter gourd production. This aimed to achieve a healthy and vigorous vegetative growth to enable the plants to resist any pest infestation after flowering. Though it is a proven success in controlling pests during the early stage, according to farmers the response is not encouraging due to the high cost of materials and labour envisaged for installation and of the technology in the field.

Several serious greenhouse pests can be excluded by screens/ insect proof nets, by strictly adhering to the characteristics of the insects, especially their sizes related to height/ width or diameter. In the previous chapter, the use of nets and mesh (eye) sizes and its effectiveness in the protection from insect infestations was highlioghted.As per the following mesh sizes or smaller mesh sizes one inch is 25,400 microns and one mil is 0.001 inches.

Table 4.17: Insect proof nets (mesh sizes)

Insect	Size hole	
	microns	**inches**
Serpentine leaf miner. (Liriomyza trifolii)	640x10-6 m	0.025 in
Sweet potato white fly (Bemisia tabaci)	462x10-6 m.	0.018 in
Melon aphid (Aphis gossypii)	340x10-6 m	0.013 in.
Greenhouse white fly (Trialeurodes vaporariorum)	288x10-6 m.	0.0113 in
Silver leaf whitefly (Bemisia argentifolii)	239x10-6 m	0.0094 in.
Western flower thrips (Frankliniella occidentalis)	192x10-6 m.	0.0075 in

Source- Bethke, 1990

iii. Mulch

The objective of the mulching is to improve productivity and reach harvest at an early date. Ideally suited for high value crops. However, a diverse variety of mulch that includes the organic and artificial are extensively used in agriculture production, irrespective of the scale of operation/ cultivation. The mulch also helps to control weeds by covering the surface of the planting beds.

The FPOs in project areas are highly experienced in in using different types of organic mulch- mainly during the nursery development and soon after transplanting the seedling in the field. According to them, these practices are used to cover the soils and young plants which are spared from withering/ drying due to heat and sunshine. Though this practice may contribute towards the control of pests and diseases during nursery/ seedling stage, the method was not recognized by the farmers in the provinces. The International research report indicates that straw mulching in potato cultivations reduced the damage done by the Colorado beetle by favoring the presence of several species of predators that prey on eggs and, larvae. Use of Waxed paper, plastic, or metal cups or cans can be placed around the stems of seedlings to deter the cutworm from feeding. Though these practices are not observed during the study, the provincial growers use bunches of cuttings from small leaved trees available in the vicinity to cover the seedlings.

Artificial materials such as paper, plastic, aluminized films, are used for mulching. These mulches are modified using different colours that helps to alter the behaviuor of particular insects. It was reported that thrips are attracted to blue black and white, aphid are attracted to yellow and blue. The ultra violet reflection properties on aluminized materials are utilized by strawberry farmers inreducing the damage of the tarnished plant bug *Lygus lineolaris*.

Polymulch technology adopted by small farmers in the project provinces have served two purposes; control of weeds and reduction of the incidence of pesst and diseases by allowing the plants to grow more vigorously. This technology was successfully implemented by a cluster of 80 farmers in the Thanamalwila area under a project promoted under the Cargills, Sarubima initiative. The similar initiatives under ASMP was also observed in the provinces which have benefitted the farmer in the control of tweeds around planting fields resulting in the cost incurred for weeding. Further research interventions are important to study and identify the effective types of polymulch according to the AER and its effect on pest control, specifically soil borne pests, diseases to achieve the sustainable adoption of technology.

iv. Inert dust

The review of reports identified the commercial types of inert dust especially used for pest control in storage produce. These contain less mammalian toxins and are used in protected the stored produce from a number of coleopteran spp., pests. These are identified as; lime (dolomite), common salt, sand, kaolin, paddy husk, wood ash, clays, diatomaceous earth synthetic and precipitated silicates and silica aerogels. It was observed that farmers in certain provinces use gypsum in the ground nut cultivation fields. Wood ash was used in ancient farming in Sri Lanka and at present, farmers use the burnt plant debris or wood ash during land preparation.

v. Pneumatic

The FPOs identified that the sprinkler irrigation technology is to some extent effective for reducing the pest infestation especially thrips and aphids. However, they are skeptical about its effectiveness and continue to use chemical spraying. The use of blowing air is not implemented by the small farmers in growing fields. Blowing will dislodge insects from plants effectively and it is necessary to collect them and destroy to avoid repeated infestation. The research in this regard highlights that Lygus spp, on Strawberry, L.huidobrensis on celery, and Bemisia tabaci on melons should be efficiently removed by blowing.

vi. Bagging

Bagging is another protective method is used to cover the young fruits using waxy paper bags until harvesting**.** It was observed that in some areas farmers use their own preparation of bags that are made from printed paper or poly bags that are less effective compared to waxy bags. Farmers in the study area are increasingly using the bags by observing the improved quality characteristics and market acceptance. Though the bagging method is used to protect the fruit from pest and diseases incidences, the effectiveness is yet to be seen. The main fruits introduced to this method include mango and guava.

4.5.2.4 Biological control

Being an agricultural country, crop yields have a huge impact on the economy, social well-being and the livelihoods of people. The spread of pests and weeds has become a major threat to the native fauna and flora in Sri Lanka. Several sectors, such as agriculture, irrigation and the native bio-diversity have been affected by them. Most pests and weeds are alien species, which have invaded the natural environment. Past experiences have identified water hyacinth (Japan jabara and salvinia (serious weed, covering waterways, reducing water flow and harming native species) as an alien species brought in for ornamental and experimental purposes which has eventually turned in to invasive plant.

Land disturbances favour plant species with rapid growth by increased rate of reproduction. Thus, the natural enemies (organisms that naturally control other organisms) too survive poorly and operate slowly and inefficiently within the ecosystem, favouring the rapid population increase of the host plant. Some local examples of poorly survived plant species include ‘Lotus’ and ‘Pan’ .Plant species, such as ‘Gandapana’ and ‘Yodha Nidikumba’ which have also become invasive in Sri Lanka, posing a threat to both agricultural and natural ecosystems.

i. Protection and encouragement of natural enemies

Types of natural enemies involved in biological control identified as; Parasitoids, Pathogens, Predators, and Weed feeders.

Predators are mainly free-living species that directly consume a large number of prey during their whole lifetime. Given that many major crop pests are insects, many of the predators used in biological control are insectivorous species.

Parasitoid is an organism that lives in close association with its host and at the host's expense, and which sooner or later kills it. Parasitoids lay their eggs on or in the body of an insect host, which is then used as food for developing larvae. Most insect parasitoids are wasps or flies, and many have a very narrow host range. Parasitoids are most effective at reducing pest populations when their host organisms have limited refuges to hide from them.

Pathogenic micro-organisms include bacteria, fungi, and viruses. They kill or debilitate their host and are relatively host-specific. Various microbial insect diseases occur naturally, but may also be used as biological pesticides. When it occurs naturally, these outbreaks are density-dependent in that they generally occur as insect populations become denser.

In nature, many organisms survive by feeding on other insects, disease causing organisms and weeds which are available in abundance. Such organisms can be successfully exploited for the management of pests as bio control agents. The papaya mealy bug Paracoccus marginatus has been successfully managed by releasing a parasitic insect. Lady bird beetles are potential natural enemies of aphids. Insecticidal properties of many strains of bacteria, fungi and viruses have been identified. Bacillus thuringenisis, nuclear polyhedrosis viruses and entomo-pathogenic fungi like Beauveria bassiana, Verticillum lecani have potential for commercial use. Fungal antagonists like Trichoderma viride and T.harzianum are useful bio control agents for the control of many soil borne fungal pathogens. Scientific mass raring and inundative release of such beneficial insects and organisms will play an important role in keeping pest populations suppressed without disturbing the ecosystem and natural environment.

Table 4.18: Biological interventions for control of pests/diseases and weeds

1 Predator	**Host Pest (adult/eggs/larvae/pupae**
Neochrysocharis sp.Hymenoptera vericornis Closterocerus sp.,Diglyphus isaea,Opius sp.	Leaf miner (Liriomyza sativea)
Spotted Lady beetle *(Coleomegilla maculata)*	Adults of ***Aphids ,mites, Scale insects, Caterpillars,*** Egg/Larvae of ***C.Potato beetle***
Hoverflies *(Syrphid flies)*	Adults of ***Aphids & Thrips***
Nematode *Phasmarhabditis hermaphrodita*. Associated with a pathogenic bacteria *Moraxella osloensis*	Slugs
Midge *(Feltiella acarisuga)*	Two spotted spider mite and Western flower thrips
Lady bird *(Stethorus punctillum)*	
convergent lady beetle,*(Hippodamia convergens)*,	Aphids
2-Parasitoids	**Host Pest (adult/eggs/larvae/pupae**
Ichneumonid wasps,	Caterpillars
Braconid wasps	Caterpillars,other insects aphids;
Chalcid wasps,	eggs and larvae of many insect species
Tachinid flies,	True bugs, caterpillars, beetle adults and larvae
Wasps,*(Trichogramma ostriniae)*,	European corn borer *(Ostrinia nubilalis)*
Formulations of bacterium *(Bacillus thuringiensis)*	
Salvinia weevil *(Cyrtobagous salviniae)* and Salvinia stem-borer moth *(Samea multiplicalis)*	Salvinia (*Salvinia molesta*)-*Weed*.
Agasicles hygrophila	Alligator weed *(Alternanthera philoxeroides)*
Wasp *(Encarsia formosa)*,	White fly *(Trialeurodes vaporariorum)* GH Vegetables
	Black sooty moulds in GH vegetables
Gonatocerus ashmeadi *(Hymenoptera: Mymaridae)*	Glassy-winged Sharp shooter *Homalodisca vitripennis (Hemiptera: Cicadellidae)* GH vegetables
3- Pathogens	**Host Pest (adult/eggs/larvae/pupae**
Bacterium *(Bacillus thuringiensis)* BT incorporated transgenic crops	Lepidopteran (moth, butterfly), Coleopteran (beetle) and Dipteran (true fly)
Bacterium- *(Paenibacillus popilliae)*	Japanese beetle *(Popillia japonica)*
Bacterium-sp	Brown blotch diseases in Mushroom
Fungi- Beauveria bassiana	Whiteflies, thrips, aphids and weevils.

Fungi-Pandora neoaphidis *(Zygomycota: Entomophthorales)*	Green peach aphid,
Fungi- Lecanicillium spp.	White flies, thrips and aphids.
Fungi-Metarhizium spp.	Beetles, locusts, grasshoppers, Hemiptera, and spider mites
Paecilomyces fumosoroseus	White flies, thrips and aphids;
Purpureocillium lilacinus	Root-knot nematodes,
Fungi-Trichoderma viride	Dutch elm disease, and suppressing silver leaf of stone fruits (pathogenic fungus Chondrostereum purpureum.
Fungi-sp	Dry bubble disease in Mushroom

As a common feature across the provinces, farmer recognition and awareness towards the biological methods are poor due to inadequate technology/knowledge transfer activities focused at farm level. Though biological control is novel, the farmers in the provinces reported it is an indigenous practice adopted for generations in Sri Lanka. The latest interventions by GOSL that successfully controlled several P&D are identified below.

- The coconut leaf miner which devastated coconut cultivation, the leaf minor which was a threat to the vegetable cultivation in the hill country and the guava white fly which killed many guava trees even in-home gardens was completely eradicated or kept under control by imported parasitoids.

- The Salvinia weevil has helped the successful control of Salvinia in most of the aquatic habitats at low elevations. The mottled water hyacinth weevil and the chevroned water hyacinth weevil brought from Thailand have been introduced to control water hyacinth.

- Damping off disease caused by fungal pathogens at the nursery stage of big onions is a major constraint on its production. Scientific studies have been carried out to assess the ability of selected Trichoderma sp. isolated from local onion fields in suppressing the damping off pathogen Fusarium sp., which is known to be an effective method worldwide.

- The Papaya Mealy bug ('Piti Makuna') is an alien invasive insect species feeding on many plant species. Due to the nature of the pest and the variety of host plants it attacks, insecticidal control became less effective. Therefore, a parasitic insect named Acrorhagus papaya, already proved to be successful in Sri Lanka.

Farmers cultivating passion fruit under provincial programs identified the advantage of natural pollinators; types of bees conserved in hollow wood stacked in farm houses that continue its life cycle while helping the passion fruit to pollination.

FAW invasion is the very recent incidence that caused heavy damages tomaize crops, devastating large extents cultivated under small farm lands. The use of biological control methods; either by identifying natural enemies from our ecosystems or the use of host-specific exotic biological agents or bio-pesticides were explored and introduced in the fields with combined pest management practices including the recommended use of five pesticides based on the nature of the attack.

The FAW has all the characteristics of being an invasive pest. The short life cycle (about 60 days), multiple egg-laying cycles (about five times during the 10-21 days life span of the moth, laying 50-200 eggs).The moth can even lay 1,500-2,000 eggs during its life cycle. The pest lives in many plant hosts and the adult moth travels long distances to lay eggs. The adult moth has an alarming, single wind-aided flight of about 80-100 km. This has given a perfect setting for the pest to be invasive during a short period over a wide land area.

The farmers understand that, controlling pests only with toxic insecticides will not be a long term solution where according to their own experiences the pest incidences are still troubling them. With the recent outbreak, it was noticed that the farmers have experimented the indigenous pest management methods as alternatives to t chemical control.

During the study it was found that an initiative of the private sector collaboration project with farmer clusters in the Central hills promoted organic vegetable farming for many years that enabled to rehabilitate the soil and environment to increase the presence of micro-organisms in the soil and beneficiary insect population within the crop environment. Also the farm managed to establish the pest balance by adopting non-chemical pest management systems. The report highlights that natural parasitoids could be saved and increased if the farmers willingly control or reduce the use of chemical pesticides.

Natural enemies survive as long as pests are living in the locality. When the pest leaves, natural enemy populations decrease drastically and may even die out, leaving no effective defense against the next invasion. Such dynamically unstable interactions between pests and control agents largely rule out introduction as a viable strategy, and augmentation or inundation, coupled with a means for forecasting outbreaks, is recommended.

ii. Genetic practices

The sterile insect technique (SIT) is a method of biological insect control, whereby overwhelming numbers of sterile insects are released into the wild. The released insects are preferably male, as this is more cost-effective and the females may in some situations cause damage by laying eggs in the crop.

The technique has successfully been used to eradicate the screw-worm fly (Cochliomyia hominivorax) in citrus, from North and Central America. Many successes have been achieved for control of fruit fly pests, most particularly the Mediterranean fruit fly (Ceratitis capitata), the Mexican fruit fly (Anastrepha ludens) and diamond black moth (Plutella xylostella) that only operates on females. Sterilization is induced through the effects of irradiation on the reproductive cells of the insects. SIT does not involve the release of insects modified through transgenic (genetic engineering) processes rather than being sterilized by irradiation. Moreover, SIT does not introduce non-native species into an ecosystem. Though the fruit fly incidence is high in Sri Lanka there is no evidence to indicate SIT is practiced in farmers' fields. Apart from the above, pest management methods are derived through the genetically modified crops/ transgenic crops to enable resistance to pests and diseases.

CHAPTER FIVE: PESTICIDE USE AND MANAGEMENT IN PROJECT PROVINCES

5.1 Pesticides usage pattern in Sri Lanka

Pest control in the past was primarily based on biological, cultural, physical and mechanical methods or there was no pest control at all due to natural tolerance characteristics of traditional crop varieties. Investment on pesticides was also not feasible due to the low yield of traditional crop varieties. However, with the green revolution technologies, the natural tolerance characteristics of crop varieties disappeared, demanding chemical control of pests to ensure high yields to feed the ever-growing population. In the project provinces the farmers insisted that the higher yield losses were due to pest attacks. However, there is no evidence of assement or research information to elaborate the economic loss of yield and feasibility of pesticides use at national level.

The cultivation of high yielding hybrid varieties of paddy under irrigated conditions has reached its maximum level (almost 100%) and the cultivation of hybrid and high yielding varieties of vegetables and other food crops has rapidly over taken the native crop varieties. Seeds were only one of the inputs of the green revolution package. It was important to apply a considerable amount of fertilizers and agro chemicals to harness the full benefit of the package.

Influenced by the technical interventions under the green revolution in the 1960s, Pest management in Sri Lanka was mostly pesticide dependent and the annual imports of pesticides cost around 0.1 percent of the Gross Domestic Production. In 2016 Sri Lanka imported 4000mt of pesticides. Main pesticides imported are weedicides (50%), insecticides (28%) and fungicides (22%). The demand for weedicides was higher due to the increasing cost of labour and shortage of labour for agricultural activities.

Table 5.1: Volumes of Pesticides Imported to Sri Lanka during 2006-2016

Pesticide	2006	2010	2011	2015	2016
Technical material					
Insecticide	128.38	144.38	90.50	115.8	3.08
Herbicides	207.94	1605.58	1118.94	75.17	107.0
Fungicides	0.40	02.0	0.40	0.0	0.0
Sub total	***336.72***	***1751.96***	***1209.84***	***190.97***	***110.08***
Formulations					
Insecticide	1576.41	1843.95	1712.58	1759.06	1151.3
Herbicides	3197.06	5366.63	5031.05	2862.74	2088.15
Fungicides	847.56	1048.02	949.40	1233.8	903.9

Sub total	***5621.03***	***8258.60***	***7693.03***	***5855.60***	***4143.35***
Total	***5957.75***	***10010.56***	***8902.87***	***6046.57***	***4253.43***

Source: Records maintained by Registrar of Pesticides

Among the weedicides Glyphosate is most popular followed by MCPA and 3, 4 DPA.Glyphosate was used in the plantation sector as a measure of mitigating the issues on labour shortage and reducing the cost of weeding drastically. However, identifying the advantages, the small farm producers were encouraged to use glyphosate for clearing weeds and shrubs during land preparation. Also it was noted that B-Onion farmers increasingly used these herbicides as a better option for weed control during the early growing stage. However, the glyphosate was banned in 2015 and with the re-introduction of its imports was only through public sector cooperation that permitted it to be used only in the plantation sector. Currently it was made to understand there is volumes of illegal entry of glyphosate including other banned chemicals (pesticides) which are freely available in the market used by farmers posing serious challenges to registered pesticides importers and dealers as well as a national threat of increasing hazards for humans and the environment.

It was reported that highly poisonous chemicals are banned from being imported to Sri Lanka. Three technical grades are determined as a follow-up of WHO classifications of pesticides by hazard levels.

Table 5.2: Classification of pesticides by hazard class

Class	LD50 for the rat (mg/kg body weight)				
		Oral		Dermal	
		Solids	Liquids	Solids	Liquids
Ia-(Red band)	Extremely hazardous	5 or less	20 or less	10 or less	40 or less
Ib-(Red band)	Highly hazardous	5 - 50	20 - 200	10-100	40 – 400
II-(Yellow band)	Moderately hazardous	50 - 500	200 - 2000	100-1000	400 – 4000
III-(Blue band)	Slightly hazardous	Over 500	Over 2000	Over 1000	Over 4000

Source-WHO -2009

The classification distinguishes between the more and the less hazardous forms of each pesticide based on the toxicity of the technical compound and on its formulations. Sri Lanka has successfully phased out a number of hazardous pesticides including all the WHO hazard Class 1 pesticides and persistent pesticides from usage. Currently recommended pesticides are less toxic and least persistent compared to the banned pesticides.

5.2 Registered Agro pesticides

About 114 active ingredients of different pesticides have been registered at the office of the Registrar of Pesticides which are currently marketed in the form of 500 commercial products.

There are a number of household pesticides imported to the country to cater to the demand of domestic (Ex: Control of rats and cockroaches), Industrial (Ex: Paint industry), public health (Ex: Mosquito control, hospital cleaning) and veterinary needs.

Table 5.3: Profile of Registered pesticides

Category	No. of Active Ingredients	No. of Marketed Products
Insecticides	46	234
Fungicides	27	97
Weedicides	33	149
Molluscicides	1	2
Total	**107**	**462**

Source: Registrar of Pesticides 2015

The stocks of outdated pesticides are quite significant and hence disposal of it is a serious issue which needs immediate attention. Although persistent pesticides were prohibited from use in agriculture and from public health pest control services, more than two decades ago, traces of some pesticides and its derivatives have been detected in some environmental compartments and this requires further investigation. There is limited information available on the residues of these chemicals in groundwater and surface water bodies, in agriculture areas. Awareness on pesticide related issues, concerns and required remedial measures are alarmingly poor among most of the sectors in the society.

While the reporting of pesticide use and market data is patchy and irregular, it is generally clear that the use of synthetic pesticides in agriculture has grown steadily, and amounts to 3.5 billion kg of active ingredients (a.i.) per year. The highest world market growth rates recorded in 1960s, was at 12% per year, later falling back to 2% and below during the 1980s–1990s, then rising to 3% per year to 2014. The value of the current global market is US $45 billion per year. Herbicides account for 42% of sales, insecticides 27%, fungicides 22%, and disinfectants and other agrochemicals 9%. The largest markets are in Europe and Asia (US$12 billion each), Latin America ($10 billion) and North America ($9 billion); the market in the Middle East and Africa is $1.5 bn (all 2012 data). Synthetic pesticides entail a huge cost; it has been estimated that the costs to bring a single active ingredient to market is $250 million, having synthesized 140,000 compounds to find success.

Table 5.4: Pest and Pesticides used by FPOs in ASMP project provinces

Common Name	Abamactin	Abamactin	Abamactin	Abamactin	Imidacloprid	Imidacloprid	imidiclopid	Imidacloprid	profenofos	profenofos	Thiamethoxam	Phymetrozine	chlorantraniliprole	thiocyclam hydrogen oxalate	Carbosalfan	Acetamiprid	Emamectin bensoete	Fipronil	spinosad	Etofenprox	chlorantraniliprole+ thiomithoxam	
Brand name	abamectin	mikzu	mity	Zoro	Admire	imidiclopid	Merit	Provado	calcron	Proponopose	Aktara	Chess	corajan	Evisect	Marshal 20	Mospilan	Proclaim	Rigant	Sucxes	trebon	Vertakor	Total Brands
Chilli Leaf Curl Complex	1	1	1		1		2		1			1		1	1	1				1		12
Bitter Gourds Fruit Fly							1															1
Bitter Gourds VTI	1			1			1				1	1			1			1				7
Big Onion mites	1														1							2
Big Onion caterpillars									1						1		1					3
Big Onion leaf Hoppers															1							1
Ridge Gourd Melon Fly																		1				1
Ridge Gourd insects	1																					1
Snake gourd insect and mites					1		1					1										3
Groundnut wilt Virus Vectors									1			1				1						3
GroundnutVTIs																		1				1
Long bean Insects															1							1
Long bean Caterpillars					1								1									2
Papaya Mealy Bugs						1									1							2
Papaya VTI	1																					1
Mango Fruit Fly						1									1							2
Mango hoppers															1							1
Mango Mealy Bugs										1											1	2
Pineapple Mealy Bugs						1																1

Common Name	Abamactin	Abamactin	Abamactin	Abamactin	Imidacloprid	Imidacloprid	imidiclopid	Imidacloprid	profenofos	profenofos	Thiamethoxam	Phymetrozine	chlorantraniliprole	thiocyclam hydrogen oxalate	Carbosalfan	Acetamiprid	Emamectin bensoete	Fipronil	spinosad	Etofenprox	chlorantraniliprole+ thiomithoxam	
Brand name	abamectin	mikzu	mity	Zoro	Admire	imidiclopid	Merit	Provado	calcron	Proponopose	Aktara	Chess	corajan	Evisect	Marshal 20	Mospilan	Proclaim	Rigant	Sucxes	trebon	Vertakor	Total Brands
Guava Fruit Fly									1						1		1		1			4
Guava Fruit Borer													1									1
Guava Mealy Bugs									1	1					1							3
Guava Other Insects	1							1							1							3
Passionfruit Insects and mites	1				1			1			1											4
	7	1	1	1	4	3	5	2	5	2	2	4	2	1	12	2	2	3	1	1	1	62

Table 5.5: List of Recommended Pesticides for Crops under provincial projects

Crop/Pest	Common name of the Insecticide	Dilution (ml or g per 10L	Low foliage	High foliage	PHI Day
Tomato					
Fruit borer	Novaluron 100 g/l EC Chlorfluazuron 50g/l EC Chloranthraniliprole185g/l SC Spinosad 450g/l SC Flubendiamide 24%WG	10ml 15ml 2ml 3ml 2g	320ml 480ml 90ml 140ml 86g	600ml 900ml 130ml 220ml 140g	14 10 07 07 07
Whiteflies Thrips Aphids	Carbosulfan 200g/l SC2 Fipronil 50g/l SC2 Thiamethoxam 25%WG Imidacloprid 70%WG Thiocyclam 50%SP	20ml 10ml 3g 1.25g 25g	640ml 16ml 320ml 40g -	800ml - 600ml 75g	14 - 14 14 14
Chilli					
Chilli leaf curl complex Aphids Thrips White flies	Carbosulfan 200g/l SC Thiamethoxam 25% WG Imidacloprid 20% SL Abamectin 18g/l EC Abamectin 3.6 EW Thiocyclam 50%SP Chlorantraniliprole20%+ Thiamethoxam20% WG Spinosad 45%SC	30ml 10g 10ml 6ml 3ml 5g - 20ml 5ml	960-1200ml 320-400g 320-400ml 190-250ml 100ml 160-200g - 100g 200ml	1200-1800ml 400-600g 500-600ml 250-360ml 180ml 200-300g - 120g 300ml	14 14 14 07 07 14 - 10 07
Chilli-mites	Abamactin 18 g/l EC Hexythiazox 10%WP Flufenoxuron 10g/l DC Neem Seed water extract Azadiractin 50g/l EC Fenpyroximate50g/l EC Sufphur 80%WP	6ml 5g 15ml 400g 5ml 8ml 80g	 300ml 8ml 130g	 600ml	7 7 7
Chilli Pod borer	Chlorfluazuron 50g/l EC Chlorantraniliprole20%+Thiamethoxam 20% WG Flubendiamnide 240WG	10ml 2.5g - -	320-400ml 100g -	500-600ml 120g -	10 10 - -

Crop/Pest	**Common name of the Insecticide**	**Dilution (ml or g per 10L**	**Low foliage**	**High foliage**	**PHI Day**
			-	-	
Onion					
Onion thrips	Fipronil 50g/l SC Imidacloprid 200g/l SL Thiacloprid 240g/l SC	10ml 10ml 10ml	320ml 160ml 320ml	400ml 200ml 400ml	14 14 14
Onion caterpillar	Emamectin Benzoate 5%SG Chlorfluazuron 50g/l EC Metaflumizone 240g/l EC Lamda cyhalothrin Diazinon 500g/l EW	4g 10ml 25ml 5ml 50ml	130g 320ml 800ml 160ml 1600ml	160g 400ml 1000ml 300ml 2000ml	07 10 14 07 14
Maize					
stem borer and Cob borer	Etofenprox 100g/l EC Thiocyclam hydrogen oxalate 4%GR Novaluron 100g/l EC Fipronil 0.3%GR Diazinon 5%GR	15ml -- 10m	480ml 15kg 320ml 12kg	900ml - 600ml	07 14 14 14
Ground nut					
Ground nut Leaf miner	Abamactin 18 g/l EC Neem Seed water extract Azadiractin 50g/l EC	6ml 400g 20ml	240ml		7 7 7
Brinjal & Thibbatu					
Shoot & fruit borer	Lamda cyhalothrin Spinosad 450g/l SC Chromafenozide 50g/l SC Chloranthraniliprole200 g/l SC Flubendiamide 24%WG Flubendiamide 20%WG Spinotoram 25%WG Etofenprox 100g/l EC	- 3ml 20ml 2ml 3g 6g 3g 15ml	600ml 100- 120ml 640- 800ml 150ml 5g 9.5g 5g 480- 600ml	825ml 150- 180ml 1000- 1200ml 210ml - - - 750- 900ml	07 07 07 03 07
Leaf hopper	Acetamiprid 200g/l SL Thiamethoxam 25% WG	10ml 3g	320- 400ml 120g	500- 600ml -	14 14
White flies	Buprofesin 10%WP Thiamethoxam 25%WG Imidacloprid 70%WG Thiocyclam 50%SP	6g 3g 1.25g 25g 2.5g	190g 120g 60g	- - -	14 14

Crop/Pest	**Common name of the Insecticide**	**Dilution (ml or g per 10L**	**Low foliage**	**High foliage**	**PHI Day**
	Chlorantraniliprole20%+ Thiamethoxam20% WG5 Acetamiprid 200g/l SL -	10ml	800g - - 240ml	1000g - - 480ml	14 14
Mites	Hexythiazox 5%EC		600ml	1000ml	-
Cucurbit					
Gall fly	Profenofos 500g/l EC3	30ml	50ml		
Melon fly	Protein bait+ Spinosad 25g/lSC along with IPM Practices	250ml	1000ml	2000ml 07	07
Mango					
Mango leaf hopper1	Imidacloprid 20% SL Thiamethoxam 25% WG	10ml 10g			14 14
Mango fruit fly	Protein bait + Spinosad 25g/l SC along with IPM practices	250ml+ 10ml	1000ml	2000ml	07
Stem borer	Refer general recommendations				
Pineapple					
mealy bug	Carbosulfan 200g/l SC2 Acetamiprid 20%SP	- 50ml	- 1300ml	- 1600ml	- 07
Papaya					
Mealybug	IPM + biological control Mineral oil	50ml	1300ml	1600ml	07

Name of the Disease / Pathogen	**Common Name**	**Dilution (Product per 10 l of water)**	**Rate of Application when low foliage (Product per ha)**	**Rate of Application when high foliage/ha**	**Application interval in days (only if subsequent application as required**	**PHI days**
Chilli						
Foot rot/fungal wilt (Sclerotium rolfsii, Fusarium solani	Thiram 80% WP	70 g/ 50 l /10m2			6-8	14

Name of the Disease / Pathogen	Common Name	Dilution (Product per 10 l of water)	Rate of Application when low foliage (Product per ha)	Rate of Application when high foliage/ha	Application interval in days (only if subsequent application as required	PHI days
Anthracn ose (Colletotri chum spp	Thiophanate-methyl 70% WP	10g	325-400g	300-600g	7-14	21
	Metiram 55% + Pyraclostrobin 5% WG	20g	650-800g	1000-1200g	10-12	14
	Fluazinam 500 g/l SC	10ml	325-400ml	500-600ml	7-10	14
	Chlorothalonil 500g/l SC	30ml	950-1200ml	1500-1800ml	7-10	14
	Trifloxystrobin 250g + Tebuconazole 500 W	6g	200-250g	300-350g	10-12	21
Cucumber						
Downy mildew (Pseudoperonospora cubensis)	Mancozeb 64% + Metalaxyl 8% WP	12.5g	400-500g	625-750g	12-14	14
	Captan 50% WP	20g	650-800g	1000-1200g	6-8	14
Groundnut						
Foot rot/Root rot (Sclerotium rolfsii, Aspergillu s niger, Fusarium oxysporum)	Thiram 80% WP	70g/50L/10m2			6-8	14
	Thiophanate-methyl 70% WP	30g/50L/10m2			10-12	14
	Thiophanate-methyl 50% + Thiram 30%WP	50g/50L/10m2			7-10	14

Name of the Disease / Pathogen	**Common Name**	**Dilution (Product per 10 l of water)**	**Rate of Application when low foliage (Product per ha)**	**Rate of Application when high foliage/ha**	**Application interval in days (only if subsequent application as required**	**PHI days**
Big Onion						
Anthracnose (Colletotrichum gloeosporioides)	Thiophanate-methyl 70% WP	10g	325-400g	500-600g	7-14	21
	Metiram 55% + Pyraclostrobin 5% WP	20g	650-880g	1000-1200g	10-12	14
	Followed by either: Mancozeb 75% WG	20ml	650-800ml	1000-1200ml	7-10	14
	Chlorothalonil 500g/l SC	30ml	950-1200ml	1500-1800ml	7-10	14
	Fluzinam 500g/l SC	10ml	320-400ml	500-600ml	7-10	14
Purple blotch (Alternari a porri	Tebuconazole 250 g/1 EW	3.5ml	100-150ml	175-200ml	14-21	21
	Metiram 55% + Pyraclostrobin 5% WG	20g	650-800g	1000-1200g	10-12	14
	Mancozeb 75% WG	20g	650-800g	1000-1200g	7-10	14
Pineapple						
Heart/stem /root rot (Phytopththera spp	Copper (Cupric Hydroxide) 37.5% WG	250g/50L/10m2			6-8	14
	Mancozeb 64% + Metalaxyl 8% W	150g/50L/10m2			10-16	14
Guava						

Name of the Disease / Pathogen	Common Name	Dilution (Product per 10 l of water)	Rate of Application when low foliage (Product per ha)	Rate of Application when high foliage/ha	Application interval in days (only if subsequent application as required	PHI days
Anthracnose / Twig blight (Colletotrichum spp., Gloeospor ium spp.)	Copper (Cupric Hydroxide) 37.5% WG	50g	1600-2000g	2500-3000g	6-8	14

5.3 Pesticides application

Inorganic pesticide use is the most popular method of pest control in a wide range of cereals, vegetables, yams and fruits cultivated under diverse AERs in the provinces. Farmers prefer to use a high dose of pesticide than recommended and apply it more frequently, maintaining shorter application intervals and the usage of a wide variety of pesticides to ensure better results in crop productivity.

There are many challenges related to the use of pesticides in Sri Lanka. Though there are recommendations with specific crops, types of pesticides, dosage and instructions/directions on application noted in the labels, most often the farmers do not adhere to it. It has been recorded that 59% of the farmers in Matale, Nuwara Eliya, Badulla and Kandy Districts use more than the recommended amount of pesticides in their vegetable cultivations and among the intensive cultivating farmers in the hill country, about 45% use more pesticides than the recommended amount and apply them in higher frequencies to ensure better crop productivity (Watawala et al, 2010). Farmers in the Vavuniya District in the Northern Province also uses pesticides extensively for upland vegetable cultivations to get higher economic returns from cultivation. In Vavuniya District, 60% of farmers had applied 30-40% higher concentrations of pesticides than the recommended dosage (Selvarajah and Thiruchelvam, 2007).

As the agricultural extension system is weak in Sri Lanka, a majority of farmers get their information from pesticide traders or their fellow farmers. Farmers are highly exposed to pesticides mostly when mixing and spraying. Farmers have increasingly detached themselves from recommended practices, in which they do not adopt any safety measures or wear protective clothes when spraying. Scarcity of labour has led to long hours of spraying of pesticides by farmers and thereby increasing the time of exposure to pesticides and they also ignore the timing recommended for the application of pesticides. Farmers are not concerned about the pre-harvest interval when using pesticides and apply pesticides even a few days before the harvest. Even though the pre-harvest interval and maximum residue levels are gazetted/ published there is no proper enforcement system. A research conducted by the office of the Registrar of Pesticides has shown that 33% of the tested vegetable samples were contaminated with pesticide residues.

The results of the study while confirming the above status in the provinces, identified differences of opinions among the farmers/ key persons who participated in the interviews and discussions. All farmers were in agreement that they are highly depended on the use of pesticides due to the nature of crops cultivated and its short gestation period. However, farmers are aware that the chemicals available at present are not strong as before due to GOSL initiatives to restrict and ban the import and distribution of highly toxic pesticides. In view of this there are clusters of farmers who are determined to find alternate options to protect their crops. Yet these farmers try their best to enhance the strength by mixing different chemicals available in the market. Though the farmers are aware of other options of non-chemical control practices they are reluctant to use these due to the lack of knowledge and inadequate skills.

However, there is notable change in farming practices in Central, North Central and Uva provinces in which farmer clusters working with private sector agriculture development initiatives informed that the use of pesticides are greatly reduced with non-chemical technology approaches promoted in respective areas. It is the commitment of extension officers attached to respective companies, who communicate effectively with farmers by implementing trainings, demonstration, farm visits, personnel contact, and follow-up with market linkages for regular purchasing of produce. The close networking mechanism of the agri business investments in the provinces influenced the farmers to deviate from routine spraying practices and adopt sound agronomic methods and input management based on the selected crop cultivated.

It was reported that in the central province farmer clusters are adopting chemical free crop production which is focused on achieving organic certification in a few years time. According to the farmers of this cluster at Nuwara-Eliya, their lands had become totally infertile due to the continuity of conventional farming using agro-chemicals and inorganic fertilizers for a long period of time. Cargills Agribusiness investments have sponsored the select farmer cluster to carryout organic cultivations in these lands under their BEE-Safe project. Accordingly they had been advised and guided to grow vegetables without synthetic agro-chemicals and inorganic fertilizers. Cargills in coordination with experts have introduced biological and organic inputs such as bio-pesticides, bio fertilizer, and bio flowering liquids.

Robert Gamage is a farmers'-Met at Shanthipura, Nuwaraeliya. He cultivates about 0.1 ha of vegetables under the above program. He applied 150kg basal and two top dressing 150kg and 75kg of organic manure costingless than LKR 2000compared to inorganic fertilizer which costs

LKR 8500 or 0.1ha. In addition, he had done 3 foliar applications according to growth stages but had not been charged as it had been given as a trial. Accordingly, he further added that the yield under this system is somewhat lower but the company has agreed to pay 30 percent more thanthe normal market price. He concluded that although the profitability of this system is still under investigation, it is likely to continue in 0.1 ha if the market is assured and prices are reasonable, as a citizen, to show others to value the system which is implemented to ensure the environmental safety.

Though there are crop and pest wise recommendations for different types of pesticides, dosages/ instructions and directions are clearly mentioned in the labels of the pesticide but reported poor adherence. Farmers were yet to understand the technical status of pesticides covered under Grades II and III. Though the toxicity of grade II and III are low compared to Grade I (highly poisonous) the effectiveness is not reduced. According to the DOA, the pesticides under class II and III are well effective but slow responding by de-activating the pests immediately and not killing the pests instantly as in the case of Class I pesticides. This fact is still not understood by the farmers due to inadequate communication and information diffusion at farmer level. The farmers' goal is to see that pests are instantly killed when pesticides are applied.

Further it was confirmed by the findings of a previous survey that about 40% percent of the farmers always apply pesticides as a precautionary measure prior to the appearance of any symptoms of pests or disease, though it is needed for only selected pests and diseases. Another 38 percent apply pesticides prior to the appearance of symptoms for selected pests and diseases. However, 37 percent of farmers apply pesticides only after the appearance of the symptoms of pest or disease, which is mostly recommended (Pdmajani et, el. 2014).

In contrast, in this study, 58 percent of farmers had applied pesticides after observing the damage and it was further revealed that 44% and 31% of them had been advised by the AI and by reading the label on pesticide packages respectively. It is unfortunate that 41% of farmers who had applied pesticides before failed to follow the instructions and advice noticed that the advice given by the representatives and dealers of pesticides, resulting in long term hazards.

It was a common topic in all agriculture related forums to discuss the challenges on the usage of pesticides and its effects. However, the use of pesticides or application in farming fields continue, causing the farmers an increase in cost of production, poisoning the environment and creating health problems to the population in the long run.

The cost incurred for pest control has increased annually due to the increasing cost of pesticides manufacturing /importing and internationally imposes regulations and safety requirements coupled with increasing pest resistance at farm level. In chillies it has increased from 25% to 32% over the past years. At times the cost of pesticides have increased by 75% of the total cost of cultivation (Mohottige et, el. 2002). This was confirmed during the farmer group discussion at MASL: farmer clusters producing chilli seed and vegetables in Madatugama block area. The over use of insecticides for vegetable cultivation is not limited to up country areas. It was found that, farmers in the Vavuniya District in the Northern Province also use pesticides extensively for upland vegetable cultivation as their crops are more susceptible to pests and diseases.

Based on the observations during this field study and shared experiences by representatives of modern retail chains who indicated that a high frequency of pesticide applications are used in the Low Country Dry Zone than that of the Up Country areas due to off-seasonal cultivations targeting at high priced market potentials. However, the continuous cultivation pattern which amounts to three times per year in the up country areas are not largely effected by pests and disease incidences according to farmers and KIIs. The discussion with different individuals identified that hill country farming practices are now integrated with diverse agronomic practices supported with foliar nutrient applications to facilitate the rapid/vigorous crop growth during the vegetative period. This resulted in reduced incidences of pest infestation. This was further confirmed at a meeting with Cargills farm produce suppliers.

Further the farmer communities following conventional pest control practices tends to ignore the causes of pest infestations and instead rely on routine, scheduled pesticide applications. These farmers were susceptible to being trapped by myths spread by Pro-Pesticide groups that say that pesticides are often temporary fixes and ineffective over the long term. The truth is that “No pesticides can be considered safe”.

Northern Province farmers re-fertile the soil on an annual basis by adding compost/cattle manure for cultivation of seasonal vegetables. They also practice dense planting for vegetables such as green chilli where they plant around 4-5 seedlings per hill. This practice may require high nutrients to the plants but it is doubtful that the farmers are applying the necessary inputs according to the densities. The filed observations revealed that pests and disease infestation is high due to conducive micro environment build up around plant and canopy. The record keeping method of the ASMP program with farmers may be used to evaluate this situation and promote corrective measures.

Almost all the farmers in the project provinces have completely depended on chemical pesticides to manage pests and diseases. If a particular chemical is ineffective in controlling a given pest or disease, farmers use different strategies to curtail the incidence.

Before banning the extremely hazardous chemicals, farmers had experienced the effectiveness of those chemicals that responded instantly. With the effect of the ban on those class I chemicals, pest control has become a difficult task as the level of response is poor according to farmers. Therefore farmers tend to use cocktails of two or more chemicals based on the experience gained/ shared by other fellow farmers/ informants. The farmers in the project provinces also admitted that they use cocktail mixtures, in order to make sure the effective control of P&D. The cocktail pesticide users believe that such mixtures saves time; while another anticipates that such mixtures are more substantive and therefore effective in controlling pests and diseases.

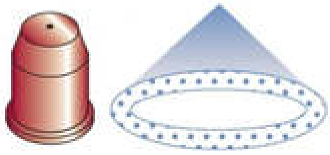
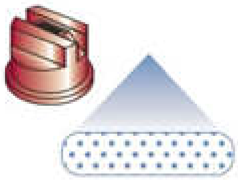
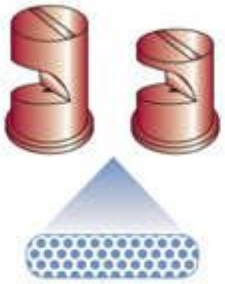
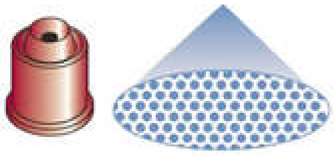
Weed Management with different herbicides were tested by the DOA to evaluate the weed controlling ability and phytotoxicity on maize crop. Weeds were effectively controlled by Tembotrione 420 SC 350 ml/ha as a post emergence herbicide and Pendimathalene 33 % EC 3.5 litres/ ha as a pre emergence herbicide identified as an opportunity to farmers to reduce the cost of labour involved in weeding operations.

The recommended practices for application of pesticides are established and published by the DOA under the guidance of ROP. Based on the crop extent, the spray volumes of recommended rates of pesticides was determined by considering the factors such as type of sprayer (knapsack/ power), capacity of sprayer, land terrain, walking speed of applicator, type of nozzle, growth stage of plant, level of canopy (height/ size/ spread) and level of infestation. These recommendations allow farmers to dilute and use pesticides as necessary and accurately, preventing any low or over discharge. The spray volumes under different pesticides are indicated in relation to canopy size/ area.

A majority of vegetable producing farmers in the provincial area indicated that through their own experience the application rates are determined by the number tanks per acre or unit area. The volumes varied from farmer to farmer and the level of infestation. Irrespective of the recommended rates the farmers blindly use pesticides spraying around 20-25 rounds of 16litre knapsack tanks per acre per time.

Using the correct type of nozzles increases the efficiency and safety of spraying. The farmers are aware of the proper type of nozzles to be used in application of different pesticides at different crop growth levels. It is very important that appropriate nozzles should be supplied with the sprayer to make them freely available in all farming environments. It was reported that inadequate technical knowledge on selecting proper nozzle types and spray operations hindered achieving optimum benefits from the application of pesticide. It was learned that a majority of farmers are ignorant or do not possess right information/skills to identify the correct type of nozzle types but use double or single nozzle sprayers.

Table 5.6: Choice of nozzle

Type of pesticide	Type of nozzle	Nozzle and spray pattern	Approx. pressure
Insecticides & Fungicides	Hollow cone nozzle		3bars
	Flat Fan nozzle		3bars
Herbicides	Deflector Nozzle *(also called poly jet, food jet, impact, flood or anvil nozzles)*		1-2bars
	Flat fan nozzle		1-2bars

Although following recommendations for spraying are established and made aware for the farmers, the adoption of such instructions are not observed during the study. The instructions established by the DOA are noted below:

Table 5.7: Farmer responses for DOA Recommendation for spraying

DOA instruction	Farmer response/perception
Determine the growth stage of the crop	Poor
Spray calibration/rate of application	Good
Hollow cone nozzle-(Insecticides/Fungicides0	Irregular/Not particular
Deflector nozzle-(herbicides)	Irregular/Not particular
Flat fan nozzle-(for flat/parallel to soil surfaces	Poor
Avoid excess drain off from leaves	Poor
Use of 4-5 hole hollow cone nozzle not recommended	Not aware

DOA instruction	Farmer response/perception
Distance between nozzle & spray surface - 50cm	Not always adhered
Adjustable nozzles –not recommended	Not aware
Cleaning nozzles	Own practice

Source-S&P Study team, 2019

5.4 Information sources on decisions for use of pesticides

Informal sources such as fellow farmers and retail traders were the most popular sources of information. Although a few farmers reported that Agricultural Instructors (AIs) were their main source of information there is a communication barrier for meeting them due to the large number of farmers (more than 2000) to be served under one AI range.

Agricultural Research and Production Assistants (ARPA) were not a popular source of information used by many of the farmers, mainly due to the farmer's sensing that the ARPAs do not possess enough experience or knowledge compared to AIs to give recommendations, especially related to usage of pesticides. However, APRAs have also undergone many agriculture related trainings and especially selected APRAS in ASC areas have attended crop clinic programs and assisted the crop doctors (trained AIs) in respective areas. It was found that APRAs are currently attached under different administrations that obtain instruction from the Agrarian Services Commissioner and not directly connected to the MOA or the Provincial DOA. This resulted in the reduced involvement and support of APRAS in facilitating agriculture extension activities at grass root levels in the provinces.

Table 5.8: Percentage of Farmers using different practices (application and quantities)

	Province - No.of Farmers & (%)					
	Central	**UVA**	**East**	**North**	**N/C**	**Total**
A Source of Information	n=20	n=26	n=46	n=50	n=55	N=197
Extension Officer	1(5)	22(84)	8(17)	14(28)	7(13)	52(26)
Pesticide Dealer	5(25)	2(8)	15(33)	27(54)	8(15)	57(29)
Label information	5(25)	2(8)	10(22)	4(8)	25(45)	46(23)
Leaflets	4(20)	-	-	-	1(2)	5(3)
Guided by contract farming company	-		12(26)	-	8(14)	20(10)
Based on experience-high doses	4(20)	-	1(2)	3(6)	6(11)	14(7)
Occurrence of P&D in neighboring farm	1(5)	-		2(4)	-	3(1)
B Base for Pesticide Application	n=20	n=26	n=46	n=50	n=55	N=197
Routine application/Before symptoms	11(55)	0	10(22)	2(4)	24(44)	47(24)

Based on pest monitoring/ surveillance/ based on symptoms	9(45)	26(100)	36(78)	48(96)	31(56)	150(76)
C Pesticide Application Intervals	n=20	n=26	n=46	n=50	n=55	N=197
Once in 4-6 days	2(10)	0	6(13)	0	7(13)	15(8)
Once in 6-8 days	10(50)	2(8)	8(17)	17(34)	28(51)	65(33)
Once in 14 days	4(20)	4(5)	7(15)	11(22)	12(22)	38(19)
Depend on pest population	4(20)	20(77)	25(55)	22(44)	8(14)	79(40)

Source; Expert Team-S&P Holdings, 2019

The traders were of the view that they could make recommendations because they had the license from the Pesticide Registration Office. The initiative of ROP has promoted the traders and their sales personnel to train on pesticides usage practices and technical aspects of pesticides, storage, marketing, advice to farmers to equip/strengthen the dealer network with scientific skills through Agrochemicals Sales and Technical Assistance (ASTA) which is a certificate program conducted by ROP/ DOA. The dealers interviewed have undergone this training and they are confident that the training improved their skills and capacity to offer advice more prudently and technically to farmers in the vicinity. This mechanism also enables the traders to keep updating the new developments related to the plant protection technology, policy, and marketing. Dealers reported that although it is true that dealers are helping farmers to select best effective pesticides for their cultivations, there are some farmers who mistrust the advice/ guidance given by dealers. Instead these farmers make their own purchasing decisions that may be costly and harmful to the environment.

The dealer network in the provinces also maintain a strong relationship with the pesticides importers, stockists, distributors and provincial administrative networks. The leading pesticides distributor companies have their own marketing representatives who operate at provincial levels and work with dealer networks in the region and coordinate with the extension services of DOA and private sector agribusiness companies. According to main associations such as, “Crop Life” Sri Lanka affiliated to “Crop Life global” which represent 26 companies’ dealing with importing/packaging, storing and distributing, pesticides have implemented programs on farmer education and awareness on pesticides use and best practices focused on mitigating challenges and issues on Environment and human safety. The member companies of Crop Life in coordination with DOA has trained 300 marketing/ extension representatives to acquire skills on GAP certification programs. This has helped the companies to move very closely with farmers and dealer network to solve problems related to pests & diseases and pesticides at field level. This could be an ideal opportunity to promote private public extension support network to improve the farm productivity and diffuse technological information under one platform. It was noted that farmers are increasingly linear towards private sector services that responds swiftly to the crop problems, though they are promoting the own business agendas of each entity.

The rapid expansion of digital communication systems has overtaken the print and electronic media in disseminating information on agriculture production/marketing including pest and disease awareness and control solutions. A large number of apps introduced worldwide and DOA instrumented mobile apps are increasingly popular among the farmer community that operates through smart mobile phones. Some of these identified as Govi mithuru (Dialog), Sri Lanka E-Agriculture (DOA), Govipola (Croptonix), etc.

Organic and natural farming approaches promoted by various agribusiness ventures have established guidelines for non-chemical pest control methods. These investments are instrumental in changing the mind set of farmers to adopt these methods in cluster contract farm producers in Central, NC and Uva Provinces.

The GAP certification program promoted by the DOA is another decision making option of the farmers that lead to controlled use of chemical pesticides on vegetables and fruits cultivations. The provincial FPOs are trained to adopting the GAP practices and registration/ certification of farms producing chilli, groundnut, B-onion, bitter gourd, mango, guava, passion fruit and papaya which is path to progress.

Farmers’ attitudes about Integrated Pest Management is negative, mainly due to the lack of proper awareness about the the technologies. The farmers have no confidence on the technologies promoted under IPM and there were no demonstrated effects shown regarding the benefits of the practices. Most farmers knew that, as they have undergone training programs but not made any visits to observe the areas/ farms where IPM is practiced.

It is noted that farmers are supported for decision making processes on pesticides use on crops by many stake holders in the field. Even though the DOA is the largest extension network that reaches out to the farmer community, there are other institutions like MASL, DEA, EDB, NEDA, CAA, DS, SEDD,and private sector entities such as, Cargills, Keells, CIC, Hayleys, Exporters, NGO, Crop Life, etc., who areactive either in coordination with the DOA or on their own. Accordingly, under the present situation the farmers are not neglected or left out as pointed by many forums identifying the agriculture extension system in the rural areas which are not effective. It is the problem of non-cooperation by all public/ private/ NGO extension services and working in isolation which hinders the dissemination of information to farmers. Different institutions working with their own programs/ agendas in the field level have caused the problem of being persistent barriers for technology transfer interventions including the promotion of P&D control/ management.

Based on the legal procedures under the Pesticides Act, the labels of pesticides are well establsihed according to the standards stipulated by the ROP by meeting the international code of practices. This provides the farmer at the field level a great opportunity to understand the contents and, uses, precautions, disposal, etc. The majority of farmers interviewed are informed that they should read the label, mainly to identify the product, directions for use, dosage and price. It was noted that price is important for them to calculate cost for the land area cultivated. They are not very keen to see the active ingredient or precautionary methods, date of expiry, pest to apply. Further the farmers complained that the prints on labels describing many details were too small to read.

Table 5.9: Farmers' recognition towards the information in pesticide labels

Description	**Province Scaling – (*** Poor ***** Excellent)					
	Central	**Uva**	**East**	**North**	**N/C**	**Other**
Category mark & class/colour band	*	*	*	*	*	
Brand name only	*****	*****	*****	*****	*****	
Active ingredient and percentage	*	*	*	*	*	
Recommendations –dosage	***	*****	****	*****	***	
Recommendation type of crops & insects	****	****	****	****	****	
Volume required and available pack sizes	****	****	****	****	****	
Expiry date	*	*	*	*	*	
Application methods	***	***	***	***	***	
Precautionary methods	*	*			*	
Remedies during accident	*	*			*	

Source; Expert Team-S&P Holdings, 2019

5.5 Analysis of Farmers knowledge and skills on pesticide usage

Farmers cultivating seasonal crops always focused on saving crops from pests and diseases as the main threat for their sustainable income. In this regard farmers always look for swift solutions that kills the pests instantly by the use of highly toxic pesticides. However, they are aware of the consequences but continue to use the chemical irrespective of the damages caused to humans and environment. The current global trend promoting protective measures on use of pesticides have influenced Sri Lanka to enforce a ban on high toxic chemicals and induce import of Class II and Class III hazard type less toxic chemicals for the use of agriculture. It is found that farmers are not satisfied with this move as the chemicals according them are less effective and need more chemicals per unit area. This an indication for the prevailing knowledge gap of farmers in identifying the pesticides. The farmers are not aware of the nature of response of low toxic chemicals and its effectiveness of controlling pests.

In some provinces farmers expressed their knowledge, gathered through experience in which the identification of control measures are related to the time of the day. It is informed that farmers have identified that pests in moringa, pests in cabbage are active after sunset and determine that spraying is effective during this period. However, the use of this opportunity is limited due to personal and social commitments.

Table 5.10: Factors influencing Farmers in Selecting Pesticides

Factor	Level of influence
Quality/Efficiency of control	High
Experience	Medium
Availability	Average
Company reputation	Average
Income	Average
Price	Low
Novelty of product	Marginal
Packaging	Marginal
Rules/Regulation	Negligible
Transport distance	Low
Dealer influence	Low
Promotions	Very Low
Belief & Attitudes	Extremely Low
Purchase on Credit	Extremely Low

Source; Tropical Agricultural Research & Extension 19 (2): 2016

The main determinant identified is quality of the product on which farmers decide the purchase of the pesticide. The Farmers' knowledge pertaining to safe handling of pesticides is not encouraging as per the discussions and it elaborated the need for more educative and informative training programs for the improvement of knowledge/ skills.

Table 5.11: Farmers' knowledge related to pesticides and its safety

Description	Very weak	Poor	Moderate	high
Colour band/Class	--			X
Toxicity level	--		X	
Post-harvest Interval	--			X
Banned Pesticides	--		X	
Recommended dose	--	X	X	
Safe Handling	--		X	
Proper application	--	X		
Safe disposal	--	X		
Protective cloths	--	X		
Harmful effects	--			X

Source; S&P Holdings, 2019

Identifying the low response rate of the pesticides currently available in the markets, the farmers are influenced by various practices to strengthen the plant growth and vigour by using modern plant nutrients that are used for vegetative growth and fruit setting. The interview with key informants at Cargills and its linked farmers in the provinces have identified that vegetables supplied through the farmers in the central province are less toxic as the use of insecticides is less compared to other areas. It was reported that timely application of foliar nutrients based on identified growing stages contributed to the reductionin P&D infestation. This fact was observed in farmer clusters in the Central and UVA provinces that use foliar nutrients and Gibberelic acid to induce the flowering of bitter gourd.

Regular discussions were held at institutional levels highlighting the fact that farmers use pesticides prior to harvesting to make the harvest fresh and storable until it reaches the market. Accordingly, the safety of consumers are neglected, increasing the risk of residues being consumed. Past research highlights this fact but the interviews with farmers have no significant indication to confirm the farmers' practice of the application of pesticides prior to harvest or post harvest.

It was further confirmed that GAP certified farmers managed their crops to avoid any residual effects on their harvest. However, it was found that large volumes of pesticides are used for vegetables, especially bitter gourd, chilli etc., in the project provinces posing the danger of residual contamination. Most of the farmers indicated that they are aware of PHI for chemicals used based on the type of crop. It was revealed that farmers have not followed the PHI as recommended due to various reasons mentioned mainly as practical barrier for implementing.

5.6 Farmers' knowledge on pesticide residues

Out of the total volume of pesticide mixture applied to the field, only about 20-30% is absorbed by the crops and the rest is left in the environment (Huang, 2001). Therefore over application of pesticides has more harmful effects on the environment. Almost all farmers were aware of the fact that pesticide residues remain in the environment, viz. atmosphere, soil and surface water sources. However, farmers are nonchalant or completely ignorant about their part in taking responsibility on polluting the resources/ environment but they do understand the harmful effects of pesticides on the beneficial organisms like earthworms and beneficial insects.

The recent development initiatives in agriculture technology diffusion programs have helped the farmers to improve the knowledge on pesticide residues on crops and the environment including hazards on humans and animals. In this regard, farmers interviewed are thoughtful about the usage of pesticidesand handling practices.

Farmers were positive about the regulatory actions taken by authorities to ban high toxic chemicals in Sri Lanka as a protective measure to safeguard the human health and environment. Farmers are made aware through the pesticides dealers, and DOA official, representatives of pesticides companies, that toxicity of available pesticides are lower than those banned chemicals and application of low toxic chemicals act slowly initially by making the pest inactive and unable to damage the crop. But the opinion of the farmers is that present pesticides are not effective enough as it does not kill the pest instantly. In this respect the farmers paid less attention to the frequencies, quantities, and health and safety indications and applied high doses of pesticides. Based on the educational background the farmers are able to read and understand information, instruction, recommendation, active ingredients, toxic levels, poisoning effects, remedies, time gaps between application and re-entry to the field/pre-harvest periods, storage and disposal of empties, user safety measures, etc., noted in the labels of the pesticides packages. Yet, the usage of pesticides continues according to the traditional manner as per the experinces garnered through years of farming even if the effects are highly detrimental.

5.7 Storage practices

The storage of pesticides in the farming areas and households are a cause for alarm. . The Public Health Inspectors (PHI) trained on pesticides related regulatory empowerment in the provinces indicated that some farm households store the pesticides/ spray tanks within the living areas in the house as a majority of farmers have no storage room for Agri equipments and input storage. They use the the side or rear entrances of the house which in most instances is adjoining the kitchen, posing a probable risk of food contamination and poisoning of household entities and children. 'Crop life Sri Lanka,' under their outreach programs have conducted participatory farmer training/ awareness programs/ demonstrations focusing on pesticide related hazard mitigation practices in selected provinces. The associations such as Crop Life, LFVPPEA, and SLFPA in cooperation with DOA have promoted safe storage methods for pesticides. The Crop Life under their program, have implemented projects to distribute storage boxes and provide collection and disposal mechanisms for canisters, cans and bottles which contained pesticides. The farmers were supplied with storage boxes in Mullativu District. As a result of the promotional effort of Crop life, the farmer clusters invented and innovative household lockable pesticide storage box by converting 20litre capacity rectangular empty plastic containers which are available in the area. This indicates that guidance to farmers will carry a long way in mitigating the challenges/issues pertaining to pesticides usage and applications. The national support to replicating such programs islandwide is imperative to counter the hazardous effects of poisonous pesticides.

Field visits in the provinces identified that farmers are still not very concerned about the environment as the empties of pesticide packages are disposed in and around the farming fields, thrown into bushes in the vicinity of houses, waterways, agro wells, roadsides, etc., satisfying their convenience due to negligence of consequences such as endangering human life and polluting the environment. Though the discussions with farmers indicated they are aware of the importance of proper disposal but it is always over sighted. A larger capacity of empty cans are seen hanging in many small boutiques which may be detrimental to the environment or people in the vicinity. Some households utilize the large empties to store kerosene/diesel. The study identified that there are no farmers' practice of burying of empties or no respondents to burning of the empty cans. It is observed that knowledge on disposal of empties is required to strengthen and further influence the farmers to adopt measures on proper disposal systems.

Table 5.12: Disposal methods for empties of pesticides packages

Description	**Province** (No.of Farmers & %) n=197* * some farmers has given more than one answer					
	Central	**Uva**	**East**	**North**	**N/C**	**% of total**
Thrown to irrigation channels, ground, outside the house	4(9)	4(9)	10(23)	12(28)	13(30)	43(100)
Buried in the ground	6(10)	13(21)	15(25)	10(16)	17(28)	61(100)
Burning the package (polythene, paper, plastic)	2(10)	4(20)	3(15)	2(10)	9(45)	20(100)
Dumping into garbage	14(41)	6(18)	-	-	14(41)	34(100)
Collect for recycling (plastics/glass) factories	1(8)	-	4(31)	5(38)	3(23)	13(100)

Source; Expert team S&P Holdings 2019

The study revealed that farmers have repeatedly used any surplus/balance spray solution prepared for same crop or in some cases it is used for another crop cultivated in the same land area. However, farmers are well aware of the compatibility of using the same solution to multiple crops as per the information carried on the label of the package.

The study found that farmers are washing/ cleaning the sprayers after its use in irrigation canals/ reservoirs/ domestic water sources, causing pollution in surface water bodies intentionally or unintentionally.

Farmers in the ASMP provinces are not aware of collection systems of empties of pesticide packages. According to "Crop Life Sri Lanka" in cooperation with the DOA intervened to implement a program on collecting empty pesticide packages at regional/rural producer areas. Farmers noted the importance of such interventions and informed the necessity of organizing the collecting points to minimize the issues on environment pollution and health hazards due to adhoc disposal practices.

The ROP was instrumental in promoting mechanisms on disposal of pesticide empties from the farming fields. There are two pertinent sources of containers viz. by company disposals of large drums and smaller containers disposed at farmer fields. It is estimated that the yearly turnover of empty glass containers only amount to 1,000 tons at a value of Rs. 38 million. It has been estimated that 14.6 million pesticide containers (which includes all types of containers as of 2011) are disposed of haphazardly every year into the environment without a proper management option.

Implementation of Empty Pesticide Container Management in Sri Lanka in collaboration with the Ministry of Mahaweli Development & Environment (MMDE) has initiated a program to develop strategies to manage empty pesticide containers in the country. It was found that recycling of glass and plastic containers is a well-established private enterprise in the country, which is regulated by the Central Environment Authority (CEA). It was revealed that currently, there are several projects executed by the CEA to strengthen waste management systems within the industry under the premise of “public-private partnership” programs. By considering the unique and hazardous nature of wastes, pilot programs are executed through Crop Life, Sri Lanka (which is the pesticide industry coalition in Sri Lanka) for collection, processing and manufacturing of non-consumable items. According to Crop life, the plastic and glass containers are recycled through M/s Polykar PVC (Pvt.) Ltd., & M/s Piramal Glass Company (Pvt.) Ltd.

The proposed empty pesticide container management program blessed with the support of the CEA with the participation of the MOA and the MMDE, and other stakeholders, signed a Memorandum of Understanding (MOU). The office of the Registrar of Pesticides distributed two plastic waste crusher machines to be deployed at pilot projects on waste recycling through the CEA. Also, four regional container collection centers were established at (i) Seetha Eliya Government Seed Farm, (ii) Polonnaruwa Government Seed Farm, (iii) Pelwehera Government Seed Farm, and the (iv) Regional Agricultural Research & Development Institute, Makandura (NW) These centers will be functioning as the link between the farmer (at the field level) and the recycler. Field collection mechanisms will be implemented by Crop Life, Sri Lanka (company association with a membership of 29 pesticide companies in Sri Lanka. Apart from the recycling of empties, a new concept of Bio-beds which uncover the injudicious disposal of empties in the farm field and expected to collect all soiled containers unattended in the field and house-holds have been initiated under the ROP, promoting farmers to direct them to regional collecting points.

5.8 Use of precautionary measures

The study revealed that all farmers interviewed have not used any precautionary measures to protect the ill effects of pesticides. A majority of farmers used hired labour and these individuals are reluctant to use protective gears. The precautionary measures/ guidelines and clothing/ protective gears are recommended and published by the ROP. However it was informed that farmers or applicators were discouraged to use protective clothing due to warm climatic conditions prevails along the ASMP project areas, which make farmers uncomfortable. It was noted that the pesticide applicators work the entire day and they only cover the body with long sleeve shirts and long trousers without any shoes. Some individuals wear the cap. However no farmer or labourer (applicator) adopted the recommended precautionary clothing/gears during the spraying of chemicals.

Table 5.13: Use of protective gears

Protective measure	**Province** (No.of Farmers & %)					
	Central n=20	**UVA n=26**	**East n=46**	**North n=50**	**N/C n=55**	**%of total197**
Wearing of shirt and trousers	20(100)	23 (88)	24 (52)	13 (26)	45 (82)	63
Overall/Covering all body	1 (5)	10 (38)	0	1 (2)	10 (18)	11
Boots	1 (5)	10 (38)	0	1 (2)	10 (18)	11
Mask/Goggles	8 (40)	22 (85)	32 (70)	14 (28)	32 (58)	54
Gloves	4 (20)	11 (42)	23 (50)	12 (24)	20 (36)	35
Caps	20(100)	23 (88)	17 (37)	27 (54)	55(100)	72

Source; Expert team S&P Holdings 2019

It was reported that hygienic practices were not strictly followed and negligence of this has caused many ill effects for applicators in the long run. The applicators avoid eating and drinking while spraying but they are constantly chewing beetle despite the awareness on harmful effects. The applicators, as a practice wash/ bath before meals and use the washroom facilities.

5.9 Environmental & social effects/ risks

It has been made aware that pesticide dependent pest control practices are common in small farm agriculture production that caused negative impacts on environment and human life due to high levels of toxicity. In many forums the responsibility is put on the shoulders of the farming community as the users do not adopt the proper technology on handling, storing, application, disposal, etc. The study reveals that there are many institutional and legal entities involved in promoting and controlling best practices for pesticides use. Though these entities are well aware of the techniques, the information and demonstrated effects are not taught comprehensively to the farmers. It is been made aware that farmers have limited capacity to accommodate scientific knowledge and technology systems. Continuous communication with farmers at least for five years would require the enhancement of proper technology practices for the usage of pesticides to be adopted by farmers. In view of this, the relevant technical and legal systems operated by private and public sectors need to team up with farmers to be effectively promoted and practiced in connection with the use of pesticides and the adoption of agricultural best practices as a way forward in protecting the environment and ensuring human safety.

Uncontrolled use of toxic chemicals will affect the agricultural production and human safety through;

- Destruction of pollinators of crop plants leading to poor crop yields

- Elimination of the natural enemies of pests and consequent loss of natural pest control that keeps the population of crop pests very low.
- Development of pest resistance to pesticides, encouraging further increases in the use of chemical pesticides which poses further challenges as shown below;
- Contamination of the soil and water bodies
- Pesticide poisoning of farmers and deleterious effects on human health
- Loss of bio-diversity in the environment, particularly of aquatic species.
- Pesticides can contaminate soil, water, and other fauna and flora. In addition to killing insects or weeds, Pesticides can be toxic to a host of other organisms including birds, fish, beneficial insects, beneficial microorganisms and non-target plants. Although several categories of agro-chemicals have been banned or phased out in the country due to its harmful effects and persistent nature in the environment, several groundwater contaminants such as 2-4D, MCPA (Herbicides) and Carbofuran (insecticide) are still being used and are extremely popular among farmers.
- Run-off of pesticides flowing into water bodies has the potential to significantly impact aquatic organisms by inhibiting growth and causing reproductive failure. Fungicides have a higher amount of Zinc and Manganese which has a high risk of polluting groundwater and surface water sources. Water resources are polluted by pesticides in numerous ways;
  a) Application of herbicides to control aquatic weeds
  b) Discharging surplus pesticide formulation to waterways after spraying
  c) Washing of sprayers and other containers in the waterways
  d) Runoff and erosion of pesticide treated soil
  e) Accidental spillage of pesticides
  f) Aerial sprays of pesticides

Organo chlorines and Organo-phosphates groups of pesticides have been detected in significant concentrations through research carried out at Walawe and Nilwala rivers (De Silva, 2003). Studies are also being conducted to determine pollution of water bodies due to Chlorine containing pesticides. The Mahaweli River is also being screened for pesticide residues. National Aquatic Resource Agency (NARA) is conducting a study on pesticide residues in the aquatic environment. Since 1997 the National Water Supply and Drainage board has been monitoring residue levels of pesticide in water from areas such as Nuwara Eliya where there is extensive vegetable cultivation.

It has been estimated that, more than 50% of pesticides applied to crops lost their target surface and fell onto the soil surface (Mathes, U.d.). Organo Chloro and some other pesticides can premain in the ground for years. Though all pesticides are non-systemic, they can be absorbed by plants and transferred to animals through the food chain. Organo phosphate and Carbomate pesticides are non-persistent, but their toxicity and damage to non-target species are very high.

Farmers' in the provincial areas have little or no knowledge on how pesticides react when it touches the soil. Though the training sessions discuss the issues, farmers have not paid good attention /not understood clearly as it may be new information or highly technical for them to absorb. As noted before, incorrect spraying practices releases more pesticides in the soils and the excess use of granular formulas also accumulates and is retained in the soil while damaging the existence of beneficiary soil based insects, fungi,nemotodes, helping the buld up of harmful insects.

Almost all farmers expressed the fact that they are aware of the beneficial insects, and microorganisms *(Mychoryzae)* that facilitate the improvement of soil fertility. Even though they use pesticides as they have no proper idea on alternate technologies integrated to practices other than chemical control. A majority of the farmers expressed that there is a reduction of soil macro-organisms in the cropping area. Thus affecting the efficiency of plant nutrient utilization.

Comprehensive studies conducted in specific field areas where intensive agriculture is practiced (Eg. Kalpitiya area. (British Geological Survey, 1992)), identified overuse and misuse of pesticides have a direct effect on development of resistance. It was reported that estimated number of 600 insects and mites species are now known to be resistant to pesticides. (Rajapakse, 1997).

The pesticide industry is growing fast worldwide. Development of a new pesticide product needs a huge investment. According to Mc Dougall (2010), the discovery and development of a pesticide takes about 10 years and had absorbed around 256 million dollars in 2005 to introduce a new active ingredient.

Farmers interviewed reported that the available pesticides were not effective in controlling the pest population and stronger chemicals were needed. But chemical companies expressed that the bio-efficacy data clearly shows that the existing pesticides are effective in controlling the pests. Most of the time the farmers do not follow the recommendations. The awareness of the farmers was low on possibilities for increasing pest resistance due to inappropriate use of pesticides. So the training programs needs to include more information on these issues.

Research conducted on environmental effects of agro chemicals has been limited due to lack of technical feasibility and high cost. The interventions and regulatory mechanisms to monitor the effects of agro-chemicals and minimize the environmental impact is not adequately implemented.

5.9.1 Environmental impact of conventional Agriculture

Interventions of modern/ intensive conventional farming systems caused substantial environmental degradation (Stoll 2002) due to inappropriate agricultural practices. It was evident that large-scale irrigation projects developed for conventional agriculture have consumed water at unsustainable and inefficient rates, delivering only 40 % of water to crops (Stoll, 2002), causing water-logging and salination. Monoculture and dependence on a few plant varieties has diminished genetic diversity: Scialabba (2003) reports that currently, 1,350 breeds face extinction, with two breeds being lost each week.

It was informed that the increasing availability of hybrid/high yielding crop varieties and potential demand for uniform produce in the markets attracted the small producers in the provinces get away with traditional seed/ planting materials. At present Sri Lanka has lost or in the verge of losing its traditional varieties of vegetables/ fruits especially types of bitter gourd, luffa, pumpkin, maize, okra, chili, melon, etc. Unlike the traditional seed and planting materials the hybrid/ improved varieties are demanding a higher energy and quick response which are only available in an inorganic farm. High yielding products associated with modern technology forced to change the production/ management pattern that affected natural potentials of soil and environment.

The FPOs in UVA identified the potential for natural pollinators in passion fruit. However, there is a dearth in the species who may have gone extinct to due the excessive pesticide usage in the vicinity of farming that caused the destruction of pollinators of crops in addition to passion fruit which has led to the reduction in crop yield in the past.

As proven, agriculture today depends heavily on agrochemicals and non-renewable fossil fuels which has accounted for over 20 % of global anthropogenic greenhouse gas emissions (Scialabba, 2003). In Asia, this figure could be slightly higher as most of the fertilizers used in Asia are nitrogen-based (Stoll, 2002) and the industrial process of producing nitrogen fertilizer releases nitrogen dioxide, a strong greenhouse gas, into the atmosphere. (Nitrous dioxide is a greenhouse gas that is over 300 times stronger than carbon dioxide (Saunders, 2004).

Table 5.14: Environment impact by intensive Agriculture

Description	**Environmental impact**
Soil erosion	Low productivity, increased salinity, reduced water-holding capacity, depleted soil fertility
Sedimentation	Reservoir siltation, increased navigation channel siltation, floods, increased costs of road maintenance, habitat degradation, and reduced tank capacity
Over irrigation	Depletion of groundwater, increased water logging, increased Salinization
Agrochemical	Deteriorated Worker health, high water contamination, weed choking, cost of medical treatment
Soil compaction	Low soil productivity, poor drainage

Deforestation	High Soil erosion, crop damage from high wind, loss of genetic diversity
Wetland drainage	Decreased water purification service, genetic diversity loss
Air pollution	Odour, smoke, ozone layer depletion
Climate change	Increased GHG, Prolonged drought/rain, increased environmental temperature.

Source: Karp, et.al. In Crucefix 1998.

5.9.2 Effects of Pesticides on Human Health

All farmers interviewed are aware that regular exposure to pesticides is harmful for the health and further indicated the different pesticides have varied strengths due the type of active ingredients and percentages that could be absorbed by the skin and other exposed areas of the body. Though farmers have not responded with any pesticide related injuries, the medical authorities in the provinces highlighted that there are cases with skin injuries and mild poisoning incidences; especially the applicators, and involvement of farmers including women/ children in the process of mixing/ spraying.

i. Pesticides contamination/ residues

Currently, pesticide residues on fruits and vegetables is a major concern due to not following Good Agricultural Practices (GAP) in agricultural production. Higher pesticide residue levels have been detected in exported consignments of vegetables and fruits to the European Union (EU), not complying with their standards. Hence, EU is in the process of continuous auditing of the existing implementation strategies in Sri Lanka. However, information on pesticide residue analysis and detection in fresh food products in the country was limited. Therefore, there was an urgent need to establish a reliable database for pesticide residues on various agricultural products in local production channels.

Most farmers do not adhere to the pre-harvesting intervals (period between last application of pesticides and harvesting) recommended in the label. The farmers felt that practically it is difficult for adopting PHI for crops especially vegetables, cucumber, bitter gourd, okra, etc., which require regular harvesting in order to cater to the markets that demand products before its full maturity stage. The exporters working with out-grower networks including GAP certified farmers are yet to understand the mechanism to implement the PHI recommended for papaya where fruits are harvested every other day.

There is no proper enforcement system even though it is mandated that farmers should follow the pre-harvesting interval indicated in the label. Pesticides residue analysis undertaken by the office of the Registrar of Pesticides, Government Analyst, Industrial Technology Institute and private testing laboratories on fruit and vegetable samples had sporadically reported levels of pesticide residues. But, these analyses were not done on a regular basis due to the high cost.

It was reported that agri produce exported to EU markets were rejected due to high residual contamination of pesticides especially those banned in Sri Lanka. It was also noted that Gulf countries one of the major markets for Sri Lankan fruits and vegetables are now alerting the exporters about the high level of residues and issued warning, if remedial measures are not effectively implemented the ban of imports are imminent. The field observation related to pesticides use practices indicated that the possibility of pesticide residues remaining in the harvested products is high.

The cucumber industry is encountered with frequent complaints from their buyers regarding the pesticides residues levels beyond the approved amounts. It was informed that the companies provide residual testing certificates from accredited testing services in India. However, due to differences of calibration levels of similar equipment and similar testing methods of those used in India and in EU destinations identified a variation in the results for residue levels that are causing problems for export consignments.

The reports from the ROP identified that The results of monitoring for major pesticides in 145 vegetable samples from the local market revealed that 63 samples had been tainted with pesticides but only one sample exceeded the proposed regulatory limits adopted from the CODEX Alimentarius Commission, CODEX (i.e., Crop: Bean, Violation: Tebuconazole 0.37 vs. 0.30 ppm). The results of a collaborative study (Senthuran et al., 2016. Assessment of pesticide residues in vegetables of selected domestic markets in Sri Lanka in 45 vegetable samples from Nuwara Eliya, Puttalam and Matale Districts revealed detectable residue levels but none of the samples were exceeding regulatory limits of CODEX. Meanwhile, 28 vegetable samples taken from exporter pack houses were tested (during 07/2016) for major pesticides and 12 samples were found to be tainted (43%), and except for eight (08) samples (28%) the contamination levels in all the other samples were below the EU MRLs of respective pesticides. Profenophos, Thiamethoxam, and Tebuconazole were among those detected out of 52 pesticide active ingredients including commonly used contemporary pesticides and several banned pesticides (Method Detection Limit, MDL =0.01 ppm), according to the scope of analysis at the Industrial Technology Institute; there were more frequent violations in leafy vegetables. However, the quite narrow scope of analysis hinders a meaningful decision on food safety with respect to pesticide residues. The EU MRLs are much more stringent, and it is only about 40% of the local MRLs adopted from the CODEX. Meanwhile, 41 commercial rice samples (local, imported and some traditional varieties) were analyzed in a collaborative study (Pannipitiya et al., 2016), to determine levels of selected heavy metals in rice (in the Kandy District). It was found that none of the rice samples were contaminated with toxic heavy metals (assessment included Pb, Cd, As, Hg & Se) exceeding the FAO/ WHO tolerable Daily Intake Levels.

Table 5.15: MRLs for identified pesticides

Pesticide	Crop	MRL mg/kg	Capability of Analysis
Abamectin	Chilli	0.01	Not capable
Acephate	Rice Gotukola	0.01 0.01	SGS LOD 0.01 mg/kg
Acetamiprid	Brinjal Okra	0.2 0.2	SGS LOD 0.01 mg/kg
Benfuracarb	Rice	0.1	
beta-Cyfluthrin	Brinjal	0.21	
Bistrifluron	Cabbage Radish Knolkhol Cauliflower	-	
Buprofezin	Rice	0.5	
Carbosulfan	Rice yard long Beans Chilli	0.01 0.01 0.002	
Chlorfluazuron	Rice Beans yard long Beans Cabbage Radish Knolkhol Cauliflower Tomato Onion	-	Can be analyzed SGS LOD 0.01 mg/kg
Chlorantraniliprole	Brinjal Bean Tomato	0.6 0.8 0.6	
Deltametrin	Brinjal Onion	0.4 0.06	BV LOD 0.01 mg/kg
Diafenthiuron	Bean	-	
Diazinon	Rice Beans Onion Tea	0.01 0.01 0.05 0.05	ROP lab. LOD 0.04mg/kg, SGS lab. 0.01 mg/kg, BV* LOD 0.01 mg/kg
Emamectin Benzoate	Cabbage Radish Cauliflowers Onion	0.01 0.01 0.01 0.01	Not capable
Etofenprox	Rice	0.05	
Ethiprole	Rice		
Fenobucarb	Rice		
Fenvalerate	Brinjal	0.06	BV LOD 0.02 mg/kg
Flubendiamide	Bean	0.5	Not capable
Fipronil	Rice Capsicum Tea	0.005 0.005 0.005	ROP lab. LOD 0.04 mg/kg,
Hexythiazox	Rice	0.5	Not Capable

Pesticide	Crop	MRL mg/kg	Capability of Analysis
Imidacloprid	Chilli, Onion Mango Papaw	0.5 0.1 0.2 0.05	SGS lab. LOD 0.01 mg/kg
Indoxacarb	Cabbage Radish Cauliflower	0.2 0.3 0.3	Not capable
Lufenuron	Cabbage Radish Knolkhol Cauliflower Chilli	0.5 0.02 0.2 0.2 0.02	
Lambda cyhlothrin	Brinjal	0.5	
Novaluron	Beans yard long Beans Tomato	0.7 0.7 0.1	
Permethrin	Brinjal	0.05	
Phenthoate	Rice		ROP lab. Limit of detection is 0.04mg/kg
Phosalone	Chilli	0.01	
Profenofos	Cabbage Radish Knolkhol Cauliflower Chilli Cucurbits Pineapple Gotukola	0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01	ROP lab. LOD 0.04mg/kg, BV LOD 0.02 mg/kg
Prothiophos	Potato Chilli	0.05 3.0	ROP lab. LOD 0.04mg/kg
Quinalphos	Rice	0.01	ROP LOD 0.04 mg/kg, BV LOD 0.01 mg/kg
Spinosad	Cabbage Radish Knolkhol Cauliflower	2.0 0.3 2.0 2.0	Not capable
Spinosad	Brinjal Bean Tomato	0.7 0.3 0.7	
Tebufenozide	Rice Cabbage Radish Knolkhol Cauliflower Okra	0.1 5.0 0.05 0.5 0.5 0.2	
Thiacloprid	Rice Onion	0.02 0.01	
Thiamethoxam	Rice Chilli Mango	0.01 0.01 0.2	SGS LOD 0.01 mg/kg

Pesticide	Crop	MRL mg/kg	Capability of Analysis
	Papaw Beans Gotukola	0.02 0.3 0.01	
Thiodicarb	Beans yard long Beans Chilli	0.01 0.01 0.01	
Azoxystrobin	Grapes Banana Cucurbits	3.0 2.0 1.0	
Bitertanol	Beans Cucumber Banana Tea	0.01 0.01 0.01 0.01	
Captan	Gherkin Tomato Cucumber Bell pepper Ginger	0.03 1.0 0.03 0.03 0.1	Not capable
Carbendazim	Rice Banana Chilli Crucifers Cucurbits	0.01 0.1 0.1 - 0.1	
Chlorothalonil	Chilli Crucifers Cucumber Onion (bulb) Bell pepper Leeks Tomato Strawberry Papaw Banana	0.01 - 0.5 0.01 0.01 8.0 6.0 4.0 15.0 15.0	ROP LOD 0.04 mg/kg SGS LOD 0.01 mg/kg
Dimethomorph	Tomato	1.0	Not Capable
Edifenphos	Rice	-	
Flutolanil	Rice	2.0	
Flutriafol	Banana	0.3	
Hexaconazole	Rice Beans Cabbage Tea	0.01 0.01 0.01 0.05	
Isoprothiolane	Rice	5.0	
Mancozeb	Chilli Bell pepper	0.05 5.0	

Pesticide	**Crop**	**MRL mg/kg**	**Capability of Analysis**
	Cucumber	2.0	
	Crucifers	-	
	Cucurbits	2.0	
	Onion	1.0	
	Leeks	3.0	
	Tomato	3.0	
	Strawberry	10.0	
	Papaw	7.0	
	Banana	2.0	
Metiram	Tomato	3.0	Not capable
Pencycuron	Rice	0.05	
Propamocarb	Tomato	4.0	
	Bell pepper	3.0	
Propiconazole	Rice	1.5	SGS LOD 0.01 mg/kg BV LOD 0.01 mg/kg
	Beans	0.01	
	Cabbage	0.01	
	Banana	0.15	
	Tea	0.05	
Propineb	Beans	0.05	
	Chilli	0.05	
	Leeks	0.05	
	Tomato	2.0	
	Strawberry	0.05	
Pyraclostrobin	Leeks	0.7	
	Tomato	0.3	
	Strawberry	1.5	
Tebuconazole	Rice	1.0	ROP laboratory. LOD 0.04mg/kg SGS lab. LOD 0.01 mg/kg, BV LOD 0.01 mg/kg
	Beans	2.0	
	Cabbage	0.7	
	Leeks	0.6	
	Banana	1.5	
	Tea	0.05	
	Gotukola	0.01	
Thiophanate-methyl	Rice	0.01	Not capable
	Cucumber	0.1	
	Bell pepper	0.1	
	Banana	0.1	
Thiram	Chilli	0.1	
	Crucifers	0.1	
	Cucurbits	0.1	
	Onion (bulb)	0.1	
	Onion (spring)	0.1	
	Tomato	0.1	

Pesticide	Crop	MRL mg/kg	Capability of Analysis
	Bell pepper	0.1	

Most of the Pennywort cultivators are used to apply pesticides like Acephate, Carbosulfan, Profenofos, etc. As some of the pesticides (e.g. Profenofos) are banned in EU countries, and has raised negative impressions in this regard. It is imperative that export products to the EU market must comply with most stringent Maximum Residue Limits (MRLs), where in most cases the EU banned compounds are set at a default MRL at 0.01 ppm.

ii. Pesticides poisoning

Farmers were seriously exposed to the pesticides mostly when mixing and spraying. Free measuring cups given by many liquid pesticides have caused a reduction of contaminations during mixing. But safety measures in application were minimal. Discomfort of wearing safety gear in the fields, high cost and shyness prevented farmers from using safety devises such as head covers, nose and mouth covers, gloves and foot covers. Farmers' expression was that there is no significant harm in not using safety measures. But, knapsack spraying is considered as the most dangerous method of pesticide application according to the Registrar of Pesticides. The ROP office has introduced complete kit for protective pesticide application and awareness sessions conducted to promote the uses. Yet the applicators are reluctant to use.

A fair attempt has not been made by research institutes to develop pesticide application devises suitable for our conditions. Private companies also do not take much interest in introducing a better method, because that could be costlier than the knapsack sprayers. Lack of labour and the intention of finishing pesticide application within one day, had led to the long hours of application by farmers. It was revealed that, nearly 40 per cent of the farmers were applying pesticides for more than eight (08) hours continuously. Health problems reported by farmers include mild poisoning symptoms suchas nausea, headache, dizziness, and skin and eye irritations during the application of pesticides. This was significantly high with the longer duration of application but farmers were not overly concerned seeing it as normal to feel the discomforts during pesticide applications. Proper blood and urine tests would give the actual level of poisoning caused to the farmers. But a comprehensive study has not been conducted to measure the chronic health effects of using pesticides. A recent review of pesticides and impacts on health confirms there is no satisfactory data on pesticide impacts worldwide. A comprehensive analysis of 122 studies published post-2000 showed specific clusters, especially applicators and farmers, often had significantly higher odds ratios for some cancers, risks of dementias and respiratory symptoms.

Pingali and Roger calculated the human health cost of pesticide usage in irrigated rice systems of the Philippines, and compared the economics of three pest control strategies: complete protection comprising nine sprays per season, economic threshold decisions involving two sprays per season, and IPM with no pesticides. Pingali and Roger concluded: "the value of crops lost to pests is invariably lower than the cost of treating pesticide-related illnesses and the associated loss in farmer productivity. When health costs are factored in, the natural control option is the most profitable pest management strategy". Finding effective IPM approaches that reduce pesticide use will thus have important effects on rural public health.

Table 5.16: Benefits and health costs of three pest management strategies in irrigated rice, Philippines

Pest Management Strategy	Agricultural Returns	Excluding Health Costs (Pesos/ha)	Health Costs (Pesos/ha)	Net Benefit (Pesos/ha)
Complete protection:	standard practice of 9 pesticide sprays per season	11,850	7,500	4,350
Economic threshold:	treatment only when threshold passed usually no more than two applications used	12,800	1,190	11,610
IPM: pest control	predator preservation and habitat management, alternative hosts and resistant varieties	14,000	00	14,000

Source: Pingali and Roger

Global pesticide use may have resulted in biodiversity loss (Kumar et al., 2013; Zhang et al., 2011). There are more than 20000 species of bees on Earth, which pollinate more than 90% of the world's 107 major crops. However, bee populations have significantly declined in the past years. It is reported that 75% of the honey in the world has been found to have traces of insecticides harmful to bees, particularly neonicotinoids, including acetamiprid, clothianidin, imidacloprid, thiacloprid, and thiamethoxam (Harvard School of Public Health, 2015; Sheridan et al., 2017). Neonicotinoids have been identified as a key contributor to the decline in the number of bees worldwide. Furthermore, both species and an abundance of insects have declined during the past decades and the use of pesticides was considered as one of the major factors. Scientists in Radboud University Nijmegen and Entomological Society Krefeld have investigated an abundance of insect species in more than 100 nature reserves of Western Europe since 1980s', and found that the insect population in Orbroicher Bruch nature reserve has declined by 78%. A pitfall record indicated that there were 143 species of hoverflies in 1989 and 104 species in 2014 (Jin, 2017). In addition, pesticide use has led to various human / animal diseases, and injured human fecundity and intelligence quotient (IQ) in the past years

(Chen et al., 2004; Zhang et al., 2011; Zhang, 2018). The reports in this regard indicated that global pesticide overuse and pollution have increased over the decades. (Carson, 1962; Pimentel, 2009b; Liu et al., 2008; Zhang and Liu, 2017).

A government report in 2016 stated that pesticide use of Chinese farmers reached three times the global average. In 2013, Greenpeace reported that 70% of pesticides used in China was not absorbed by plants, but instead seeped into the soil and groundwater (Fan, 2017). Chen et al. (2005) reported that pesticide poisoning caused by insecticides, rodenticides, and herbicides accounted for 7.16%, 6.47%, 3.42% of the total (Zhang et al., 2011). The major pesticides for human poisonings were highly toxic organo- phosphorus pesticides, which accounted for 86.02% of the total cases (Zhang et al., 2011). A study published in June 2017 found that nearly 3000 children were poisoned by pesticides in eastern China’s Zhejiang province between 2006 and 2015, with most cases occurring during the farming season (Fan, 2017).

Methods of self-harm in Sri Lanka have changed with time. Before 1960, hanging was the commonest method of suicide in Sri Lanka. In the 1960s ingestion of acetic acid became the commonest method used. Since the 1970s the main mode of suicide has been ingestion of pesticides. Since 1997, the Ministry of Health has classified poisoning according to the 10th revision of the International Classification of Diseases. It reports admissions due to poisoning under three categories:

- Toxic effects of pesticides.
- Poisoning by drugs, medicaments and biological substances;
- Toxic effects of other, ‘chiefly non-medicinal’ substances, including solvents, halogen derivatives, corrosives, metals, gases and food.

Analysis of admissions in the Anuradhapura and Polonnaruwa hospitals in 2002 showed that the most common poisons ingested were pesticides (49%), followed by oleander seeds (34%). Medicines and hydrocarbons (commonly kerosene) were more often taken by women than men. A study carried out in Southern Sri Lanka between 1990 and 2002, found that more than half of the admissions due to poisoning were caused by pesticides (61%) but poisoning with medicines (68%) and plant products (55%) were more common among women. *(Ceylon Medical journal 22/August/2012, 57; 152-157, R. Hanwella, et, al)*. The study further reported that during the period from 2005 to 2008, Polonnaruwa, Anuradhapura, Kurunegala and Hambantota had the highest rates of total admissions due to poisoning and the mean rates in these districts were more than double that of many districts. Almost half the admissions were due to pesticide poisoning. Districts with highest area under paddy cultivation in Sri Lanka are Anuradhapura, Kurunegala, Ampara, Polonnaruwa, Batticaloa and Hambantota. Pesticides are widely available in these districts. It is surprising that these districts also have the highest rates of poisoning with drugs, medicaments and biological substances. The rates of poisoning with these substances were higher in these districts than in the more urban districts.

It was reported that in Anuradhapura and Polonnaruwa, there is a changing trend in the pattern of substances used for poisoning. There is a decline in pesticide poisoning and a rapid increase in rates of poisoning with drugs, medicaments and biological substances. In Sri Lanka one of the major causes of death was due to acute poisonings of pesticides. According to the Department of Census and Statistics, in 1999 pesticide poisoning had been the sixth leading cause of death recorded in the government hospitals. It had been ranked as the number one cause of death in Anuradhapura, Polonnaruwa, and Hambantota Districts, which are agriculture-based areas. The number of people hospitalized for treatments for pesticide poisoning in the year 2000 was more than 20,000. This was an increase of more than 8000 cases when compared to year 1991. Hospitalization for pesticide poisoning had increased in every district in the past ten years. Most number of deaths was due to deliberate ingestion of liquid pesticides. Many of the studies conducted on pesticide poisoning reveal that, poisoning among many farmers using pesticides may be greater than that as shown in hospital records. The current situation is out of danger where cases of pesticides poisoning is low compared past decades. Sri Lanka ingestion of pesticides as a method of self-harm has become less frequent in recent years. However, self-poisoning has become more common overall, as medicinal drug overdoses and poisoning by other substances are classified as “chiefly non-medicinal” are more frequently used for self-harm. This changing pattern of self-poisoning was observed in most districts. Reduction in the use of pesticides in self-poisoning in districts such as Anuradhapura and Polonnaruwa which have high suicide rates would have contributed significantly to the overall reduction in the suicide rate. Although there is a gradual shift of substances used in self-poisoning from pesticides to medicinal drugs, the steep rise in self-poisoning rates in most districts is of serious concern.

Table 5.17: Cases reported on poisoning due to Pesticides and other methods of self-harm. (2016)

Province	District	Toxic Effects of Pesticides				Poisoning by drugs, medicaments and biological substances		Toxic effect of other substances mainly non medicinal		Total Number	
		Organophosphate and Carbamates insecticides		Other Pesticide							
		Cases	Deaths	Cases	Death	Cases	Death	Cases	Death	Cases	Death
Western	Colombo	215	13	202	7	2196	3	2111	23	4724	46
	Gampaha	229	10	134	3	2176	2	1978	10	4418	25
	Kaluthara	62	1	175	6	1542	4	1829	12	3608	23
Central	Kandy	355	26	188	4	1911	3	2950	10	5404	46
	Mathale	488	9	91	2	657	2	1471	8	2707	21
	Nu/Eliya	551	16	116	3	505	2	1726	8	2898	29
	Galle	68	2	126	9	1019	5	1357	17	2570	33

Southern	Mathara	80	4	107	20	755	1	1387	16	2329	41
	Ham/thota	564	3	315	4	1044	7	739	4	2662	18
Northern	Jaffna	394	11	44	-	542	-	3131	7	4114	18
	Kilinochchi	6	-	66	-	197	-	1307	4	1576	4
	Mullathivu	135	2	4	-	203	-	339	-	681	2
	Vavniya	4	-	2	-	214	2	1525	8	1745	10
	Mannar	6	-	2	-	80	-	789	5	877	5
Eastern	Batticoloa	453	1	138	1	1135	1	1840	2	3566	5
	Ampara	334	1	264	4	805	3	1570	5	2973	13
	Trincomale	260	3	213	-	725	1	1096	3	2294	7
North Western	Kurunegala	1115	37	244	2	2053	3	2472	17	5885	59
	Puttalama	661	25	147	4	854	1	1919	10	3581	40
North Central	Anu/apura	792	33	662	5	1472	1	3332	8	6259	47
	P/naruwa	418	13	166	1	709	2	1158	2	2451	18
Uva	Badulla	565	21	55	1	717	1	2620	16	3957	39
	M/ragala	380	13	245	2	565	1	1076	8	2266	24
Sabaragamuwa	Rath/pura	486	12	58	2	1177	3	1422	30	3143	47
	Kegalle	172	11	71	1	649	1	951	5	1843	18
Total		**8794**	**267**	**3835**	**81**	**2387**	**49**	**42095**	**238**	**78531**	**635**

Source - Annual Health Report-MOH 2016

5.10 Measures identified to mitigate the risks/hazards associated with use of pesticides

Since the advent of the Green Revolution the technology interventions through international experts and support agencies continue to introduce new crop varieties, hybrid/ high productive planting materials, and improved crop management systems/ practices which are focused to increase agricultural production, international trading and small farm income. The change was accelerated by demonstrated performance and yield advantages of new improved varieties that essentially require high energy inputs of inorganic chemicals and fertilizers. Accordingly the farmer community in Sri Lanka increasingly depended on inorganic inputs that led to the loss of farmers' ability/ expertise to independently manage their farms and over the years/ generations the traditional/indigenous farming practices and knowledge is rapidly disappearing. There are a few individuals and villagers that continue to practice the indigenous methods/ techniques protecting the environment/ nature and human health (AGCO in Nuwara-Eliya,).

Although overdependence on chemical pesticides/ fertilizer has created serious health hazards across the agriculture production systems and households as major consumer sector, the results of study reveal that farmers cultivating rice, vegetables, maize, fruits, etc., continue to rely on chemical methods over non –chemical or traditional pest control methods. The trend has caused many negative consequences such as development of pest resistance, resurgence of pest populations, emergence of secondary pests, (Eg. the current situation of Fall Army worm-FAW- incidence to the maize crop in Sri Lanka) toxic hazards to human /household pets, loss of beneficial organisms, increasing cost due to extensive use of pesticides leading to high cost of production. Weedicides such as diuron and glyphosate are recently detected for its high level of contamination in tea, cinnamon, fruits and vegetables.

The current globalization trend has increasingly restricted the trade of contaminated food by strictly controlling the levels of pesticide residues at the border controls of international markets. There is growing consumer demand for non-contaminated/ toxic free food following the awareness on the health effects of pesticide residues on food and hazards to humans and Environment. In view of this, it is a global concern to implement best practices for managing and controlling pests in crop cultivation.

Sri Lankan authorities, especially the Ministry of Agriculture/ Department of Agriculture, Department of Agrarian Services, Ministry of Primary Industries/Department of Export Agriculture, Mahaweli Authority of Sri Lanka, Ministry of Plantation Industries, and Central Environmental Authority of Sri Lanka, are well aware of the negative impacts of farm pest control practices such as continued/routine application of pesticides and over use or usage of agrochemical cocktails to control weeds/pests/diseases in crops cultivated under respective mandated areas. There is no organized programs/plans to counter or mitigate the hazardous or harmful effects of pesticides on short term or seasonal agriculture production at a national level. Farmers are constantly driven to resort to using toxic chemicals rather giving the opportunity to improve/combine the traditional/non- chemical farming practices that were carried forward until recently.

Green band pesticides are safer products to the environment and human health, but the cost of the product is comparatively higher. Another aspect of safer products is there inability to offer quick solutions as the results are slow compared to traditional pesticides. This does not mean that they are slow in action, but eradicating pests cannot be immediately visualized. This issue needs more awareness among farmers about the effectiveness of the product as they are compelled to use more quantities of chemically active ingredients to see the immediate results.

5.11 Pesticides management best practices to reduce the risks

It is observed that farmers in the provinces are using pesticides without much emphasis for protective measures stipulated/ recommended under the ROP office. According to the DOA there are continued trainings for farmers/ officers regarding pesticide use and risk mitigation measures with protective gears/ equipments/ techniques. However, in the field, farmers show a negative attitude in this regard. Implementation of the use of safety kits/ Personal Protective Equipments (PPE) for pesticide application was hindered due to the lack of experienced extension personnel in the provinces.

Based on the powers of ROP, a novel initiative was put in to action to promote the use of PPE a compulsory requirement for the pesticides applicators and requesting all pesticides dealer networks to make avaialble complete PPE / Gears at an affordable price with quality and safety complying with guidelines and regulations made under the Control of Pesticides Act No. 33 of 1980. However, the study did not identify any FPOs or individuals using complete PPE/Gears during the field study. It was evident that farmers use long sleeve shirts, caps, footwear, and long trouser but certain parts of the hand, face, head, and legs are exposed to pesticides during application. The standard PPEs include: protective eye wear, nose guard, face mask, long sleeved vest + longs or overall, hand gloves, boots, etc. Therefore, it is high time to design effective and targeted outreach programs which deal specifically with pesticide risks, safe handling and averting hazards.

The use of PPEs during application of plant protection products including pesticides by the local farmers are expressively meagerm resulting in the danger to human lives. While chemical pesticides have contributed greatly to the increase of yields in agriculture by controlling pests and diseases, and towards the control of some vector-borne diseases in the human health sector, they continued and irresponsible usage has resulted in many problems. According to a recent collaborative study (K.G.A.P. Dulanjalee, Uva Wellassa University, and Badulla. Impact of Pesticide Use Practices on Farmers Health: A Case Study in Wijayagama and Eheranda in Matale District) was conducted in rural farming villages in the Matale District. It has been revealed that the type of pesticide, the dosage of pesticide, hours of exposure, number of bad practices and awareness on re-entry period were the significant factors affecting the severity level of impact on farmers‟ health due to practices related to the usage of pesticides. The study documented a serious consequence of the indiscriminate use pesticides to farmers’health. This study gave indications that a majority of farm households do not take cognizance of the long-term and short-term health hazards of occupational exposure and acute pesticide poisoning symptoms are under-reported.

The matter has requires the immediate attention of the pesticide industry. The Office of the Registrar of Pesticides has determined to make it a deliberate responsibility of the pesticide industry to create the availability of suitable PPEs in the market place, especially in all pesticide dealer outlets island wide. Individual proposals were sought from individual pesticide industries on avenues for making availability of PPEs suitable and affordable to the farmer. In the meantime, the ROP is to take appropriate actions to make the farmers aware about the importance of using PPEs, through their field staff (i.e. to conduct as many demonstartions as possible). The pesticide industry is responsible for fulfilling the requirements under their stewardship initiatives.

CHAPTER SIX: IPM EXPERIENCE IN PROVINCIAL AREAS

6.1 Adoption of IPM in Sri Lanka

Traditional agriculture in tropical Asia was practiced in harmony with nature. It preserved the diverse life forms with the agro-ecosystems and promoted the conservation of bio-diversity within farming systems. However, with the introduction of chemical insecticides, plant protection specialists in the early 1950s recommended complete control of pests with chemical insecticides, ignoring the beneficial role of fauna. Subsequently, during the period of the Green Revolution, farmers in developing economies were urged to use insecticides on a "calendar basis" or based on economic threshold levels of pests.

The costs were considered an acceptable insurance "premium". However, farmers were unable to deal with the complexities of pest development under high input regime. Some governments contracted pesticide companies to provide large-scale aerial applications of insecticides disregarding the negative impacts. Crop protection specialists and government-supported extension services assumed that they were better able to take decisions to control pests, than the farmers. However, their perceptions got jolted due to massive outbreaks of pests like brown plant hopper (BPH) in many rice-growing countries in South- East Asia. Researchers soon discovered that BPH outbreaks were insecticide-induced (Kenmore et al., 1984) and that breeding rice varieties resistant to BPH under continued pressure of insecticide use would be a futile exercise (Gallagher, 1984). The false notion of protecting crops by large scale use of pesticides by government agencies supported by plant protection specialists has led to the development of resistance among pests, pest resurgence and secondary pests emerging as major problems, environmental pollution, pesticide residue in food and food commodities and increasing health hazards to farmers and consumers (Peter Ooi, 1998; Ragunathan, 2002).

In response to the emergence of such problems associated with chemical pesticides which were used/ promoted by governments, extension services and farmers, the search for solutions to these problems led to the development of a new form of Integrated Pest Management (IPM) through a farmer educational approach. The working definition of the participatory form of IPM is composed of four principles.

Table 6.1: IPM Principles

Principle	Description
Grow a healthy crop	Good Hygienic/Agricultural practices necessary for growing a crop that is able to withstand environmental stresses such as infestation by plant feeding insects or plant diseases and climate change.

Principle	**Description**
Conserve natural enemies	Aim of reducing the use of chemical insecticides is to deliberately support the populations of beneficial Organisms
Conduct regular field observations	Regularly observe and analyse their crop ecosystem in order to make timely and evidence-based management decisions.
Farmers become experts	Expertise on sound crop management has to be with the farmers themselves, who are in the best position to respond to local and dynamic field situations

IPM is recognized to play a key role in reducing the cost of production and increasing productivity in rice farming in Sri Lanka. IPM technologies were promoted/demonstrated /adopted for rice farming in Sri Lanka since 1984. In 2002 a report prepared for the FAO program for community IPM in Asia (GCP/RAS/172/NOR) ''Participatory IPM in Sri Lanka'' revealed that IPM in Sri Lanka was first introduced by a technology transfer model identified as Training & Visit (T&V) maintaining a stronger relationship with the farmers , demonstration plots, and regular meetings. The effect was limited. The concept was replaced with a group approach named as Block demonstration or tract cultivation/ yaya demonstration. The farmers in the particular tract follow a periodic training over a period and applied technology uniformly in the tract, covering a minimum extent of 10ha.The initial results were positive and the program scaled up with 2300 extension officers training 35000 farmers by 1987.Block demonstration continued until 1992. In 1995 the program on participatory IPM/Farmer Field Schools (FFS) was initiated. By 2002 when the IPM project ended, there were 220 IPM master trainers, half of whom were found irrigation systems of the Mahaweli Authority of Sri Lanka (MASL), and over 200 farmer trainers (farmers who have become FFS trainers), capable of facilitating FFS in a large number of locations (see van den Berg, Senerath & Amarasinghe, 2002). Human resources in the Northern and Eastern provinces have been small due to the long history of the conflict.

The advantage of FFS is that it provides the farmer an opportunity to mitigate the issues on complexity and variability of the rice ecosystem through a practical educational approach that replaced the message based extension approach. Participants at FFS enhanced their skills by learning in the field, through the introduction of activity/explaining the process and setting the platform for farmers to work. The training is participatory and farmers make observations, analyse and draw conclusions on how to manage the crop over the next week. The facilitator will encourage the farmers to communicate more, through questions than give solutions or lecturing. In contrast the training effect shows eroding patterns over the years as pesticide applications were gradually increasing while the effect of training remained for a period of 4-6years.

6.2 IPM technologies/methods available in the provinces

Apart from the DOA mandated areas, the MASL settlement projects have also take the initiative to join with IPM promotional activities. It was understood that MASL is still continuing to promote and monitor IPM systems for pest management under irrigated rice farming areas. The farmer field school continues to be the principle activity of the program in addition to several types of follow-up activities which are being conducted since 1999 to strengthen specific skills of experimentation and organization, or to encourage networking between farmer groups. The overall purpose of the training model is the development of local, farmer-driven programs.

IPM through FFS contributed towards reducing the economic/ social disparity between farmers in the provinces by supporting farmers'in improving farming practices in line with ecological/natural balance, development of farmer skills/ improved decision making, build the voice of the farmer by social networking, improve household status,provide increased purchasing power at village level. Further, the FFS helped to remove the barrier between trainer and Farmer; enhancing the local ownership of participatory IPM, restoring the cultural, elements (Aththam-Mutual help), social values (shramadana-gift of labour for community work) that suffered due to modern agriculture systems.

6.3 Comparison of Agronomic Practices at non IPM & IPM

It is made aware that agronomic practices on rice farming varies according to social and economic conditions of the provincial population. The agronomic practices identified as land preparation, improving soil fertility, availability of quality seeds, method of planting, seed, irrigation and fertilizer application. The review of rice IPM highlighted the comparison of agronomic practices for rice IPM as detailed below:

Table 6.2: Agronomic practices in Rice IPM systems

Description	Non IPM	IPM
% of farmers adopted deep ploughing	55	64
Number of ploughing	3	3
% of farmers direct seeding	87	85
Seed rate used Kg/Ha	133	126
%Hand weeding	63	43
% farmers incorporating rice straw	31	84

Source; Participatory IPM in Sri Lanka: A Broad-Scale and an In-Depth Impact Analysis Henk van den Berga, et,al -2002

It was observed that the trend of mutual help and sharing labour systems practiced in ASMP project/ pineapple cluster in UVA. The cluster studied in Medagama area have shown great cooperation in implementing the common cultivation programs planned at the inception. The timely interventions on land clearing, preparing, planting, good hygienic and agricultural practices introduced by DOA has achieved vigorous plant growth and low pest and disease incidence. The clusters in East identified for green chilli and cucumber also work in a similar pattern. The cucumber farmer clusters follow the calendar of the company that determines the volume, price and cropping pattern. The farmers manage cultivation individually according to technical guidelines and supply of inputs (seed, fertilizer, pesticides, foliar nutrients/ hormones) by the Extension Officer of the company. The chilli growers in the Eastern province follow their own practices developed through the experience. However, in some provinces the farmer lands are scattered within the GN or village area and the project supported farm lands are isolated or not adjoining each other and located far apart. Thus making the task of introducing a common pest control system such as non-chemical PM technologies or IPM practices much difficult.

The land preparation practices are varied and depend on the province and farmers' social/cultural/economic nature. It was stressed, that plough depth depends not only on the equipment but also on how the equipment is used. The plough and the use of the mammoty (a hoe-like tool) were considered to provide deep ploughing. In the provinces where farmers used tine tiller 2-3 time before leveling and planting ground nuts. This practice was observed in East and North ASMP project areas. In the project provinces, few farmers practiced deep ploughing using 4-wheel tractor mounted discs when preparing the land for fruit cultivation and vegetables cultivation. However, a power-driven 'rotavator' attached to a two-wheel tractor, which is becoming increasingly popular among farmers, results in shallow-ploughed fields. This implement is meant for breaking the soil to a finer tilt, but farmers use it also for ploughing to cut the cost of operations. Continued shallow ploughing for long periods will create a poor soil structure leading to a less vigorous vegetative phase, making it susceptible for P&D infestations.

Table 6.3: Cost involved in land preparation activities

Description	**Cost/Ha**	
	North Central Nochchiyagama	**Uva** Bibila
Jungle clearing with heavy machines including the uprooting of medium sized trees	40000.00	-
Scrub Jungle clearing with tractor mounted implemented	12500.00	15000.00
1st disk plough +2nd Plough with rotavator	24500.00	25000.00
Tillering	18000.00	18000.00
Levelling	18000.00	18000.00
Making plant beds	39000.00	45000.00

Highland Cultivations -Weeding and earthening up with memory in 1st to 6 weeks	27500.00	32000.00
Highland Cultivations -Weeding and earthening up with memory in 6 to 10th weeks	50000.00	50000.00

Source; S&P Holdings (Pvt) Ltd)

According to the farmers, it was proven that deep ploughing has facilitated the better plant growth compared to other methods especially shallow ploughing lands. Yet land preparation technology for vegetables and fruits are not clear for farmers and affects the of land preparation which remains unresolved with regard to vigorous plant growth and reducing P&D.

Direct seeding is the mainstream method of planting rice compared to the transplanting method promoted under IPM interventions for reducing the use of herbicides. It was observed the transplanting of rice still continued in upcountry rice farming in small plots of terraced/ sloppy lands. The shortage of labour and large extents of rice lands in the dry zone influenced the practice of direct seeding instead of transplanting. Availability of herbicides have further popularized the direct seeding in rice. Though IPM introduced transplanting as a technology that help to save water and control loss of seed due to bird attack during sowing and plant establishment and control of pest and diseases during the early growth stage. The average seed rate for direct seeded rice was 22% and 18% above the recommended rate of 104 kg ha-1 for non-IPM and IPM sites, respectively.

In the provinces it was identified that rice farming and other field crop farming is a family oriented enterprise that enables them to earn a year round income. In this regard the IPM technologies are not considered new but there is lack of awareness, and confidence to integrate the rice into IPM practices as an alternate field crop cultivation in their own farms. The use of seed and planting materials are common in vegetable productions where crops like chilli, brinjal, B-onion, etc., are established by transplanting the seedlings of crops like maize, ground nut, gourd, cucumber, melon which are traditionally raised from direct seeding. The current trend is to plant hybrid varieties with characteristics, especially high yield potential and resistant to P&D. Though the farmers use improved seed varieties, the planting methods varied from province to province. It was found that in the Northern and Eastern area the farmers plant around 4-5 seedlings per hill and used a high seed rate for ground nut, etc.

Also the planting method has not given any due consideration for the prevention of pests and diseases. It continued to practice the traditional methods without adopting better techniques to raise and plant healthy seedlings instead of direct seeding. Open field nurseries attract more pest and diseases during the early growing period. The private sector initiatives have promoted soilless seedlings raising technology standards that are used to pelleted planting trays and achieving healthy and vigorous seedlings that could withstand the occurrence of pests and diseases during the early growth stage and contributing towards the reduced use of pesticides.

The seed and planting materials are sourced from agro input dealers and the DOA. Farmers in the provinces depend heavily on imported seed varieties. It is been made aware that all seed varieties are released for marketing/distribution by screening and certifying its yield potential and resistant characteristics by the authorized division, SCPPC of the DOA. It was found that the FPO in Eastern province produced their own seeds for traditional chilli variety PC-1 which has been cultivated for generations. Except for new improved varieties, farmers cultivating traditional crops set aside a portion from the harvest as seed for the next planting season. Even the FPOs in project provinces practice the similar methods. This may lead to the deterioration of characteristic and the repetitive use without a screening process may cause increased P&D infestations.

The Eastern province FPO in Kaluthaweli mainly cultivates chilli and brinjal with specialty varieties focused on the demand in the regional consumer market. Accordingly, the varieties are PC-1 for chilli and Thinnavely purple for brinjal. Also they have identified alternate crops such as bitter gourd, tomato, snake gourd, R-Onion, beet and okra. Farmers in general have an understanding of the available cultivars, quality variations, yield performances and ability to withstand the pest and disease occurrence.

The reports highlight that IPM interventions had bought striking results in use of straw. Low use of straw by non IPM farmers, caused a dependency on synthetic fertilizers. Farmers identify that adding straw to the fields have increased the soil fertility and plant growth. Rice straw incorporation among non-IPM farmers was highest in Sabaragamuwa, Western province and Mahaweli Authority irrigation systems. The training on straw incorporation was greatest in the Uva, Central and Southern provinces.

The farmers are inclined to overuse nitrogen fertilizer at planting because they associate the resulting greenness and lushness of the crop canopy with crop health. However, research into the plant’s demand for Nitrogen demonstrated that rice requires additional Nitrogen throughout the reproductive crop stages. Even though the total dosage of urea was similar among non-IPM and IPM farmers, the dosage/ intervals by application was different. IPM farmers applied less urea at planting and tillering of rice but more during panicle initiation. The promotion of proper nutrients supply system under rice IPM have demonstrated the efficient ways to use inputs for obtaining higher yields and avoiding infestations of pests & diseases.

The provincial FPOs under the project and outside the project are aware of the importance of using compost to the soil. According to farmers especially in East and North the adding of compost at least annually is considered important as a majority of farm lands are sandy soil.

The compost materials will keep maintaining the soil fertility and increase soil water holding capacity for better plant growth. Though it is continued for generations the farmers are yet to understand the scientific background related to fertility levels/ nutrient contents and applicable nutrient doses according the crop. Since there is no mechanism to conduct regular soil testing/analysis and make recommendation to farmers on nutrients and levels of application, the FPOs in the project provinces continue to use loads of compost without knowing the possible accumulation of certain nutrient that may be detrimental to the plant growth and productivity. It was identified that straw is mostly used in rice farming and the compost (cow dung, farm yard materials, poultry litter,) is mostly incorporated to the soil during initial land preparation. Also as a protective measure, farmers use mulch for covering the seedling planted in the field. Leaflets of wild plants and dried leaves are used as mulch and as vertical support. The FPOs were also identified with new technical interventions through ASMP where it has provided poly mulch for protecting the plants from weeds. It was noted that the technology transfer related to nutrient supply, weed control and soil moisture management through mulching technology is still not effectively transferred.

The continued IPM programs on rice farming show a profound effect on a number of pesticide applications. Use of Insecticides on rice is reduced by 18% by IPM farmers. Fungicide use was low and was reduced by 50%, due to technical interventions of IPM/FFS training. Herbicide use was not influenced. After training, farmers still depended on herbicide use for weed management. In predominantly direct seeded rice, mechanical weeding or hand weeding is impractical. ‘

The alternate crop farming, especially the seasonal vegetable producers’ use diuron herbicide to control weeds during the early growing stage. The evidence as per the discussion with Crop Life Sri Lanka identified that weedicide like roundup is in use even though it is restricted/ prohibited to use in crops other than those recommended within the plantation sector.

The organophosphates chlorpiriphos and dimethoate and the carbamates carbosulfan and fenobucarb jointly accounted for almost 70% of all insecticides used in rice at the study sites. These chemicals have been classified as hazardous (Class II) by the WHO.

Fruit fly, thrips, mites, aphids, white fly, caterpillars and plant hoppers are considered the frequent target for chemical applications. According to farmers there are no IPM technologies which are specifically introduced to vegetable farming. However, the lack of awareness and knowledge in the farmers are cause for not perceiving the technical/scientific base of the crop stage -wise practices and its contribution to controlling and ensuring the pest incidence below ETL. Farmers are yet to learn the best practices for crop management on the road to mitigating the issues on P&D.

Table 6.4: Target insects in provinces and Target PM Techniques for control

Crop and pests	Pest Control Cost/ha			Cost of production Rs/ha	% to the COP	Related provinces
	Insects & Mites	Diseases	Total			
Chilli LCC + Anthracnose	46320.00	23028.00	69348.00	324500.00	21	Eastern, Northern, North Central
Bitter gourd VTI, Fruit Fly + Fungal	57885.00	24750.00	82635.00	524875.00	16	North Central
Cucumber Plant Hoppers, VTI + downy mildew	7904.00	12412.00	20319.00	194600.00	10	Eastern
Big Onion Mites, caterpillars + Anthracnose, Purple Blotch	24921.00	38054.00	62975.00	551057.00	11	Central, North Central
Groundnut Plant Hoppers, Thrips, Root Termites + Fusarium Root Rot	19960.00	0	8081.00	102500.0	8	Eastern, Northern
Mango Fruit Fly, Leaf Hoppers, Mealy Bugs ,Leaf rolling Caterpillars + anthracnose	24176.00	12073.00	36249.00	Pest control cost is only up to June this year		Central, Northern, Uva
Papaya Mealy Bugs, Melon Fly, VTIs + Ringspot	20436.00	0	20346.00	do		North Central
Guava Fruit Fly, Mites, Nematodes + Anthracnose	31248.00	11718.00	42966.00	do		Central, North Central
Pineapple Mealy Bug + dieback		6000.00	6000.00	do		Uva
Passionfruit	22176.00	11055.72	33231.00	do		Uva

Crop and pests	**Pest Control Cost/ha**			**Cost of production Rs/ha**	**% to the COP**	**Related provinces**
	Insects & Mites	**Diseases**	**Total**			
Scale Insects, VTI + Collar Rot						

Source; S&P Holdings PL, 2019

Farmers in the provinces are involved in seasonal cropping of rice and vegetables/fruits. The IPM is introduced only to rice and it is noted that trickle-down effect of technologies in vegetable farming. However, the farmers still observing the benefits especially economic advantages of using IPM technologies. The study identifies non chemical or reduced chemical farming technology interventions by private sector investments in Central, UVA and NCP promoting vegetable cultivation with cluster farmer participation. (Eg. AGCO farms –vege- , / Cargills –vege-/ Dasini-Moringa-).

Also the FFS influenced/ promoted the knowledge sharing interventions among non-rice farmers integrating traditional or new methods of pest management. These outcomes are originated by farmers or guided by facilitators. Farmers in the Moneragala area use botanical control measures such as Neem extracts and plant parts that learned from rice FFS. In Galle area farmers grow marigold with chilli in order to prevent/repel vectors to control leaf curl disease. Also this practice was observed in Eastern province FPOs growing chilli. It is aware that the DOA has introduced bio control methods for mealy bug infestation which devastated a wide array of crop vegetables, fruits and foliage plants. However, the farmers in the provincial FPOs are still dependent on use of pesticides. It was noted that imposing of regulations for limiting the high toxic chemicals have in no way obtained positive results among the vegetable growers. The farmers continue to use chemicals on routine application and when pests are detected they use an over dose with a mixture of chemicals to see that the pests are instantly killed. It was observed that farmers linked with private sector agribusiness investments expressed different attitude towards pesticides. The clusters in provinces are made aware of the effectiveness of agronomic/ physical and biological factors on reducing the pest infestations and therefore the use of pesticides should not be the number one option.

The farmers in the provinces are aware of the major pests in their cultivations and responded that they adopt chemical control measures as soon as they sight the insects. However, a different opinion from the farmers in Eastern province indicated they are aware that IPM has an impact on reducing the use of chemicals in vegetable farming but only few farmers practiced the methods introduced by NGOs.

The IPM trained farmer shows considerable skills/ knowledge in identifying beneficial insects such as spiders, ladybird beetles, crickets and wasps. Use of insect traps are common in all provinces. It is noted these traps are not used to ascertain the types, numbers, or as a tool of measuring the insects movement/ populations. Different types of traps such as sticky box, sticky papers, light traps, pheromone traps, and baits are used by the farmers in the provinces. However, it was found there are no guidelines or technical knowhow available for the farmers to identify the effective way of using these traps. Therefore the use of traps are showing a negative trend. The IPM trained farmers indicate that Neem extract, Garlic, Eucalyptus have insecticidal properties that is proven in the control of fruit flies in bitter gourd and snake gourd. This was also disclosed by a cluster of farmers in Vahare area cultivating vegetables using organic methods. The particular farmer cluster was trained by World Vision Lanka and monitored through their extension network. However, some farmers have withdrawn from organic methods due to the interventions of company promoted cucumber cultivation with the complete package of inputs, technology and buy back at pre-determined price. However, the particular company by studying the organic vegetable farming practices have implemented action to introduce organic cucumber production with farmers who continue to produce organic vegetables in the adjoining area.

6.3.1 Economic benefits

Despite the marginally higher costs of fertilizer at IPM sites, total input costs were substantially higher at non-IPM sites. The reduction in insecticides contributed 18% to total input savings. Fertilizers and herbicides continued to be a major expenditure. Reported yields of rice at IPM sites indicated a 23% higher average than that of non-IPM sites, which is substantial. With its lower inputs and higher outputs, the profit at IPM sites reached to a level of 41% higher than non-IPM sites.

Table 6.5: Agrochemical inputs (in US$/ha) at non-IPM and IPM sites

Description	Non-IPM	IPM
Fertilizer	52.6	55.1
Insecticides	22.6	4.0
Fungicides	2.9	1.0
Herbicides	24.8	23.7
	102.8	83.9

Source;No.175/2015-H.J.C Jayasooriya & M.M.M.Aheeyar

Table 6.6: Profits (ha-1) at non-IPM and IPM sites

Description	Non-IPM	IPM
Total inputs (US$)	102.5	83.9
Yield of paddy (Kg)	3754	4629
Selling price paddy (US$/Kg)	0.125	0.129
Total income (US$)	468.3	598.4

Profits (US$)	365.5	514.6
Benefit of IPM (US$)		149.1

Source; No.175/2015-H.J.C Jayasooriya & M.M.M.Aheeyar

There is evidence (No.175/2015-H.J.C Jayasooriya & M.M.M.Aheeyar) to show the effectiveness of the use of IPM in vegetable cultivations that has produced positive results in many countries including Bangladesh (Rich, 2013); Uganda (Steed, 2013): and India (Krishnamurthy and Kumar, 2004). These countries have used the IPM concept very effectively for managing P&D in vegetable cultivations. IPM is well known for its ability to cut down the cost of cultivation by means of reducing the amount of pesticides used. In Sri Lanka, farm level trials have proven that IPM practices in chilli has shown, over 50% reduction in P/C application (Piyasena FAO 2009). IPM practices on cabbage cultivation (Ariyadasa, et, et al. 2005) contributed to reduced cost of pest control by 80%, increasing the profit margin by 20%. It is reported that IPM adoption in vegetable cultivation is poor or not available due to; Lack of priority in national/ provincial extension planning, poor institutional support/ resource limitation, inadequate resources/ lack of technical expertise or capacities for extension staff, lack of confidence of farmers due to bad experience or wrong beliefs (myths), easiness/ effectiveness of chemicals against inherent weaknesses of non-chemical practices and lack of advisory services at farm level.

6.4 IPM operations in the provinces

The previous studies identify that there were marked differences in the number of insecticide applications on rice cultivation between provinces. In Western and Central province, where rice is partly grown for subsistence, insecticide use was low. Insecticide use in the irrigation systems of the Mahaweli Authority was comparatively low, possibly because previous awareness programs on IPM (not participatory IPM) had been conducted on a large scale during the 1990s. Insecticide use was highest in UVA, Sabaragamuwa, North-western, while the use of chemicals were lower in Northern & Eastern provinces because of inadequate availability of agrochemicals due to the ethnic conflict. However, the latest study reports highlighted that several provinces have significantly reduced the use pesticides due to adoption of IPM. The table below provides the comparison of rice fields which adopted IPM procedures and rice fields which are non IPM.

Table 6.7:No.of insecticide application per season in rice

Province	Non-IPM	IPM	% Reduction
North & East	3.38	0.94	72
North Central	2.27	0.68	70
North Western	2.53	0.42	84
Western	0.83	0.22	73
Sabaragamuwa	2.83	0.65	77

Central	1.50	0.44	71
UVA	3.75	0.55	85
Southern	2.32	0.30	87
MASL	1.41	0.20	86

Source: No.175/2015-H.J.C Jayasooriya & M.M.M.Aheeyar

Yields were highest in Mahaweli Systems. Yield increase is attributable to training in North-western and Sabaragamuwa provinces. Yield increase in irrigation systems of the Mahaweli Authority was more modest, indicating that the potential for yield increase is lower. Rice farmers in isolated or marginal agricultural areas frequently reported over 100% yield increase due to training, attributed mainly to the adoption of improved agronomic and fertilizer practices.

Table 6.8: Yield (Kg/Ha) by Provinces

Province	Non-IPM	IPM	% Increase
North & East	4081	5447	33
North Central	3750	4553	21
North Western	3482	4747	36
Western	3235	4008	24
Sabaragamuwa	3508	4737	35
Central	2683	3578	33
UVA	4000	4525	13
Southern	3403	4206	24
MASL	4750	5282	11

Source: No.175/2015-H.J.C Jayasooriya & M.M.M.Aheeyar

There is a trend for increasing small farm vegetable cultivations on organic and least use of chemical applications identified in UVA, NCP, and Central provincial areas. The AGCO initiative in Nuwara-Eliya covering 80acs of organic cultivation of vegetables under certification of control union supplies vegetables to modern retail chains and hotels. The agronomic practices involved, continued adding plant materials/ cattle or poultry litter during the land preparation and crop growing periods have proven vigorous plant growth and attractive yields. It was enlightened that the soil fertility and microbial activities are improved as a result of recycling plant materials and zero chemical use. This was proven that even during drought the plants were thriving well as the moisture holding capacity of soil has increased.

The study found that concept of IPM was introduced in Batticaloa District in late 1996, by CARE international using the non-formal educational approach; FFS. The report (AGRIEAST (2007) 6:41-48 on evaluation on adoption of IPM by farmers in four villages (Kaluthaweli, Cheddipalayam, Vantharomoolai and Palugamam) are involved in vegetable cultivation and occupied fulltime in farming. It was revealed that 85% of the farmers in Kaluthaweli (currently implementing the ASMP/Pilot project FPO on chilli) have a good understanding of the IPM practices, especially the selective use of insecticides based on ETL, use of resistant varieties, beneficial organisms and cultural practices. Farmers in different villages informed that the IPM concept was made aware to them through the pre-seasonal meetings on planning for rice cultivation. It was noted, only farmers in Kaluthaweli responded to IPM in vegetable farming and other villages in the study have not recognized or not understood the concept and practices.

IPM farmers visited their rice crop more regularly (every 2.4 d) than non-IPM farmers (every 3.5 d). Short intervals imply regular field observations and hence timely crop management decisions. Moreover, IPM farmers were visited more regularly by their local extension officer after graduating from their FFS (every 17 d) than non-IPM farmers (every 33 d). The intensity and practical approach of the FFS strengthens relationships between farmers and their extension officer, resulting in more frequent extension visits e.g. to support follow-up activities after the field school. It was revealed that the visits by extension officers are reduced drastically due to shortage of staff and limited financial allocations in the provinces.

An average of 18.2 farmers participated per field school. Participation depended partly on the size of paddy tracts (fields fed by a single field canal) in the dry zone or on the size of cultivated valleys in the intermediate climatic zone. Typically, paddy tracts consist of 12-20 farmers. Participation was highest in North-Central and Sabaragamuwa provinces. Women made up 29.7% of field school participants. Women participation was also reported highest in these provinces compared to considerably lower levels in North, East, Central and UVA provinces. A majority of farmers reported that their mutual cooperation within FFS and outreach areas had improved due to FFS training.

The study reported that the training effects erodes slowly with time but the distinct effect still remains even after 4-6years of FFS training. The durability of training was also tested for the effect on rice straw incorporation. This variable was strongly influenced by the training which clearly demonstrated that around 81% IPM farmers, continue to use/ incorporate rice straw compared to non-IPM farmers (31%). This indicated that, once farmers recognized the benefits of a particular practice (eg. Rice straw incorporation) and/or got accustomed to the practice introduced they continued/ sustained in the future. The effect is striking and, on its own, emphasizes the need for practical farmer training.

6.5 Recognition of IPM programs by public/private institutes/ Strengths and weaknesses

Based on the above discussion, it was noted that IPM practices introduced in the 1980's and diverse programs implemented to promote the concept and practices focusing the importance of sustainable development of rice in Sri Lanka. It was observed that different avenues like training and visiting, demonstration, FFS are identified activities to promote IPM at village levels. It was a success in the areas where it was promoted and demonstrated but beyond that did not take off due to farmer attitudes, inadequate extension support, lack of financial commitments. However, the concept has shown a trickle-down effect where the message was diffused through seasonal meetings, farmer training, fellow farmer knowledge sharing, etc.

The dilution of extension network under the DOA has hindered the continued promotion of the IPM program initiated by international donor agencies. The only national program on IPM implemented was on rice. The DOA and MASL together covered almost all rice producing areas influencing the rice producing farmers to implement cost effective practices while reducing the cost of pesticides and increasing the yield. The results showed success in disseminating the concept and improving the farmer skills/ knowledge on IPM technologies. The post evaluation reports highlights that the use of pesticides in rice have reduced by 18% at national level. IPM activities and promotional programs and training events are continued in areas under the purview of MASL.

IPM programs were sponsored by NGOs, mainly by FAO focused on rice production. Though there were private sector agri businesses involved, the use of the IPM concept was not observed. Despite the trends in IPM on rice, there are isolated projects implemented for promotion of IPM in vegetable farming under small farm clusters in selected provinces. But the practices are not continued by farmers due to lack of continued training and communication. The IPM programs implemented for vegetables cultivation was proven a success but there is no national program to promote such programs in the field.

The concept of FFS was used as a tool to introduce and promote IPM concepts among the small farmers cultivating vegetables. However, the published reports identified that level of adoption is low due to poor understanding of the concept and lack of effective technology transfer/information dissemination activities. The review of reports indicates that the recent development for diversification of consumer segments/ markets (local & international) increasingly demands the hygienically produced safe food that is free from harmful elements/ contaminants/ toxic chemicals/ residues. Accordingly the marketing entities especially exporters of food products have extended their investments to establish organic farming clusters to produce hazard free food.

The success of the IPM program in rice over the last several years has resulted in the demand for IPM for other field crops as well. During 1996 Yala season IPM was adopted for chilli in order to bring down the volume of pesticides used. The Farmer Field Schools (FFS) which were conducted with a group of chilli farmers were able to change their attitudes on pesticide use and reduced the pesticide usage by about 75 percent (Administration Report, Department of Agriculture, 2000). This has motivated agriculture research for further studies on IPM for chilli and other crops as well. Most farmers in the central region of the country were adopting rice/vegetable mixed cropping patterns with rice being the minor crop. Since these farmers seldom apply any insecticide on rice, the positive gain by IPM was not evident. Unlike in rice, during the vegetable cultivation period, farmers apply large quantities of pesticides. The experience gained by them by interacting/sharing methods on rice/FFS ecosystem analysis and identification of pests and their relationship with natural enemies have made a considerable change in their thinking about pesticide usage in the growing of vegetables. These preliminary observations confirmed that there is much scope for IPM in vegetable production. Expansion of IPM on vegetables is further explored by the Department of Agriculture with the technical backup given to the provincial extension service to conduct IPM demonstrations in farmer fields on tomato and leafy vegetables (Administration Report, Department of Agriculture, 2000).

Leaf Curl Complex (LCC) is the most serious pest problem in the chilli cultivation in the provincial FPOs. This study observed 11 brands of insecticides under eight (08) common names which had been used to control chilli pests. It was reported that on an average of 7 to 8 rounds of spray applications were required during the season. The cost of pesticides as informed by farmers was LKR46, 000. It is about 14% of the cost of cultivation. Although officers in Northern and North Central provinces discussed about promotion and implementation of IPM programmes at field level, it was limited to only adopting select practices determined by farmers. Practices such as growing border crops, application of plant based extracts, establishment of blue and yellow colour sticky boards, use of sprinkler irrigation, traps, etc., were observed in an isolated manner. Therefore these practices had not effectively helped to cut down the quantity or cost of insecticides. It was also learnt that farmers as well as officers did not have a proper idea or knowledge and confidence about a PM or IPM package. This identifies that concept of IPM for vegetable cultivation is still in the developing stage. Therefore in order to build confidence among the farmers it is necessary to implement participatory research, experiments and demonstrations at provincial level. It is important to conduct motivational programs on use of integrated technologies covering crop stage-wise practices focused for reducing the P&D incidences while increasing the yield.

Farmers reported that they were very watchful of their crops and during the first month of growing they are vigilant about pest infestations and do not wait for a single day once they observe pest in the field and immediately take action to apply pesticides. They are reluctant to take risks. Officers in the field also confirmed that farmers carry on with this attitude and that poses a challenge in promoting any combined PM practices. It is there only income source. Officers agreed that they too lack the confidence to advice farmers to study the pest dynamics and wait a few days to applying pesticides. They pointed out that the only solution to this, is to implement well designed practical and demonstrated training activities to build confidence through enhanced technical capacity and skills by participatory approach. Also it is important to implement continuous training with demonstrations in the farmers' fields with the close supervision and guidance of research and extension officers. Allocating necessary staff, making sufficient funds availabile and monitoring are other important needs in this regard.

The observations in the project area identified that FFS is now phasing out as there is inadequate attention by farmers and lack of continued training and demonstration to promote IPM. It further revealed that the FAO has initiated a successive program, deviating the concept of FFS to develop an entrepreneurship skills program identified as Farm Business School (FBS) where the curriculum includes teaching business negotiating skills for farm produce after harvesting and the program has not considered the production aspects before harvesting. Promoting a business culture without identifying/ developing a proper supply chain of produce may challenge the future sustainability of rural farming.

Guiding with the market opportunities and considering the experienced gained through FFS/ IPM/ Organic farming programs, the DOA with exporters and modern retailing chains have intervened to develop and promote SL-GAP (Sri Lanka- Good Agricultural Practices) a certified system for producing crops for consumer markets. The SL-GAP focused to ensure quality and safety of fruits, vegetables and food products for local and export market. The DOA in collaboration with SLSI has established and published recommended practices and guidelines for SL-GAP standard on select vegetables and fruits. ("Sri Lanka Standard 1523 part 1:2016, UDC 631.57:634). The standards are available for 11 varieties of fruits and vegetables. The program attracted the exporters of fresh produce by solving the major issues on border rejection of vegetables exported from Sri Lanka to EU, due to pesticides residue contamination. The initiative has achieved over 1,000 training programs conducted island wide on GAP practices. Around 600 GAP based farms were formed. Covering all districts, it has established 22 GAP demonstration farms and 10 GAP farmer cooperatives.

It was found that ASMP project interventions are increasingly promoting the concept of SL-GAP among the FPOs through facilitating the training/technology transfer and adopting the practices through a process of audits and certification. An SL-GAP identified package of practices/ standards established for crop production systems would be an ideal platform for introducing the best practices on pest management for farmers in the provinces.

Table 6.9: The principles of SL-GAP

Principle	Description
History of the site selected	Information on land history and cultivation, Previous land use, Potential risks for surrounding crops, potential risks to the crop cultivated due to surrounding activities.
Land Management	A map of the farmland, Location, Entry point, Land area, Legal ownership, Lands above 5000 feet with a slope of 60%.not suitable for farming

Principle	**Description**
Seed and planting materials used	Select according to the recommendation of the Department of Agriculture or an authorized institution, Keep track of seed condition, type. Planting material is suitable for resistance to pests and diseases. Keep records if treated
Soil nutrient management	Keeping a rough soil map of the land, Soil type, Soil texture, Minimizing activities that are harmful to soil structures, Soil erosion prevention strategies, Use Reports relating to soil fumigation, Test the soil and use fertilizer accordingly, If not, use fertilizer only to the recommended level, Keeping records of the types of fertilizer used, locations obtained, quantities, fertilizer applied / dates, Storage of fertilizer,(bags/containers/buckets). Do not use human excretes at all, Store organic fertilizer appropriately, Apply appropriate treatment, Keep records.
Water source and water management	Crop Production Planning in line with crop water requirement and available water source Quality of water source/water used, avoid sources mixed with pollutant of industrial discharges, Recycled water should be properly treated, adopt efficient irrigation methods. Test water quality on annual basis, Keep track of the quality of water used for irrigation.
Plant protection/Pest and Disease Control	Least use of pesticides, implement integrated PM practices, priority for non-chemical control practices, rely on DOA advise for pest management, use only DOA recommended spray equipments, pesticides and dosage, keep records on applications, maintain pre harvest interval for respective pesticides, proper storage of pesticides and disposal of empties as instructed by authorities. use calibrated/DOA recommended spray equipments/utensils, Workers Health and Safety/ Wear clothes and protective gears, avoid any environment pollution ,prepare only the right amount of mixture as required, Not to use any cocktail mixtures of chemicals. Maintain pesticides use record at farm level.
Harvesting and post-harvest handling/packaging	Provide and area for storage, remove all impurities on the produce-train staff in this regard, employees who are wounded/ sick should not be involved in this procedure. Follow good hygiene practices, keep all equipment, containers clean. Use clean packaging containers/ materials, maintain cleanliness of the transport vehicles, and use only food grade packaging materials. Follow the SLS143 and SLS614 recommendation on post-harvest management of fresh

Principle	Description
	produce, controlled use of approved pesticides under food Act of Sri Lanka, maintain traceability records. Maintain MRLs, mitigation plans for control of high MRL levels if identified.
Employee welfare	Plan for the safety and welfare of the employees, employee training, counter plan for emergency situations, training on pesticide handling, facilitating employee service / sanitation only towards the farms that protect basic human rights are eligible for GAP, no child labour allowed, all employees should be above 18yrs.Follow the standards for occupational health and safety.
Protecting the environment	Maintain proper storage, disposal, cleaning.
Maintenance of records	Maintain all farm records for traceability requirements.-soil, land development, cultivation, harvesting, and distribution. Farm accounts. Consumer complaints and recommendations. Annual audit and records/reports.

Various programs have been introduced to farmer sporadically to control the use of pesticides and mitigate the hazards on humans and environment. IPM was considered the main activity implemented in the past. The current trend is that application of IPM in rice is continued in isolated locations in provinces. However, the vegetable producers, increasingly performed with chemical control measures as there is no established promotional mechanism or concept developed on IPM for vegetables. The influence of current market forces that demand for hygienically produced food, certified free from human and environmental hazards, have prompted the agriculture value chain actors and support services on the necessity of adopting international best practices for agriculture production, envisaged to reduce the level of toxicity in food.

As a result of discussions held to find a lasting solution for border control issues related to high level of pesticide residues in agricultural products, the DOA has intervened to establish a system approach integrating activities as discussed above and in accordance with the food act No.26 of 1980, Pesticides act No.33 of 1980, environment protection act No.07 of 1980, soil conversation act no.24 of 1996, and women and Child protection act No.47 of 1956 which is highly recognized by the market forces.

It was made to understand that private sector agribusiness companies working with small farmer clusters are already in the process in achieving the GAP certification for their farmers in the provinces. These programs are focused to cater to the increasing health conscious consumer segments in the local modern retailing chains. Also export oriented investments established in the provinces with small farmer clusters certified for GAP in order to supply arange of fruits and vegetables for export. The GAP was made popular among the pesticide importers and distributors under the umbrella of Crop- Life Sri Lanka Association that trained their field staff to be equipped with the knowledge on GAP procedures.

The FPOs in project provinces are gradually promoted to adopt the GAP certification for seasonal crops cultivated. It is also noted that the GAP system recognizes IPM practices which and embedded within the procedure. Therefore unlike the IPM concept, GAP has provided a wide opening to promoting combined crop production practices while keeping the pesticides use option as the least or last priority.

Learning the issues and challenges faced under IPM implementation in the field, the promotional efforts for the GAP system made considerable progress since inception. However, the adoption rate by farmer community is lower than expected due to inadequate expert resources within the DOA. There is only one GAP officer deployed to coordinate with the provincial DOA (PDOA). The shortage of staff under the GAP program at the DOA hindered the up scaling of the program initiatives.

6.6 Integrated Vector Management

The IPVM project originates from the request by the Stockholm Convention on POPs, the Bahia Declaration of the Intergovernmental Forum for Chemical Safety and World Health Assembly resolution WHA 50.13, to develop viable alternative strategies for the control of vector-borne diseases, malaria in particular, and to reduce the reliance on insecticides through promotion of integrated pest-management approaches. FAO Sri Lankan office has been instrumental in facilitating the process of planning with the sectors of Agriculture (PPS), Health (Anti-Malaria Campaign) and Mahaweli Authority.

The Integrated Pest and Vector Management (IPVM) project in Sri Lanka has for the first time implemented a combined program involving rural agriculture communities educating and promoting concepts/systems for reducing the health risks of vector-borne diseases. Integrated Pest and Vector Management (IPVM) builds upon the successful experience in Integrated Pest Management (IPM), which is based on the practical, field-based education of groups of rice farmers in weekly sessions of the Farmer Field Schools (FFS). The IPVM project in Sri Lanka, started in 2002 with support from FAO and UNEP and has been unique in connecting vector management with agricultural activities, thereby actively involving farming communities in observation-based decision-making on vector management.

It is aware that plant protection measures often lead to an increase in pesticide use, which can result in mosquito resurgence and cause resistance in vector populations against the insecticides used in current vector control interventions. Therefore, there is a need to converge the IPM and IVM strategies in such a way that farmers practicing IPM not only improve their crop productivity by adopting environmentally sound practices, but also minimize the health risks associated with farming practices and community behaviuor.

6.7 Health risks associated with agriculture production systems

- Irrigated agricultural environments provide a breeding habitat for vectors of malaria, lymphatic filariasis, Japanese encephalitis, dengue, etc.
- Use of insecticides in agriculture can result in mosquito resurgence and cause resistance in vector populations against the insecticides
- Disease-transmitting vectors breeding in agricultural environments, thereby reducing the effectiveness of insecticide-based vector control methods.
- Spraying of insecticides causes occupational poisoning besides poisoning at the household level
- Spraying may leave toxic residues in food, thus adversely affecting consumers' health
- Destruction of beneficial fauna by broad-spectrum insecticides can cause resurgence of disease-transmitting Vectors
- Domestic animals and livestock can serve as alternate or main hosts of diseases affecting humans
- The level of income and food produced through agriculture influences the well-being and resilience of farming communities

6.8 Health impacts of IPVM

IPVM Farmer Field Schools are expected to enhance the environmental management and crop management practices and thus, increasing income from agriculture. The consequences of these practices are reduced vector breeding, increased ecosystem integrity, and reduced risk of insecticide resistance, increased personal protection, living conditions and social empowerment. IPVM-FFS sessions are occasionally attended by local Public Health Inspectors (PHI). These actors potentially play an active role, for example in educating the communities on personal protection and pesticide health risks. In line with this, the ROP has initiated programs to train the PHIs on pesticides and pesticide usage practices which will enabled 56 PHIs to obtain certified training as authorized pesticides officers and empower them to take legal action against illegal practices that cause hazards to humans/ environment. However the current study has not come across any promotional action related to IPVM in the field during the past few years.

The project has completed 67 Farmer Field Schools on IPVM, benefiting some 1000 individual farmers and their families in a total of 11 villages in 11 Districts including the Mahaweli systems. The field school participants were commonly neighbouring farmers from one irrigation tract.

Table 6.10: IPVM project locations

District or system	Village	Started	Discontinued
Mahaweli H	H Talawa	2002	2005
Udawalawe	Kiriibbanwewa	2002	-
Monaragala -	Buttala	2002	-
Matale	Lenadora	2005	-
Mahaweli C	Weheragala	2005	-
Mahaweli G	Diyabeduma	2005	-
Matara	Various villages	2004	-
Hambantota	Meegahajandura	2004	-
Puttalam	Nawagattegama	2002	2004
Vavuniya	Unknown	2002	2003
Trincomalee	Unknown	2002	2003

Source; Evaluation of the Integrated Pest and Vector Management (IPVM) project in Sri Lanka 2006-H van den Berg

The evaluation report on IPVM identifies the need for facilitating participatory planning to promote IPVM-FFS clusters. The enhanced group skills and education will assist the farmers in deciding on their future course of action related to vector management. These activities are expected to facilitate farmer-operated community programs which address agricultural problems and human vector-borne diseases.

Accordingly, FBS promoted by the ASMP/ WB project would be a next entry point to continue the field based education and training mechanisms by combining the technologies and practices of PM/ IPVM/ GAP, to introduce best practices for pest and disease control through observation based agriculture production in healthier environments.

6.9 Crop Clinic Program

Field level extension officers repeatedly mentioned that Crop Clinics (CC) programs aim to mitigate the pest and disease problems by providing solutions at the field level. It was identified as an extremely successful extension service approach promoted/ implemented by the DOA. It had helped to improve the AIs image in the village too. Many farmers of the area had approached them, seeking solutions and the interpersonal relationship with farmers and extension officers had been improved. It is more effective during the periods when pest and disease problems are abundant in their cultivations. Most of AIs had been trained as Plant Doctors (PDs) under two training modules and ARPAs (**Krushi Pariyeshana ha Nishpadana Sahakara-KRUPANISA-**) in the area and a dominant farmer had been trained as CC assistants (CCA). The CCAs together with farmers identify the P&D or crop problem and grouped samples of affected plants/ parts are observed by Plant Doctors to diagnose the problems and subsequent solutions. All problems which have been directed to the CC had been recorded in specific forms with necessary copies. All solution seekers had been registered in a separate book. A prescription had been issued to the pesticide dealer in a specific form if the problem is related to application of agrochemicals.

This program had been carried out smoothly and frequent assessments had been done by higher officials to assure the team to become experts in handling pest and disease problems and given solutions. Accordingly, all AIs are well experienced in identifying and giving solutions to pest and disease related problems. Yet, in a later stage, the ARPAs and CCAs are found to have irregular attendance issues at CCs and breakaway from the team, in which AI alone was responsible in conducting the program. Higher officials participation in monitoring and evaluation had become almost withdrawn/ non-existent. Subject matter updates have been totally stalled and the AIs enthusiasm for conducting CCs is reduced. Some officials reported that the out- break of Fall Army Worm problem in maize would have not happened if the CC programs continued.

This program had been affirmed as a Permanent Crop Clinic to be implemented by AIs at ASCs.According to officers at the PP services, it had been misunderstood that the CC programs are essentially to be conducted at the ASC as a monthly event. The AIs in the ASCs reported that there had been practical difficulties to continue in such a manner. However, experts who were responsible for instigating and establishing this program reported that it originally planned as a monthly event, to be conducted at a venue identified by AIs in consultation with the farmers/ CCAs according their convenience. It was noted that in Jaffna/ Siyambalanduwa/ Dimbulagala the AIs attend the weekly fairs to cover farmer problems related to P&D. Some officers at PDOA proposed to design a mechanism to implement “Everyday Crop Clinics” (ECC) in areas where active agriculture takes place (production/ marketing/ services). The officials’ highlighted areas like Chavakachchari, Thambuttegama, Dambulla, Nuwara Eliya, Welimada, Siyambalanduwa, where currently the DECs are well established, which could be used for promoting ECC. They further stressed that each facility/ ECC unit should be equipped with digital/printed information and materials including connectivity to global/local expert services enabling to identify and mitigate problems. Moreover, identify the need to deploy a permanent cadre (proposed under action plan) covering all provinces.

Although CC had been a successful extension tool in the past, it had gradually weakened and collapsed due to its low priority level under the DOA annual program. Yet the Extension officers and farmers still believe that it is an important program to be revived in order to provide solutions to pest and disease problems while increasing the image of the government extension service.

CHAPTER SEVEN: POLICY REGULATORY FRAME WORK AND INSTITUTIONAL CAPACITY

7.1 Regulatory control measures

The use of pesticides in agriculture has played an important role in the enhancement of agricultural production and protection of the health of humans and animals. Pesticide use in some regions, e.g. in South-East Asia and Latin America, has increased because of the need for improved agricultural production and reduced post-harvest losses, whereas in other regions it remains at about the same level. At the same time, the growing concern related to food safety by keeping the pesticide residues at the lowest possible level, the principles of Good Agricultural Practice (GAP), including Integrated Pest Management (IPM), have to be observed. This requires high quality pesticide products to assure the producers in the field that the crops are sufficiently protected when the application instructions on the label are followed and the pesticides are applied with calibrated and well-maintained spraying equipment.

Farmers may follow the application and safety instructions but this only holds true as long as the pesticides provide efficient control of pests and plant diseases. This can only be achieved with products of consistently high quality. Products of inferior quality may include imported and locally produced pesticides. Also degraded, expired and other kinds of sub-standard products leading to improper dosage and overuse are some consequences reported as a result. The accumulation of obsolete pesticide stocks in developing countries is a major concern related to environmental protection. Regular quality control of pesticides marketed in any country is essential to facilitate their safe and efficient use and for increasing agricultural productivity while at the same time protecting the farmers, consumers and the environment. Therefore, safety of pesticide products remains an issue of worldwide concern.

There has been an increase in the amount of pesticide active ingredients used annually. This is because of the availability of cheaper off-patent generic pesticides, which are applied in relatively large quantities per hectare. In many countries, the generic products are formulated in factories of varying size and technical capability. This production to a large extent is not regulated and monitored in the frame of rigorous quality control or surveillance programmes. Furthermore, reduced efficacy of sub-standard generic or obsolete pesticide products induces resistance of pests and increases residue levels on commodities resulting in risks to human health and the environment and wastage of national resources. The estimated proportion of inferior quality products in developing countries amounts to about 30%, posing a serious threat to human health and the environment. There are also indications of an increasing number of counterfeit goods, which can significantly affect the quality of food crops and may cause considerable losses in yield.

Effective pesticide product quality monitoring programmes greatly enhance the national capability to ensure more efficient pest control and reduce undesirable collateral effects on human health and the environment. Throughout the world, regulatory authorities require the quality of pesticide products to be monitored, particularly their active ingredient content. At the very least the physical and chemical properties of formulations and active ingredient contents of the pesticide products should be determined.

Table 7.1: List of institutional acts directly or indirectly involved in pesticides related regulatory measures.

Scope of Product sector	FOOD SUPPLY CHAIN COMPONENTS								
	Primary production to harvest	Primary processing	Secondary processing to manufacture of foods	Ready to eat foods – restaurants to street food.	Retail	Consumers	Transport	Import	Export
Plant based	Pesticide Act 1980 2: Plant Protection Act 1999 3: Coconut Development Authority Act 1987 4: Sri Lanka Tea Board act 1975	Plant Protection Act 1999	Food Act 1980	Food Act 1980	Food Act 1980	1: Consumer Affairs Authority Act 2003 2: Food Act 1980	Food Act 1980	Pesticide Act 1980 2: Plant Protection Act 1999 3: Food Act 1980 4: Imports and Exports (Control) Act, 1969	1: Plant 2: Protection Act 1999 2: Food Act 1980 3: Coconut Development Authority Act 1987 4: Sri Lanka Tea Board act 1975 5: Imports and Exports (Control) Act, 1969
Animal based	Animal Diseases Act 1992 2: Animals Act 1958	: Animal Diseases Act 1992 2: Animals Act 1958	Food Act 1980	Food Act 1980	Food Act 1980	1: Consumer Affairs Authority	Food Act 1980	1: Animal Diseases Act 1992 2: Food Act 1980	1: Animal Diseases Act 1992 2: Food Act 1980

Scope of Product sector	FOOD SUPPLY CHAIN COMPONENTS								
	Primary production to harvest	Primary processing	Secondary processing to manufacture of foods	Ready to eat foods – restaurants to street food.	Retail	Consumers	Transport	Import	Export
	3: Animal Feed Act 1986	3: Butchers Ordinance 1894				Act 2003 2: Food Act 1980		3: Imports and Exports (Control) Act, 1969	3: Imports and Exports (Control) Act, 1969
Processed food			Food Act 1980	Food Act 1980	Food Act 1980	1: Consumer Affairs Authority Act 2003 2: Food Act 1980	Food Act 1980	1: Food Act 1980 2: Imports and Exports (Control) Act, 1969	1: Food Act 1980 2: Imports and Exports (Control) Act, 1969
Fish based						1: Consumer Affairs Authority Act 2003 2: Food Act 1980	Food Act 1980	1: Fisheries and Aquatic Resources Act 1996 2: Food Act 1980 3: Imports and Exports (Control) Act, 1969	1: Fisheries and Aquatic Resources Act 1996 2: Food Act 1980 3: Imports and Exports (Control) Act, 1969

Scope of Product sector	**FOOD SUPPLY CHAIN COMPONENTS**								
	Primary production to harvest	**Primary processing**	**Secondary processing to manufacture of foods**	**Ready to eat foods – restaurants to street food.**	**Retail**	**Consumers**	**Transport**	**Import**	**Export**
								4: Animal Disease Act 1992	4: Animal Disease Act 1992
Environment	National environmental Act no.47 of 1980	National environmental Act no.47 of 1980	National environmental Act no.47 of 1980	National environmental Act no.47 of 1980					

According to the table above Sri Lanka has a spectrum of laws that cover the whole food chain but these are not integrated into a single food control management system with clear responsibilities, accountabilities and management of gaps, overlaps and the interface between the different laws. The current legal structures in Sri Lanka provides sufficient authority and powers to government departments for the management of food along the food supply chain. However, these do not provide a coherent integrated food control management system that seamlessly covers food from farm to fork. This is proven that legislations for aspects pertaining to primary level handling of plants and plants based products, are covered only in the plant protection act. The food act under the purview of MOH does not extend its empowerment to primary production or primary processing.

7.1.1 Plant protection legislation Sri Lanka

Prior to 1962, pesticides were more or less freely imported into the country. With the changing import policies in late 70's, pesticides were imported on open general licenses even including prohibited products such as DDT and endrin by unscrupulous traders. With the gradual involvement by the DOA, under the mandated arm, Seed Certification & Plant Protection Centre (SCPPC) empowered to protecting the national agriculture sector by preventing entry of alien pests; promoting environmentally friendly, technically feasible and economically viable pest management strategies; ensuring appropriate quality pesticides for pest control; assuring safe use of pesticides; promoting seed industry to assure the availability of quality seeds; conserving of genetic resources of food crops and supporting their utilization.

In order to perform the mandated functions effectively the SCPPC operates with five independent units such as;

Name of unit	Mandated Functions
National Plant Quarantine Service (NPQS),	Facilitate the import and export of pest free plants and plant products, for the development of agriculture and related industries in the country.
Plant Protection Service (PPS),	Plant Protection Act No. 35 of 1999 to protect the local agriculture and promote effective pest management strategies with the least harm to the environment
Office of the Registrar of Pesticides (ROP),	Control of Pesticides Act No. 33 of 1980 to ensure availability of high quality pesticides with the least hazard to human health and environment
Seed Certification Service (SCS)	Seed Act No. 22 of 2003 to safeguard the farmers as well as the seed handlers from

	malpractices that would harm the seed industry
Plant Genetic Resources Centre (PGRC).	Explore, collect conserve, introduce, evaluate and utilize the diversity of crop genetic resources

7.1.2 Office of the Registrar of Pesticides

Registrar of Pesticides (ROP) is the legal authority empowered and entrusted on the functions related to the registration and regulation of pesticides in Sri Lanka (appointed under the Control of Pesticides Act No. 33 of 1980, as amended by the Act No. 06 of 1994 & the Act No. 31 of 2011). According to the Act, it is the duty of the ROP to regulate pesticides imported to and produced in Sri Lanka, and to assure their quality and safe use, and to assess and to declare Maximum Residue Limits (MRLs) in agricultural produce. The basis of regulation is the compulsory registration of all pesticide material. The post registration activities are an inherent part of Sections 20-22 of the Control of Pesticides Act, which enables the regulatory process to safeguard food quality, human health and the environment against pesticides.

It makes provisions to regulate the import, formulation, packing, labeling, storage, transport, sale and use of pesticides. Thus, it is evident that the law applies to all pesticides, whether the end use is in the fields of agriculture or public health, or whether the products are to be used in the household, veterinary or the industry. The post-registration activities include monitoring of pesticide formulation and re-packing factories, storage sites and outlets, detection of unauthorized activities and taking legal actions, analysis for pesticide quality, analysis of pesticide residues in/on agricultural products and setting legally allowed MRLs in food, monitoring of pesticide poisonings, etc.

Sri Lanka is a member country of the United Nations and has agreed to support the International Code of Conduct on the Distribution and Use of Pesticides, which outlines the overall responsibility of member governments in participation of the pesticide industry to allocate high priority and adequate resources for pesticide management.

The Crop Life-Sri Lanka was established in 1981 as an integrating body of pesticide traders in Sri Lanka including firms, companies, corporations and individuals in importation, distribution, formulation, and marketing of pesticides. The contribution shown by the Association towards the observance of the International Code of Conduct (FAO, 1990), especially in extending the message of safety in the use of pesticides is more convincing. Currently, self-monitoring in the areas of maintaining factory standards in pesticide formulation, re-packing and quality control of locally formulated pesticides is warranted. However, the challenge will be how to achieve compliance with local laws and regulations in an efficient way, which may involve working cooperatively with members, non-members, other state agencies especially the pesticide regulatory authority.

The office of the Registrar of Pesticides continues to be involved in reducing the pesticide related hazards by setting up several environmental safety advocacy programs such as empty pesticide container management and the management and disposal of obsolete pesticides. It was aware that Crop Life Sri Lanka Pesticide Association of Sri Lanka (Presently called as Crop Life-Sri Lanka) in coordination with DOA/ROP implemented pilot programs for empty container collection and recycle project at provincial levels. Further the action has been initiated to establish registration procedures for indigenous biological pesticides; reviving the regulation of high-risk pesticides. The laboratory analytical calibre is to be enhanced by participating in international assessments for ISO/IEC 17025: 2005 accreditation and laboratory procurements; applicator safety initiatives; continuous improvement in training and awareness raising on pesticides and participating at local and international auditing on pesticide and residue management systems in Sri Lanka.

Registration of Pesticides

No pesticide may be imported in to the country without registration and the appropriate license authorizing importation of pesticides issued by the Registrar of Pesticides (ROP). Processing of an import license is based on compulsory pre-registration, quality, source identification and regulatory policies with special consideration on banned and restricted pesticides.

Table 7.2: Activities under ROP

Evaluation of original registration applications	In order to arrive at a decision whether the product does not cause harmful effects under local conditions and to minimize agricultural input cost
Evaluation of third party registration application	
Evaluation of re registration application	
Evaluation of data for local trials	To release human and environmentally friendly formulations to assure products are imported from a correct source of supply and discontinue importing unwanted volumes
Issue of import approvals	
Evaluation of pesticide quality certificates	To import quality pesticides and to ensure products conform to FAO specifications
Screening of labels, advertising materials for approval	To give the correct message for the farmers and other relevant authorities on judicious use and protection
Inspection of factories/ repacking facilities and stores	To assure factory standards are actually followed/packing activities/standards and thereby maintain product quality

Inspection of fumigation and household pest control services/ certification of Pest Control Operators	To regularize fumigation operations thereby avoid rejection of export/regularize/ prevent unskilled people from taking advantage of this industry
Inspection of Sales Outlets Dealer training classes / Issue of dealer training certificates	Prevention of adulteration and spurious products/ To ensure pesticides are sold only through trained people and certified outlets
Field Complaints/ Legal Prosecutions	To take legal action against persons contravening the provisions or regulation in the Act
Technical Advisory & Committee Meeting	To advise the Registrar on all matters relating to the Act
Formulation Analysis/ Residue analysis/ Disposal of Obsolete stock	To analyze the quality of Pesticides and residues in food and water /minimize environmental contaminations
Publish newsletters/Seminar for school children/ Officer Training Classes	To ensure information dissemination/train the trainers/ improve the awareness of community

Legal provisions are provided by the Control of Pesticides (Amendment) Act No. 06 of 1994 for licensing of traders, appointment of authorized officers, specifying the functions and powers to seize pesticides in outlets conducting activities contrary to the legal provisions and regulations. All traders engaged in the storing, selling or offering for sale of any pesticides are required to obtain a certification for sale from an Authorized Officer. As a mandatory requirement for the issuance of a license, applicants for dealership are required to undergo one-day training on the principles of pesticides safety, identification of pesticides and awareness on the registration system conducted by the officers of the office of the Registrar of Pesticides. Awareness and legal binding thus created would expect to minimize unscrupulous trade practices and thereby prevent adverse impacts caused due to pesticides.

There are approximately 190 active substances representing 647 registered pesticides in commercial use in Sri Lanka. Out of all active substances, 107 active substances are used in agriculture and the corresponding number of registered products are 459 as of December 2016.List published in Gazette no 1994/71 dated 24/11/2016.

In line with growing concern for manufacturing and promoting bio pesticides along with the government policy to promote safe initiatives in agricultural production, there are entrepreneurial motives to introduce biological pesticides in the country. In this regard the ROP has initiated to prepare, draft proposals on the requirement for registration of biological pesticides in different origins. The draft proposals were further discussed at the Consultative Workshop on Registration of Bio-pesticides in Sri Lanka and Relevant Guidelines were reviewed. Review of preliminary data submitted for local/indigenous bio-pesticides with the intention that “upon bio-efficacy evaluations are ongoing where select products will be screened and prioritized for local testing and further chemical verifications before releasing the registration procedure. However, it was understood that several brands of bio fertilizers, insect repellents, flowering fertilizers are made available for farmers cultivating organic vegetables. Also it was noticed there are test samples distributed to farmers through pesticide dealers in certain provinces. This indicates the urgent need to establish the registration process for bio pesticides to avoid any future issues due to negative effects on crops, insect behavior, environment and human safety.

It is the view of the private sector companies, specifically the voice of Crop Life Sri Lanka which identified that unnecessary procedural delays in registration of pesticides and time consumed for approval for import and distribution on pesticide could be minimized by assessing the procedures and implementing a more efficient way forward combined with outsourcing technical experts for non-confidential documentary evaluations. It was noted that the process of registration takes around 3-4 years due to the lengthy gap of time between the Agro pesticides subcommittee meetings, lack of efficiency of bio efficacy testing at research stations, farmer field trials, and evaluation proceeds on the dossier. Considering the current nature of international development of innovative and efficient pesticides that are introduced in the shortest possible time gaps, the business entities looking for more simplified ways of processing the permits/ licenses for import and distribution of such chemicals. Delaying procedures will erode the opportunities for using such high tech innovative pesticides which are promoted globally. The license for pesticides importers should be renewed every three years.

All pesticide companies are required to be registered with the ROP with the intention that all functions associated with the pesticide business are critically evaluated in a competent manner to safeguard human health, environment and wildlife resources as pursuant to the Sections 5 (a) and 5 (b) of the Government Gazette Extraordinary No.1870/63 dated 10.07.2014. During the year 2016, all 76 pesticides import establishment profiles were thoroughly reviewed for competency certification. The major outcome of this exercise was that the entire Pesticide Industry is shown mandatory accomplishments in ISO 9001 (quality), 14001 (environment) & 18001 (health), and other accomplishments for environmental protection goals as set out under the National Environment Act No. 47 of 1980, depending on the nature of business.

Based on the regulatory requirement for sale and supply of pesticides under Gazette no.1716/23 of 27/07/2011 ROP in coordination with Provincial, inter provincial and MASL staff provided training for 656 participants representing pesticides dealer network in the provinces. This was a preliminary training to be updated about the latest development and improve the knowledge of dealers related to pesticide sales. Pesticide dealer licenses are valid for one year. Under the purview of ROP, a regular NVQ IV program was established for competency training of Agrochemical Sales and Technical Assistants (ASTA) personnel. The study revealed that there are traders especially proprietors of pesticides sales centers in the provinces not trained or participated in the ASTA program. It is observed that more farmers rely on these dealer networks for making the decision on the purchase of chemicals. As such it is important that the NVQ and ASTA qualifications be made mandatory for all stake holders in the pesticides trade who require licences for dealers

Illegal pesticide sales and attempts are prosecuted under the ROP by the provincial authorized officers who are empowered under the act. Though there was progress in this matter in the field, it is required to strengthen the capacities and staff especially under the purview of the ROP. Currently authorized officers are provincial AIs or PHIs in the regional level.

During the year 2016, there were six (06) training classes held for 210 participants of Public Health Inspectors (PHI) from the Department of Health. It is envisaged to facilitate the prosecution for illegal activities under the Control of Pesticides Act No. 33 of 1980 as "Enforcement Officers" (i.e., persons empowered to institute proceedings and conduct prosecutions). The Section 24(A) of the Control of Pesticides (Amendment) Act No. 06 of 1994 has been crafted in such a manner to exploit external resources for legal actions, nominated as persons empowered to institute proceedings and conduct prosecutions. The office of the Registrar of Pesticides proposed further recruiting of external Officers for field monitoring of pesticides. At provincial level there are 26 AIs covering all district areas which are empowered by the ROP as authorized officers for legal prosecution on pesticides irregularities. There are significant cases of prosecution reported by the ROP. Some cases are on going, some are prosecuted and some are lost due to procedural lapses.

However, these officers are attached to a provincial mechanism and due to the workload and social environment has hindered the performance on executing the duties. Similarly the PHIs, though were trained they are more oriented towards medical related activities where time available for food/pesticides may be limited.

Farmers' awareness programs and printed materials used to educate and promote segregating the pesticide empties and collecting methods in the field are monitored and facilitated by the ROP in an effort to diffusing one message for all by creating a common platform. Thus reducing the environment and human hazards.

The ROP under the provisions of the Act made arrangements to outsource the quality assurance of pesticides through private sector laboratories. In this regard a levy on the services extended to the industry is imposed to mitigate the financial constraints.

It was highlighted that over 26 metric tons of obsolete pesticides are accumulated in the DOA farms and research institutions over a period of 2-3 decades. Inspection reports of obsolete pesticides identify that some of the stocks at regional centers (e.g. Deputy Directors Office at Ampara) were voluminous and badly decayed requiring great caution in handling. The ROP is badly in need of secure storage facilities to manage the regional stocks of obsolete pesticides.

Though there are regulations and standard procedures established on pesticide imports, storage, distribution and sale at the provincial level, the retail sales have not adhered to it. Accordingly, there is a high potential for mishandling pesticides during trading by dealers and during use by farmers. It was observed that the ROP has taken an initiative on prescription based pesticide sales through the CC program. It is envisaged that the prescription based sales should be further strengthened and introduced to all pesticides. The ROP need to promote and deploy authorized officers for this purpose. It is proposed to use the digital/ mobile communication system to mitigate the problem of inadequate extension staff at field level.

The ROP laboratory facilities are accredited and competent to analyzing 10 active ingredients. Currently, the analysis has been performed on five (05) active ingredients namely; Fipronil, Tebuconazole, Chlorpiriphos, Prothiophos and Diazinon and it will continuesly be upgraded to increase the scope to 30 ingredients in future. It was informed that a comprehensive assessment of agricultural products for pesticide residues and the whole analytical infrastructure in the country must meet to analyse over 107 active ingredients used in agriculture. The ROP also outsourced the analytical work related in this regard due to the demand and urgent need of the industry. In order to complement the national food safety assurance, 221 pesticide tolerance limits (maximum residue limits, MRLs) on 39 crop/food categories for 65 active ingredients were finalized for the Government Gazette Extraordinary notification. The Law requires the office of the Registrar of Pesticides to set MRLs for over 100 active ingredients to ensure food safety in the country.

The STDF project under the ITC has extended support by mobilizing two EU Experts on agronomy and chemical testing aspects. The experts conducted training/awareness workshops on the EU food control systems and its challenges, pesticide control, procedures of marketing and use of pesticides, the EU requirements for laboratory analysis and related control systems in tandem with field visits. The training sessions were attended by trainees, including policy makers from stakeholder organizations, agricultural product exporters, researchers, and extension and laboratory staff of the DOA. As an outcome of this initiative, the DOA has implemented an Exporters registration system to assess/ control levels and unauthorized pesticides in vegetables and fruits exported to EU markets. The program was executed by the ROP in coordination with the Counselors of Agri business (CAB) of the DOA to establish a “direct farmer and exporter link” to ensure that the pesticide residue limits are not violated at the EU entry point.

Under the initiative of the ROP, a directive was established that Personnel Protective Equipment (PPEs) should be made available at the market place at a reasonable price in compliance to the existing regulations made under the Control of Pesticides Act No. 33 of 1980. It was further noted that the "International Code of Conduct on the Distribution and use of Pesticides" under Article 5 to state that, for Reducing Health and Environmental Risks, the Government & Pesticide Industry should cooperate in further reducing risks by promoting the use of proper and affordable PPEs. Alternatively, there are regulations published under the Control of Pesticides Act No. 33 of 1980 to promote the farmer use of PPEs by the Government Gazette Extraordinary No.1113/5 dated 05.01.2000 Vide Regulation 6 (b) that "every person who sells or offer for sale any general or restricted pesticides shall sell or offer for sale all protective clothing which may become necessary in the application of pesticides in order to ensure the safe use of such general or restricted pesticides".

However, the field observations revealed that the use of PPEs during application of plant protection products including pesticides by the local farmers are expressively poor resulting in the danger to human lives. While chemical pesticides have contributed greatly to the increase of yields in agriculture by controlling pests and diseases, and towards the control of some vector-borne diseases in the human health sector, their continued and irresponsible usage has been the cause of many problems to surface.

Sri Lanka is a party under the Basel, Rotterdam, and Stockholm & Minamata Conventions. The ROP has been functioning as the Designated National Authority (DNA) on powers vested with regulation and control of pesticides. Therefore there are direct responsibilities under the Rotterdam & Stockholm Conventions while there are indirect responsibilities under the Basel & Minamata Conventions. Inter-agency responsibilities under the above four Conventions are fulfilled by official representations and follow-up on decisions.

Table 7.3: Mandates of different conventions related to the control of pesticides

Name of convention	**Area covered**
Rotterdam Convention	Banned and severely restricted pesticides are managed in a form of international information sharing during importation and exportation, which is known as "PIC", Prior Informed Consent Procedure.
Stockholm Convention	Persistent Organic Pollutant (POP) pesticides which are highly toxic and persistent in the environment and have global concerns due to their trans-boundary transport. The global elimination and safe disposal of these types of compounds are the ultimate objectives.
Basel convention	Control of transboundry movement of hazardous waste and their disposal.

Name of convention	Area covered
Minamata convention	A global treaty to protect human health and the environment from human-induced emissions and releases of mercury and mercury compounds.

7.2 Pesticide quality

Quality of a pesticide is a major factor determining its efficacy and impact on the environment and human health. Quality pesticides should have the correct active ingredients, other adjutants and solvents with required physical and chemical standards as set out by the FAO and World Health Organization. The quality is also monitored and noted by the ROP.

7.2.1 Pesticides Technical and Advisory Committee

The Pesticides Technical and Advisory Committee is the statutory body of the Control of Pesticides Act that makes national policy related to pesticides and assists the Registrar of pesticides on technical issues related to the enforcement of the Act. This committee consists of experts and ex-officio members of relevant institutes. These members include the Director General of Agriculture (Chairman), Registrar of Pesticides (Secretary), Director General of Health Services, Director General of Sri Lanka Standards Institute, Director General of Central Environmental Authority, Commissioner of Labor (Occupational Health), Government Analyst, Director of Tea Research Institute, Director of Rubber Research Institute, Director of Coconut Research Institute, a representative of the Attorney General, and five experts in related disciplines.

The ROP is the legally authorized office for controlling and managing all aspects pertaining to agro -pesticides import/ manufacturing to marketing that ensures the safety of the environment and the health of consumers. Though the ROP has been empowered legally to carry out the duties at national level, the study identified that there are many gaps due to inadequate staff at the ROP office and interruptions due to the support received at provincial level. It is noted that a few legal actions on scrupulous traders were implemented but in many circumstances it was not effectively carried out at provincial level. It was observed that there is no authorized officers in the provinces, who are directly under the purview of the ROP. All authorized officers are attached to the provincial DOA administration. This has hindered the smooth implementation of ROP activities in the field.

7.3 Plant Protection Services

The core activities of the Plant Protection Service can be stated as the control of pests/ disease outbreaks, implementation, monitoring and evaluation of field level IPM programs in rice and vegetables managing pests in bulk seed storage in the Department of Agriculture farms through fumigation, conducting research in pest management and pesticides. These mandates revolve around regulatory provisions made under the Plant Protection Act No.35

of 1999. Mitigating PPS was the entrusted division under SCPPC to implement and promote Permanent Crop Clinic Programs (PCCP) in the regional level that was initiated through the support of the Center for Agricultural Bioscience International (CABI).

7.3.1 Programs implemented under PPS

PCCP was the result of an intervention to control beans yellowing disease where DOA interacted with international technical experts to identify the cause and determine the control mechanism. Under the PCCP collaborative program, with the Center for Agricultural Bio Science International (CABI) in United Kingdom and DOA focused to strengthen national plant health system through developing local capacity to establish 20 master trainers covering thematic areas on How to become a “Plant Doctor”, Managing plant health problems, How to become a technical writer and green and yellow lists, Monitoring and Evaluation of crop clinics. PPS informed that 548 AIs were trained and qualified as plant doctors covering 11 district areas. The officers in the provincial DOA indicated that crop clinic programs are continued but they are unable to make it a regular activity due to commitments on the provincial work plan. However, it was noted in some provinces the crop doctors visit the weekly vegetable markets with the intention of meeting with farmers who come there for selling produce or buying produce. Though it was a good move to establish and strengthen the communication, the impact of this act is very limited where it could reach only a handful of farmers every week. At the field the AIs are following with the Plant Wise –App (a global program led by CABI) for identification/ finding solutions regarding pests and diseases in the farmers’ field. Also it was noted there are many Apps introduced farmer networking and communication for marketing, price information, seed/ planting materials, etc., viewed by a large number of farmers.

At provincial level the study identified that the Crop Clinic (CC) Program is scheduled to be held every fortnight (two CC per month). There are no regular events conducted. Though all AIs were trained and certified as Crop Doctors the follow-up activities are poor. However, in Jaffna it was noted that, regular meetings are held at the weekly vegetable market in Chavakacheri. However, the AIs were forced to go at times where the pest/ disease epidemic is observed in the field and complaints are flowing from farmers. It was highlighted that farmer interest and participation is more when the pest infestation increases in the fields.

Though the AIs are empowered as Crop Doctors and to implement regular CCs in the field, the programs are frequently cancelled due to other official commitments (adhoc/ planned) entrusted by provincial administration. Accordingly, the farmers lose confidence in the officers and the program,

Promoting IPM and GAP based pest management in rice farmer fields the PPS contributed to, reduces the level of pesticides induced health hazards and environmental issues. It was informed the PPS intervened to train 293 extension service officers and 627 farmers to enable them to identify pests and natural enemies at each growth stage and manage the pest population below economic injury levels by applying different strategies which are applicable under farmer field conditions. It was also aimed on conservation of natural enemies in the agro-ecosystem and managing the pest population. The study though did not cover the rice production farmers. A majority of farmers interviewed were experienced in rice cultivation during the heavy rainy season and knowledgeable about the IPM practices. It was noted that PPS interventions have influenced the farmers to utilize the chemical methods for managing pest occurrences.

The pest surveillance program implemented under the PPS to compile the paddy pest infestation data at district level. The PPS prepared the data base in coordination with District Extension Officers to make aware or inform the farmers on the pest situation in paddy cultivation. The dissemination of the pest situation is done through radio broadcasts. According to the farmers, a majority were not keen on listening to the radio broadcast as due to time constrains.

IPM / GAP technologies on vegetable farming is yet to be adopted. It was observed that the concept was not fully digested by farmers and it was informed that they lacked confidence on the practices identified. However, the lengthy discussions noted that the technology is already implemented where integrated practices such as land preparation, time of planting, variety of seed, monitoring of pests ,etc. are implemented, with or without their knowledge, that its contribution for the control of pest incidences. Number of training programs for extension officers were conducted at different locations where a total of 463 officers and 702 farmers were trained. Also PPS initiatives have introduced IPM/GAP technologies to 133 farmers in Western Province.

PPS identified a sporadic outbreak of Banana Skipper (Erionota thrax) and that 60 extension officers were trained on identification of pest and control measures using the IPM package. The field observations highlighted that the damages due to this insect was controlled by bird attacks. This was proven at the Banana growing areas in Mahaweli (Walawe) area. According to Plant wise information there are many parasites that pray on Banana skipper.Pyrithroids are effective but it may kill the natural enemies causing major outbreak.

The results of the study understand that PPS at SCPPC /DOA working closely with provincial DOA offices to deliver the services and transfer plant protection technologies, including IPM and GAP to facilitate the plant pests and beneficiary insect management at crop fields. The PCCP, one of the main focus areas in which combined pest management technologies can be introduced and pest and diseases in the field are identified through effective coordinations among the officer and farmer. However, it was found that the crop clinics and crop doctors are yet to perform at the maximum level in the field. The promotion of a smart phone culture would be a better option to link outreach programs in the field level including the private sector. Further it would be advantageous to promote/ integrate the concepts of crop clinics/ crop doctors to ASMP led FBS modules via digital networking mechanisms.

7.4 National Plant Quarantine Service

The mandate of the National Plant Quarantine Service of Sri Lanka is to facilitate the prevention of, introduction of, eliminate the spread of dangerous alien pests within the country and the establishment of and involvement in domestic pest control programmes; Development of treatment technologies to eradicate pests of quarantine importance; Promotion of the export of healthy plants and plant products, the import and export of pest free plants and plant products for the development of agriculture and related industries in the country. To achieve this, emphasis were given to both research and service oriented quarantine activities. Phytosanitary certification, inspection and treatment of import and export plants and plant products, testing of detained samples, issuing of import permits for plant and plant products, pest risk analysis, field certification for fruits and vegetables and pack house registration, dissemination of knowledge on all aspects of plant quarantine via training and awareness programs for interested groups are the main activities accomplished in collaboration with national research institutes, universities and institutes and centers of DOA.

NPQS is equipped to carry out the testing of import and export of plant products on insects, pathogens and weeds, by drawing samples as required. It was noted that the major pests identified are parasitic nematodes, common storage pests in seed potato, maize, soya, etc. Pathogens were identified in the samples tested which included; Mucor spp., Rhyzoctonia spp., Erwinia spp.,Geotrichum spp., Fusarium spp., Colletotricum spp., Cylindrocarpon spp., Bacillus subtilis and Curvularia spp. Import consignments tested and found to be contaminated with soil and weed seeds will be confiscated and destroyed to avoid any infestation by alien species. This is considered as a potential risk of multiplication and infestation if released undetected. It was noted that a majority of work is focused on potato seed imports and to ensure a high quality of seed is delivered to farmers. A program was established to identify and to investigate the presence of maize wilt causal organism Pantoea stewartii in imported seed lots which may become infested if not protected. In order to increase technical expertise, the NPQS continue to carryout research and development activities through pest surveys, pest risk analysis, weed control research, Pathological research, and Entomological research and Quarantine treatment research.

Table 7.4: NPQS procedures for import of plants, plant materials and Seed

Description	Ascertaining quality of imported plant/plant product	Ascertaining quality of imported seed
Entry point inspection	√	√
Sampling	√	√
Document check	√	√
Receipt of samples submitted by entry points to NPQS	√	√
Laboratory testing for plant pathogens	√	√
Laboratory testing for plant insects	√	√
Laboratory testing for plant nematodes	√	√
Laboratory testing for weeds	√	√
Submission of test reports	√	√
Submission of final test reports	√	√
Release	√	√
Treatment recommendation	√	√
Re-export or destruction	√	√

The Socio Economic and Planning Centre (SEPC) functions as an advisory body, supporting the DOA and the Ministry of Agriculture, in formulating agricultural policies. The Centre conducts research and development planning, socio-economic research and agricultural policy analysis. The SEPC maintains a statistical unit to compile agricultural statistical information. Crop forecast is a monthly publication of SEPC which monitors the monthly cultivation progress of paddy, other field crops and vegetables. This report provides information related to the prevailing situation on crop cultivation, forecasts the production, regional distribution of production, harvesting periods, occurrence of extreme weather conditions, pests and diseases. Twelve crop forecast reports were prepared during the year covering latter 2015/16 Maha, 2016 Yala, and early 2016/17 Maha.

7.5 Extension & Training Centre

The Extension & Training Centre plays a vital role to achieve the highest level of productivity in the food crops sector to ensure food security of the country as well as to improve living standards of the farming community. Achievements of the Centre are focused on four main areas: Extension, Training, Agricultural Education and Examination. Programs implemented by the E&TC and its effective contribution to the PM of crops relevant to the ASMP program is discussed as below:

Chilli villages were promoted in eight (08) provincial areas and the only province excluded was Sabaragamuwa. The 50% cost sharing programs encouraged famers to adopt the IPM/GAP technologies. The DOA interventions identified modern technology support to farmers by providing sprinkler irrigation systems, rain sheds for nursery establishments, nursery trays, power sprayers, water pumps, agro wells, and chilli seeds -aiming to increase the small farm productivity contributing towards the national chilli supply. Further, under the national food production program, the DOA assisted to cultivate 1100ha of maize, (with 12 ridger machines and intercultivators), the ground nut program established 217 demonstration farms (sprinklers, seed, 01 decorticator and 3 intercultivators), on the basis of 50% cost sharing. It is also found that selected farmers' clusters within the programs promoted for seed production and some were promoted for value added product development for enhanced income options.

The fruit village establishment is a three year program which spanned from year 2013 to year 2015. In year 2016, field monitoring/ evaluation was carried out to examine the farmer-field level performance in 13 fruit villages that included two (02)sweet orange villages (Batticaloa District), three (03) wood apple villages (Batticaloa and Hambantota Districts), three (03) soursop villages (Kalutara, Kurunegala and Matale Districts), two (02) mango villages (Anuradhapura, Hambantota Districts), one (01) grape village in Polonnaruwa District, one (01) pears village in Nuwara Eliya District and one (01) pineapple village in Ampara District. During the interview, the plant survival rates below 50% was reported at Wood apple village at Tissamaharama in Hambantota District. The available information indicates that the extension workers had visited the fruit villages several times but specific training on time of training need, distribution of plants on time, selection of suitable farmers are required to reach expected outcomes of the project. According to DOA officials interviewed informed that plant survival rates reported to be below 50% at wood apple village at Tissamaharama in Hambantota District. The available information indicates that the extension workers have visited the fruit villages several times but specific training, distribution of plants on time, selection of suitable farmers are components required to reach expected outcomes of the project.

In order to ensure the quality/ safety of agricultural products for export and local markets, the DOA has promoted 400 GAP certified commercial farms and 22 DOA demonstration farms which are GAP certified. A total of 1,031 training classes were conducted for farmers and other stake holders and 19 field tours were conducted for farmers to show the successful GAP implemented farms. 12 media programs were conducted and 12 books and leaflets were printed to educate the public. Around 56 GAP practicing farmer co-operatives were implemented. 1,194 export farms and pack houses were monitored. Though the GAP and IPM concepts were promoted through training and demonstration, the proper adoption of agronomic practices that could lead to reducing the use of chemical inputs was unclear.

Good Agricultural Practices (GAP) are being introduced on crop basis for fruits and vegetables. Producers are registered and certified at DOAgbiz as quality assured suppliers while DOAgbiz acts as a data hub to provide necessary information to the parties concerned. Agri business Counselors in the field were provided with the latest IT facilities (Android tablets PC, Laptop computers and etc.) for fast dissemination of information and issuing of QR certificate for traceability.

Water Management and the Protected Agriculture Unit is dealing with the following subjects in respect of the technology generation and dissemination to the technical staff of the Department of Agriculture, Other departments and institutes, private sector and to the farming community in Sri Lanka.

- Agricultural adaptation technologies to mitigate climate change
- On farm Irrigation & Irrigation management
- Micro irrigation technology and fertigation technology
- Controlled environment agriculture (Protected Agriculture) (Poly–tunnel, Rainout shelters, Net houses)
- Commercial farming (Advanced planning of commercial farms) for annual and perennial crops
- Hydroponic culture & Advanced Nursery Management

The national pesticide policies in Sri Lanka are also geared towards supporting IPM in crop production. Restriction of highly hazardous WHO class Ia/Ib pesticides only for certified applications, total banning of all class Ia/Ib pesticides from retail use, thorough and intensive screening at research level of solely the pesticides having narrow activity or less effects on natural enemies and pilot scale testing before registration, and promotion of bio-pesticides are some of the supportive roles given through the implementation of the Control of Pesticides Act. Also the move of ROP to outsource the services of PHIs in provinces to strengthen the legal /regulatory empowerment against the scrupulous pesticides market, forces another step forward in making stringent controls over pesticides and its use.

7.6 Central Environmental Authority

The Central Environmental Authority (CEA) was established on 12th August 1981, under the provision of the National Environmental Act No: 47 of 1980. The Ministry of Environment which was established in December 2001 has the overall responsibility in the affairs of the CEA with the objective of integrating environmental considerations into the development process of the country. The CEA was given wider regulatory powers under the National Environment (Amendment) Acts No: 56 of 1988 and No: 53 of 2000.

The Environmental Protection License (EPL) is a regulatory/ legal tool under the provisions of the National Environmental Act No: 47 of 1980 amended by Acts No 56 of 1988 and No 53 of

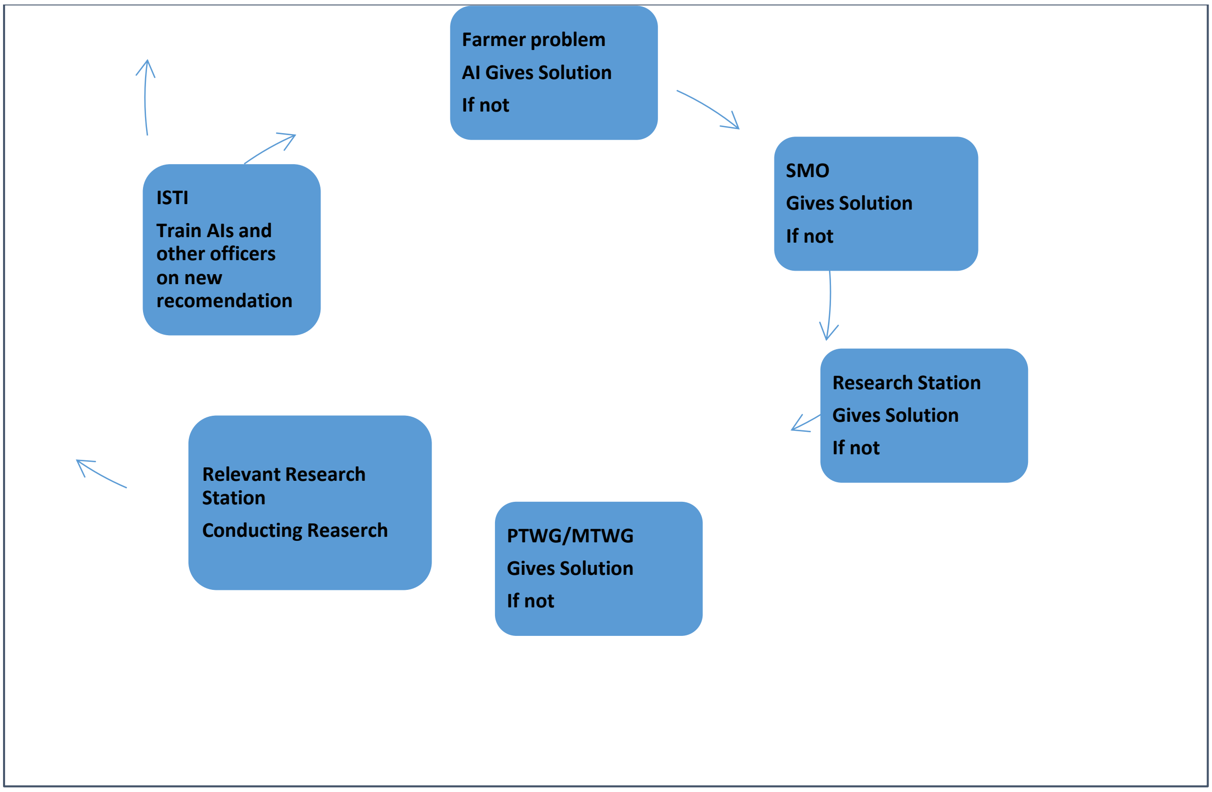
2000. Industries and activities which required an EPL are listed in Gazette Notification No 1533/16 dated 25.01.2008. Industries are classified under 3 lists i.e., List "A","B" and "C", depending on their pollution potential. Part "A" comprises of 80 significantly high polluting industrial activities and Part "B" comprises of 33 numbers of medium level polluting activities. EPL for industries in lists "A" and “B” have to be obtained from the relevant Provincial Offices or District Offices of the CEA.

Part "C" comprises of 25 low polluting industrial activities which have been delegated to Local Government Authorities, namely Municipal Councils, Urban Councils and Pradeshiya Sabhas. EPL for the industries in List "C" has to be obtained from the respective Local Authorities. The Local Authorities carry out issuing of EPLs and related functions such as follow up, monitoring and law enforcement. It is clearly mentioned that all Pesticides, insecticides, fungicides and herbicides manufacturing, formulating or repacking industries required to obtain the Environment Protection License complying the regulatory requirements and standards as stipulated under the act.

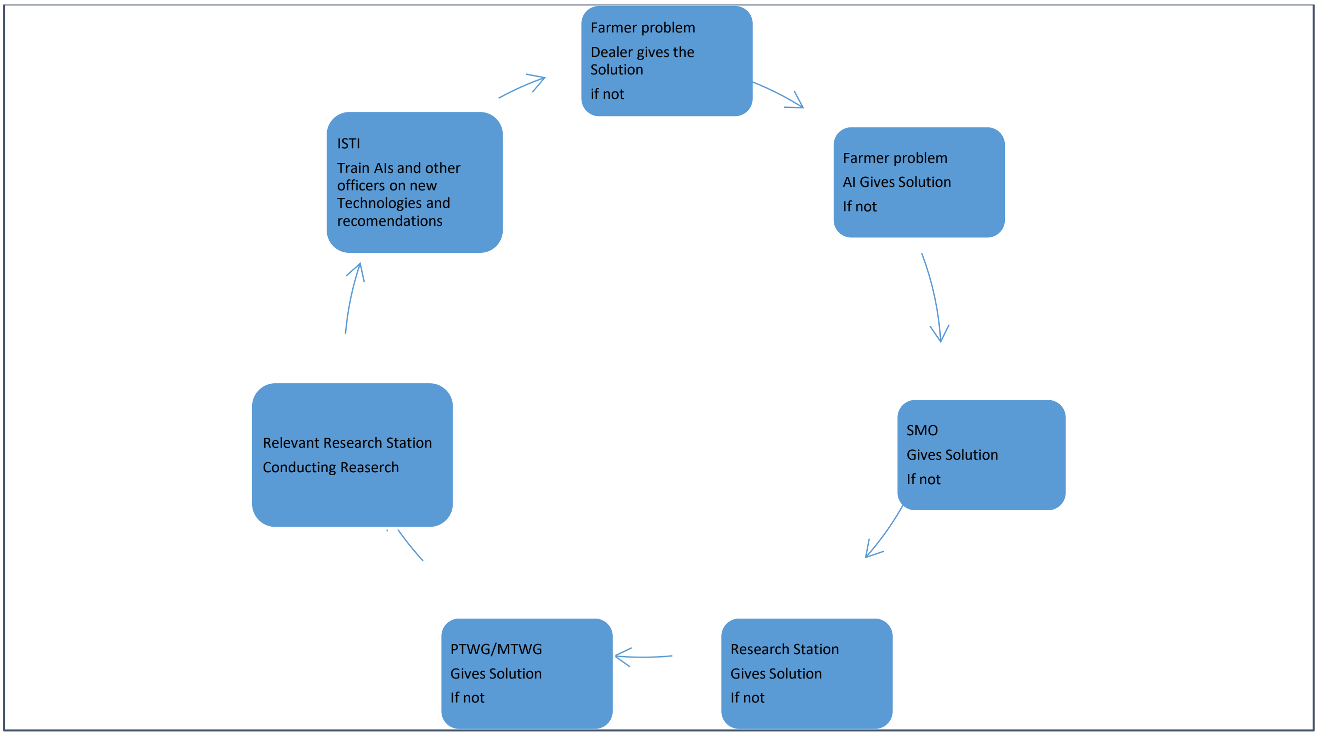
7.7 National Environment Act

Sri Lanka’s National Environmental Act of 1980’s controls the discharge and disposal of pesticides in to the environment. Based on the limits set by Australia, European Commission countries, India, Malaysia and the Codex Committee on Pesticide Residues, the maximum permitted residue levels of pesticides in food have been set by the Sri Lanka Standards Institution. In addition the CEA takes action against anyone if there are complains related to pesticides and fertilizer storage. Likewise, CEA has authority to oversee all things related to hazardous waste management activities including pesticides and fertilizer. This waste should be managed according to the guidelines given by the CEA. According to the CEA officer at NCP, it was noted that they are receiving complaints about the banned chemical like malathion which is available in the area and used in households/ grain stores, but it is difficult for them to trace the chemical due to inadequate technical know how. The produce isconsidered contrabrand and sold at local outlets and distributed among households/ farmers. The general public must be warned and made aware of its deadly effects and advised against its usage.

7.8 Diagrammatic view of Pest Management Mechanism for - AI Range



7.9 Diagrammatic view of Pest Management Mechanism – Institutional



7.10 Effectiveness of legislation

In spite of the legislations and institutional mechanisms in place, pesticides are heavily misused posing both environmental and health hazards. It is estimated that annually about 16,000 pesticides related poisonings are reported in Sri Lanka. Approximately 700,000 kilograms of pesticides are imported annually. Almost every rural grocery store has shelves full of many brands of pesticides and over 100 chemicals, including Malathion in more than 200 formulations, are sold. Liquid preparations of pesticides can be lethal in minute doses. Enforcement of these regulations and strengthening of the existing institutional structure is essential to ensure pesticide management is conducted in a sustainable manner and the detrimental effects they have controlled.

7.11 Institutional Capacities

7.11.1 Extension services by DOA

The discussions with farmers highlighted that the GOSL extension mechanism is still in close contact with the farming community. However, over the decades, the services were eroded due to scarcity of staff at field level. The study identifies anumber of other reasons associated with causing hindrances for farm level activities. It was noted that the extension services of the DOA operates under two different administrative systems; intra provincial and inter provincial. The inter-provincial extension system is only responsible in areas where agriculture production under major irrigation settlement schemes is conducted (excluding Mahaweli irrigation settlement project areas). Intra provincial extension system command area covers provincial agriculture systems under minor irrigation tanks/ lift irrigation/ rainfed cultivations within the boundaries of particular province.

Table 7.5: Staff strength at DOA

Category	Total		% short of staff
	Approved	Existing	
All	**12256**	**9952**	**18**
Assistant Directors(Dev/Ext/R)	746	421	43
Extension Officers	1237	1059	14
Agriculture Instructors	1242	873	30
Development officers	369	299	19
Research Assistants	815	238	71
Project Assistants	177	85	52

Source; DOA

The study revealed that the farmers exposure to extension service in all provinces are not encouraging as there is no regular farm visits or meetings or training for preparing cultivation calendars, seasonal cropping patterns, timely cultivation of crops other than paddy with farmers in the area. Farmers knew that AIs are attached to all ASCs at close proximity to the farmer clusters but it is difficult to meet either at his office or in the field. Though the farmers are unable to meet the AIs or DOA officials, they are aware of the services available for farm development and solving problems. The communication devices, especially mobile phones are used as the tool for contacting them when the need arises. The farmers under the ASMP cluster program indicated that they are in close contacts with AIs in the particular villages, mainly due to the interventions of the PPMUs initiated pilot programs. These programs depend on the provincial DOA extension services for identifying farmer clusters, villages, potential crops, technical support, farmer training, project related special programs (FBS) for program implementation.

The meeting with all farmers in particular command areas of the AI become impossible due to operational limitations on visiting or meeting a large number of farmers that may go beyond 2000, due to shortage of staff at the provincial level and lack of planning on deploying the available man power resources such as development officers, project assistants to coordinate and work with AIs at the ASC level. Majority of AIs in the field are recently recruited graduates or Diploma holders with an agriculture background. The experienced and trained officials have retired and the diffusion/ sharing of their expertise also hindered. Long delays in recruitment procedures for filling vacant positions resulted in a vacuum in the extension services.

According to respondents, these officers have limited experience in identifying and providing a quick solution related to problems, especially on pests/ diseases/ nutrient deficiencies at the field. The extension staff in the field areupported by Subject Matter Specialist at provincial/inter provincial levels. Yet there are gaps on farm services; specially in promoting best practices for agriculture with improved technology, cost effective farming packages to reduce the cost of chemical inputs and increase the small farm income at provincial agriculture. The AIs in the provinces are trained and certified as Crop Doctors to serve as pest management specialists assisted through a PLANT WISE mobile app for online solutions and connecting with experts. The plant clinics are not actively performed in the fields. Also it is observed that the diagnosis and identification of solutions are not attractive to the farmers. This envisaged the need for more training to equip/ strengthen the plant doctors with updated resources/ guides/ printed materials/ digital links.

The results of the discussions identified that, inter provincial programs are affected due to inadequate staff at regional/ provincial level. Though agricultural programs are considered a priority area, there is no strong support for implementing the activities at field level. This fact was further proven by the fact that ASMP/ PPMUs pilot projects encounter challenges when programs are not in par with farm development activities planned under the provincial administration.

7.11.2 Extension services by MASL

The Mahaweli agriculture development programs are strictly aimed at farmer settlements in the project command areas under diverse settlement systems. The study extended to Mahaweli farming area as well. The results pertaining to extension support on crop production and minimizing chemical inputs found encouraging for the farmers as the extension system reaching the grass root level through field assistants reporting to Unit Managers/ Agriculture Officers. The agriculture extension program focuses on promoting best agricultural practices for increased productivity with optimum use of inputs maintaining the lowest possible hazards on human health and environment. The farmers speak about the pest management activities adopted with non-chemical methods and continued observation/ demonstration/ supervision/ training by Mahaweli Agriculture extension services. According to farmers, the rice IPM activities have been followed as learned during the early 90s and as supported by the Mahaweli extension system up-to-date.

7.11.3 Extension services by Private Agri business investments

Since the initiation of globalized economic development, the Agriculture sector in Sri Lanka attracted private businesses -those whom identified options for investing production, processing and marketing in agriculture. The increasing involvement of agri business companies in Sri Lanka for market oriented production have increased its services to establish own extension/ marketing staff working with farmers, mitigating challenges due to the scarcity of staff at state run extension services.

The intervention of **exporters of fresh produce** from Sri Lanka introduced regional collecting centres linked with farmer clusters to make their business competitive by supplying farm produce with assured safety and quality. With increasing demand for volumes the exporters invested with support services for farmer training and extension services in the producing areas. The Fresh produce exporters in collaboration with their international partners are further expanding this concept established in model farms cultivating fruits and vegetables to popularize high productive varieties, best agricultural practices and controlling methods for pests and diseases. Apart from extension support to farmers in the vicinity, the exporters provided seed/planting materials, inputs, technology training, farm visits and the purchase of produce from contract farmers.

The farmers in ASMP pilot regions discussed the importance of the presence of **HJS condiments Ltd,** a private sector Company with uninterrupted extension support that reaches them throughout the crop cycle to maintain the crop growth, productivity and manage the quality and assure the safety by controlling chemical inputs specially pesticides. Farmers highly appreciated and supported the system in which the extension staff visiting their fields advise the steps to be followed and input applications that led to obtaining a high farm income. Irrespective of the fact that farmers are aware or not, the company investing in an export oriented venture, essentially covers the cost for extension services provided. This can be elaborated as a case where farmers are obtaining hired extension services for growing vegetables through contract farming at a pre-determined selling price of vegetables.

Cargills, the largest modern retailing chain in SriLanka sources its farm produce from more than 5000 small farmers in the provinces. The collection in the provincial areas have established contacts with farmers in the area for a continuous supply of produce with specified quality/standards and prices flexible with daily market rates. A total of 14 staff operated island wide covering farm extensions, quality maintenance, farm visits at regular intervals and provides advice on crop management, pest management, harvesting time, while observing the use of chemical inputs and time of application. Extending its services to the farmers, the company developed a model agriculture system with 80 farmers in dry zone areas in which modern technology with extension support to promote change of attitudes in farmers by demonstrating the possibility of increasing productivity and decreasing cost of production through combined technologies for crop production with matching grant for selected farmers to invest in farm development activities. The particular program was initiated within a few select farmers whom were exposed to international agric production systems and modern technologies in India and trained as TOTs. The successful venture identified that the technology package should couple with regular extension support to make the change possible through strengthened farmer - market links.

Farmers growing moringa in Anuradhapura District commented on the technology and extension advisory support extended through a medium scale company, **Dasini Dehydrated Products** a processor and supplier for dehydrated moringa powder, curry leaf powder, gotukola powder, vegetables and fruits. The company provide extension support to farmers through two extension officers. The company already establsihed 100acs of moringa, covering 100 farmers. The package identified, is diffused through the extension officers and technical know how was brought from DOA and Indian experts that supplied the moringa plant varieties. The combined technology package applied in the field monitored regularly by extension staff led to success of keeping the pests and diseases away from cultivations.

Based on the above information about the extension services, it was noted that there is a positive momentum of farmer services at field level through committed private sector agri business investors. However, the results of the study indicate that this cannot be isolated from the public sector extension services as the private entities to initiate action the public sector extension support deemed essential. The current dearth of extension staff in the public sector could be compensated by promoting/networking private investments with their own extension staff to enable small farmers to make use of the rapidly expanding agriculture technology.

It is noted that farmers are supported in the decision making process on pesticides use on crops by many actors operating in the field. Even though the DOA is the largest extension network that reaches the farmer community, there are other institutions like DEA,EDB,NEDA, CAA,DS, SEDD, and private sector entities; Cargills,Keells,CIC,Hayleys,Exporters, NGO,Crop Life, etc., are active either in coordination with the DOA or on their own. Accordingly, under the present situation the farmers are not neglected or left out as pointed by many forums incorrectly accusing the DOA agriculture extension system in the rural area of not functioning effectively. It is the problem of non-cooperation by all public/ private/ NGO extension services and working in isolation that hindered the dissemination of information to farmers under one platform. Different institutions working with their own programs/ agendas in the field level have caused the problem of persistent pests/ diseases in the agriculture areas. Therefore it is required to promote and establish national agricultural extension development program by integrating the private/ public/ NGO under one platform.

7.11.4 National Agriculture Policy interventions

The National Agricultural Policy interventions identified three focus areas to harness the potentials of the Agriculture sector in Sri Lanka.

- Assuring food security
- Ensuring environment sustainability
- Developing economic opportunity

The above focus areas are guided through the principles and values of;

- Agricultural practices shall be environmentally sound, nationally appropriate, socially acceptable, and economically viable.
- Safety aspects shall be considered and integrated throughout the production cycle
- Fair distribution of benefit to both farmers as well as consumers
- Sustainable consumption and production.
- Ecosystems stability is ensured.
- Traditional knowledge and practices will be respected in the development of farming systems.
- Effective governance will be ensured through integration of agriculture, water and environmental components to the maximum possible extent

Based on the interventions and principles, the policy strategies/statements are determined to cover all aspects pertaining to food, floriculture and market oriented crop production designed to promote enhanced farm income through economically viable, environmental friendly agro technology for achieving sustainable small farm agriculture production and marketing.

Table 7.6: List of policy strategies/statements

Policy Statement	Details
Promoting Agricultural production	Efficient and effective use of resources, increased cultivation of rice, field crops, root and tuber crops,fruits,floriculture,herbal crops, **promote IPM/IPNM**
Seed & Planting materials	Enforcement of certification/quarantine laws to maintain and secure high quality/productive seed & planting materials for farming. Monitoring & evaluating the **pest/disease resistants and yields** of imported varieties before releasing to markets.
Fertilizer	Promote **IPNS to reduce the use of chemical fertilizers** & increase use of bio & organic fertilizers, preventive measures to stop misuse, promote **site specific fertilizer application** through soil/plant testing
Pesticides	**Promote IPM** & use of bio pesticides/**reduce use of chemical pesticides**, provide adequate infra-structure/man power facilities to operate/**empower regulatory measures of PC/Act, strict compliance to PP act to prevent alien species**
Agriculture Machinery	Promote use of machinery/**mechanization/**manufacturing industries to introduce appropriate **technology for productivity improvement**
Irrigation & water management	Efficient use of modern/intensive crop **irrigation techniques**, save water for future, promote technology for rain water harvesting**, ground water conservation, mulching**, increase

Policy Statement	Details
	participatory irrigation management, **prevent pollution of water resources**,
Land use	Promote efficient use of degraded/infertile/barren and **lands under shifting cultivation** to productive agriculture.**Net working with institutions related land and agriculture,** ensure efficient land is used to **increase intercropping**
Soil conservation	Empower & implement soil conservation act, promote **soil conservation for sustainable agricultural development**.
Agricultural credit	Ensure agriculture credit with simplified procedures, strengthen Govi Setha fund
Agriculture Insurance	Promote appropriate scheme to protect farmers from crop loss and risks.
Agriculture research	Focus on livelihood improvement, efficient agriculture production/environment conservation, mitigating technology lag, monitor effects & impacts of agriculture activities on environment & health, crop breeding,
Agriculture Extension & education	Modernize & strengthen to disseminate modern technology, focus on ICT for effective farmer communication, promote farmer participation at R&Ext, dialogues, review & update training/ education curricula to meet the emerging agriculture developments, provide opportunities for farmers/officers to enhance skills & knowledge on innovative/emerging productive technologies. Empower/recognize women & youth in agriculture.
Post-harvest Technology	Develop & popularize efficient technologies for post – harvesting/processing/ packaging/storing/ transport, manufacturing value added products, Promote & enforce SPS measures, interventions through model projects introducing food processing machinery/equipments.
Marketing	Interventions and networking to promote market linkages, encourage/support private sector investments/branding/GI registration, promote small farmers to produce high quality farm produce adopting good agricultural practices, promote shared service centres, and ensure an efficient agriculture marketing system for small farm produce.
Agro based industries	Induce/promote agro based industries in coordination with private sector.
Traditional Agricultural crops & Methodologies	Compile, preserve & disseminate/exchange among farmers the knowledge on traditional agriculture technologies on crop

Policy Statement	Details
	production, organic farming, pest control, post-harvest processing for food and nutritional purposes.
Home gardening	Increase the participation of households in home garden agriculture and urban gardening for producing food for nutrition. Encourage women in home gardening.
Investments in Agriculture	Promote private sector on planting material production/supply, research & development, marketing, export promotion, development of small enterprises.
Institutional development	Establish mechanisms for effective coordination and networking with national and provincial level public/private institutions and community based organizations involved in agriculture and related activities.
Utilization and sharing plant genetic resources	conservation of varieties for breeding/development by adopting strategies for preserving national identity, sharing resources through international treaties, farmer participatory breeding methods,
Youth involvement in Agriculture	Promote active participation of youth in agriculture, through high value crops, agro industries,incentives,etc.
Agricultural exports	Integrated program networking of all relevant institutional and producer groups to facilitate production and export of food safety/quality assured products that meet the international food safety specifications and standards.

As at present, the development programs initiated and implemented all in line with national policy documents establsihed under different administrative regimes/governments in power before and after 2015. It was observed that most of the programs though initiated different national development plans the implementation of activities are carefully lined up with the legal and regulatory framework pertaining to the subject areas. It is further identified that agro food chain as a whole, is implemented or coordinated by diverse authorities under different ministries. The management of the agro-food chain is under many ministries and institutions with very little links among them.

Table 7.7: Agencies responsible for management of agro-food chain

Agro-food sector	Agencies
Paddy, pulses and legumes	Department of Agriculture Paddy Marketing Board Institute of Post-Harvest Technology
Fruits and Vegetables	Department of Agriculture Institute of Post-Harvest Technology

Agro-food sector	Agencies
	Cargills and other supermarkets Economic Development Centres Vegetable Growers Association Sri Lanka Food Processors Association Agribusiness Council
Fish and fishery products	Department of Fisheries and Aquatic Research NARA Ministry of Health
Meat and meat products	DAPH Veterinary Research Institute Ministry of Health
Coconut and coconut products	Coconut Research Institute Coconut Development Authority
Tea and tea products	Tea Research Institute Sri Lanka Tea Board
Spices and spice products	Department of Export Agriculture Sri Lanka Spice Council Industrial Technology Institute

According to the above table there are various organizations contributing to food safety/hazard control. But it was observed that there is no established forum to discuss the new developments and problems of food safety especially with these stake-holders, hence food safety is negatively affected. It is been made aware that contamination of food with agro-chemicals and heavy metals enter into the environment through industry effluents and other means. These heavy metals can enter into the food chain. Therefore it is utmost important to test our foods for residues of agro-chemicals and heavy metals. The policies of different ministries operated in isolation and there is a duplication of activities where Food act 1980 the primary food law, under the purview of MOH generally addresses food control at the processing/ manufacturing and retail end and not the complete food chain. The other Laws for the animal, plant and fisheries sectors generally deal with the primary production, though they are responsible towards ensuring safety of food in the processing part of the food chain. The fishery sector however has established good control systems, basically due to a strong export demand.

Plants and plant products, the production and primary processing aspects are managed through the Plant Protection Act No.35 of 1999, Plant Protection Ordinance 1980, Control of Pesticides Act No.33 of 1980 (amended in 1994), Seed act No.22 of 2003 and Soil conservation act No.25 of 1951. These also provide the framework for management of phytosanitary concerns in both imports and exports. The Department of Agriculture (DOA) is responsible for administration of controls on primary production under these Acts. The Pesticide Act 1980 regulates pesticide approvals, registration and conditions of use in Sri Lanka including capacity to regulate the withholding period and pesticide MRLs in produce. This Act identifies that it is an offence to 'harvest, or put up for sale, crops where the withholding period between last application of a pesticide and harvest has not been met, or where residues are in excess of prescribed maximum residue limits' (Extra Ordinary Gazette No.2023/34-2017/06/14). However, there are yet no MRLs stipulated under the Act. (A draft regulation on MRLs is currently being circulated for comment).

It was also noticed that the Central environmental Authority act No.47 of 1980 (amended in 1988 and 2000) stipulates that industries involved in pesticides import/ packaging/ storing/ distribution need to obtain Environmental protection licenses for commercial operations. It was learned that companies adhere to this procedure but in the provincial level there is no such environmental related license system identified with agro –chemicals and pesticides retail or wholesale dealers. The provincial level or district level officials are yet to intervene at farm level or field level monitoring/ empowering the regulatory measures, especially on disposal of pesticides use empties/ cleaning of equipment, storing of pesticides etc. that could pollute the environment and cause health hazards. There are no regulations for maximum levels (MLs) of environmental contaminants such as heavy metals under the Food Act.

The DOA, in coordination with SLSI has developed/and established standards and procedures for the application and certification of formal Good Agricultural Practice (GAP) programs for fruit and vegetable production in Sri Lanka. The DOA has already embarked on quality/food safety assurance programs which are especially focused on the control of pesticides residues/MRLs on Fruits and vegetables exported to EU destinations. The exporters informed that the current international food markets are increasingly demanding safe food with no residual contamination or that which is below the stipulated levels. Apart from EU the Gulf countries, another major destination for Sri Lanka F&V are now screening for pesticides and other hazardous residues, posing a threat toSri Lankan exporters. It was learned that this assurance mechanism is promoted by the DOA among the small farmer clusters to increase the supply base on F&V to meetthe export demand. Sri Lanka needs to consider adopting international best practices along the food chain aiming at pro-active measures to control food safety hazards which are especially revolved around pesticides residues and heavy metal contaminations.

It is important to review the policy and insert the GAP as a national program in the National Agriculture Policy for uninterrupted implementation and sustainable promotion. This needs to be given importance as the study observed that a number of action programs be implemented in corporation with donor support such as IPM, Crop clinic, etc, are diluting its way forward and hindering the promotional efforts as there is no legal recognition in any of the acts under purview of the SCPPC which oversea the PPS, ROP, Seed certification empowered by acts and regulatory procedures. Any efforts to bring in prevention of food safety hazards requires policies linking all these organizations to implement common decisions.

Though the ROP is empowered to implement legal action against misconduct of pesticides sales/ use /disposal, there is hindrances due to inadequate staff to deploy at provincial level. According to the act, the provincial AIs are trained and authorized as representatives of the ROP. However, the AIs empowered are not actively intervening to carry out the duties/ actions and they are not directly responsible to ROP but they are officials responsible for provincial administration. Accordingly it was noted that due to commitment of activities under the provincial set up and social nature of field operations, the time available to carryout/ monitor pesticides related legal/ regulatory actions in the provincial level is limited. Therefore the policy related developments are necessary to review in this regard to strengthen the number of staff directly under the purview of the ROP to enable to deploy them at provincial level to monitor/ audit/ regulate the pesticides act at provincial level.

CHAPTER EIGHT: RECOMMENDATIONS

8.1 Production/PM technologies

Farmers in the provinces continuesly practice the traditional way of farming. Introducing modern technologies and mechanization interventions require increased training/ practice to gain hands on experience and confidence among the farmers. The study identifies that the technologies are in-built/ automatically integrated to the crop cycle where all cultivation practices are connected to achieve a better/ vigorous crop growth that enables the plant to withstand any pest or disease occurrence. The farmers are not willing to risk their crop and they believe inorganic compounds are the best option. In this regard it is recommended to implement more demonstrations involving the farmers to utilize appropriate technology for crop production and its contribution to reducing the pest and disease incidences. Attention on following crop production practices are considered to play an important role in controlling pest and disease incidences at field level. The cultivation practices themselves on crops could be modified without affecting the productivity, in order to bring down the pest population below the economic injury level.

Agronomic practices- different cultural practices help to create a micro-environment conducive to better crop growth; they do not demand supplementary inputs/materials other than a few more labour hours.

- Land preparation – promote deep ploughing at least once a year
- Soil testing for identifying the structure, level of nutrients, making correct decisions on crop suitability, nutrients supply, etc.
- Seed / planting materials- Build farmers knowledge/ skills on selecting good seed & planting materials – avoid dependency on market forces, cropping methods and effects on pest & disease incidence
- Change nursery practices from soil bed to sterile pelleted trays. It is important to promote proper nursery technology and use of non-soil sterilized planting trays using pellets to raise high quality, vigorous planting material for strengthening the tolerance level for the occurrence of pest/ diseases at the initial vegetative growth.
- Planting options - introduce appropriate technology- identifying the advantages and disadvantages of current practices. Identify the micro environment and potential for pest & disease build up (especially in vegetable farming). Farmers lack awareness on pest & disease infestation and population movements during different growth stages (Germination/ vegetative/ flower initiation/ fruit setting/ maturity) of the crop. It is important to facilitate to bridge the gap through participatory training.
- Training/pruning plants – Introduce appropriate methods/ technologies to build farmers capacity. In fruit farming this is important as farmers are yet to experience the technology on pruning/ bagging/ field hygiene/ identification of pest under different stages of the crop.

- Irrigation systems- Exposure on selection of a suitable irrigation system, training for installation, maintainance/ cleaning, determining the water quality, irrigation intervals, and water flowing pressure. Increase farmer participation to reduce wastage of water and save water for future farming.
- Nutrients supply- Important area to cover as farmers knowledge is mostly based on market forces and old recommended rates that may not be suitable or not considered as best practices for nutrient management. Promote INMP to improve the efficiency of nutrient applications based on plant growth and soil characteristics.
- Protective technologies- Farmers are yet to build confidence on protective technologies introduced. Conduct exposure/ demonstration programs/ visits to projects/cluster investments that achieved best performances. Training/ skills development program to enhance knowledge on identifying the correct machinery, equipments, utensils, materials, inputs, etc,
- Timely harvesting- Training is necessary for farmers to develop knowledge and skills on identifying maturity levels/ index and determining the time of harvesting in line with market demands.
- Post-harvest practices require more attention where poor field handling, coupled with poor hygienic practices are detrimental to the keeping quality of fresh produce. Use of mixed transport packaging needs to be corrected to enhance the shelf life of the produce. Farmers should be made aware and trained to practice grading of produce for different market segments.
- Economic importance of above activities proposed to be include in the curriculum of FBS which is innovative intervention promoted by the ASMP for commercialization of small farmer clusters.

It is evident that the knowledge/skills in field level officers and farmers in FPOs on innovative technological approaches need to be enhanced. In this regard it is recommended to organize exposure/ knowledge sharing programs with private sector technology initiatives/ model projects in the UVA province NCP and Central provinces by those who adopt technology packages in growing vegetables, moringa, aloe vera, etc., demonstrating the performances in terms of product quality, productivity, increased income and essentially reducing the cost of production due to combined technologies that helped to manage crop cycles with the minimum use of pesticides.

8.2 Crop management/PM practices

The project provinces are identified suitable for a wide array of vegetables, fruits, and yams as listed in the report. The farmers in the provinces implement combined technologies that contribute towards managing/ controlling the pest and disease incidences, intentionally or unintentionally. Also it is evident that farmers carry skills and knowledge through experience from indigenous farming systems and through learning process. However, further training and demonstration is essential to promote the effective implementation of combined systems due to poor attention on pest and disease monitoring/management and crop maintenance practices at small farm level. Therefore it is recommended to promote/integrate innovative technologies through expert interventions to improve the skill/knowledge to facilitate the vigorous plant growth, and achieve profitable crop yield. Accordingly farmers' skills and knowledge on monitoring, interventions and practices are considered important for managing / controlling pest and diseases incidences.

- Monitoring – It is an adhoc activity of the farmers whether intentionally or unintentionally the status of pests' infestation is determined at field level. But there is no systematic approach of farmers in this regard to ascertain the possible economic loss due to pest/disease infestation. The farmers lack knowledge, skills, and awareness. This indicated the need to implement training to build farmer capacity on pest monitoring activities with record keeping procedures.
  It is recommended to involve extension officers of public and private sector institutions and provide scientific training/ capacity building on monitoring practices such as identification, surveillance/ forecasting, diagnostic, scouting, and ETL.
  The farmers should be trained on field level activities pertaining to monitoring and guided through the extension staff for observations and record keeping.
  It is observed that GAP procedures involved with surveillance and forecasting at farm level where improving the farmer knowledge on monitoring will recognize the importance of adopting SL-GAP for crops cultivated. Make the farmers adapt good agriculture practices (GAP).
  Promote community level surveillance mechanism to make farmers aware about pests and diseases incidences.

- Mechanical methods – practiced include hand destruction, exclusion by barriers, and use of traps where farmers are aware of the benefits. According to the observations in identified locations/ provinces farmer cluster use sticky traps, polyhtene trap boxes, pheromones, baits for trapping insects. Live barriers identified in some provincial areas. Farmers also practiced hand picking of eggs/ larvae and pupae. These practices are not focused as a measure of reducing the pest incidence but used as a fact in determining the spraying of chemical insecticides covering total crop area. Therefore it is recommended that implement training and skills development programs for FPOs to gain knowledge on use of mechanical methods and there contribution for managing weeds, pest/ disease.

- Physical methods-There are number of physical methods discussed in the report. The recent interventions include semi protected netting, polymulch, trenches, bagging, yet there is gap in technical expertise/ knowledge in transfer of technology at farmers' fields. Therefore it is recommended to implement capacity building programs for extension officers, and skills development programs for farmers to increase the knowledge while rectifying the technical errors and demonstrating the best performance of the use of such technologies.

- Biological control- practices are not novel to Sri Lankan farmers. However, as at present it is required to re-organize the balance of pests and beneficiary insects population to managing the pests population at below ETL.Though the report highlighted the potentials of sustainable PM with identified natural enemies of pests, farmers are yet not ready to adopt due to the lack of awareness/ knowledge and skills. The information diffusion through extension services hindered due to inadequate experts at field Level. Therefore it is recommended to implement participatory training/ practical exposure programs to identify and integrate the biological measures/ practices facilitating the pest management efforts within the crop production cycle.

8.3 Promote pesticides use best practices

Chemical pest control is to be the last option where all other interventions have failed or there is an inability to control the emergence of pest/ disease infestations. However, it is evident that at field level farmers use chemical inputs mostly by-passing the recommended rates, practices, method of applications, protective gear, type of equipment, utensils, and also it is not given due recognition to national regulations and laws pertaining to pesticides usage and the best practices in disposing of empties, concerns over pesticide related environmental consequences due to residual contamination. Therefore it is recommended to promote and demonstrate participatory approach on pesticide use of best practices to build farmer capacity and abilities for surveillance/ forecast based decisions for purchase and application of chemical pesticides as the last option. Accordingly, it is proposed to increase farmer knowledge on:

- Effectiveness of agronomic & other pest management interventions/practices on protecting crops from pest & disease infestation
- Identifying the relationship between growth stage of the crop and pest & disease occurrence.
- Assessing the level of pest infestation, concentrated areas/field pockets and potential for crop damage.
- Determine the type of pesticides based on the pest species. Introduce bio-pesticides as the first option.
- Guide farmers to follow label instructions in the pesticide containers and to use only the recommended pesticides for control of pests.
- Introduce the basis for spraying- on infested locations or blanket application only when necessary- saving on cost/ environment

- Spray calibration/ rate of application, type of application equipments (sprayers)/ utensils (nozzles). Farmers' tendency is to ignore technical recommendations and depend on their own experience often leading to indiscriminate application. The importance of education and training of farmers is increasingly recognized as a major vehicle to ensure safe use of pesticides. Minimize the need for regular pesticide applications
- Influence the necessity for using protective gears/safety measures for applicators, determining the time of application, identify the suitability of weather conditions that lead to safe and efficient use of pesticides.
- Enhance the farmer cooperation on using safe storage of pesticides, application equipment to prevent any hazards due to poisoning.
- Introduce disposal mechanisms with collector networks and avoid any environmental pollution and health hazards due to adhoc disposal of pesticide empties.
- Importance of adhering to pre-harvest interval regulations for using pesticides.

It was made to understand that few farmer clusters at provincial levels use insect traps (light/sticky) as they believed it kills all pests that are harmful or beneficial. But they are not aware of the next step for separating/ differentiating/ identification of those insects to determining the level of pest occurrence and potential damage to determine on correct control measures. Accordingly it is recommended to implement more focused training/ demonstration and capacity building for farmers to voluntarily determine the ETLs before resorting to chemical use.

According to farmers, the present pesticides in the markets are less toxic and the impact on pests are low as it does not eradicate instantly. However, it is evident that farmer awareness is inadequate to understand how these low toxic pesticides react to the pests. Therefore it is recommended that farmers be trained and educated to enhance the knowledge and skills regarding the level of response and effectiveness of chemical categories grade II and III.

It is recommended to provide adequate knowledge through training the farmers on determining resistant development instances of pests/ pathogens and choosing the alternative mitigation measures and identifying the pesticides (if required) for control.

8.4 Climate on PM

The statistics indicates that over the last decade there are significant variations in the climate with regard to temperature, rain fall and humidity. However, the rainfall intensity is varied and in most of the provinces the rain fall distribution over a number days is declined. This pattern may cause effects on plant growth and productivity, especially in short term crops. Farmers in the area have not yet perceive the climate changing pattern and yet they continue the traditional way or those integrated with modern techniques. It is recommended to increase farmers' knowledge on pest surveillance based on changing climate/weather patterns in the local area.

Crops when planted in an area where the environmental factors are optimum for its development, grow rapidly and give an early harvest. On the other hand when the same crop is planted on land where the factors of crop growth are below the optimum requirement, the growing period is substantially lengthened and as a result the incidence of pest attack may be high. Still other crops are more susceptible to particular pest and disease attacks when planted in an area where the incidence of attack is reported to be high. Similarly, short-aged crops are preferred to long-aged crops; in the latter case, the period of crop exposure to natural calamities such as climatic variations, envisages greater risk of pest outbreak. Therefore, it is recommended that farmers knowledge on the selection of crops with particular reference to the ecological and climate of the needs to be improved to achieve the benefits of pest management interventions is promoted among the clusters.

8.5 Regulatory/ Policy strategy on PM

It has been declared as one of the GOSL policies in sustainable development of agriculture. The government of Sri Lanka has a long-standing commitment to PM. In the policy statement (1994) of the President of Sri Lanka it was declared that "the dependency on chemical fertilizers and agro-chemicals will be progressively reduced through soil fertility improvement measures, adoption of integrated pest management and other agronomic practices". Therefore it is recommended that farmers should receive a thorough education through carefully designed Pest Management (PM) interventions, and comprehensive campaigns, based upon technical as well as socio-economic aspects of the farming community.

Based on the current market situation, the SL- GAP certification is considered a way forward and a timely effort to assure the safety of farm produce at the consumer market places. However, the program needs to be accelerated to cover the farmers in every province to enable the increased supply of certified farm produce. It is recommended to implement crop sanitation and field sanitation as participatory programs for small farm clusters in the provinces/ regions to popularize and recognize the necessity for adopting GAP in the project area and also integrating the existing/ ongoing programs under national food program, national seed production program and private sector agribusiness interventions.

It is recommended that the GAP certification is made mandatory for marketing fresh produce for locals and exports.

As revealed in the report, the GAP program is mainly implemented through Extension and Training Centres by the DOA in coordination with provincial DOAs. The field level program is intervened by a trained GAP officer who is required to coordinate the activities to promote the concept and initiate the farmers to adopt GAP certification on crops cultivated. Though it was expedited by accommodating the district level seed certification officers for audit and report through net based communication, yet the implementation and promotion is hindered due to the nature of crops (short gestation period) and inadequate personnel for farm visits and auditing. In this regard it is recommended to train and integrate identified development officers at the DOA, Selected field officers/unit managers at MASL, and Private sector agribusiness companies operating in different provinces (Cargills / HJS/ Exporters /Crop Life, etc.) and authorizing them to perform selected activities to expediting the process. This will also enable to increase the number of individuals with knowledge and skills on GAP concept while narrowing the communication gaps among the farmers and officers.

According to Crop life Sri Lanka, it has around 300 field level officers representing the pesticides/ plant nutrition/ seed materials importers and distributors and they were trained and certified under SL- GAP program through the DOA. This could be a good resource base that has established links with small farmer communities in the provincial areas in promoting and guiding the farmers on GAP and pesticide use of best practices. It is evident that farmers are increasingly linear towards private sector services that responds swiftly to the crop problems, though they are promoting own business agendas of each entity. In this regard it is recommended to capitalize the opportunity to promote a private - public link for extension and support to improve the farm productivity through more coordinated technical interventions, including the promotion of GAP based on farm practices focused on a common agenda for adoption of sustainable pest management practices.

The current market trend demands hygienically produced safe food, certified by a third party accredited authority. It is evident that local retail chains and exporters dealing with fresh produce are increasingly in need of products that are certified for free from hazards and declared environmentally safe products for their consumers. Though some companies are already working in this regard, it is recommended to capture/ expedite/ accelerate the existing/ emerging development to initiate collaborative programs with private sector retail chains and exporters to promote and adopt SL-GAP for small farm clusters in the provinces.

GAP certification is increasingly made aware within private agribusinesses as a branded marketing option and there are a number of investments currently taking place in the provinces with cluster farmer links. The GAP promotes the practices that enable the minimum use of pesticides, assuring the consumer of obtaining environmentally friendly and human safe produce. In order to take forward the GAP program in a sustainable manner and avoid any interruption in future implementation, it is recommended to incorporate the practices under an act of PP or control of Pesticides in which the institutional authority is under the purview of SCPPC.

Introduce pesticides with shorter pre harvest intervals. Most pesticides gazzeted at present have a pre harvest interval of 14 days. For crops like leafy vegetables and fruits like Papaya, this time is too long. Therefore it is recommended to introduce and register pesticides with shorter pre harvest intervals especially for vegetables.

Recommended to display posters on banned chemicals at dealer networks and other relevant offices to make aware of the farmers and general public to avoid purchasing or using.

A majority of farmers knew agrochemicals are harmful to the environment and the health but are un-aware of the unacceptable levels of toxic chemicals present in their produce/ environment. Farmers demand the continuity of education systems to upgrade their knowledge on this issue. Therefore, it is recommended that MRL information relevant to pesticides/ fungicides/ weedicides be published for the awareness of farmers and interested individuals.

Further, non-availability of farmer acceptable, efficient, alternate non-chemical pesticide based pest and disease control methods (i.e. botanicals, pheromones, bio-control agents, knowledge on companion crops, flowering weeds, eco-system management methods) hinder minimizing pesticide use in vegetable cultivation. It is recommended to share the research information by awareness/ training/ field experimentation and demonstration to promote the potential of bio-chemicals, benefits and sources of manufactures /suppliers.

It is evident that traditional/ Indigenous practices are in the verge of disappearing due to heavy dependence/ routine application of chemical inputs. Although the importance of reducing the use of pesticides were debated at the highest level, there is no due recognition/interventions for promoting the farmers to adopt such technologies. The level of disappearance of such technologies further confirmed that the extension service providers also have little or no knowledge in this regard. Therefore it is recommended to introduce and integrate the identified indigenous practices helping the farmers to reduce pest & disease infestation and reduce the necessity for implementing chemical control measures.

Traditional cultivation techniques though continued have challenges due to changing conditions on soil structure, degradation of land fertility, soil fertility, climate and environment. In order to maximizing the land use the farmers add compost, dense planting for vegetables, etc., that could contribute to pest/ disease infestations. It is recommended that ATDP monitor the advantages and disadvantages through assessing the crop records of each farmer to enable the project to identify the impacts.

Recommend the ATDPs to implement provincial/ national level knowledge sharing programs to diffuse technical information and the benefits of adopting agronomic and other non-chemical interventions to prevent any infestation in different stages of crop cycles through awareness and demonstrations in selected FPOs in the project area.

Recommemd that ATDPs use FBS participatory training to introduce permanent crop clinics by accommodating 2-3 crop problems demonstrated and practically discussed using digital information under the plant wise app with a focus to continue after completion of the FBS program.

It is recommended to train farmers to use digital communication technology information platforms that deliver crop/ market information/ provide solutions on field problems and timely control methods through smart phones, by updating farmers' knowledge and link them to relevant best sites including local apps promoted under the DOA.

Farmer Organization/ Producer organizations are promoted through different institutional systems such as private sector agribusinesses, public sector (DOA, DEA, EDB, etc.) and NGOs. The private sector oriented FPOs are focused on supply of agricultural produces or marketing of agricultural inputs and harvests. The NGO based organizations have a different focus that is to enhance the household/farm income. However, the GOSL promoted FPOs have legal status and is recognized by all national level institutional systems that support agriculture production, marketing, financing/ technology transfer. It is recommended that the members/ organizations of original FOs are to be recognized and integrated to FPOs to enhance the active participation in ATDP development programs.

Though the agricultural policy identified the importance of private sector networking and promoting for provincial investments, there is no real impact observed in the field. As at present, the farmers by using hybrid seed materials and modern nutrients are achieving high yields. There are many instances found in the past and also recently during the study where farmers have not been able to sell their produce from the farm gate. The melon growers in NCP area were frustrated with their crop as they not harvested due to the non-availability of buyers at the farm gate. Also in the past they had undergone similar situations with pumpkins. Though the technology and modern agricultural practices are introduced there is need to look into the aspects of smooth market operations especially at times where farmers are unable to sell due to market fluctuations. Therefore it is recommended to provide a revolving fund for the farmer clusters to relieve them from any form of constraints and economic loss due to unexpected drop in market.

It is noted that farmers are supported through decision making processes on pesticides use on crops by the relevant stakeholders in the field. Even though the DOA is the largest extension network that reaches the farmer community, there are other institutions like DEA, EDB, NEDA, CAA, DS, SEDD, and private sector entities such as Cargills, Keells, CIC, Hayleys, Exporters, NGO, Crop Life, etc., who are active either in coordination with the DOA or on their own. Accordingly under the present situation the farmers are not neglected or left out as pointed by many forums which indicate that the agriculture extension system in the rural areas are not effective. It is the problem of individualistic approach of all public/ private/ NGO extension services, working in isolation and hindering the dissemination of appropriate technical information under a common platform. A number of institutions working with their own programs/ agendas in the field level have caused the problem of persistent pests/diseases in the agriculture areas. Therefore it is recommended to consolidate/pool all resources at field level to enable to disseminate the pest management technologies under one national plan with an established mechanism at District/ AI range for coordination.

The chemical pesticide purchases are mainly implemented in consultation with dealer networks in the provinces. It has been made aware that dealers could influence the farmers to purchase the choice of dealer and may not be the correct solution for farmers' pest/ disease problem. Therefore it is recommended to initiate a prescription based chemical pesticide purchasing system at provincial levels by empowering the crop doctors and pesticide officer. This may control the unethical use, wastage of pesticides/increase cost of production/ environmental issues, etc. The registrar of pesticides has made it compulsory to have a technical sales assistant to be present in each of the pesticide dealer stores. These technical assistants are trained and certified in the use and handling of pesticides. Further it is recommended to train and qualify more crop doctors and empower selected APRAs, Development officers, GNs, private sector extension officers to serve as farmer advisers assisting the area AIs (who are already certified as crop doctors) in pesticide use and handling.

Increase Knowledge and Skills on PM

It is recommended to fill the existing knowledge and attitudinal gaps of farmers and extension officers in PM tools identified as monitoring, interventions and practices integrating the GAP program.

- Develop and implement a tailor-made PM training program for SMOs and the extension officers working at the field level (ADs, AIs, DOs and APRAs).
- Conduct awareness programmes to change farmers' attitudes towards management of pests and diseases concerning Monitoring and intervention tools on PM.
- Strengthen a number of field staff by qualifying selected Development officers/ APRAs/ Private extension staff (PES) as crop doctors.

Practicing PM at field level

- Conduct 'participatory PM demonstrations in FPOs fields in the project provinces to motivate and convince farmers towards adopting PM technologies/farming practices and modern technology interventions. Farmer business School approach is recommended as an initiative. Farmer Field School approach is recommended to begin the programme.
- Recommended to utilize the services of ARPAs/ DOs/PES as information carriers communicating among farmers and AIs, on PM related awareness/ promotion and troubleshooting

Consumer awareness GAP produce for PM

- Create a special market entry for fresh produce cultivated by using PM interventions and certified under GAP. Promote awareness among exporters, modern retail outlets, hotel supplies, catering services, and especially the GMP/ HACCP certified food processing factories locally and in the provinces.
- Launch awareness campaigns using mass media to enable vegetable consumers identify and motivate them to purchase 'pesticide free vegetable/ fruits products'.

Research/ experiments/ demonstration on PM

- There is no nutrient recommendation published for hybrid/ improved seed and planting materials. Farmers on their own discretion use the different dose of fertilizer/ hormones/ additives, not knowing the negative impacts. There is a need to develop/ improve and establish input recommendations for high yielding varieties to reap the maximum benefits for the farmers.

- Irrigation technology is a proven high productive technology and there is increasing demand in the farming areas. The promotional approaches are still not streamlined for effective implementation of irrigation technology at small farm level. Before it gets loosened from the systemic establishment the DOA and Private Sector to be involved and identify guidelines for selection, field installation, maintenance, its uses for mitigating climate related plant stresses, to avoid any negative mind set of farmers who compare the interventions with traditional flood irrigation practices.

- Farmers believe that pheromone traps are not effective in reducing the incidence of fruit flies especially in cucurbits. Also farmers have no idea about the amount of traps to be installed per unit land area. Though the instruction is made available in printed materials those numbers have not effected/ controlled the infestation. There is buildup of negative attitudes towards pheromone use and farmers continue to depend on pesticide application. It is recommended to initiate a research program to assess the situation and propose appropriate guidelines.

- The farmers as well as agro industries especially exporters of fresh produce are indicating that PHI regulations need to be further evaluated to identify the implementation methodologies for fruits (eg. vegetables, papaya) that continue to be harvested every other day where maintaining the PHI for pesticide use is practically difficult according to quality of the market requirement. Farmers are aware that there is an availability of low PHI pesticides used for vegetables.

- It is the appropriate time to conduct experiments and develop innovative devices/ approaches and introduce mechanical/ physical pest control practices integrating the traditional/ indigenous technologies such as winnowing to be improved with pendulum type of device to oscillate with the wind, introduce border crops (Mee, Cycas, Marigold, etc.), effectiveness of using sound gadgets, etc.

- Recommended research interventions to study and identify the effective types of polymulch/ insect nets according to the AER and its effect on pest control especially weeds, pests (soil/ crop atmosphere), diseases to achieve the sustainable use of technology.

The previous records revealed that farmer organizations/ producer organizations were in existence for many decades and established through the DOA and Agrarian Services Centers, registered as legal entities. However, it is revealed that due to weaknesses on member communication and participatory linkages, the organizations performances have hindered. In this regard it is recommended to further study the gaps/ challenges and propose mitigation measures in line with crop value chain process.

8.6 Conclusion

Adoption of PM techniques among FPOs is not at a satisfactory level. As the clusters depend on chemical pest control as the number one option other pest management tools are poorly adopted.

There is a knowledge gap in terms of the tools of PM and its application among farmers. Despite the level of adoption, understanding of farmers on the basics of PM concept and its techniques was very poor. At the same time, lack of training opportunities and awareness of farmers on PM was recorded and it could have directly resulted in the poor understanding on the contribution of the different crop production/management practices on preventing pests and disease incidences.

Emergence of diverse pest management technologies such as IPM, Crop Clinic which phases out with time due to the lack of funding and donor withdrawal and not being operated in a sustainable way. The current ongoing program on GAP certification created interest in wide agri business investments as an ideal intervention in controlling pesticide related challenges and issues, but the promotions and implementation was hindered by the adoption at field level. The main constraints to this are identified as lack of recognition of PM as a priority area in the policy statement, poor attitudes of farmers, inadequate experience/ technical expertise in extension services, and weaknesses in the extension system and institutional/ communication gaps at provincial and national level.

Insufficient human resources in the current extension system, lack of capacity of the extension officers on IPM, lack of resources and institutional support for IPM promotion and, improving the knowledge and attitudes of farmers' towards IPM need to be addressed in the short-run for an effective IPM promotion in the vegetable sector.

CHAPTER NINE: LOGICAL FRAMEWORK

9.1 Crop Growth Stage wise PM Logical Framework

The study highlights that around 25-30% crop loss is incurred nationally due to insect/pest diseases and weeds. In the current context of global up rise for nontoxic safe food for human consumption required to promote and adopt economically accepted, ecologically sound, socially responsible, environmentally sustainable alternative legislatively empowered pest management practices to minimize the use of chemicals in crop production. The alternative methods under PM practices include Cultural, Physical, Biological, Mechanical, Legislative, and Chemical. Sterile insects, Insect Semio chemicals, etc., are also included.

Despite the support and experiences acquired from IPM projects funded by international organizations, the up-scaling and adoption of proven PM technology hasbeen low at national level. The main reason for its not having gained widespread adoption among local farmers is due to the lack of public financing to sustain project-dependent IPM programs. Transfer of this technology is also constrained by the range of expertise and the inadequate innovative participatory approaches required for its dissemination. This framework and action plan proposes the way forward to promote crop growth stage wise participatory PM technology interventions which are sustainable in small farm productions in the provinces.

Intervention logic	Approach	Baseline	Targets	Means of verification	Responsibility
Goal; Introduction of effective and environmentally friendly pest and disease management approach to small farm producer clusters	Establishing a pest and disease management system based on nd tailor-made to suit local conditions including biological, ecological, agronomical and mechanical means to minimize use of pesticides	DOA guidelines MASL guidelines	Strengthen the pest forecasting practices. Encourage to adopt PM tools to avoid killing beneficiary insects.	Number of Farmers adopted non-chemical control measures.	ASMP/PMU/ PPMU Project funding and Institutional & expert support from MOA/ DOA/SCPPC district

Intervention logic	**Approach**	**Baseline**	**Targets**	**Means of verification**	**Responsibility**
		Cost of pesticides 20%	Identifying and Prioritizing non chemical treatments. Identifying the pest control measure based on pest monitoring/ interventions & practices.	Reduced cost of pesticides by 10%.	extension services
Objective; Enhance the use of non-chemical control practices	a) Encourage the reduction of pesticide use in increasing the user intervals and quantity b) Introducing a Pest management Plan (PMP) by combining technologies for pest forecasting/ agronomic/biological/ physical/ ecological /mechanical pest control. c) Enhance the technical capacities of extension service providers and knowledge base of farmers	Existing high frequency of application NA Crop Clinic Program	At the end of ASMP project FPOs in 20 pilot ATDP adopt PM technology/practices	Pesticides use frequencies reduced by 20% No.of farmers trained. No.of exposure visits. Implemented No.of demonstration units established No.of crop clinics conducted. No.of farmers participated. No.of crop solutions	PPMU/SCPPC/ PMEO/PMC FPOs in pilot ATDPs will adopt PM technologies

Intervention logic	**Approach**	**Baseline**	**Targets**	**Means of verification**	**Responsibility**
Output -1 **Institutional and Organizational Capacity enhanced to promote PM interventions in Provinces**					
Intervention logic	**Approach**	**Baseline**	**Targets**	**Means of verification**	**Responsible**
1.1 Establish a Team of Pest Management Extension Officers (PMEO) dedicated towards promotion and implementation of Provincial/district level PM programs.	a) Individuals identified from existing DOA extension officers with experience on PP/IPM/GAP/Crop doctors/Pesticides authorized officer Team comprised of Agronomists, crop protection experts, environmentalists, public health ,safety/ infection control experts, at provincial/inter provincial	Organized structure NA	01 National PM team 22 District level PM team 01 National Cordinator	List of PM team (National/regional) PMEOs delegated at district level/PPMUs NC deployed SCPPC Minutes of meetings	MOA/ASMP/ PMU /DOA/ SCPPC
1.2 Establish provincial/ district level PM cluster networking public/ private/NGO/Civil societies involved in farmer extension and support services on PM	a) Institutional networking mechanism determined b) PM cluster (PMC) established c) Task & functions determined d) Guidelines for delivering the right message/ information/PM technologies for farmers/FPOs documented	Organized structure NA	01 PM cluster 01 PM Extension Guideline	List of PMC at Provincial/district level. Minutes of meetings	DOA/SCPPC/PMEO/ PPMU/PDOA/ PM Cluster/ PDOA/NGO
1.3 Conduct training/Exposure visits for PMEO and PMC build capacities to enable them to carryout participatory farmer development programs for promoting the adoption of PM	a) Provide in-depth training for PMEOs/PM cluster members on PM tools (Monitoring, Interventions/Practices.) b) Increase technical capacity to understand the contribution of PM tools to avoid/reducing chemical pesticides use	Training dedicated to PM technology NA	16 training events a) Increase No. of national level staff trained.	No of Training sessions No. of participants gained	SCPPC/ PMEO/ PPMU/ASMP/ PM cluster

Intervention logic	**Approach**	**Baseline**	**Targets**	**Means of verification**	**Responsibility**
technology by FPOs in ASMP provincial projects extended to national level.	c) Exposure visit programs to ongoing technology interventions d) Training to increase knowledge on SL-GAP/ Global GAP/ Organic/ LEISA/practices and climate change effects/ approach contribute to crop pest/ diseases diagnosis and solution. e) Participatory PM interventions with FPOs in PPMU provinces		b) Increase No. of district level staff trained c) Increase No. of field extension staff trained	knowledge/skills on PM technology - Evaluation summary List of competent/authorized PM technical experts.(PMEO & PMC)	
1.4 Identify and integrate current pest management interventions promoted through GAP, Organic certification, LEISA, IPM, protected systems, & strengthen the adoption /implementation of PM technologies /practices in FPOs in ASMP provinces, & extended to national level.	a) Pest management practices proposed under GAP, & other production systems identified & listed. b) Relevant technology on PM incorporated/combined to strengthen the PM tools. c) Technical information/communication guides developed for training and awareness in human safety and environment friendly PM technology. d) Prepare Training materials/information related to PM technology adaptation and mitigation of climate change effects.	Individual program approach (IPM/ GAP /Organic)	No. of training materials on PM tools No.of communication materials on PM tools No.of technical guides on crops/ P&D. No.of technical guides on crops/climate change/PM tools	FPOs/Farmers aware and well informed on PM tools/technologies through technical guides/information materials.	DOA/SCPPC /PMEO/ PPMU/ ASMP/ PM cluster MOA/PMU/ SCPP/
Output 2 **Social and behavioural attitudes of Farmer clusters enhanced through participatory PM approaches**					
2.1 Enhanced knowledge on the principal differences of crop	a) FPO/Farmers at ASMP provinces trained PM technology package Monitoring, Cultural,				

Intervention logic	Approach	Baseline	Targets	Means of verification	Responsibility
production using PM tools and conventional/ traditional production systems on pest and disease control.	Mechanical, Physical, Biological, and Chemical practices/ methods and it's important in different farming systems. b) Strengthen FPOs practical knowledge on pest life cycles/behaviuor, diverse pest control practices, that could prevent pest infestation without killing pests by routine chemical applications)	Poor awareness	No of FPO clusters/farmers trained. Report on pre and post training evaluation	FPO cluster meetings	DOA/ SCPPC/ PMEO/PM cluster/ PPMU/ PDOA/ASMP
2.2 Increase level of recognition by providing participatory training integrated with FBS, demonstrating the effectiveness of PM tools on control of pests without harming the beneficiary fauna, Environment and human safety.	a) Conduct training programs to clear misconceptions on cost and time factors on PM technologies. b) Farmers Convinced and encouraged to implement PM monitoring and technology interventions before deciding the chemical methods. c) Increased No. of farmers/FPOs understand PM as evidence based pest control process. d) Identified skilled farmers successfully implementing PM technologies and create pool of lead farmers as message carriers.	NA	No. Farmers/FPO trained Cost –benefit fact sheets developed. Recognized PM farmer pool established.	Post activity evaluation List of crops/pest /control practices and cost. Volunteer PM communicators	
2.3 Strengthen the cooperation/networking among the Farmers/ FPOs PMEO/PMC & different actors in the crop value chain for the success of PM interventions.	a) FPOs promoted to develop and implement timely cultivation of selected crops b) Provide training to increase knowledge and skills on climate changes effects on crop production. c) Establish/strengthen the communication link among Farmers/FPOs and PMEO/PMC in the provinces.	0	No. of FPOs executing crop cultivation schedule. No. of FPOs implement climate smart production practices No.of FPOs working with PMEO/PMC	Seasonal crop calendar Collective or consolidated procurement and distribution of inputs Minutes of meetings.	

Intervention logic	**Approach**	**Baseline**	**Targets**	**Means of verification**	**Responsibility**
Output 3 **Market failures and Imperfections –mitigated through sustainable PM technologies**					
3.1 Increase market opportunities and strengthen the producer –market link with hazard free safe produce certified according to international safety assurance systems.	a) Create awareness for FPOs on diverse certification systems (GHP, SL- GAP, G-GAP, FSMS, Organic,) & integration of PM technologies. b) Promote FPOs to adopt SL-GAP or other certification. c) Increase private sector participation with provincial FPOs for sustainable implementation of PM technologies	NA	No.of FPOs trained No.of FPOs/Farmers registered for GAP No.of farmers/FPO certified GAP farms. No.of FPOs linked to local/ International markets	Post activity evaluation Market entities established collecting/packing centers.	MOA/ DOA/PMU/ PPMU/ SCPPC/ PMEO/PM cluster /Private sector food markets
3.2 Increase level of recognition by providing training to enhance commercial orientation of FPOs increasing the negotiating capacity to capture premium price for residue free safe food crops.	a) Training to increase knowledge on assessing the cost benefits of PM interventions. b) Training for FPOs to negotiate with diverse markets directly. c) Increase the No. of farmers to understand the value of evidence based PM interventions. d) Establish a brand identity for produces from FPOs and certified for hazard free human safe environmentally friendly cluster farms.	NA	ATDP pilot FPO clusters trained ATDP pilot FPO clusters trained No.of FPO promoted to establish brand names No.of brand names determined **(SL-GAP+^{PM})**	Post activity evaluation Post activity evaluation	

Intervention logic	**Approach**	**Baseline**	**Targets**	**Means of verification**	**Responsibility**
3.3 Promote FPOs participation in local/ overseas food exhibitions and events to expose to diverse food and market segments and demand for produce with minimum poisonous chemical residue or contaminations	a) Organize FPOs to implement exposure tours in agriculture marketing and technology events. b) Provide opportunities to identify new markets/consolidate existing markets. c) Identify PM technologies/ biological practices/emerging technologies which are affordable to small farm agriculture	0	No of FPOs participated No.of FPO negotiated new market opportunities FPOs gained exposure on technology interventions	Establishment of seasonal crop production/ management schedule Collective procurement/ distribution of inputs	
Output 4 **Participatory R&D capacity & interventions enhanced to enable sustainable promotion of PM technologies/practices in small farmer fields**					
4.1 Participatory (Farmer – Extension-Research) R&D to identify develop/ experiment/ demonstrate and Introduce elements to identify problems early and determine control measures with due consideration on ecosystem analysis in selected Districts/Provinces.	a) Introduce farm based approaches for early detection of pest problems b) Identify farmer problems related to pest/diseases and find scientific mitigation measures c) Conduct R&D to identify and introduce/integrate appropriate indigenous PM practices/methods.	NA	No. of approaches No. of Environmentally sound PM practices introduced. No.of indigenous practices introduced.	Enhanced skills/knowledge of farmers and technical services. Mapping of potential P&D risk areas. Post evaluation	PPMU/ DOA/ SCPPC/PDOA/ PMEO/PM cluster/ CARP/ HORDI/ RRI/FPO
4.2 Improve knowledge/ skills of Farmers to determine the practical/ environmentally sound effective control measure/s and	a) Conduct R&D to identify and introduce effective /efficient PM practices, integrating the climate smart technologies		No.of R&D conducted Recommendation for technologies		PPMU/FPO /SCPPC/ PDOA/PM cluster/ CARP

Intervention logic	**Approach**	**Baseline**	**Targets**	**Means of verification**	**Responsibility**
prepare for future actions to reduce the infestations.	b) No. of experiments/ demonstration conducted in FPOs/farmers field. c) No. of FPOs/farmers trained and determined to adopt environmentally sound/ effective control methods.		mitigating the effects of climate change. No.of FPOs witnessed experiments/ demonstrations No.of FPOs determined to adopt PM practices	Farmer crop records	/HORDI/RRI/ Env.Auth
4.3 Coordination with FPOs/PMEO/PMCs to identify the variables in determining economic importance of crop/pest infestation and adoption of appropriate PM technology in relation to determine particular control measure.	a) Create awareness on economic damage(ED), economic Injury Level(EIL) and Economic Threshold (ET) b) Experiment/ demonstrate affordable technology for monitoring techniques	ET levels on diverse crops to be updated	FPOs/Farmers learn to investigate the cause for pest/disease and weeds No.crops determined with ET	Cost control practices and benefits of crop(yield, quality, value) No of Farmers were able to choose the best choice of control	MOA/PPMU/ PDOA/ASMP / DOA/ SCPPC/PDOA/ PMEO/PM cluster/ CARP/ HORDI/ RRI/FPO
4.4 Determine the suitability of bio-pesticides available in the market. Conduct research and experiments involving farmers to develop/ introduce environmentally sound, economically feasible and effective bio chemicals.	a) Conduct R&D on effectiveness of select indigenous PM practices b) Assess the availability of pest repellent crops/plants c) Conduct participatory R&D/ Experiments/ demonstrate the effectiveness Pest repellent plants d) Create awareness on recommended bio pesticides & nutrients.	Lack of awareness on Bio-pesticides/ nutrients.	List of indigenous PM practices. List of pest repellent plant No.FPOs/Farmers cultivating No. of bio-pesticides recommended	Indigenous practices introduced in the field Farmers know the benefits of selected pest repellent plants.	PPMU/ DOA/ SCPPC/PDOA/ PMEO/PM cluster/ CARP/ HORDI/ RRI/FPO

Intervention logic	Approach	Baseline	Targets	Means of verification	Responsibility
				Farmers use bio-pesticides	
Output 5 **Policy and regulatory empowerment capacity enhanced**					
5.1 Review the registration process and expedite solution to simplify/expedite action on procedural process introducing bio pesticides.	a) Determine mechanisms to outsource expert services. b) Procedural and operational delays in registration process minimized c) Establish registration procedures for bio-pesticides	scarce staff/ROP 3years NA	List of experts identified Activities under the registration process are simultaneously implemented Bio-pesticides registration procedure in operation.	Registration process accelerated	
5.2 Strengthen the pesticides regulatory mechanisms in the regions.	a) Increase No.of authorized pesticides officers under direct supervision of ROP b) Empower PMEO under SCPPC to enforce pesticides related regulatory/legal measures at regional level. c) PMEOs trained to enhance the knowledge/skills on regulatory legal process and powers under pesticides/PP acts.	0	PMEOS trained and empowered as authorized Pesticide officers.	List of duties/task of PMEOS identifies Pesticides related legal enforcement activities.	
5.3 Regulate the regional/rural pesticides marketing interventions and user practices to avoid hazards due to	a) Increase dealers/sales personnel capacity through training on safe handling of pesticides/ uses/dealer services, legal and regulatory mechanisms on marketing.	ASTA	No.of trainings conducted No. personnel trained and Certified	Communication network mechanisms	

Intervention logic	Approach	Baseline	Targets	Means of verification	Responsibility
inappropriate advice/ misuse of poisonous chemicals at farmers' level.	b) Recommend/enforce all pesticide sales strictly based on prescriptions issued by an authorized pesticides officer/crop doctor/GAP officer. pesticides sales necessary actions for upgrade and strengthen the control system c) Create awareness on bio-pesticides and uses for the dealers/sales personnel/farmers	Currently on selected pesticides only.	No. of FPOs/Farmers aware of best practices. List of authorized officers empowered & area covered No.of Dealers/Sale personnel/farmers trained	strengthened with PMEO/PMC at provincial level. Progress of Prescription based pesticides sales. Post training evaluation	

9.2 Crop growth stage wise PM Action plan

Plant protection and pesticides control services are legally recognized by the plant protection act and pesticides control acts of Sri Lanka. The responsible authorities identified are PPS and ROP under the purview of SCPPC of the DOA administered through the Ministry of Agriculture. According to the given authority under the acts the SCPPC with the support of ROP and PPS empowered to implement programs to protect the crops from infestation and the introduction of alien species of pests/ diseases/ weeds and control of using pesticides that effects human health and environment due to poisonous elements. The services are covered on primary agriculture production; from seed to harvest/ post-harvest. The processed products are not covered or there is no integration of activities or legal binding to the food act of MOH though the relevant agencies including the Central Environmental Authority who work hand in hand.

Table 9.1: Existing Organizational structure of PM

PM functions	Organizational units responsible
PM Policy development/legislation/enforcement	MOA,DOA, SCPPC,PPS,ROP,/MOH/CEA
PM research & development	HORDI,RRI,PPS,ROP,PDOA,CARP
PM Recommendation/guidelines	SCPPC,PPS,ROP,E&TC,PDOA
PM training & extension	SCPPC,PDOA,E&TC,/MOH/CEA
GAP training	E&TC,SCPPC,PDOA

Policy statements related to pest management includes promotion of organic farming, reduced use of pesticides, promotion of IPM, GAP certification, Crop Clinics, deployment of crop doctors, as highlighted in the national agriculture policy document. However, the field level implementation of these programs depend on the general extension arm of the DOA (Extension & Training Center) and the provincial agriculture extension mechanism. The study identified that there is large resource pool of extension staff trained and qualified as GAP officers, Plant doctors, IPM trainers, authorized officers for pesticides, who were deployed at provincial and inter provincial level to facilitate and promote small farm agriculture development programs including PP and pesticides best used practices. However, it was observed that diffusion of technology and relevant information on PM and PP is not effectively implemented at farmer level due to the commitment of diverse activities to be performed as required under provincial and inter provincial level. It was revealed that lack of staff or an identified team dedicated for implementing PP/PM technology transfer programs has hindered the sustainable promotion/adoption of PM best practices at field level.

Therefore it is proposed to strengthen the services of SCPPC by setting up a team of officers deployed at district level and entrusted to carryout PP/PM related technology diffusion/extension support programs as a sustainable way forward to ensure the adoption of PM best practices at small farms in districts/ provinces. This idea was conceptualized during the process of the study where GAP programs had already initiated such interventions by deploying GAP officers at district level and monitored/supervised by E & TC/DOA. The proposed intervention is not suggesting any additional funding/budgetary provisions where the team could be built through pooling of selected officials from available resources at MOA/ DOA such as Extension officers, Research assistants, Project officers, Development officers, APRAS.

9.3 Proposed institutional arrangements for implementation of PM Action plan

The supervision and monitoring of the PM plan proposed to be handled through the SCPPC in coordination with PPMU and PDOA, integrating the existing private sector agro projects extension mechanisms at provincial level. There is existing staff under PDOA who are trained and qualified as crop doctors, under ROP and PPS to implement crop clinic programs at field level. Also there are diverse private sector representatives effectively communicating with farmers and trained under the GAP program/ IPM indicating the opportunity for integrating with SCPPC for the successful implementation of the PM action plan.

Accordingly, it is proposed that the PM plan is to be implemented through the respective PPMUs under the supervision and guidance of PPS and ROP headed by SCPPC. In this regard, it will require experienced technical experts on PM for the overall supervision and monitoring at national level initially coordinating with ASMP/P MU under MOA. The responsibility of provincial level activities are taken care of by the district level PMEO under the purview of SCPPC/ National PM Expert.

9.4 Implementation of action plan

Based on the recommendations derived from the study and considering the requirements of the TOR, an action plan for the implementation of PM practices in provincial level is developed. The focus of the action plan is to implement short/ medium/ long term programs through a participatory approach, integrating all relevant agri business support services/ actors operating in the provincial level. As indicated in the TOR the study identifies that SCPPC as the ideal institutional arm of the DOA to take responsibility for overall implementation and monitoring of the PM action plan, initially with the PMU and PPMUs while strengthening the PM technology diffusion mechanism at provincial level at the completion of the ASMP project in 2020.

The strategies identified in the action plan include;

- Institutional & Organizational Capacity building (short term measures),
- Small Farmers capacity building approach for Social & Economic enhancement, (short term measures),
- Mitigating Market failures/imperfections, (medium term measures),
- PM related R&D (medium term/long term measures),

- Policy/regulatory support (long term measures).

9.5 Action plan

Strategy	Barriers	Justified action	Proposed measures	Time frame	Estimated cost	Agency responsible(AR)	Funding sources	Indicators of success & Risks
Institutional and organizational capacity	Inadequate cooperation and communication between the involved institutions leading to the failure of PM projects	Increase technical skills/knowledge on PM tools Foster collaboration between all stakeholders involved in agriculture	**Establish** a list of officers from existing DOA staff available at provincial/national level preferably trained under plant doctors/GAP officers/pesticides control/IPM programs, (E) **Screen** and select 22 individuals (PM Extension Officers) for district level implementation of PM Extension services and 01 national level PM coordinator (S) **Design** & develop Institutional networking mechanisms to create PM clusters at provincial level integrating district level extension/support representatives of diverse private/public/ NGO/ civil societies	Short term strategy 2019/2020 Short term strategy 2019/2020 Medium term strategy 2020/2021	01mn LKR 02mn LKR 03mn LKR	MOA/DOA/SCPPC/ ASMP MOA/DOA/SCPPC/ ASMP SCPPC/PMEO/PPMU/PDOA/ Private Agbiz investment/PDOA/ NGO SCPPC/PMEO/PPMU/ASMP/ PM cluster SCPPC/PMEO/PPMU/ASMP/ PM cluster SCPPC/PMEO/PPMU/ASMP/FPO/PM cluster DOA/SCPPC/PMEO/PPMU/ ASMP/PM cluster	GOSL/ Donors/ Private sector/ NGO	List of officers identified at provincial/district level. District level PMEO-delegated for PM tasks National PM coordinator – delegated for PM tasks. Provincial level PM clusters established (09 PM clusters). No.of progress review meetings/minutes Task & functions determined/established *(Delivering the right message/*

Strategy	Barriers	Justified action	Proposed measures	Time frame	Estimated cost	Agency responsible(AR)	Funding sources	Indicators of success & Risks
			involving small farm agriculture development.(D) **Identifying** functions and powers for PM clusters dedicated to promote/ implement PM programs recognizing the legal and institutional framework of PP, Pesticides, and Seed and Environmental services.(I) **Develop**/prepare training materials/technical guides/ technical information/communication materials for promotion/ training/ skills development/attitude change/effects on climate change related to PM interventions in provinces **Strengthening** the technology diffusion, information sharing	Long term strategy 2021/2022 Short term strategy 2019/2020	04mn LKR 05mn LKR 01mn LKR			*information/ technology for farmers/FPOs under DOA guidelines)* No. of training materials developed No.of communication materials developed No.of technical guides developed on identified crops/climate change. No.Reports and progress review briefs for future planning and sustainable implementation of PM technologies with small farm FPOs.

Strategy	Barriers	Justified action	Proposed measures	Time frame	Estimated cost	Agency responsible(AR)	Funding sources	Indicators of success & Risks
			mechanisms under one platform (PM cluster). (D) **Provide** In-depth training for PMEOs/PM cluster members on PM tools and practices identifying the contribution for reducing chemical pesticides (gain knowledge /skills on SL-GAP/Global GAP/Organic/LEISA/climate change effects and approach for crop pest/diseases diagnosis and solution (crop doctors/Apps)(P) **Practical** exposure for PMEOs/PM cluster on contribution of PM tools/climate change interventions on reducing the use of pesticides.(P) **Establish** & publish a list of individuals of PMEO/ PM cluster certified as	Long term strategy 2021/2022 Medium to long term strategy 2020/2022 Short to long term strategy 2019/2022	03mn LKR 02mn LKR 01mn LKR			No.training sessions. No.of participants increased knowledge/ skills. (Pre & post training evaluation) No.of exposure visits to ongoing technology interventions on PM. No.of participatory programs implemented at farmer fields/FPOs in ATDP/PPMU provinces No.of FPOs adopted PM technologies. No.of individuals competent to conceptualize/

Strategy	**Barriers**	**Justified action**	**Proposed measures**	**Time frame**	**Estimated cost**	**Agency responsible(AR)**	**Funding sources**	**Indicators of success & Risks**
			trainers/ advisers/PM extension officers. At respective provincial/district areas.(E)					design & implement PM interventions at provincial/district level determined/ establsihed. ***Risk-Delays in decision making at higher administrative level.*** ***Irregular participations and poor contribution lead to delayed decision making.*** ***Poor linkage. between Research, extension and Market actors.***
Social and behavioural attitudes of Farmer clusters	Increased reluctance/ Resistance to change from dependent chemical	Enhance farmer skills and demonstrate added benefits of PM technologie	**Expose** and train farmers on PM tools/practices- identifying the advantages in conventional farming, organic farming, protected systems, etc.(E)	Short term strategy 2019/2020	02mn LKR	DOA/ SCPPC/ PMEO/PM cluster/ PPMU/ ASMP	ASMP/PMU	No.of farmers trained and exposed for PM tools/practices.

Strategy	**Barriers**	**Justified action**	**Proposed measures**	**Time frame**	**Estimated cost**	**Agency responsible(AR)**	**Funding sources**	**Indicators of success & Risks**
	Control culture.	s those embedded to activities on crop cultivation and management	**Develop** positive attitudes through participatory demonstration & knowledge sharing on effectiveness of implementing PM tools/ practices on mitigating the P&D infestations/occurrence. (D)	Short/ medium term strategy 2019/2021	07mn LKR	DOA/ SCPPC PMEO/PM cluster/ PPMU/ ASMP DOA/ SCPPC PMEO/PM cluster/ PPMU/ ASMP	MOA /SCPPC Donor	No.of farmers/FPOs convinced No. of farmers adopted PM practices No.of FPOs increased crop yield/income
			Increase farmer skills/knowledge by demonstrating the potentials contribution on reducing P & D incidences adoption of productive/innovative crop technologies integrating PM practices expertise for FPOs.(I)	Short/ Medium term strategy 2019/2020	05mn LKR			No.of farmers gained knowledge/ awareness on cost effectiveness of PM practices No.of FBS sessions discussed the PM practices. No.of FPOs participated & level of knowledge gained.
			Conduct demonstration and training for FPOs to identify and made aware of the economic and environmental benefits		06mn LKR			No. of expert Farmers recognized as

Strategy	Barriers	Justified action	Proposed measures	Time frame	Estimated cost	Agency responsible(AR)	Funding sources	Indicators of success & Risks
			by adoption of environmentally sound human safe PM practices.(C) **Integrate** PM technologies in FBS training to encourage cluster participation/ identify the economic importance of implementing PM practices in FPOs. **Implement** awareness/training/demonstration for FPOs/ Farmers identify/ learn/understand the climate change patterns & influence of pest/disease incidences/ outbreaks. Train the FPOs/Farmers to facilitate the use of Agri/P&D related technology provides Apps through mobile networks.	Short/ Medium term strategy 2019/2020 Short term strategy 2019/2020 Short/ Medium term strategy 2019/2020	05 mn LKR 05 mn LKR 05mn LKR			Volunteer PM communicators No.of FPOs recognized influence of climate change on pest outbreak. No.of FPOs/Farmers using Agri based App for P& D solutions. No.of awareness/ publicity programs conducted ***Risk – Risk averse nature of small farmers.*** ***Freely available & Convenience of using pesticide***

Strategy	**Barriers**	**Justified action**	**Proposed measures**	**Time frame**	**Estimated cost**	**Agency responsible(AR)**	**Funding sources**	**Indicators of success & Risks**
			Mass media awareness campaigns. PM package introduced- • Monitoring • Cultural practices • Mechanical practices • Physical • Biological • Chemical for details refer chapter no.4	Short term/long term strategy 2019/2022				***Attitudes towards non chemical pest management practices.***
Market failures and Imperfections	Inadequate/ irregular/poorly linked market prospects & promotional programs- to identify emerging market segments, Eco branded products (GAP/LEISA/ chemical free foods)	Provision of market information / financial incentives to encourage farmers to shift to sustainable Practices through established farmer/market	Public awareness on adoption PM practices as sustainable alternative minimizing the use of chemical pesticides. Strengthen the producer/ market link influencing the FPOs to adopt GHP, GAP, BRC/G-GAP, FSMS, etc. Promote FPO/market linkage with private sector Agri businesses	Medium term strategy 2019/2020 Medium/ Long 2020/2022 Short/ Medium	5mn LKR 20mn LKR 05mn LKR	MOA/ DOA/PMU/ PPMU SCPPC/ PMEO/PM cluster /Private sector	GOSL/FPO Private sector GOSL/ FPO Donor/private sector GOSL/FPO Donor/private sector	No. of public awareness campaigns implemented No. of FPOs farmers Trained and equipped with certification. No.of regular supply contracts established

Strategy	Barriers	Justified action	Proposed measures	Time frame	Estimated cost	Agency responsible(AR)	Funding sources	Indicators of success & Risks
		collaboration.	Increase commercial orientation of FPOs through FBS programs identifying the relative importance of PM practices/Tools Enhance the opportunities by promoting FPOs to negotiate with diverse markets (local /overseas-direct/indirect). Influence the FPOs to participate at local and international agriculture marketing/technological events/forums to gain exposure on latest affordable technologies, consumer behaviouor & also access to direct market entry.	term strategy 2019/2021 Short/Long term strategy 2019/2022 Short/Long term strategy 2019/2022	06mn LKR 14mn LKR		GOSL/ FPO Donor/private sector	No.of FPOs identified the commercial value of PM practices/tools. No.of FPOs increased/gained skills for negotiating with direct market entities. No. of farmers/FPOs gained exposure ***Risk- Negative attitudes of farmers. Demand for high farm gate price. Lack of commercial approach***
R&D capacity	Limited capacity for R & D on PM technologies	Exploit / link private Agbizs R &D opportunities	Create awareness/train researchers/scientists on PM tools	Short term strategy 2019/2020 Short/ Medium	2mn LKR	ASMP/ DOA/SCPPC/PMEO/PM cluster/ CARP/ HORDI/ RRI	GOSL/ Donor/private	No.of researchers/scientist trained and exposed with international PM best practices

Strategy	**Barriers**	**Justified action**	**Proposed measures**	**Time frame**	**Estimated cost**	**Agency responsible(AR)**	**Funding sources**	**Indicators of success & Risks**
	Lack of skilled human resources Limited pesticide residue monitoring facility	for commercialsation of PM Technologies. Encourage private sector participation in research –extension dialogues	PM technologies/tools to be included in FBS curriculums In coordination with PM cluster encourage and induce increased cooperation of private/ public institutional dialogues/ forums. Conduct R&D and experiments to introduce efficient/effective PM technologies with possible integration of indigenous methods Conduct R&D for improved/affordable technology solutions for mitigating P&D incidences due to climate change effects in provinces. Create awareness, exposure on	term strategy 2019/2021 Short/ Medium/ long term strategy 2019/2021 Medium/ long term strategy 2020/2022	02mn LKR 02mn LKR 07mn LKR	ASMP/ DOA/SCPPC/PMEO/PM cluster/ CARP/ HORDI/ RRI/Envt. Authority ASMP/ DOA/SCPPC/PMEO/PM cluster/ CARP/ HORDI/ RRI	sector/National & International research centers	PM technologies integrated in FBS curriculum/No .of FPO/Farmers trained, No. of Private/ public forums/dialogues. Report on identified R&D needs related PM practices. No.of PM technologies tested (including plant nutrients recommendations) experimented/demonstrated and disseminated No.of FPOs demonstrated on climate change effects & P&D incidences.

Strategy	**Barriers**	**Justified action**	**Proposed measures**	**Time frame**	**Estimated cost**	**Agency responsible(AR)**	**Funding sources**	**Indicators of success & Risks**
			effectiveness of plant based extracts and bio pesticides in PM. Demonstrate and promote farmer friendly technology on pest monitoring/surveillance/ savoid unnecessary use of PC Develop profiles and information materials of locally adapted PM technology specific to crop & pests under local conditions.	Short/ Medium/ Long term strategy 2019/2022	06mn LKR			No of bio-pesticide developed/ experimented/demonstrated No.of FPOs established/operating pest monitoring techniques/practices Technical guides for PM on diverse crops developed ***Risk- Trained staff moving out of PM programs (Loss of track on IPM/,regular Crop Clinic, etc.***

Strategy	**Barriers**	**Justified action**	**Proposed measures**	**Time frame**	**Estimated cost**	**Agency responsible(AR)**	**Funding sources**	**Indicators of success & Risks**
Policy and regulation	Inadequacy of policy & legal system to Support towards national recognition of PM technologies and discourage promotion of chemical pesticides	Need to minimize the dependency on chemical pesticides for sustainable agriculture / in line with national food safety environmental protection policies	Outsource expert services for non-confidential documentation screening. Review and identify registration procedures/ activities possibility for simplify the documentation process. Strengthen ROP with team of officers under the purview of SCPPC/ ROP to handle legal empowerment matters at regional level Regulate Pesticides sales by promoting/regulating the prescriptions, based mechanism through ROP authorized/certified personnel- (Crop doctors/ROPs	Long term strategy proposed to be initiated by 2020 Medium/ Long term strategy proposed to be initiated by 2020 Long term strategy 2021/2022 Medium/ Long term strategy 2021/2022	03mn LKR 03mn LKR 04mn LKR 05mn LKR	MOA/ SCPPC/ROP/PP/ NPQS/ PMEO/PM cluster	GOSL/ Donor/private sector	Simplify pesticides registration procedures Registration process accelerated No. of staff increased. PMEOs empowered Regulatory system enforced on prescription based sales/issues for pesticides. No.of FPOs adopt DOA recommended practices/using protective gears. No. of FPOs trained & action implemented

Strategy	Barriers	Justified action	Proposed measures	Time frame	Estimated cost	Agency responsible(AR)	Funding sources	Indicators of success & Risks
			representatives in the regions/GAP officers) Empower/enforce regulations to promote recommended practices for use of pesticides including protective measures Train and educate on storage, disposal of pesticides disposal of empties Monitoring residue levels/contamination. Introduce regulations on development/registration/distribution/ marketing/promotion of bio Pesticides	Long term strategy proposed to be initiated by 2021	04mn LKR			List of updated MRLs established. Regulatory measures for bio-pesticides enforced. ***Risk – Lack of organizational/ political will***

9.6 IPM monitoring & Evaluation plan

The focus of monitoring and evaluation is to assess the incremental capacities of PM practices in the FPOs and ensure that the PM techniques are adopted in crop production and the achievements of economic benefits that farmers derived from implementing the PM plan in farmer fields.

The regular monitoring and evaluation during project supervision includes;

- Number of FPOs identified and number of farmers received PM training- Evaluate the trainee response on training contents/ materials, methodology, time spent through analysisng the Pre training & post training feedback at the end of each session.
- Number of farmers who adopted PM practices in their crop production efforts.
- Number of crops/ types of crop production systems (eg. vegetables/ fruits, leafy vegetables, yams) and rate of increase at provincial level.
- Assess the producer crop records to identify the production performance and benefits for FPOs implementing PM tools.
- Level of pesticides used and reduction over the seasons (Yala/ Maha/ Mid)
- Number of experiments/ demonstrations/ participatory research and technology support programs implemented.
- Number of joint PM programs implemented by networking with relevant partners at provincial level.
- Number of review meetings on joint PM programs held during the season/year

9.7 PM Implementation and Monitoring plan for year 2020

Program	**Indicators of success**	**Time frame (months)- 2019/2020**												**Agency responsible**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
Strategy1.0-- Institutional and organizational capacity														
Activity 1.1 -Increase technical skills/knowledge on PM tools														
Task 1.1.1 -Establish a list of officers from existing DOA staff available at provincial/national level, preferably trained under plant doctors/ GAP officers/ pesticides control/IPM programs.	List of officers identified at provincial/ district level.	▨												MOA/DOA/ SCPPC/ ASMP
Task 1.1.2- Screen and select 22 individuals (PM Extension Officers) for district level implementation of PM Extension services and 01 national level PM coordinator.	District level PMEO(EO)-delegated for PM tasks	▨	▨	▨	▨	▨	▨							MOA/DOA/ SCPPC/ ASMP
	National PM coordinator (NC) – delegated for PM tasks	▨	▨											
Task 1.1.3-Design & develop Institutional networking mechanisms to create PM clusters at provincial level integrating district level extension/ support representatives of diverse private/public/ NGO/ civil societies involving small farm agriculture development.	Provincial level PM clusters establsihed (09 PM clusters-CL).	▨	▨	▨	▨	▨	▨	▨						MOA/DOA/ SCPPC/ PMEO/ ASMP
	No.of progress review meetings/ minutes	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	
Task 1.1.4-Identifying functions and powers for PM clusters dedicated to promote/ implement PM program recognizing the legal and institutional framework of PP,	Task & functions determined/established *(Delivering the right message/ information/ technology for farmers/FPOs under DOA guidelines)*	▨	▨											SCPPC/PMEO/PPMU/PDOA/PM Cluster/ PDOA/NGO

Program	**Indicators of success**	**Time frame (months)- 2019/2020**												**Agency responsible**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
Pesticides, and Seed and Environmental services.		■	■											
Activity 1.2- Foster collaboration between all stakeholders involved in agriculture production in provinces														
Task 1.2.1-Develop/prepare training materials/technical guides/ technical information/communication materials for promotion/ training/ skills development/attitude change/effects on climate change related to PM interventions in provinces **Strengthening** the technology diffusion, information sharing mechanisms under one platform (PM cluster).	No. of training materials developed			■	■									SCPPC/PMEO/PPMU/ASMP/ PM cluster
	No.of communication materials developed			■	■									
	No.of technical guides on crops/ P&D.			■	■									
	No.of technical guides on crops/climate change			■	■									
	No.Reports and progress review briefs on PM technology interventions with farm FPOs in Provinces			■	■	■	■	■	■	■	■	■	■	
Task 1.2.2-Provide In-depth training for PMEOs/PM cluster members on PM tools and practices identifying the contribution for reducing chemical pesticides (gain knowledge /skills on SL-GAP/Global GAP/Organic/LEISA/climate change effects and approach for crop pests/diseases diagnosis and solution (crop doctors/Apps).	No.training sessions.		■	■	■	■	■	■	■					SCPPC/PMEO/PPMU/ASMP/ PM cluster
	No.of participants increased knowledge/ skills. (Pre & post training evaluation)		■	■	■	■	■	■	■					

Program	**Indicators of success**	**Time frame (months)- 2019/2020**												**Agency responsible**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
Task 1.2.3-Practical exposure for PMEOs/PM cluster on contribution of PM tools/climate change interventions on reducing the use of pesticides.	No.of exposure visits to ongoing technology interventions on PM.		▨	▨	▨	▨	▨	▨	▨					SCPPC/PMEO/PPMU/ASMP/ PM cluster
	No.of participatory programs implemented at farmer fields/FPOs in ATDP/PPMU provinces			▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	
	No.of FPOs adopted PM technologies.													
Task 1.2.4-Establish & publish a list of individuals of PMEO/ PM cluster certified as trainers/advisers/PM extension officers and competent to conceptualize/design/implement PM programs at respective provincial/district areas.	No.of individuals competent to conceptualize/ design & implement PM interventions at provincial/district level determined/ establsihed.							▨	▨					SCPPC/PMEO/PPMU/ASMP/ PM cluster
Strategy 2.0- Social and behavioural attitudes of Farmer clusters														
Activity 2.1- Enhance farmer skills and demonstrate added benefits of PM technologies those embedded to activities on crop cultivation and management														
Task 2.1.1 Expose and train farmers on PM tools/practices- identifying the advantages in conventional farming, organic farming, protected farming systems, etc.	No.of farmers trained and exposed for PM tools/practices. *(PM package introduced- Monitoring, Cultural, Mechanical, Physical, Biological, and Chemical methods.)*				▨	▨	▨	▨	▨	▨	▨	▨	▨	DOA/ SCPPC/ PMEO/PM cluster/ PPMU/ PDOA/ASMP
Task 2.1.2 Develop positive attitudes through participatory demonstration & knowledge sharing on effectiveness of implementing PM tools/ practices on mitigating the P&D infestations/occurrence.	No.of farmers/FPOs convinced				▨	▨	▨	▨	▨	▨	▨	▨	▨	
	No. of farmers adopted PM practices								▨	▨	▨	▨	▨	

Program	**Indicators of success**	**Time frame (months)- 2019/2020**												**Agency responsible**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
Task 2.1.3 Increase farmer skills/knowledge by demonstrating the potentials contribution to reducing P & D incidences by adoption of productive/innovative crop technologies.	No.of FPOs increased crop yield/income										▨	▨	▨	
Task 2.1.4 Conduct demonstration and training for FPOs to identify and make aware of the economic and environmental benefits by adoption of environmentally sound human safe PM practices.	No.of farmers gained knowledge/ awareness on cost effectiveness of PM practices						▨	▨	▨	▨	▨	▨	▨	
Task 2.1.5 Integrate PM technologies in FBS training to encourage cluster participation/identify the economic importance of implementing PM practices in FPOs.	No.of FBS sessions discussed the PM practices.				▨	▨	▨	▨	▨	▨	▨	▨	▨	
	No.of FPOs participated & level of knowledge gained.				▨	▨	▨	▨	▨	▨	▨	▨	▨	
	No. of expert Farmers recognized as Volunteer PM communicators										▨	▨	▨	
Task 2.1.6 Implement awareness/training/demonstration for FPOs/Farmers identify/learn/understand the climate change patterns & influence of pest/disease incidences/outbreaks.	No.of FPOs recognized influence of climate change on pest outbreak.							▨	▨	▨	▨	▨	▨	
Task 2.1.7 Train the FPOs/Farmers to facilitate the use of Agri/P&D related technology provides Apps through mobile networks	No.of FPOs/Farmers using Agri based App for P& D solutions.									▨	▨	▨	▨	
	No.of awareness/publicity programs										▨	▨	▨	

Program	**Indicators of success**	**Time frame (months)- 2019/2020**												**Agency responsible**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
Task 2.1.8 Mass media awareness campaigns.														
Strategy 3.0 Market failures and Imperfections														
Activity 3.1 Provision of market information /financial incentives to encourage farmers to shift to sustainable PM Practices through established farmer/market collaboration														
Task 3.1.1 Public awareness on adoption of PM practices as sustainable alternative minimizing the use of chemical pesticides at farmer level.	No. of public awareness campaigns implemented								▨	▨				MOA/ DOA/PMU/ PPMU SCPPC/ PMEO/PM cluster /Private sector food markets
Task 3.1.2 Strengthen the producer/market link influencing the FPOs to adopt GHP, GAP, BRC/G-GAP, FSMS, etc.	No. of FPOs farmers trained and certified.						▨	▨	▨	▨	▨	▨	▨	
Task 3.1.3 Promote FPO/market linkage with private sector Agri businesses	No.of regular supply contracts established.								▨	▨	▨	▨	▨	
Task 3.1.4 Increase commercial orientation of FPOs through FBS program identifying the relative importance of PM practices/Tools	No.of FPOs identified the commercial value of PM practices/tools.										▨	▨	▨	
Task 3.1.5 Enhance the opportunities by promoting FPOs to negotiate with diverse markets (local /overseas-direct/indirect).	No.of FPOs increased/gained skills for negotiating with direct market entities.											▨	▨	
Task 3.1.6 Influence the FPOs to participate at local and international agriculture marketing/technological events/forums to gain exposure on latest affordable technologies,	No. of farmers/FPOs gained exposure								▨	▨	▨	▨	▨	

Program	**Indicators of success**	**Time frame (months)- 2019/2020**												**Agency responsible**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
consumer behaviuor & also accessing to direct market entry.									■	■	■	■	■	
Strategy 4.0 R&D capacity & interventions enhanced to enable sustainable promotion of PM technologies/practices at Small farmer fields.														
Activity 4.1 Exploit / link private Agbizs R &D opportunities for commercialsation of PM Technologies - Encourage private sector participation in research – extension dialogues														
Task 4.1.1 Create awareness/train researchers/scientists on PM tools	No.of researchers/scientist trained and exposed with international PM best practices	■	■											ASMP/ DOA/ SCPPC/PDOA/PMEO/PM cluster/ CARP/ HORDI/ RRI
Task 4.1.2 PM technologies/tools to be included in FBS curriculums	PM technologies integrated in FBS curriculum/No .of FPO/Farmers trained,	■	■	■										
Task 4.1.3 In coordination with PM cluster encourage and induce increased cooperation of private/public institutional dialogues/forums.	No. of Private/ public forums/dialogues.				■			■			■			
	Report on identified R&D needs related PM practices.			■			■			■			■	
Task 4.1.4 Conduct R&D and experiments to introduce efficient/effective PM technologies with possible integration of indigenous methods	No.of PM technologies tested (including plant nutrients recommendations) experimented/demonstrated and disseminated		■			■			■			■		ASMP/ DOA/ SCPPC/PDOA/ PMEO/ PM cluster/ CARP /HORDI/RRI/ Env.Auth.
Task 4.1.5 Conduct R&D for improved/affordable technology solutions for mitigating P&D incidences due to climate change effects in provinces.	No.of FPOs demonstrated technologies/interventions on climate change effects & P&D incidences.									■	■	■	■	
Task 4.1.6 Create awareness, exposure on effectiveness of plant based extracts and bio pesticides in PM.	No of bio-pesticide developed/ available/experimented/demonstrated and recommended								■	■	■	■	■	ASMP/ DOA/SCPPC/PMEO/PM cluster/ CARP/ HORDI/ RRI

Program	Indicators of success	Time frame (months)- 2019/2020												Agency responsible
		1	2	3	4	5	6	7	8	9	10	11	12	
Task 4.1.7 Demonstrate and promote farmer friendly technology on pest monitoring/surveillance/scouting avoid unnecessary use of PC	No.of FPOs established/operating pest monitoring techniques/practices					🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟨	
Task 4.1.8 Develop profiles and information materials of locally adapted PM technology specific to crop & pests under local conditions.	Technical guides for PM on diverse crops developed										🟨	🟨	🟨	
Strategy 5.0 Policy and regulatory empowerment capacity enhanced.														
Activity 5.1 Minimize the dependency on chemical pesticides for sustainable agriculture / In line with national food safety environmental protection policies														
Task 5.1.1 Outsource expert services for non-confidential documentation screening.	Simplify pesticides registration procedures										🟨	🟨	🟨	MOA/ SCPPC/ROP/ PP/ NPQS/ PMEO/PM cluster
Task 5.1.2 Review and identified registration procedures/activities possibility for implementing simultaneously	Registration process accelerated											🟨	🟨	
Task 5.1.3 Strengthen ROP with team of officers under purview of SCPPC/ ROP to handle legal empowerment matters at regional level	No. of staff increased. PMEOs empowered under SCPPC/ROP			🟨	🟨	🟨	🟨	🟨	🟨					
Task 5.1.4 Regulate Pesticides sales by promoting/legalizing the prescriptions, based mechanism through ROP authorized/certified personnel- (Crop doctors/ROPs representatives in the regions/GAP officers)	Regulatory system enforced on prescription based sales/issues for pesticides.					🟨	🟨	🟨	🟨	🟨				

Program	Indicators of success	Time frame (months)- 2019/2020												Agency responsible
		1	2	3	4	5	6	7	8	9	10	11	12	
Task 5.1.5 Empower/enforce regulations to promote recommended practices for use of pesticides including protective measures/Application equipment	No.of FPOs adopt DOA recommended practices/using protective Gears.							▨	▨	▨	▨	▨	▨	
Task 5.1.6 Train & educate storage, disposal of pesticides disposal of empties,	No. of FPOs trained & implement action safe disposal/storage.										▨	▨	▨	
Task 5.1.7 Monitoring residue levels/contamination.	List of updated MRLs established.								▨	▨	▨	▨		
Task 5.1.8 Introduce regulations on development/ registration/ distribution/ marketing/promotion of bio Pesticides	Regulatory measures for bio-pesticides enforced.									▨	▨	▨	▨	

9.8 PM institutional monitoring and evaluation mechanism proposed

Infrastructure	Description
Organizational approach	• SCPPC to identify a list of officers from existing DOA staff at provincial/national level preferably those trained under plant doctors/GAP officers/pesticides control/IPM. • SCPPC screen and select 22 individuals (PM Extension Officers) for district level implementation of PM Extension services and 01 national level PM coordinator • SCPPC to assign the team with tasks fully dedicated for PM extension services, promotion and adoption of PM practices/technologies for increased productivity and reduced use of chemical pesticides in FPOs/Farmers in the provinces. • Conduct intensive training to update/improve skills on PM tools, activities and implementation of farm level programs. • SCPPC in coordination with ASMP/PMU/PPMU implement pilot PM extension programs at ATDP/FPOs by deploying 05 PMEO in ASMP provinces

Infrastructure	Description
	• Based on the experience gained from pilot programs extend the PM extension mechanism covering other provinces. • Continue the PM extension/ farmer support services as a national program to enhance farmer productivity and increase household income.
Institutional networking mechanism to create PM clusters at provincial level	• PMEO to identify and list all private sector agri business investments, agro chemical input services, at district level. • PMEO to identify and list all NGO/civil society organizations to be involved in agriculture/rural development, at district level • PMEO to establish a List of field level extension/support representatives private/public/NGO/civil societies at district level • SCPPC/PPMU/PMEO to design & develop a networking mechanism identifying functions and powers dedicated to promote/ implement PM programs recognizing the legal and institutional framework of PP, Pesticides, and Seed and Environmental services.
National PM program –annual basis	• SCPPC under DOA/MOA to recognize and integrate PM action plan under national agriculture development plan • SCPPC/PMEO to review and establish annual PM plan in coordination with all identified stakeholders at district/Provincial level. • SCPPC/PMEO to ensure participation of all stakeholders under one platform enabling to promote PM technologies as planned. • Collect available information and relevant materials on PM interventions and compile a data base/prepare training materials/technical guides/technical information/prepare communication materials for promotion/training/skills development/attitude change/ related to PM interventions.
Progress monitoring and reporting	• Monthly review of implementation/work plan on identified tasks and activities determined. (SCPPC/PPMU/PMEO/PM cluster) • Record field level PM interventions and practices implemented/adopted by farmers • Record hindrances/ constraints/ issues/ challenges • Record farmer problems informed/ discussed /solved/ identified as research priorities

REFERENCES

Annual Health statistics Sri Lanka Report (2016) Ministry of Health Nutrition and Indigenous Medicine.

Annual Report (2018) Central Bank of Sri Lanka

Charles Vincent, Guy Hallman,Bernanrd Panneton and Farncis Fleurat-Lessard,(2003) Management of Agricultural Insects With Physical Control Methods, annual Review Entomology; 2003;48,pg 261

Christina S.De Silva, and Juan A Rodriguez Diaz, (2011) Spatial Impacts of Climate Change on Major climatic Factors in Sri Lanka

Department of Census & Statistics

Dharmasena P.B., Nimal Gunasena, and Upul Jayaweera, (2017), Sustainable Management Practices for Agricultural Lands in the Central Highlands of Sri Lanka, Up country Rain-fed Farming system,GCP/SRL/063/GFF,(FAO)2017.

FAO,(2016) Integrated management of the Fall Armyworm on maize, A guide for Farmer Field Schools in Africa, ISBN 978-92-5-130493-8, FAO 2018

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Rome 2015 Introducing the farm business school A training package.

Galanihe L.D., Madugalle S., Rajapaksha S.P. and. Siriwardena M.I.(2017) Influence of Companion Crops on Sucking Pest Complex of Tomato; Annals of Sri Lanka Department of Agriculture 2017. 19: 27 – 35.

Global Gap, Control Union Integrated Farm Assurance, control points/compliance criteria 2019

Greathead D.J. and Waage J.K., (1983) World Bank Technical paper on Opportunities for Biological Control of Agricultural Pests in Developing Countries.

Guidelines to Classification (2009) The WHO Recommended Classification of Pesticides by Hazard, ISBN 978 92 4 154796 3, ISSN 1684-1042.

Gunapala K.R.D.,Babendreier D., and Toepfer S., (2017) Analysis of Advice quality in Crop clinics on Rice problems in Sri Lanka, Annals of Sri Lanka Department of Agriculture 2017. 19: 84 – 90.

Henk van den Berga, Hector Senerath and Laksman Amarasinghe A, (2002) Participatory IPM in Sri Lanka; A broad scale & In-depth Impact Analysis under FAO program for community IPM in Asia ;GCP/RAS/!&”/NOR

Jayasooriya H.J.C and Aheeyar M.M.M. (2015) HKARTI Research report, Application of IPM in Vegetable cultivation: Past Experiences & Suggestions for Promotion Research Report Number 175,2015

Krishani.S., Raveendranath.S. and Hemachandra.K.S., (2007), Evaluation of the adoption of Integrated Management of Vegetable pests in the Batticaloa district in Sri Lanka, AGRIEAST 6:41-48

Nagalingam T., Wijeyagunesekara H.N.P.,Hemachandra K.S.,and Nugaliyadde L. Parasitoids of Lirimoya sativea Blanchard (Diptera;Agromyzidae) in Mid country of Sri Lanka,Tropical Agriculture research volume 19:59-68 (2007)

Narayasamy P., Traditional pest control; A retrospection, Indian journal of Traditional Knowledge vol.(1),July 2002.PP 40-50.

Nishantha K.M.D.W.P., Sandika A.L., Babu A.G.C., Hettiarachchi H.A.S.N., Pushpanjali K., Abey-tilakeratna P.D., Nugaliyadde M.M.,(2016) Farmers Knowledge & Attitudes on Pesticide Usage in Vegetable cultivation in Sri Lanka, Tropical Agricultural Research & Extension 19 (2): 2016.

Pdmajani M.T., Aheeyar M.M.M., Bandara M.A.C.S, Assessment of Pesticide Usage in Up-Country Vegetable Farming in Sri Lanka, Hector Kobbekaduwa Agrarian Research and Training Institute, Research report No.164,2014.

Prasannath K.,M.Nasla M.F.F.and Prasannath V., Socio-Economic Factors and Pesticide Usage Pattern of Vegetable Farmers and Environmental Impact of Pesticide Use: Evidence from Kalpitiya Divisional Secretariat Division, Puttalam District, Sri Lanka Sch. J. Agric. Vet. Sci., Jun 2018; 5(6): pp 301-305

Prasannath Kumari, A Study of Traditional Pest and Diseases Control Methods for Sustainable Rice Cultivation in Sri Lanka, IOSR Journal of Business and Management (IOSR-JBM),e-ISSN: 2278-487X, p-ISSN: 2319-7668. Volume 18, Issue 10. Ver. VI (October. 2016), PP 34-36.

Premalatha M.G.S., Wahundeniya K.B., Weerakkody W.A.P., and Wickramatunga C.K.(2007) Plant Training & Spatial Arrangement for yield Improvements in Green house Tomato (Cucumis sativus L.) varieties,Tropical Agriculture Research.

Rajapakse R.H.S., Ratnasekera D., Abeysinghe S. (2016) Bio pesticides Research: Current Status and Future Trends in Sri Lanka.

Ramani De S. Jayathilake, The Impact of Green Revolution on the Sri Lankan Peasantry, Sn Lanka J.S.S. 1989 12 (1 & 2).

Samaraweera D. P. & Jayasinghe-Mudalige U. K., (2005)Farmer Attitudes Towards Adoption of Sustainable Protection Technologies: The Case of Integrated Pest Management in Vegetable Cultivation in Sri Lanka, Agriculture Proceedings of the Tenth Annual Forestry & Environmental Symposium 2005 Department of Forestry & Environmental Science. University of Sri Jayewardenepura, Sri Lanka

Sandhika A.L. and Withana N.R.P.(2010) Economic Analysis of Chena Cultivation in Moneragala district,Sri Lanka, Proceedings of the 15th International Forestry and Environment Symposium, 26-27 November 2010, Department of Forestry and Environmental Science, University of Sri Jayewardenepura, Sri Lanka.

Sector Vulnerability Profile (2010) Biodiversity and Ecosystem Services/ Biodiversity –SVP Nov 16-2010-ADB/Climate change secretariat.

Subashiny Nagenthirarajah and Thiruchelvam S. (2008) Knowledge of Farmers about Pest Management Practices in Pambaimadu, Vavuniya District: An Ordered Probit Model Approach Sabaragamuwa University Journal Volume 8 Number 1; ISSN 1391-3166, pp 79-89

Sununtar Setboonsarng, Organic Agriculture, Poverty Reduction, and the Millennium Development Goals Discussion paper No54, 2005 Asian Development Bank Institute.

Udaya Rajapaksha, Traditional Food Plants in Sri Lanka, Hector Kobbekaduwa Agrarian Research and Training Institute,Research study 100,1998,ISBN 955-612-031-9

Van den Berg H., Das P.K., Hildebrand Von A. and Ragunathan V., Evaluation of the Integrated Pest and Vector Management (IPVM) project in Sri Lanka, Mission Report, WHO, Regional Office for South East Asia, New Delhi.2006.

WenJun Zhang, (2018) Global pesticide use: Profile, trend, cost / benefit and more, Proceedings of the International Academy of Ecology and Environmental Sciences, 2018, 8(1): 1-27.

Wilfried Baudoin, Remi Nono-Womdim and Alison Hodder, (2013) Good Agricultural Practices for greenhouse vegetable crops, FAO Plant Production and Protection Paper ISBN 978-92-5-107649-1.

ANNEXES

1. Field Data Collection Tools
2. List of contact details & meeting schedule, attached

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Agriculture Sector Modernization Project (ASMP)

පළිබෝධ කළමනාකරණය පිළිබඳ ගොවීන්ගේ උපායමාර්ග තක්සේරු කිරීමේ ප්‍රශ්නාවලිය

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Cluster Village:			

2. ගොවියාගේ නම ……………………………………………………… වයස අවු …………

3. පවුලේ සාමාජික සංඛ්‍යාව

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4. ඉහළම අධ්‍යාපන මට්ටම

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5. බෝග නිෂ්පාදනය

5.1 බෝග නිෂ්පාදන පද්ධති

i) සාම්ප්‍රදායානුකූල ii) කාබනික

iii) වෙනත් (ආරක්ෂිත/ අර්ධ ආරක්ෂිත/ වගා මලු) සඳහන් කරන්න

……………………………………………………………………………………………………

5.2 වගා කරන බෝග වර්ග

i. වාර්ෂික බෝග අක්. …………………………..…..
ii. බහු වාර්ෂික බෝග අක් …………………………...
iii. වන වැස්ම අක්. ……………………………

බෝග වර්ගය	ගොවි ක්ෂේත්‍රය	වගා වියදම රු/ අක්.	අවට වගාව/ භූමිය

5.3 බෝග නිෂ්පාදනය සඳහා අනුගමනය කරන ක්‍රම

A) බිම් සකස් කරන ක්‍රම විස්තර කරන්න					
i) මිනිස් ශ්‍රමය/ යන්ත්‍ර					
ii) උපකරණ/ යන්ත්‍ර					
iii) බිම් සකස් කිරීමේදී භාවිතා කල පාංශු සංරක්ෂණ ක්‍රම					
B) පාංශු කළමනාකරණ විධි/ පිළිවෙත්					
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iii) පාංශු ප්‍රතිකාරක					
iv) පොදු පාංශු සංරක්ෂණ ක්‍රම (A IIIහි නැති)					
C) රෝපණ ද්‍රව්‍ය/ බීජ තෝරා ගැනීමේදී අනුගමනය කරන පදනම කුමක්ද?					
i) අත්දැකීම් අනුව		ii) ඉහල අස්වනු		iii) පළිබෝධ ප්‍රතිරෝධී	
iv) නියං ප්‍රතිරෝධී		v) වෙළඳපළට අවශ්‍ය ලෙස		vi) DOA, NGO, වෙළඳසල් හිමියාගේ ගේ උපදෙස් මත	
D) කැමති බෝග වගා ක්‍රමය (Crop model) සහ හේතු					
		තෝරා ගැනීමට හේතු			
i) ඒක බෝග වගාව					
ii) බෝග මාරුව					
iii) මිශ්‍ර බෝග වගාව					
iv) අන්තර් බෝග වගාව					

v) වාර්ෂික/ සෘතු බෝග		
vi) වෙනත්		
සටහන්		

E) ඔබ බෝග සංස්ථාපනයේදී නිර්දේශිත පරතර භාවිතා කලේද	ඔව්	නැත
i) වැඩි සනත්ව ක්‍රමය		
ii) අඩු සනත්ව ක්‍රමය		
iii) වසර පුරා වගාව		

F) බෝග වලට නිර්දේශිත පොහොර යෙදීම

	ඔව්	නැත
i) කෘෂි. දෙ. නිර්දේශිත ප්‍රමාණ		
ii) රසායනික/ අකාබනික පොහොර පමණක්		
iii) නිර්දේශිත කාබනික පොහොර පමණක්		
iv) නිර්දේශිත ප්‍රමාණවලින් කාබනික සහ රසායනික පොහොර		

V) පාංශු සාරවත්බව අනුව පොහොර යොදන කාලය/ වාර ගණන පිළිබඳ තොරතුරු ලබා ගන්නේ කෙසේද?

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අදාල වෙනත් තොරතුරු ඇතොත් සඳහන් කරන්න.

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G) භාවිතා කරන ජල සම්පාදන ක්‍රම

i) වර්ෂාව		ii) පිටාර ජල සම්පාදන (Flood irrigation)		iii) බේසම් ක්‍රමය (Basin irrigation)	
iv) ක්ෂුද්‍ර ජල සම්පාදන ක්‍රමය (බිංදු)		v) කෘෂි ළිද			

එක් කන්නයක් තුල ජල සම්පාදන වාර ගණන බෝග කීපයක් ඇත්නම් වෙන වෙනම සටහන් කරන්න බෝගය 1…………………………….. බෝගය 2………………………………. බෝගය 3………………………………	
වගාවට යෙදීමට පෙර ජලය පිරිසිදු කරගන්න ආකාරය	
i) ගබඩාකර රොන් මඩ අවසාදනය	
ii) රසායනික පිරිසිදු කිරීම	
iii) පිල්ටර් භාවිතය	
iv) වෙනත් විස්තර කරන්න	

H) වසරක් තුල වගා කරන බෝග සංඛ්‍යාව

i) එක බෝගයයි ii. බෝග දෙකයි iii බෝග දෙකකට වැඩි

I) අස්වනු නෙලන/ පසු අස්වනු ක්‍රියාකාරකම්

i) ගුණාත්මක අස්වැන්නක් ලබා ගැනීමට අස්වනු නෙලීමට ප්‍රථම අනුගමනය කරන පිළිවෙත් මොනවාද?

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ii) පසු අස්වනු ගබඩා කිරීම

(මෙයට අස්වනු පිරිසිදු කිරීම, තේරීම, වර්ග කිරීම, ප්‍රතිකාර කිරීම, ඇසිරීම, ගබඩා කිරීම යනාදී කරුණු ඇතුලත්ය.)

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J) අ).රජයේ, පෞද්ගලික ආයතන (සමාගම් වැනි සහ රාජ්‍ය නොවන ආයතන මඟින් පවත්වනු ලබන පුහුණු වැනි ව්‍යාප්ති සේවාවන් පිළිබඳ ඔබගේ අදහස් දක්වන්න

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ආ). ඔබ විසින් ව්‍යාප්ති සේවාවන් මඟින් හඳුන්වාදී ඇති නවීන තාක්ෂණික ක්‍රම අනුගමනය කරනවාද?

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ඔව් නම් ඒ මඟින් අස්වැන්නට පළිබෝධවලින් සිදුවන හානි වළක්වා ගැනීමට උපකාරී වන්නේද?

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ඇ). ඔබ විසින් බෝග නිෂ්පාදනය හා අලෙවිකරණය පිළිබඳ පුහුණුවක් ලබා තිබේද?

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K) ඔබගේ බෝග නිෂ්පාදනයේ ඵලදායීතාවය ඉහල නැංවීමට/ අලෙවිකරණය දියුණු කර ගැනීමට ඔබට අවශ්‍යයැයි සිතෙන තොරතුරු/ පුහුණු මොනවාද?

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6. ඔබගේ ගොවිපල පහත ක්‍රමවේද යටතේ ලියාපදිංචි කර ඇති ගොවිපලක්ද?
ඔව් නම් ඍජුවද වක්‍රවද යන්න සටහන් කරන්න

	ඍජුවද වක්‍රවද යන්න
කාබනික	
SL-GAP	
Global GAP	
ISO 22000	
BRC	
වෙනත්	

7. ඔබගේ බෝග වගාවක්/ වගා පළිබෝධ සහ රෝගවලින් හානිවී තිබේද

කන්නය: මහ /201.. …………., යල /201.. …………

බෝග වර්ගය ………………., …………………., ………………….., ………………………

පළිබෝධ වර්ගය ………………., …………………., ………………….., ……………………..

ප්‍රතිශත හානිය ………………., …………………., ………………….., ……………………..

පෙර කන්නයට සාපේක්ෂව ආදායම් අඩුව රු………………..

වන්දි මුදල්/ ද්‍රව්‍යවලින් අධාර ලැබුනේද?...
ලැබුනේනම් එය
i) රක්ෂණ ආයතන ii) රජයෙන් iii)රාජ්‍ය නොවන ආයතන

8. ගොවියා විසින් වැඩිපුර වගාකරන බෝග සහ ඒවායේ ප්‍රධාන පළිබෝධ

බෝගය	පවතින රෝග/ පළිබෝධ						ඉදිරියේදී ගැටලුවක් විය හැකි පළිබෝධ/ රෝග
	පළිබෝධ -1	පළිබෝධ 2	පළිබෝධ 3	රෝග 1	රෝග 2	රෝග 3	

9. ඔබ දන්නා/ අත්දැකීම් ඇති බෝග සංරක්ෂණ/ පළිබෝධ පාලන ක්‍රම මොනවාද

a) ගෘහ විද්‍යාත්මක ක්‍රම/ රෝපණ ක්‍රම	
b) භෞතික යාන්ත්‍රණ ක්‍රම	
c) ජීව විද්‍යාත්මක ක්‍රම	
d) පාරම්පරික ක්‍රම	
e) ක්ෂේත්‍රය නිරීක්ෂණය කර තෝරා ගැනීම	
f) අඩු විෂ/ විෂ නැති රසායනික ද්‍රව්‍ය	
g) පළිබෝධනාශක	

h) නිතරම පළිබෝධනාශක යෙදීම නිසා පරිසරයට හානිවන බව, පාරිභෝගිකයාට සහ යොදන තැනැත්තාට හානිදායී ලෙස බලපානබව ඔබ දන්නවාද?

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10. ඔබ පළිබෝධ පාලනය කරන්නේ කෙසේද

a) වළක්වා ගැනීමේ ක්‍රියාකාරකම්	
i) පළිබෝධ ගහණයේ මට්ටම ගැන විමසිලිමත් වීම, නිතර සොයා බැලීම	
ii) ප්‍රතිරෝධී ප්‍රභේද භාවිතය	
iii) බෝග මාරුව/ අන්තර් බෝග මාරුව/ නිවැරදි පෝෂක වර්ග හා ප්‍රමාණ භාවිතය	
iv) ක්ෂේත්‍රයේ බෝග සනීපාරක්ෂාව පවත්වාගෙන යාම	
v) පළිබෝධ හානි ඇතිවීමේ වාර්ථා නඩත්තුව	
b) හෞතික පාලනය	
උගුල්, පස් බුරුල් කිරීම, පස පෙරලීම, ශබ්ද උපක්‍රම (දිය හොල්මන/ හුලං හොල්මන	
c) යාන්ත්‍රික පාලනය	
අතින් ඇහිදීම, වල් පැළෑටි කප්පාදු කිරීම, කීටයන්, ලාවා සහ බිත්තර එකතු කිරීම, ගස් කප්පාදු කිරීම	
d) ජීව විද්‍යාත්මක ක්‍රම	
ස්වභාවික සතුරන්, විලෝපිකයන්, පාරපෝෂිතයන්, රෝග කාරකයන් පිරිමි සතුන් වඳ බවට පත් කිරීම, ජීව විද්‍යාත්මක පළිබෝධනාශක, ශාකද්‍රව්‍ය පළිබෝධනාශක, පාරම්පරික ක්‍රම	
e) පාරම්පරික පාලන ක්‍රම	
ශාකසාර, ශාක කොටස්, වාෂ්පශීලි තෙල්, කුඩු වර්ග, අළු, ශාක ක්ෂිර, නානු, බාධා ඇතිකරන ශබ්ධ, හිතකර	

සතුන්, කෘමීන් සඳහා වාසස්ථාන ඇති කිරීම	
f) ඉහත ක්‍රමවේද වල එකතුවක් (a-e)	
g) රසායනික පාලනය	

11. ඔබ ඒකාබද්ධ පළිබෝධ කළමනාකරණය පිළිබඳව සහ එහි ක්‍රමවේද පිළිබඳව දැනුවත්ද

ඔව් නම්;

ඔබ ඒ සඳහාවූ පුහුණු කීයකට සහභාගී වී ඇත්ද

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ඒ සම්බන්ධව ඔබට ඇති දැනුම, පරිචය සහ නිපුණතාවය පිළිබඳව අදහස් දක්වන්න.

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තව දුරටත් මෙම ක්‍රමවේදය සංවර්ධනය/ දියුණු කිරීමට ඔබගේ අදහස් දක්වන්න.

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12. ඔබ ඒ ගැන දැනුවත්වී සිටියත් එම ක්‍රමවේදය ඔබගේ ක්ෂේත්‍රයට යොදා ගන්නේද?
i) ඔව්　　　　　　ii) නැත

13. නැතිනම් එයට හේතුව කුමක්ද?
i) පුහුණුව ප්‍රමාණවත් නොවීම　　　　　　ii) නිලධාරී සහයෝගය නොලැබීම
iii) මෙය ප්‍රායෝගික නොවේ.　　　　　　iv) වියදම අධිකයි
v) නිසියාකාරව පළිබෝධ පාලනය සිදු නොවේ.
vi) අනෙක් ක්‍රමවලට සාපේක්ෂව වැඩි කාලයක් වැයවේ.
Vii) වෙනත් කරුණු
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…………………………………………………………………………………………

14. විවිධ බෝග සඳහා ඔබ යොදන පළිබෝධනාශක පිළිබඳව විස්තර කරන්න.

පළිබෝධය/ රෝගය	බෝගය	පළිබෝධනාශක		වියදම රු/ අක්	බෝග වගා අවස්ථාව
		නම	ප්‍රමාණය ඒකකය		

15. ඔබ පළිබෝධ පාලනය සම්බන්ධයෙන් කටයුතුකලයුතු කාලය/ අවස්ථාව සහ ක්‍රමය තීරණය කරන්නේ කෙසේද?

i) අසල්වාසීන් සමඟ ii) ක්ෂේත්‍ර තත්වය අනුව iii) ව්‍යාප්ති නිලධාරියාගේ උපදෙස් අනුව

iv) වෙනත්

16. ඔබ තහනම් කල හා උග්‍ර විෂ සහිත පළිබෝධනාශක ගැන දැනුවත්ද: i) ඔව් ii) නැත
ඔව් නම්
එම තොරතුරු ඔබට ලැබෙන්නේ කෙසේද?...

17. පළිබෝධනාශක යෙදීම් දෙකක් අතර කාල පරතරය
i). දින 4-6 ii) . දින 6-8
iii) . දින 14 iv). පළිබෝධ ගහණය අනුව වෙනස් වේ.

18. ඔබ බෝගයට පළිබෝධනාශක යොදන්නේ
i). පළිබෝධ ක්ෂේත්‍රයේ දැකීමට පෙර ii) . පළිබෝධ ක්ෂේත්‍රයේ දැකීමෙන් පසු

19. පළිබෝධනාශක යෙදීමට නිර්දේශ ලබාගන්නේ කෙසේද?

i) . ව්‍යාප්ති සහ පර්යේෂණ නිලධාරීන්ගෙන් ii) . කෘෂි උපදේශක/ මහවැලි ක්ෂේත්‍ර සහකාර/

iii). කෘ.දෙ. උපදෙස් පත්‍රිකා iv). අලෙවිකරුගෙන්

v). නිෂ්පාදිතයේ ලේබලය කියවීමෙන්

vi) වෙනත්…………………………………………………………………………

20. පළිබෝධනාශක කොපමණ ප්‍රමාණයක් යොදනවාද?

i) නිර්දේශයට අඩුවෙන් ii) ලේබලයේ අවම ප්‍රමාණය

iii). ලේබලයේ උපරිම ප්‍රමාණය iv). නිර්දේශයට වැඩියෙන්

v) තමාට සුදුසුයැයි හැඟෙන ප්‍රමාණය vi) අලෙවිකරු කියන ප්‍රමාණය

vii) වෙනත් සඳහන් කරන්න ………………………………………………………

21. පළිබෝධනාශක භාවිතයේ හානිදායක අවස්තා පිළිබඳ ඔබ දැනුවත්ද?.......................

22. ඔබ ප්‍රදේශයේ පළිබෝධනාශක විෂවීම් සම්බන්ධව දැනුවත්ද?

මරණ සංඛ්‍යාව	
අර්ධව ආබාධිත තත්වයට පත්වූ ගණන	
විෂවීම් ප්‍රමාණය වාර්ෂිකව අඩුවේද වැඩිවේද	
මේ සම්බන්ධව ඇති සමාජීය කරුණු	

23. ඔබ පළිබෝධනාශක යොදන විට ආරක්ෂිත ඇඳුම් භාවිතා කරන්නේද?

මුහුනු ආවරණ		අත් දිග කමිස		බූට් සපත්තු	
අත් වැසුම්		තොප්පි			

24. ඔබ භාවිතා කරන ඉස්නා යන්ත්‍රය කුමන වර්ගයේද ?

	නොසෙල් වර්ග
අත් ඉස්නා	
බලවේග යන්ත්‍ර	

25 පළිබෝධනාශක ලියාපදිංචිය, ආනයනය, ලේබල් කිරීම, අලෙවිය, භාවිතය සහ අපහරණය සම්බන්ධව වූකෘෂිකර්ම දෙපාර්තමේන්තුව මඟින් පනවා ඇති නීති, නියාමනයන් පිළිබඳ ඔබ දැනුවත්ද?

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26. a) පළිබෝධනාශක පරිසරයට සිදුකරන හානි, මානව සහ සත්ව සෞඛ්‍යයට සිදුවන හානි පිළිබඳව ඔබ දන්නේ මොනවාද?

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b) පළිබෝධනාශකයන්ගේ හානිදායක බලපෑම අවම කරන්නට ඔබගේ යෝජනා කවරේද?

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27. පළිබෝධනාශක යෙදීමේදී සුලඟ සහ දවසේ වේලාව ගැන සැලකිලිමත් වියයුතුබව සහ එසේ නොවීමෙන් සිදුවිය හැකි පරිසර බලපෑම සහ මනුශ්‍යයාට සිදුවිය හැකි හානි ඔබ දන්නවාද?

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28. a) හිස් පළිබොධනාශක ඇසුරුම් ඉවතලන ක්‍රමවේදය කුමක්ද?

i). පරිසරයට විසි කිරීම ii) . වැලලීම

iii). අලෙවිකරුට ප්‍රතිචක්‍රිකරණයට බාර දීම iv). වෙනත් (විස්තර කරන්න)

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b) ඔබ අනුගමනය කරන ක්‍රමය නිසා පරිසරයට යම් බලපෑමක් ඇති වේද?...................................

c) හානිකර බලපෑමක් ඇතිවන්නේනම් එය වැළැක්වීමට ගත හැකි පියවර මොනවාද?

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29. ඔබගේ බෝග වගාව සම්බන්ධයෙන් උපදෙස් දීමට ව්‍යාප්ති නිළධාරියෙක් පැමිනෙන්නේද?

I) ඔව් ii) නැහැ

30. ඔබ කෘෂිකර්ම දෙපාර්තමේන්තුවේ ලියාපදිංචි යහ කෘෂි පිළිවෙත් (GAP) අනුගමනය කරන ගොවියෙකුද?..

ඔව් නම් වැඩසටහනට අනුකූලවන පරිදි ඔබ විසින් අනුගමනය කරන පිරිවිතර/ ක්‍රියා පිළිවෙත් මොනවාද?

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කෘෂිකර්ම නවීකරණ ව්‍යාපෘතිය
Agriculture Sector Modernization Project (ASMP)

ව්‍යාප්ති නිලධාරීන්ගේ පළිබෝධ පාලන උපායමාර්ග තක්සේරු කිරීමේ ප්‍රශ්නාවලිය
Questionnaire for Assessment of Pest Management Strategies by Extension Officers

කාර්යාල ප්‍රයෝජනය සඳහා

1. **නිලධාරියාගේ නම** ………………………………………… **වයස අවු.**………….

2. **පළාත:** …………………… **දිස්ත්‍රික්කය:** …………… **ප්‍රා.ලේ.කො………………..….**

3. **තනතුර:** ………………………………………………. **සේවා කාලය:** ………………..

ආයතනය: …….. ………………………………………………………………….

4. **ඉහළම අධ්‍යාපන සුදුසුකම (ඩිප්ලෝමා/ උපාධි/ වෙනත්)……………………..**

5. **ඔබ ප්‍රදේශයේ පොදුවේ වගා කරන බෝග සහ ඒවායේ ප්‍රධාන පළිබෝධ සහ රෝග**

බෝගය	පවතින පළිබෝධ හා රෝග						ඉදිරියේදී ඇතිවිය හැකි පළිබෝධ හා රෝග
	පළිබෝධ 1	**පළිබෝධ** 2	**පළිබෝධ** 3	**රෝග** 1	**රෝග** 2	**රෝග** 3	

6. බෝග විවිධාංගීකරණය, ඵලදායීතාවය ඉහල නැංවීම සහ රෝග හා පළිබෝධ කළමනාකරණයට අදාලව සැලසුම් කර ඇති පුහුණු සහ ප්‍රවර්ධන ක්‍රියාකාරකම් මොනවාද ?

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7. ඔබ ජාතික වශයෙන් පොදුවේ වැදගත්වන පළිබෝධකයන්, පළිබෝධනාශක, පළිබෝධනාශක පාලනය/ පරිසර පාලනයට අදාල නිර්දේශ සහ නීති රීති ගැන දැනුවත්ද?, …………………………....

බෝග විවිධාංගීකරණයේදී පළිබෝධ කළමනාකරණය පිළිබඳ ඔබගේ අදහස්/ අත්දැකීම් මොනවාද?

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8. පළිබෝධ පාලනයට අදාල පුහුණු කිරීම්/ හැකියා ප්‍රවර්ධන වැඩසටහන් සඳහා සහභාගී වී තිබේද (පුහුණු කරන්නන් පුහුණු කිරීම TOT/ Master trainers)?

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9. ඔබ වී සහ එලවළු වගාවන් සඳහාවූ ඒකාබද්ධ පළිබෝධ කළමනාකරණ වැඩසටහන් සම්බන්ධයෙන් දැනුවත්ද: ඔව්/ නැත
ඔව් නම් එයින් ඔබ විසින් ක්‍රියාත්මක කරන ක්‍රමවේද මොනවාද?

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10. Dඔබ ශ්‍රී ලංකාවේ ක්‍රියාත්මකවන ගොවි ක්ෂේත්‍ර පාසල් (FFS) වැඩසටහන් සම්බන්ධව දැනුවත්ද? ඔව්/ නැත
එම වැඩසටහන ක්ෂේත්‍ර මට්ටමේදී අසාර්ථක වී ඇත්තේ ඇයි?

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11. ඔබ පළිබෝධ පාලනය/ ඒකාබද්ධ පළිබෝධ කළමනාකරණය සම්බන්ධව ක්ෂේත්‍ර මට්ටමේ යම් වැඩසටහනක් (පුහුණු/ ප්‍රවර්ධන) ක්‍රියාත්මක කර තිබේද/ ක්‍රියාත්මක කරමින් සිටිනවාද

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12. කුඩා පරිමාණ ගොවීන් සඳහා තාක්ෂණ හුවමාරු වැඩසටහන්වලදී භාවිතාකරන යාන්ත්‍රණය කුමක්ද?

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13. පළිබෝධ පාලනයට අදාල නිර්දේශිත ක්‍රම/ ඒකාබද්ධ පළිබෝධ පාලනය ගොවීන් වෙත කියාදීමේදී ඔබ මුහුණදුන් බාධාවන්/ අභියෝග මොනවාද?

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14. ඔබ ගොවීන්ට උපදෙස් දෙන්නේ කෙසේද?
තනි තනිව/ කණ්ඩායම්/ ගොවි ක්ෂේත්‍ර පාසල්/ වෙනත්

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15. ඒකාබද්ධ පලිබෝධ කළමනාකරණය ප්‍රවර්ධනය කිරීමට/ උපදෙස් දීමට තනි තනිව හෝ කණ්ඩායම් වශයෙන් ගොවීන් හමුවීම් කීයක් මාසයක් තුල සිදු කරන්නේද?

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16. පුහුණු සැසිවලදී සාකච්ඡා කරනු ලබන පළිබෝධ පාලන ක්‍රමවේදයන් මොනවාද?

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17. ඒකාබද්ධ පලිබෝධ කළමනාකරණය සම්බන්ධව පුහුණු සැසියක් සඳහා කොපමන පැය ගනණක් ගත කරන්නේද?..
ඒ සඳහා ඔබ ලබා දෙන ප්‍රමුඛතාවය කුමක්ද?

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18. ඒකාබද්ධ පලිබෝධ කළමනාකරණය සම්බන්ධව වැඩසටහන් ක්‍රියාත්මක කිරීමේදී ඔබ මුහුණදුන් අභියෝග මොනවාද?

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19. ඒකාබද්ධ පලිබෝධ කළමනාකරණය සම්බන්ධව වැඩසටහන් ක්‍රියාත්මක කිරීමට පෙර ගොවීන්ගේ දැනුම හා පරිචය (farmer skills/knowledge/ attitudes) පිළිබඳව යම් ඇගයීමක් සිදු කලේද?

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එමෙන්ම පුහුණු සැසිය පැවැත්වෙන අතරතුර හා කන්නය අවසන්ව ඒ සම්බන්ධව එවැනිම ඇගයීමක් සිදු කලේද?

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ඔව් නම් එම තොරතුරු එම වැඩසටහන් දියුණු කිරිමට උපයෝගී කර ගත්තේද?

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20. රසායනික පළිබෝධ පාලන ක්‍රම හා ඒකාබද්ධ පලිබෝධ කළමනාකරණය අතර වාසි අවාසි විශ්ලේෂණයක් (cost benefit Analysis) සිදු කලේද?

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21. පළිබෝධනාශක භාවිතයෙන් සිදුවන සමාජීය, පාරිසරික හා මානව බලපෑම පිළිබඳව යම් පුහුණුවක් ලබා තිබේද?

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22. ඒකාබද්ධ පළිබෝධ කළමනාකරණ ක්‍රමවේද සංවර්ධනය සහ දිරි ගැන්වීම සඳහා වන කුමන හෝ පර්යේෂණ සම්බන්ධීකරණ/ ව්‍යාප්ති/ ගොවි අදහස් ලබා ගැනීම වෙනුවෙන් පැවැත්වූ සැසි සඳහා සහභාගී වී තිබේද?

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23. ඒකාබද්ධ පළිබෝධ කළමනාකරණ ක්‍රමවේද/ තාක්ෂණය සංවර්ධනය කර නිර්දේශ කර තිබුණත් තවමත් ක්‍රියාත්මක කර නොමැති නිර්දේශ මොනවාද?

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24. එලවළු වගාවේ පළිබෝධ කළමණාකරණයට අදාලව ක්ෂේත්‍රයේ ක්‍රියාත්මක වන වැඩසටහන් මොනවාද?

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ඒවායින් එලවළු වගාවේ පළිබෝධ පාලනයට යම් මෙහෙයක් සිදුවන්නේයැයි ඔබ සිතනවාද?

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25. නවීන පළිබෝධ කළමනාකරණ ක්‍රමවේදයන්ට පාරම්පරික පළිබෝධ පාලන ක්‍රමවේදයන් කුමන අයුරකින් බද්ධවී තිබේද?

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26. සහ කෘෂි පිළිවෙත් (GAP), කාබනික වගාව/ ඒකාබද්ධ පළිබෝධ කළමනාකරණ පිළිවෙත් ක්ෂේත්‍රයේ ප්‍රවර්ධනය සම්බන්ධව ඔබගේ භූමිකාව කුමක්ද?

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27. ඒකාබද්ධ පළිබෝධ කළමනාකරණ ක්‍රමවේද තිරසාර ලෙස ක්ෂේත්‍රයේ යෙදවීම දිරිගැන්වීමට ඔබගේ යෝජනා මොනවාද?

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28. ඔබ සිතන ආකාරයට රසායනික පළිබෝධනාශක පාලනය සම්බන්ධව නීතිමය බලතල ඇති ආයතන ඒ සම්බන්ධව සෘජුව හෝ වක්‍රව ක්‍රියාත්මක වනවාද?

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29 පළාත් මට්ටමෙන් පළිබෝධනාශක පාලනයට අදාල පළිබෝධනාශක අලෙවිකරුවන් ලියාපදිංචිය, නීත්‍යානුකූල නොවන/ තහනම් කල පළිබෝධනාශක අලෙවිකරුවන් පරීක්ෂාව, ලේබල් පරීක්ෂාව වැනි කටයුතු සඳහා ඔබ සහභාගී වෙනවාද?

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30. පළිබෝධ පාලනයට අදාල නවීන තොරතුරු යාවත්කාලීන කිරීම, ඉදිරියේදී ඇතිවිය හැකි පළිබෝධ හානි පිළිබඳ දැනුවත් කිරීම සඳහා රැස්වීම්/ පුහුණු/ ගොවිපල සංචාර යන ක්‍රියාකාරකම් සැම කන්නයක් පාසාම සිදු කරන්නේද?

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31. ගොවීන්ගේ ක්ෂේත්‍රවල පළිබෝධ පාලනය සඳහා වෙනත් විශේෂ වැඩසටහන් තිබේද?
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ANNEX 02

List of Contact Persons

No	Name	District	Designation	Organization
1	Mrs. WWCK Chandrasekara	Anuradhapura	Agronomist	MASL, Thalawa, Thambuttegama
2	Mr. NASS Kumara	Anuradhapura	Field Assistant	MASL, Thambuttegama
3	Mr. WP Madusanka	Anuradhapura	Social animator	Dasini Dehydration, Anuradapura
4	Mr. LPGRC Udayantha	Anuradhapura	Social animator	Dasini Dehydration, Anuradapura
5	Mr. THDJDR Thirimanna	Anuradhapura	AI	North Central, PDOA, Anuradapura
6	Mr. Amith Wimalarathna	Anuradhapura	Deputy Director	IPDOA, Anuradapura
7	Mrs. Priyanjanee Madhawa	Anuradhapura	Provincial Director	NCP, PDOA, Anuradapura
8	Miss. Gayani Ratnayaka -	Anuradhapura	DD (Extension)	NCP, PDOA, Anuradapura
9	Mrs. Resha Dayarathna	Anuradhapura	DD (T&D)	NCP, PDOA, Anuradapura
10	Nilantha Upul	Anuradhapura	AI (PP)	NCP, PDOA, Anuradapura
11	Mrs. Renuka Fenando	Anuradhapura	AI (OFC)	NCP, PDOA, Anuradapura
12	Mr. RAMI Ranaweera	Anuradhapura	AI	NCP, PDOA, Anuradapura
13	Mr. SMS. Samarakoon.	Anuradhapura	Provincial Director	CEA, Anuradapura
14	Dr. Mrs Malima Perera	Anuradhapura	Director	FCRDI,Mahailuppallama
15	Mrs. Nishanthi Gunawardana	Anuradhapura	Principle Scientist, Ento.	FCRDI,Mahailuppallama
16	Mr. AGG Nandakumara	Anuradhapura	Provincial Deputy Director	ASMP Office, Anuradapura
17	Mr. JHHJB jayapathma	Anuradhapura	Agricultural Scientist	ASMP Office, Anuradapura
18	Mr. WK Rathnayaka	Anuradhapura	PHI (Admin)	MOH Office, Thalawa
19	Mr. PMN Dayarathna	Baticaloa	Provincial Deputy Director	ASMP Office, Baticaloa
20	Mr. Deepal Nawarathna	Baticaloa	Agricultural Scientist	ASMP Office, Baticaloa
21	Mr. S Sudaharan	Baticaloa	SMO (Plant Protection)	EP, PDOA, Baticaloa
22	Mrs. M Rubayshini	Batticaloa	SMO	EP, PDOA, Baticaloa
23	Mr. V Perinparaja	Baticaloa	DD (Extension)	EP, PDOA, Baticaloa
24	Mr. K Sri bavan	Baticaloa	AI	EP, PDOA, Baticaloa
25	Mr. K Nishanthan	Baticaloa	AI	EP, PDOA, Baticaloa
26	Mr. R Prabakaran	Baticaloa	AI	EP, ASC, Vaharai

ANNEX 02

No	Name	District	Designation	Organization
27	Ms.Mokshana Wijeratne	Colombo	Environmental Specialist	ASMP-WBG, Galle Road Colombo 03.
28	Dr.D.T. Kingsley Bernard	Colombo	Chairman	CARP, Vidya Mawatha, Colombo 07
29	Dr Frank Niranjan	Colombo	Deputy Director	CARP, Vidya Mawatha, Colombo 07
30	Mr. A.Junaid	Colombo	CBL Natural Pvt .Ltd	
31	Dr.Sapumal Dhanapala,	Colombo	Director	Occupational and community Health/MOH,Colombo
32	Dr.DBT Wijeratne	Colombo	Asst.regional representative FAO (Programs)	UN complex, Colobbo 05
33	Mr.S.Gnanaskandan	Colombo	PP	Lanka Fruit &Vegetables producers,processors & Exporters Association, Colombo
34	Mr.Suresh Elawala	Colombo	MD	Ellawala Horticulture Limited, Colombo
35	Mr. Ananda Pathirage	Colombo	CEO/Director	HJS condiments. Ltd
36	Mr.Ajitha Perera	Colombo	Managing Director	Hayley’s Agro, Colombo
37	Ms. Sandya Kumari	Colombo	Deputy Director	NPQS, Katunayaka
38	Mr. CK Naveendradas	Jaffna	M and E Specialist	ASMP Office, jaffna
39	Mr. Kandappu Pathmanadan	Jaffna	Provincial Deputy Director	ASMP Office, jaffna
40	Mr. M Vijithan	Jaffna	Agricultural Scientist	ASMP Office, jaffna
41	Mr.S Balakrishnan	Jaffna	SMO (Plant Protection)	NP, PDOA, Jaffna
42	Mr. K Predeepan	Jaffna	AI	NP, ASC, Chawakachchari
43	Mrs. P Sivasudas	Jaffna	AI	NP, ASC, Chawakachchari
44	Dr. Herath Ariyarathna	Kandy	Ex. Add director, HORDI	Pilimathalawa
45	Mr.S.S Weligamage	Kandy	Principle Scientist, Ento	HORDI, DOA, Peradeniya
46	Mrs. JKA Hettiarachchi	Kandy	Director SCPPC	SC&PPS,Gannoruwa
47	Dr. JA Sumith	Kandy	Registar of Pesticide	ROP Office, DOA, Gatambe
48	Dr. Mrs. Dayani Perera	Kandy	Director	PPS, DOA, Gannoruwa
49	Ms. KNS Ranathunga	Kandy	Director	E&T Centre, DOA, Peradeniya
50	Dr.KMP Bandara	Kandy	Expert	HORDI, DOA, Peradeniya

ANNEX 02

No	Name	District	Designation	Organization
51	Mrs.Disna Rathnasinghe	Kandy	Adl.Director,SL GAP Coordinator	E&T Centre, DOA, Peradeniya
52	Mr. S Rajeshkanna	Kilinochchi	ADA, Research	RARDC, Kilinochchi
53	Mr. AMJSB Adhikari	Mathale	AI	CP, PDOA, Mathale
54	Mr. MRGTK Ekanayaka	Mathale	AI	CP, PDOA, Mathale
55	Mr. RGN Wijebandara	Mathale	AI	CP, PDOA, Mathale
56	Miss. S Gunathilaka	Mathale	Agronomist	H1, MASL, Palwehera
57	Mr. EH jayaratna	Mathale	RPM	H1, MASL, Palwehera
58	Mr. BGB Harishchandre	Mathale	PHI (Inamaluwa)	MOH Office, Dambulla
59	Mr. MPK Dodanwala	Mathale	DD (Extension)	CP, PDOA, Mathale
60	Mrs. PK Senewirathna	Mathale	APD (agriculture)	CP, PDOA, Mathale
61	Mr. MB Disanayaka	Mathale	Provincial Deputy Director	ASMP Office, Mathale
62	Dr. KA Meththananda	Mathale	Agricultural Scientist	ASMP Office, Mathale
63	Mr. Sugath Wijethilaka	Mathale	M&E Specialist	ASMP Office, Mathale
64	Mr. RM Nandasiri	Monaragala	Deputy Project Director	ASMP Office, Monaragala
65	Mr. EMK Ekanayaka	Monaragala	Agricultural Scientist	ASMP Office, Monaragala
66	Mr. RMDP Dhanushka	Monaragala	AI	UP, PDOA, Monaragala
67	Mr. WDL Prasad	Monaragala	Subject coordinator	UP, PDOA, Monaragala
68	Mr. BGD Senadeera	Monaragala	AI	UP, PDOA, Monaragala
69	Mr. DS Mahadurage	Monaragala	AI	UP, PDOA, Monaragala
70	Mr. WRDKN Bandara	Monaragala	AI	UP, PDOA, Monaragala
71	Mr. WA Nilakshi	Monaragala	AI	UP, PDOA, Monaragala
72	Mr. HKP Jayalath	Monaragala	DD (Extension)	UP, PDOA, Monaragala
73	Mr. MMTS Mahakumbura	Monaragala	SMO (Plant Protection)	UP, PDOA, Monaragala
74	Mr. WKLAP Nilantha	Monaragala	SMO – Paddy and OFC	UP, PDOA, Monaragala
75	Mr. GHAT Saman Kumara	Monaragala	ABI	UP, PDOA, Monaragala
76	Mr. SU Ranasingha	Monaragala	Assistant director	IPDOA, Monaragala
77	Mr. AMPR Attanayaka	Monaragala	AI (PP)	IPDOA, Monaragala
78	Mr. N Geeganage	Monaragala	ABI	IPDOA, Monaragala
79	Mr. DADP Pushpakumara	Monaragala	Food and Drug Inspector	RHSS Office, Monaragala
80	Mr. A Ajanthan	Mullathev	Farm Manager	12 acre Farm, Oddusudan
81	Mrs. S Banujan	Mullathev	Technical Assistant	NP, ASC. Oddududan
82	Mr.Manoj Dissanayake	Nuwaraeliya	Regional Manager	Cargills Lanka Collecting Center, Nuwaraeliya
83	Mr Nawarathna Hettiarachchi	Nuwaraeliya	President	Green House Organic PVT LTD Nuwaraeliya

ANNEX 02

No	Name	District	Designation	Organization
84	Mr. Suresh Buwanaka	Nuwaraeliya	A farmer	Hawaeliya, Nuwaraeliya
85	Mr. BAP Chandradasa	Nuwaraeliya	A farmer	Shanthipura, Nuwaraeliya
86	Mr. Robert gamage	Nuwaraeliya	A farmer	Shanthipura, Nuwaraeliya
87	Mr. RMGB Kragahawaththa	Pollonnaruwa	Technical officer	NCP, PDOA, Polonnaruwa
88	Mr. RMJK Ranasigha	Pollonnaruwa	Technical officer	NCP, PDOA, Polonnaruwa
89	Mr. GRS Predeep	Pollonnaruwa	Agriculture instruction	NCP, PDOA, Polonnaruwa
90	Mis. Waruni Jayalath	Pollonnaruwa	AD (Agriculture)	NCP, PDOA, Polonnaruwa
91	Mrs. Samarakoon Menike	Pollonnaruwa	AD (Agriculture)	NCP, PDOA, Polonnaruwa
92	Mr. Aruna Yasapalitha	Pollonnaruwa	AI (Horticultural Crops)	NCP, PDOA, Polonnaruwa
93	Mr. Thusitha Herath	Pollonnaruwa	Block Manager	System B, MASL, Dimbulagala
94	Mr. Tharaka Wijesundara	Pollonnaruwa	Agronomist	System B, MASL, Dimbulagala
95	Mrs. AM Chandrika	Pollonnaruwa	Land Officer	System B, MASL, Dimbulagala
96	Mr. Gihan Guruge	Pollonnaruwa	IDO	System B, MASL, Dimbulagala
97	Mrs. GM Geethani	Pollonnaruwa	Field Assistant	System B, MASL, Dimbulagala
98	Mr. AMHS Adikari,	Pollonnaruwa	PHI, Aralaganwila	MOH Office, Aralaganwila
99	Mrs. DCM Liyanarachchi	Pollonnaruwa	DRPM (Agriculture)	System B, MASL, Welikanda
100	Mr. LM Premalal	Pollonnaruwa	A farmer	Susirigama, Welikanda
101	Mr. R Hariharan	Trincomalee	Add. Provincial Director	EP, PDOA, Trincomalee
102	Mr.Saman Premalal	Colombo	President	Crop Life Sri Lanka
103	Mr.Suresh Fernando	Colombo	Secretary	
104	Mr.Sumith Ponnamperuma	Colombo	CEO/Director	Control Union Inspection (Pvt) Ltd.
105	Mr.Shasika Rajapakse	Colombo	Certifier	
106	Mr.Nilushana Sooriyarachchi	Colombo	Biz.Dev.Consultant	SAPP (Sus.AgBiz Part.Prog.)
107	Mr.Bathiya Mallawarachchi	Gampaha	Director	CR Exports (Pvt) Ltd.
108	Mr.R.M.Ramsi	Madagama	Proprietor Rambuttan farm	Commercial Rambuttan grower
109	Mr.A.M.Aththanayake	Buttala	Director/CEO	Shehani Deshiya Oushada (Pvt) Ltd.
110	Mr.S.D.Gayan	Buttala	Manager	
111	Mr.A.M. Jayawardena	Colombo	Env. Specialist	ASMP/MOPI

ANNEX 02

No	Name	District	Designation	Organization
112	Mr. S. Dinatissa	Colombo	Value chain specialist	ASMP/MOPI
113	Mr. Haridas Fernando	Colombo	AGM (Agriculture)	Cargills Lanka Colombo

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