Food and Agriculture Organization of the United Nations

AVSI People for development

Handbook for Farmer Field School

on

CLIMATE SMART AGRICUTURE

in

coastal/delta zone

Myanmar

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"Sustainable Cropland and Forest Management in Priority Agro-ecosystems of Myanmar (GCP/MYA/017/GFF) Project"

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Foreword

The Food and Agriculture Organization of the United Nations (FAO) is implementing a project entitled **"Sustainable Cropland and forest management in priority agro-ecosystems of Myanmar (SLM-GEF)"** in coordination with the Ministry of Natural Resources and Environmental Conservation (MoNREC) and the Ministry of Agriculture, Livestock and Irrigation (MoALI) with funding from the Global Environment Facility (GEF).

The project aims to facilitate and strengthen sustainable land management (SLM), sustainable forest management (SFM), and climate-smart agriculture (CSA). The project facilitates the adoption of CSA policies and practices that will help to sustainably increase productivity, enhance resilience, reduce/remove GHGs and enhance achievement of national food security and development goals. At field level, the project is active in five pilot Townships from three different agro-ecological zones implementing various relevant CSA initiatives mainly using Farmer Field Schools (FFS) models.

- Upland/hill Pilot Site: Mindat and Kanpetlet Townships, Chin State
- Coastal/Delta Zone Pilot Site: Laputta Township, Ayeyarwady Region
- Central Dry Zone Pilot Site: Kyaukpadaung and Nyaung U Townships, Mandalay Region

AVSI Foundation was contracted as a Service Provider to develop the FFS curriculum and FFS Handbook for each of the above mentioned three agro-ecological zones. Accordingly, the FFS curriculum/module on CSA techniques/practices for the prioritized agricultural crops and cropping systems under each of the three agro-ecological zones have been developed incorporating solutions to the major problems identified during the need assessments and also considering the findings of value chain analysis. After finalizing the FFS curriculum, a FFS handbook has been developed for each agro-ecological zone both in Myanmar and English version. This handbook is intended to help the Extension Workers, FFS Facilitators and FFS Committee/farmers to implement FFS on CSA techniques and practices in costal/delta Region and scaling up the learnings in similar areas of Myanmar.

Ms. Xiaojie Fan

FAO Representative in Myanmar

Abbreviations

AESA	Agroecosystem Analysis
AVSI	Association of Volunteers in International Service
BMP	Best Management Practice
CA	Conservation Agriculture
CSA	Climate Smart Agriculture
DoA	Department of Agriculture
EM	Effective Microorganisms
FAA	Fish Amino Acid
FAAB	Farming as A Business
FAO	Food and Agriculture Organization of United Nations
FFS	Farmer Field School
FYM	Farm Yard Manure
GAP	Good Agricultural Practice
GEF	Global Environmental Facility
GFF	Global Financing Facility
GHG	Green House Gas
IMO	Indigenous Micro Organism
IPM	Integrated Pest Management
MoALI	Ministry of Agriculture, Livestock and Irrigation
MoNREC	Ministry of Natural Resources and Environmental Conservation
MRL	Minimum Residue Levels
MYA	Myanmar
PTD	Participatory Technology Development
SA	Sustainable Agriculture
SLM	Sustainable Land Management
SRI	System of Rice Intensification

1. Pre-Farmer Field School Introductory Meeting

Month: May

Week/Date: First Week

Time/Duration: Two Hours

Trainer(s): Facilitator **(**Staff from Department of Agriculture, Labutta Township

Material: Flipcharts, marker pens, training handout

Topics to be covered:

1. Objectives of FFS, guiding principle, FFS Famers selection, FFS Committee formation, selection of Lead Famer, etc.
2. Introduction of participants: facilitator, technical specialist, participants from villages.
3. Site selection for establishing demonstration plot (in Lead Famer's Field) also discussion and agreement on size (one acre), treatment to be included and layout of the demonstration plot.
4. Introduction of crops/species that will be covered in FFS training (Paddy,Green Gram and sunn hemp).
5. Collection of soil samples for soil analysis that will be sent to soil lab to get the base line data of pH ,soil texture, electrical conductivity, organic carbon, nutrient contents (N. P. K. Ca, Mg, S, Zn, B) and Na and related radicals (Cl, CO_3 and HCO_3).

Related Training Reference Materials:

1.1 Introduction and Objectives of Farmer Field School

The **Farmer Field School** (**FFS**) is a learning process whereby a group of farmers come together and engage in a process of hands-on field-based learning process over a season/production cycle. FFS is a time-bound learning by doing activity with a beginning and an end and aims to solve the problems related to cultivating crops.

FFS is a platform for holistic learning, and should address issues and aspects that directly or indirectly contribute to the performance of the local farming system, even if these issues are not agriculture-based as such.

All FFS programmes need to integrate programming on gender equality and nutrition concerns in FFS development. Gender norms, roles and customs are very relevant for FFS implementation such as assessment and targeting of the specific needs of male and female farmers, selection and gender awareness of facilitators, and composition of an FFS group (with adequate representation of women and girls) and targeting the specific needs and priorities of men and women.

This module of FFS has been designed to increase agricultural productivity of the priority crops in Labutta, by addressing the challenges identified during the needs assessment analysis conducted based on knowledge systems and practices by FAO with support of AVSI as a Service Provider. During the need assessment cultural barriers for FFS implementation, gender norms, traditions, etc. were considered. Generally, it's been observed that farmers, both men and women, have low knowledge of climate smart agriculture (CSA). The *learning objectives* of this module are to:

- Empower farmers with knowledge and skills to improve the productivity of the priority crops.
- Sharpen the farmers' ability to make critical and informed decisions that render their farming profitable and climate-smart.
- To sensitize farmers in new ways of thinking and problem solving regarding climate challenges.
- Help farmers learn how to organize themselves and their communities, with a focus on women and girls.

1.2 Key Steps of FFS Implementation

FFS implementation follows a following three phases approach in a crop season depending upon the duration of the crop cultivation.

I. **Preparatory Phase**

a. Situation Analysis,,
b. Village selection for FFS implementation,
c. Farmers selection for FFS,
d. FFS group formation and organization,
e. Selection and training of facilitators,
f. Selection of learning activity/enterprise, and
g. Design and setup of the FFS experimental field (demonstration plots). This is to comparethe current practices with improved/alternative practices.

II. **Basic FFS Cycle**

a. Regular learning cycles/sessions,
b. Evaluating participatory technology development (PTD) activities,
c. Gender-sensitive monitoring and evaluation to assess the different impacts on men and women.
d. Conducting field day (at the end of the season),
e. Organizing exchange visits (Exchange visits with other FFS), and
f. Organizing graduation ceremony.

III. **Post-graduation Phase**

a. Follow up activities,
b. Networking, and
c. Income generation and setting up second generation FFS, especially when new livelihood opportunities or challenges arise.

1.3 Pre-FFS Preparation

(a) Village Selection for the Establishment of FFS

There will be one FFS organized in each of the selected villages. FFS villages should be selected considering the following criteria:

- The villages should represent the specified agro-ecological zone.
- The villages should fall in the given pilot Township.
- The villages should be selected in such a way that they should represent the various variabilities within the given agro-ecological zone.
- The community in the village must be interested in and willing to take part in FFS activities. The community in the village should be informed about the FFS to be established in order to obtain formal consent and interest to partake in FFS activities.
- Sufficient number of men and women must be identified for the FFS Committee and to run the FFS to represent the interests and priorities of both male and female farmers. Additional knowledge created by women differs from men's due to their life experience; ensuring that both co-create the FFS thus significantly enriches the entire group.

As a general rule, to avoid duplication, FFS will only be established in villages where there are not already similar FFS activities supported by other organizations. However, if there is scope of complementarily and synergies with existing initiatives, FFS can be established in the same village.

(b) FFS Committee Formation

Facilitate the community in forming a FFS Committee comprising of 20-30 members, either through the formation of new group or strengthening of existing groups, ensuring an adequate number of women and girls. The gender dimensions should be analyzed and if men and women are generally involved in the farming activities, mixed FFS groups should be formed.

The main criteria applied for selection of participants should be as follows.

- Group (FFS Committee) of 20-30 farmers,
- Observe the gender, age and experience balance and encourage women and youth participation as far as possible,
- Farmers having experience of local production and livelihood system and to grow the crops, which are included in the FFS,
- All farmers grow crop, which is subject of FFS,
- Must be resident from the same village,

- Smallholder farmers (owning no more than 10 acres of land) or land users who are resource-poor and often have limited access to education, information, extension services, market access and financial capital,
- Farmers demonstrate interest and commitment to the full FFS cycle,
- Farmers demonstrate good attitude: eager to learn and share knowledge and experience, keen to work in the group, help to clean the site after the FFS session, etc., and
- Should continue for at least two subsequent crop cycles to see the results.

Facilitate FFS Committee to select a Chairperson, a Vice Chairperson, a Secretary, a Treasurer and a **Lead Farmer.** The Lead Farmer will host and take lead to establish study/ learning/ experiment/demonstration plot and will gradually take over the responsibility of FFS Facilitator from DoA Extension Officer from the second year onwards. Rest should be considered as general members. The other members of the FFS Committee will be responsible for taking part actively in the regular FFS meetings/training to contribute, to learn and to replicate the learning in their own field and to disseminate to other farmers.

(c) Selecting Lead Farmer (FFS Facilitator)

The FFS Facilitator is a technically competent person who facilitates hands-on exercises. The Lead Farmer/Facilitator should possess the following skills/characteristics.

- Must be a member of the FFS Committee of the respective village.
- **Social skills:** ability to engage everyone in the group into productive learning and exchange process, good communication and presentation skills.
- **Interpersonal skills:** non-judgmental, supportive attitude, sensitivity to group dynamics processes (e.g. managing dominant behavior).
- **Technical skills:** ability to lead the group through the process of improving the crop production according to CSA principles, prior experience (or education) in farming and agriculture, understanding of market economy.
- **Organizational skills:** ability to guide the process for setting up the demonstration field and ability to keep records.
- **Gender awareness:** ability to address potential gender barriers as well as to be familiar with concepts of social inclusion and social vulnerability.

- Qualified female member should be given priority as far as possible to become Facilitator/Lead Farmer. The FFS ToT programme will include gender mainstreaming issues/topics.

In the first year, while a Lead Farmer will be selected from among the FFS Committee Members, there will be a FFS Facilitator assigned by the respective Township DoA for each FFS who will be a technically competent person and will lead the group members through the hands-on exercises. From the second year onwards, the DoA Extension Officer will take a back seat only offering guidance when there is a need and the Lead Farmer will take over the responsibility of FFS Facilitator. Both the FFS Facilitator from the DoA Office and the Lead Farmer from the FFS Committee should ensure an adequate involvement of women and girls since the FFS is set up.

1.4 Collection of relevant information/data:

A village profile will be developed for each FFS village prior to the FFS implementation using a standard format. The village profile will include geographical information, demographic information, available resources and livelihoods opportunities, livelihoods profile of the people, major crops grown in the village, cropping patterns/calendar, major problems associated with priority crops, major needs of the community and analysis of the gender roles and the division of tasks of men and women for each of the selected crops, assessing their capacity and needs.

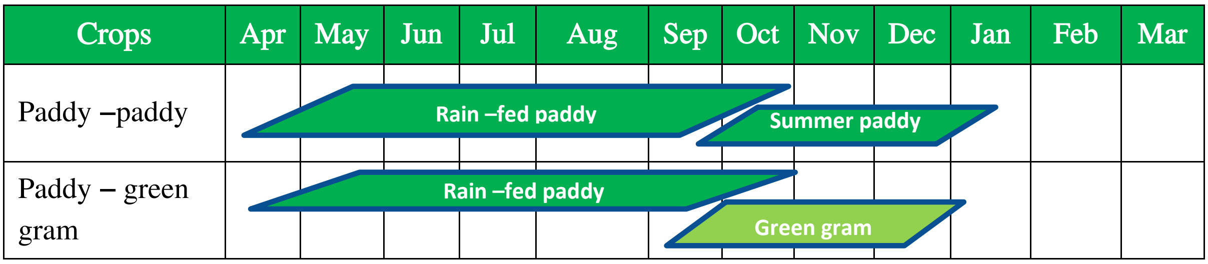
All the relevant information from the standing crops and post-harvest information will be obtained using a standard template. The tools, methods, and indicators/questions used will be gender-sensitive, i.e. they do not exclude women from being able to give their opinions, and by including questions that directly address gender inequalities in the context of implementation. Gender-disaggregated data/information will also be collected on FFS attendance and gender-sensitive indicators will be created accounting for the diversity of ethnicity, gender, age, class, religion, and culture in the impact assessment. Specific indicators will be developed that are able to measure the achievement of gender equality among programme participants. This may require disaggregation of data by sex and their analysis to identify functional relations and effects.

1.5 Guiding Principles of FFS in Costal/Delta Zone

As per the initial need assessment and value chain analysis done by FAO with AVSI Foundation as a Service Provider, paddy and green gram have been identified as the priority crops in the area based on technical feasibility, the crops already being grown in the area and have high market demand and contribute to improved nutrition of men and women and their households, especially children, the elderly and the disabled. Gender considerations will cut across all indicators for

data collection to ensure that information can be easily gender disaggregated. Therefore, the FFS module and FFS activities will cover those prioritized crops.

Cropping Calendar of the Potential Crops (Paddy, Green Gram, and Sunn Hemp) in Delta/Costal Zone



Source: Department of Agriculture, Labutta Township (Nov, 2017)

The guiding principles for this FFS module are:

- Working in groups (15-30 farmers),
- Season-long activities (following the season of crops),
- Regular meetings/sessions during the season. The formal meeting/training has been planned in the curriculum to be one time in a month however, the FFS Committee meet informally as and when needed,
- Study/learning demonstration plots/experiments to compare current practices with improved/alternative practices,
- Using group knowledge to solve problems,
- Role of facilitator: to facilitate group work, rather than impose knowledge,
- Technical expert to provide input on CSA techniques and practices related to: a) high resistance seeds to the adverse factors, b) soil testing practices, c) land preparation techniques, d) soil nutrients and water management, e) proper application of crop protection and crop nutrition substances, f) integrated pest management, g) post-harvest techniques (storage) and prospects for processing,
- Keep regular schedule of the meetings as specified in the FFS curricula for the Central Dry Zone presented in Annex 1,
- Observe the demonstration plot regularly after every FFS meetings and also outside the FFS meetings, as much as possible, to see the changes and any problems in the demonstration plot, and

- Keep the crop records during the whole cycle. Also analyze and keep record on how male and female farmers are actually benefitting from these crops and the new techniques and practices.

Once the FFS has started and demonstration plot has been established, each FFS meeting/session should include the following steps as much as possible (this should be reflected for each FFS meeting occurring after establishment of the crops till harvesting):

- Agro-ecosystem analysis (AESA),
- A group dynamics exercise,
- Special topic, and
- Feedback on the session. The feedback will include the views and perceptions of both men and women.

After the completion of the one cycle of FFS, the FFS Committee will need to continue the FFS on longer run on their own with minimum support from the project only for second year. The respective Township DoA Office will provide necessary technical supports as and when needed and will be responsible for the follow up activities. The DoA will also be responsible for monitoring the extent of adoption of newly acquired practices and how these are being scaled up in other neighboring communities.

The implementation of FFS **in Costal/Delta Zone** will follow the FFS Curriculum attached in Annex 1.

The main CSA techniques that could be used for FFS implementation **in Costal/Delta Zone** are described in the following sections of this handbook.

2. Farmer Field School Session - 1

Concept and Practices of Climate Smart Agriculture

Month:	June
Week/Date:	Second Week
Time/Duration:	Three hours
Trainer(s):	Facilitator **(**Staff from Department of Agriculture)
Material:	Flipcharts, marker pens, handouts of subject matters

Topics to be covered:

1. Concept of Climate Smart Agriculture
2. Concept of GAP and its practices
3. Concept of CA and its practices
4. Analysis of existing farming systems that affect the soil, the crop/plant, and environment from the participant's perspective (putting the points on the flipcharts) and general discussion on that (braining storming session)
5. Introduction to Climate Changes and its effects
6. Introduction of different cultivation practices of paddy applied in the area (broadcasting, direct seeding by drum seeders, transplanting by BMP/SRI: SRI practice will be applied in FFS as it is one of the CSA practices recommended by FAO)
7. Selection of paddy variety to grow in Demo Plot (Farmer's preference is Paw San Yin and registered seeds are available at Myaungmya Seed Farm and Certified seeds at DOA Labutta)
8. Preparation for nursery raising in Demo Plot by SRI practice (Detail descriptions are in the Handbook)
9. Keeping records on crop managements for each crop and data entry in every training session
10. Keeping financial records on input costs and general expenditures
11. Open discussion on the whole training session of the day and recording of participants feedbacks
12. Production of plans of actions for individuals to undertake at their own farms

Related Training Reference Materials:

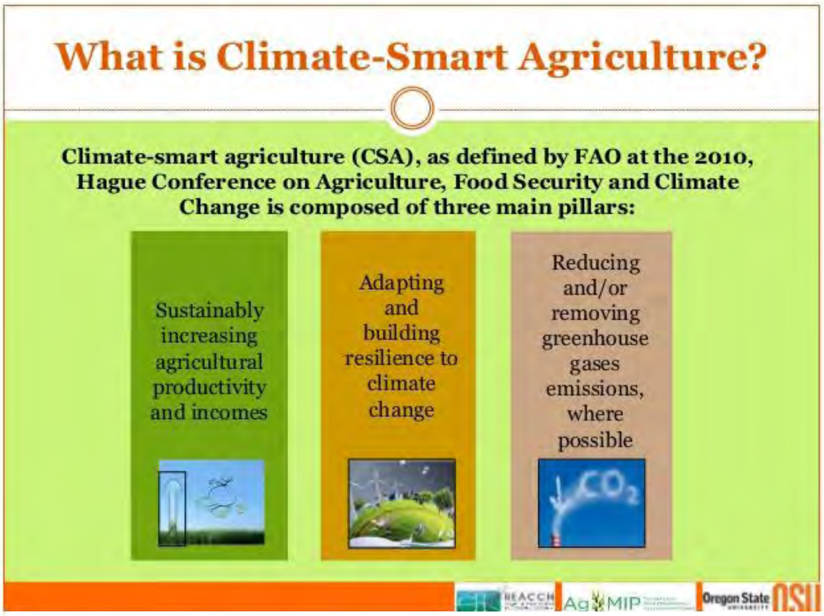
2.1 Climate Smart Agriculture

Climate-smart agriculture (CSA), as defined and presented by FAO at the Hague Conference on Agriculture, Food Security and Climate Change in 2010, contributes to the achievement of sustainable development goals.

CSA aims to sustainably improve agricultural productivity, enhance food security, boost farmers' adaptive capacity and resilience to climate shocks and contribute to GHG mitigation. Given limited understanding of farmers about CSA, the module aims to raise awareness of the principles of CSA. CSA approach integrates the three dimensions of sustainable development (economic, social and environmental) by jointly addressing food security and climate challenges.

It is composed of three main pillars:

1. Sustainably increasing agricultural productivity and incomes,
2. Adapting and building resilience to climate change, and
3. Reducing and/or removing greenhouse gases emissions, where possible.



Source: Adopting policies and priorities to encourage climate-smart agricultural practices: Susan Capalbo, Professor and Department Head, Applied Economics at Oregon, 2015

CSA is an approach to developing the technical, policy and investment conditions to achieve sustainable agricultural development for food security under climate change. FAO foresees a broader approach, working to build synergies among social protection and climate change to achieve sustainable growth and eliminate rural poverty. FAO uses a "twin-track" approach, on the one hand taking immediate steps to protect and support agriculture, food and nutrition, and

on the other addressing in the longer term the underlying factors driving risks, disasters and crises. FAO's work focuses on developing, protecting and restoring sustainable livelihoods so that the integrity of societies that depend on farming, livestock, fish, forests and other natural resources is not threatened by crises. CSA uses a comprehensive approach in seeking to improve rural livelihoods, increasing the productivity and resilience of poor communities, including rural women and girls, while also providing mitigation benefits.

Why is climate-smart agriculture needed?

Between now and 2050, it is estimated that the world's population will increase by one-third. Most of these additional 2 billion people will live in developing countries. At the same time, more people will be living in cities. If current income and consumption growth trends continue, FAO estimates that agricultural production will have to increase by 60 percent by 2050 to satisfy the expected demands for food and feed. Agriculture must therefore transform itself if it is to feed a growing global population and provide the basis for economic growth and poverty reduction. Climate change will make this task more difficult under a business-as-usual scenario, due to adverse impacts on agriculture, requiring spiraling adaptation and related costs.

Agriculture lies at the crossroads of climate-change mitigation and adaptation efforts. The agricultural sector is currently responsible for an estimated 13.7% of global greenhouse gas (GHG) emissions and is also a key driver of deforestation which contributes an additional 7-14% of global emissions. At the same time, climate change will have significant negative impacts on many agricultural communities, particularly smallholders and poor farmers who have limited capacity to adapt to adverse shocks, further exacerbating global poverty and food insecurity. Thus, both mitigation efforts to reduce GHG emissions and adaptation measures to maintain crop yields are of global significance.

Impact of climate change on small holder farmers

Many smallholder farmers in developing countries are facing food insecurity, poverty, the degradation of local land and water resources, and increasing climatic variability. These vulnerable farmers depend on agriculture both for food and nutrition security and as a way of coping with climate change. If agricultural systems are to meet the needs of these farmers, they must evolve in ways that lead to sustainable increases in food production and at the same time strengthen the resilience of farming communities and rural livelihoods.

Necessary interventions

Bringing about this evolution involves introducing productive climate-resilient and low-emission agricultural practices in farmers' fields and adopting a broad vision of agricultural development that directly connects farmers with policies and programs that can provide them with suitable incentives to adopt new practices.

CSA seeks to increase farm productivity in a sustainable manner, support farming communities to adapt to climate change by building the resilience of agricultural livelihoods and ecosystems, and, wherever possible, to deliver the co-benefit of reduced GHG emissions.

CSA is an approach that encompasses agricultural practices, policies, institutions and financing to bring tangible benefits to smallholder farmers and provide stewardship to the landscapes that support them. On the ground, CSA is based on a mix of climate-resilient technologies and practices or integrated farming systems and landscape management.

CSA also aims to strengthen livelihoods and food security, especially of smallholders, by improving the management and use of natural resources and adopting appropriate methods and technologies for the production, processing and marketing of agricultural goods.

This work is creating a better understanding about the trade-offs that may need to be made when striving to meet the interconnected goals of food security, climate change adaptation and climate change mitigation, and about the synergies that exist between these.

To ensure sustainable and long-term adoption of CSA practices, farmers need to receive immediate and long-term benefits from these practices in terms of improved food security, food production and income.

Because the adoption of CSA practices is largely determined by training sessions and farmer-to-farmer learning, it is important to support sustainable approaches for delivering extension services.

Adoption of CSA is very important for adaptation and mitigation of the adverse climate impact. There are two ways by which agricultural production can contribute to mitigate climate change:

- Reducing GHGs emissions per unit of land and/or agricultural products
- Enhancing soil carbon sinks.

Some of CSA practices

CSA is an umbrella term that includes many approaches, built upon geographically-specific solutions and characterized by a continuum of choices all aiming at making the agricultural sector better suited to handle the changes of a new climate. Some of the examples of CSA

techniques to be adopted in various agro-ecological zones are presented below of which relevant topics for Delta/Coastal Zone will be described in detail in the following sections.

1. Conservation Agriculture (CA)
2. Agroforestry
3. System of Rice Intensification (SRI)
4. Integrated Pest Management (IPM)
5. Good Agricultural Practices (GAP)
6. Integrated Soil and Plant Nutrient Management
7. Use of Varieties Tolerant to Adverse Factors
8. Water Conservation and Management, Water Harvesting
9. Water Saving Agriculture Techniques
10. Crop Cycle Management
11. Harvesting and Post-harvest Technologies
12. On-farm Storage Techniques
13. Business Model for Commercialization (improved financial management, product marketing and business planning)

Given limited understanding of farmers about CSA, the module aims to raise awareness of the principles of CSA, as part of theoretical input. CSA approach is embedded in all activities of this module and will be discussed throughout the whole training sessions in FFS.

2.1.1 Conservation Agriculture (CA)

Conservation Agriculture is a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment. CA is based on enhancing natural biological processes above and below the ground. Interventions such as mechanical soil tillage are reduced to an absolute minimum, and the use of external inputs such as agrochemicals and nutrients of mineral or organic origin are applied at an optimum level and in a way and quantity that does not interfere with, or disrupt, the biological processes. CA is characterized by three principles which are linked to each other, namely:

1. Continuous minimum mechanical soil disturbance;
2. Permanent organic soil cover; and

3. Diversified crop rotations in the case of annual crops or plant associations in case of perennial crops.

Source: Top 5 need-to-knows about CA (©FAO, 2014)

1. Continuous minimum mechanical soil disturbance

Conventional "arable" agriculture is normally based on soil tillage as the main operation. The most widely known tool for this operation is the plough, which has become a symbol of agriculture. Soil tillage has in the past been associated with increased fertility, which originated from the mineralization of soil nutrients as a consequence of soil tillage. This process leads in the long term to a reduction of soil organic matter. Soil organic matter not only provides nutrients for the crop, but it is also, above all else, a crucial element for the stabilization of soil structure. Therefore, most soils degrade under prolonged intensive arable agriculture. This structural degradation of the soils results in the formation of crusts and compaction and leads in the end to soil erosion. The process is dramatic under tropical climatic situations but can be noticed all over the world. Mechanization of soil tillage, allowing higher working depths and speeds and the use of certain implements like ploughs, disk harrows and rotary cultivators have particularly detrimental effects on soil structure. Excessive tillage of agricultural soils may result in short term increases in fertility, but will degrade soils in the medium term. Structural degradation, loss of organic matter, erosion and falling biodiversity are all to be expected.

Mechanical soil tillage by moldboard ploughs and disc harrows (Disc-plough-MASCHIO-2)
© Yucheng Machinery Manufacturing Co., Ltd.

Soil erosion resulting from soil tillage has forced us to look for alternatives and to reverse the process of soil degradation. The logical approach to this has been to reduce tillage. This led finally to movements promoting conservation tillage, and especially zero-tillage. Over the last two decades the technologies have been improved and adapted for nearly all farm sizes, soils, crop types and climatic zones.

Severe soil erosion in thoroughly ploughed plots
Left: Northern Shan, Myanmar (2014) (© FAO/U.Theinsu, 2014, Myanmar). Right: Mandalay Division, Myanmar (2017) (© FAO/U.Theinsu, 2017, Myanmar)

Experience has shown that these techniques, summarized as conservation agriculture (CA) methods, are much more than just reducing the mechanical tillage. In a soil that is not tilled for many years, the crop residues remain on the soil surface and produce a layer of mulch. This layer protects the soil from the physical impact of rain and wind but it also stabilizes the soil moisture and temperature in the surface layers. Thus this zone becomes a habitat for a number of organisms, from larger insects down to soil borne fungi and bacteria. These organisms macerate

the mulch, incorporate and mix it with the soil and decompose it so that it becomes humus and contributes to the physical stabilization of the soil structure. At the same time this soil organic matter provides a buffer function for water and nutrients. Larger components of the soil fauna, such as earthworms, provide a soil structuring effect producing very stable soil aggregates as well as uninterrupted macro pores leading from the soil surface straight to the subsoil and allowing fast water infiltration in case of heavy rainfall events.

Keeping the soil covered and planting through the mulch will protect the soil and improve the growing environment for the crop.

Spaces between sorghum rows covered by corn cobs' residues
(© FAO/U.Theinsu, 2017, Myanmar)

This process carried out by the edaphon, the living component of a soil, can be called "**biological tillage**". However, biological tillage is not compatible with mechanical tillage and with increased mechanical tillage the biological soil structuring processes will disappear. Certain operations such as moldboard or disc ploughing have a stronger impact on soil life than others as for example chisel ploughs. Most tillage operations are, however, targeted at loosening the soil which inevitably increases its oxygen content leading in turn to the mineralization of the soil organic matter. This inevitably leads to a reduction of soil organic matter which is the substrate for soil life. Thus, agriculture with reduced, or zero, mechanical tillage is only possible when soil organisms are taking over the task of tilling the soil. This, however, leads to other implications regarding the use of chemical farm inputs.

As the main objective of agriculture is the production of crops, changes in the pest and weed management become necessary with CA. Burning plant residues and ploughing the soil is mainly considered necessary for phytosanitary reasons: to control pests, diseases and weeds.

Burning crop and weed residues destroy an important source of plant nutrients and soil improvement potential. The phytosanitary motives for burning and ploughing can better be achieved by integrated pest management (IPM) practices and crop rotations (FAO).

No more tillage (left) and no more burning of residues (right) (© FAO/U.Theinsu, 2016, Myanmar)

Direct seeding or planting

Direct seeding involves growing crops without mechanical seedbed preparation and with minimal soil disturbance since the harvest of the previous crop. The term direct seeding is understood in CA systems as synonymous with no-till farming, zero tillage, no-tillage, direct drilling, etc. Planting refers to the precise placing of large seeds (maize and beans for example); whereas seeding usually refers to a continuous flow of seed as in the case of small cereals (wheat and barley for example). The equipment penetrates the soil cover, opens a seeding slot and places the seed into that slot. The size of the seed slot and the associated movement of soil are to be kept at the absolute minimum possible. Ideally the seed slot is completely covered by mulch again after seeding and no loose soil should be visible on the surface.

Land preparation for seeding or planting under no-tillage involves slashing or rolling the weeds, previous crop residues or cover crops, and seeding directly through the mulch. Crop residues are retained either completely or to a suitable amount to guarantee the complete soil cover, and fertilizer and amendments are either broadcast on the soil surface or applied during seeding.

Slashing of weeds (©FAO 2006, what is CA?)

Mowing of weeds (© FAO/U.Theinsu, 2016, Myanmar)

Ripping of sowing lines with no tillage, (© FAO/U.Theinsu, 2016, Myanmar)

Digging a hole for planting with no tillage (© FAO/U.Theinsu, 2016, Myanmar)

Seeding in sowing lines, (© FAO/U.Theinsu, 2016, Myanmar)

Manure and organic fertilizer application in sown lines, (© FAO/U.Theinsu, 2016, Myanmar)

2. Permanent soil cover

A permanent soil cover is important to protect the soil against the deleterious effects of exposure to rain and sun; to provide the micro and macro organisms in the soil with a constant supply of "food"; and alter the microclimate in the soil for optimal growth and development of

Soybean grown after paddy with no tillage and mulched (© FAO/U.Theinsu, 2017, Myanmar)

Emergence of soybean plants through straw mulch (© FAO/U.Theinsu, 2017, Myanmar)

soil organisms, including plant roots. Cover crops need to be managed before planting the main crop. This can be done manually or with animal or tractor power. The important point is that the soil is always kept covered.

Heavy mulching of sown lines, (© FAO/U.Theinsu, 2017, Myanmar)

Whole field completely mulched, (© FAO/U.Theinsu, 2017, Myanmar)

Diversified crops growing in the plot under heavily mulched, (© FAO/U.Theinsu, 2017, Myanmar)

Leucaena Hedgerow in the plot under heavily mulched (© FAO/U.Theinsu, 2017, Myanmar)

Conventional (left) and mulched (right),
(© FAO/U.Theinsu, 2012, Myanmar)

Effect of Mulching on crop growth, shorter height in conventional (front) and longer height at the side under mulched (back),
(© FAO/U.Theinsu, 2014, Myanmar)

The effects of soil cover

- Improved infiltration and retention of soil moisture resulting in less severe, less prolonged crop water stress and increased availability of plant nutrients.
- Source of food and habitat for diverse soil life: creation of channels for air and water, biological tillage and substrate for biological activity through the recycling of organic matter and plant nutrients.
- Increased humus formation.
- Reduction of impact of rain drops on soil surface resulting in reduced crusting and surface sealing.
- Consequential reduction of runoff and erosion.
- Soil regeneration is higher than soil degradation.
- Mitigation of temperature variations on and in the soil.
- Better conditions for the development of roots and seedling growth.

Means and practices

- Use of appropriate/improved seeds for high yields as well as high residue production and good root development.
- Integrated management and reduced competition with livestock or other uses e.g. through increased forage and fodder crops in the rotation.
- Use of various cover crops, especially multi-purpose crops, like nitrogen fixing, soil-porosity-restoring, pest repellent, etc.
- Optimization of crop rotations in spatial, timing and economic terms.

2.1.2 Crop rotations

The rotation of crops is not only necessary to offer a diverse "diet" to the soil microorganisms, but as they root at different soil depths, they are capable of exploring different soil layers for nutrients. Nutrients that have been leached to deeper layers and that are no longer available for the commercial crop can be "recycled" by the crops in rotation. This way the rotation crops function as biological pumps. Furthermore, a diversity of crops in rotation leads to a diverse soil flora and fauna, as the roots excrete different organic substances that attract different types of bacteria and fungi, which in turn, play an important role in the transformation of these substances into plant available nutrients. Crop rotation also has an important phytosanitary function as it prevents the carryover of crop-specific pests and diseases from one crop to the next via crop residues.

Crop rotation interrupts the infection chain between subsequent crops and making full use of the physical and chemical interactions between different plant species. Synthetic chemical pesticides, particularly herbicides are, in the first years, inevitable but have to be used with great care to reduce the negative impacts on soil life. To the extent that a new balance between the organisms of the farm-ecosystem, pests and beneficial organisms, crops and weeds, becomes established and the farmer learns to manage the cropping system, the use of synthetic pesticides and mineral fertilizer tends to decline to a level below that of the original "conventional" farming system.

The effects of crop rotation

- Higher diversity in plant production and thus in human and livestock nutrition.
- Reduction and reduced risk of pest and weed infestations.
- Greater distribution of channels or bio-pores created by diverse roots (various forms, sizes and depths).
- Better distribution of water and nutrients through the soil profile.
- Exploration for nutrients and water of diverse strata of the soil profile by roots of many different plant species resulting in a greater use of the available nutrients and water.
- Increased humus formation.
- Increased nitrogen fixation through certain plant-soil biota symbionts and improved balance of N/P/K from both organic and mineral sources.

Means and practices

- Use of appropriate / improved seeds for high yields as well as high residue production of above-ground and below-ground parts, given the soil and climate conditions.

- Design and implementation of crop rotations according to the various objectives: food and fodder production (grain, leaf, stalks); residue production; pest and weed control; nutrient uptake and biological subsurface mixing / cultivation, etc.

Rice bean after maize harvest,
(© FAO/U.Theinsu, 2016, Myanmar)

Mix cropping of maize and rice bean,
(© FAO/U.Theinsu, 2014, Myanmar)

Maize residues after harvest,
(© FAO/U.Theinsu, 2011, Myanmar)

Broad bean after maize harvest,
(© FAO/U.Theinsu, 2011, Myanmar)

General landscaping seen in Chin Hills,
(© FAO/U.Theinsu, 2011, Myanmar)

Residue of maize and cowpea in Chin
(© FAO/U.Theinsu, 2011, Myanmar)

Mix cropping of sunflower, sweet corn and chickpea, (© FAO/U.Theinsu, 2017, Myanmar)

Sequential cropping of peanut, upland rice and maize, (© FAO/U.Theinsu, 2017, Myanmar)

Mix cropping of sesame and green gram, (© FAO/U.Theinsu, 2017, Myanmar)

Mix cropping of peanut and pigeon pea, (© FAO/U.Theinsu, 2017, Myanmar)

Future Food Demand and Conservation Agriculture

Conservation Agriculture offers a powerful option for meeting future food demands while also contributing to sustainable agriculture and rural development. CA methods can improve the efficiency of input, increase farm income, improve or sustain crop yields, and protect and revitalize soil, biodiversity and the natural resource base. (Conserving resources above – and below – the ground).

"Conservation agriculture (CA) aims to conserve, improve and make more efficient use of natural resources through integrated management of available soil, water and biological resources combined with external inputs. It contributes to environmental conservation as well as to enhanced and sustained agricultural production." CA is a way of growing crops that is both good for farmers and good for the environment. Now *that's* sustainable!

2.2 Good Agricultural Practices (GAP)

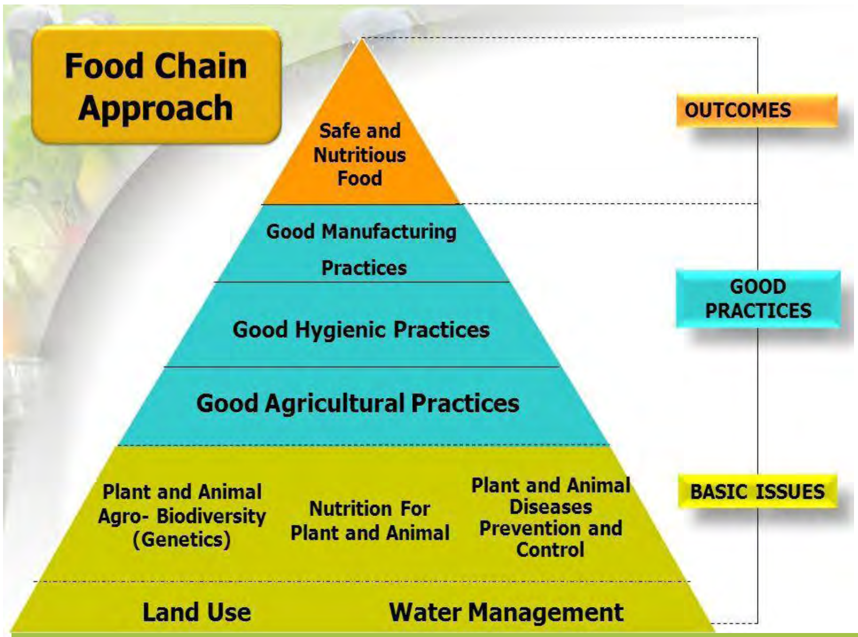
The FAO uses good agricultural practice as a collection of principles to apply for on-farm production and post-production processes, resulting in safe and healthy food and non-food agricultural products, while taking into account economic, social and environmental sustainability.

In other words, good agricultural practices are "practices that address environmental, economic and social sustainability for on-farm processes, and result in safe and quality food and non-food agricultural products"(FAO 2003).

GAPs may be applied to a wide range of farming systems and at different scales. They are applied through sustainable agricultural methods, economically and efficiently produce sufficient **(food security),** safe **(food safety)** and nutritious food **(food quality).**

The objective of these GAP codes, standards and regulations include, to a varying degree:

- ensuring safety and quality of produce in the food chain
- capturing new market advantages by modifying supply chain governance
- improving natural resources use, workers health and working conditions, and/or
- creating new market opportunities for farmers and exporters in developing countries.



Food chain approach from field to table (©Mahidol Univ.)

There are four 'pillars' in GAP:

1. Economic viability
2. Environmental sustainability
3. Social acceptability
4. Food safety and quality

These are included in most private and public sector standards, but the scope which they actually cover varies widely.

Safe produce begins with the production and handling practices on the farm. Produce that is grown and sold with little biological contamination is less likely to result in health hazards caused by poor handling during later preparation stages. Producers and their employees have the critical job of minimizing product contamination by learning about potential sources of contamination and by using Good Agricultural Practices (GAPs).

On-farm Food Safety: Guide to Good Agricultural Practices (GAPs)

Food safety concerns are increasing as once unheard of illness-causing microorganisms become more prevalent and as products previously considered safe cause an increasing number of illnesses each year. Produce, recently thought of as a safe product, has been identified as a cause of major food borne illness outbreaks in recent years. Illnesses are primarily caused by bacteria, viruses, parasites, and fungi.

These microorganisms, often referred to as pathogens or biological hazards, also are associated with ground beef, poultry, eggs, and seafood. Cooking is a common method of easily killing most pathogens in those foods. However, fresh produce is often consumed raw. In addition, produce is exposed to naturally occurring, biological hazards in the soil, water, and air. The potential risk for contamination is increased by production practices using manure for fertilizer and human handling of products. Developing a safety plan helps food producers manage the safety component of their operation by organizing the action steps identified as key to reducing those risks. Documenting of current practices and any changes over time allows for monitoring the safety of the food product.

GAPs focus on four primary components of production and processing: soil, water, hands, and surfaces.

Soil:

Maintaining **"clean soil"** reduces the risk of contaminating produce with illness-causing microorganisms found in soil during stages of growth and harvesting. Illness-causing microbes always are present in the soil, but their populations and resulting risk of product contamination can be increased tremendously by improper manure management and application. Although manure is a good form of fertilizer, all manure contains pathogens. Some pathogen levels in the soil will decrease over time due to competition from other bacteria in the soil or because of less-than-desirable conditions.

The following steps are recommended to minimize risks from manure.

- Incorporate manure or use cover mulch after application to reduce the risk of physical contamination of product from rain or irrigation splash.
- Allow a minimum of 120 days between manure application and fruit or vegetable harvest.

Water:

Water used for irrigation, cooling, processing, or for cleaning equipment and facilities should be free of microbial contaminants. Water quality and safety can be dependent on the water source. Municipal water usually has the best quality because of previous testing and safety requirements. Ground or well water will have fewer pathogens than surface water (such as ponds, streams, or rivers) because there is less chance of contamination. Regularly testing water sources provides documentation that the water is not a source of contamination. The frequency of water testing is dependent on the type of water source and the time of year. Water quality becomes more important as harvest approaches and water contact with the product occurs or increases. The method and timing of water use also has an effect on its contribution to product contamination. Using drip irrigation instead of sprinklers helps prevent contamination from soil splash and from product contact.

Putting vegetable on the ground, washing with unclean water causing great contamination (© ASEAN GAP, Food safety module, 2007)

Careful handling and washing in clean water for safety food, (© ASEAN GAP, Food safety module, 2007)

Hands:

Having "clean hands" refers to the human element involved in food safety during production and processing. The food producer and handler each have an important role in ensuring the safety and quality of foods grown and processed. Poor hygiene and health, unclean clothing or shoes, or unsafe practices on the part of workers can threaten food safety. Providing clean and appropriately stocked restroom and hand-washing facilities to field and processing employees helps prevent product contamination. A lack of restrooms results in unnecessary product contaminants in the field.

Hand-washing facilities provided, (© ASEAN GAP, Food safety module, 2007)

Preparing for packaging by washed and clean hands, (© ASEAN GAP, Food safety module, 2007)

Surfaces:

Produce items will have physical contact with many surfaces during harvest and processing. These may include harvest equipment and containers, transport bins, knives and other utensils, sorting and packaging tables, product packaging, and storage areas. Basic GAPs to help ensure clean surfaces include the following:

- Keep potential contaminants, such as soil and manure, out of the processing area or facility.
- Cull soiled produce in the field and damaged produce prior to processing.
- Use plastic containers and totes that are suitable for routine and efficient cleaning and sanitizing.
- Clean and sanitize equipment and facilities daily.
- Consider including a sanitizer in produce rinse water to reduce bacterial contamination.
- Control animal contamination sources, including pets, wildlife, birds, insects, and rodents.
- Develop guidelines for product storage and transportation.

Caring to be free from soil particles in the field at harvest, (© ASEAN GAP produce quality module, 2007)

Clean packaging tables, (© ASEAN GAP produce quality module, 2007)

Possible wounds and contamination during transportation by this packaging, (© ASEAN GAP produce quality module, 2007)

Pets and other animals near farm produce threatening for safety food, (© ASEAN GAP produce quality module, 2007)

Potential benefits of GAP

1. Appropriate adoption and monitoring of GAP helps improve the safety and quality of food and other agricultural products.
2. It may help reduce the risk of non-compliance with national and international regulations, standards and guidelines regarding permitted pesticides, maximum levels of contaminants, minimum residue levels (MRL) in food and non-food agricultural products, as well as other chemical, microbiological and physical contamination hazards.
3. Adoption of GAP helps promotes sustainable agriculture and contributes to meeting national and international environment and social development objectives.

3. Farmer Field School Session –2

System of Rice Intensification

Month: July

Week/Date: First week

Time/Duration: Three hours

Trainer(s): Facilitator **(**Staff from Department of Agriculture)

Material: Handout, flipchart, marker pens

Topics to be covered:

1. Introduction to the principles of SRI
2. Comparison of seed rates by existing farmers' practices and SRI practice
3. Germination of seeds (Detail descriptions are in the Handbook)
4. Broadcasting of germinated seeds on the soil in the frames at the rate of one tin of seeds on six frames
5. Land preparation of Demo Plot for transplanting in next ten days, leveling the field by temporary bunds if necessary
6. Fertilizer application prioritizing animal dung, compost and organic fertilizer, use of chemical fertilizer should be limited
7. Preparation of Home-made organic products (Indigenous Microorganism-IMO, Fish Amino Acid-FAA, Preparation of EM, Tobacco-chili-ginger pesticide, etc.)
8. Compost making exercise
9. Introduction of rearing of earthworms for compost production
10. Recording of expenditures in financial record book
11. Review on the individual's activity undertaken at their farms according to their plans in the previous training session
12. Production of individual's action plans to undertake at their farms

Open discussion on the practices already undertaken in the whole day session and feedbacks from participants.

Related Training Reference Materials:

3.1 System of Rice Intensification – SRI

SRI is a **management system** for rice changing how plants, soil, water, sunlight and nutrients are handled -- to produce ***more productive, more robust plants*** from any given variety, i.e., to get better **phenotypes** from any particular **genotype**.

SRI was developed in 1983 in Madagascar by Fr. Henri de Laulanié, S.J., who between 1961 and 1995 worked with Malagasy farmers and colleagues to improve the possibilities of rice production in this country. He wanted Malagasy people to have happier and more secure lives.

Fr.H.de Laulanie, Founder of SRI

SRI begins with a philosophy that rice plants are to be respected and supported as ***living creatures*** that have great potential. This potential will only be realized if we provide plants with the best conditions for their growth. If we help plants to grow in new and better ways, they will repay our efforts several times over. We do not treat them like little machines to be manipulated and forced to do things that are not natural for them to do.

Some of the things that have been done for hundreds of years by farmers in Madagascar and in countries around the world to make rice plants grow have unfortunately ***reduced their natural potential***. This new system of rice intensification changes these traditional practices to bring out of the rice plant significant possibilities for increasing production.

The yields that can be achieved by each individual farmer will depend on many things: on the careful and timely transplanting of seedlings, on the preparation and management of the soil in the field, on the control that is maintained over water, on the quality of the soil itself, on whether the variety of rice that is planted is really suitable for the growing conditions.

No purchase of new inputs -- neither new seeds nor chemical fertilizers -- is necessary for farmers to get much increased yields. The increases can be very great as rice plants grown with SRI methods have a very *different structure* than usual, with several times more tillers and much larger root systems that can absorb more nutrients from the soil.

The plants also have many times *more grain per panicle*. It has always been possible to get this different structure and this much greater productivity from rice plants. But this potential has not been elicited by the most appropriate practices to manage the plants, soil, water and nutrients.

The **result** is enhancement of the health and functioning of **root systems** and more abundant, diverse **soil biota.** These concepts and practices can be adapted for growing rice that is irrigated,

unirrigated or rainfed as well as other crops. SRI methods, by promoting growth of more productive and robust plants:

- Give ***higher yield*** -- more tons of rice per hectare or per acre,
- Require ***less seed and less water*** -- because plant populations are reduced, and paddy fields are not kept continuously flooded,
- Do not require purchase of ***external inputs*** – since chemical fertilizer or agrochemical protection are not necessary, although they can be used with the other practices, and
- Do not require the purchase of ***new seeds*** – since practically all rice varieties give higher yield with these methods, though **some high-yielding varieties respond better than others.**

SRI methods are particularly accessible to and beneficial for the poor, who need to get the maximum benefit from their limited land, labor, water and capital. However, SRI concepts and practices can be adapted and used with ***any scale of production***, from small-scale to large-scale. In an unprecedented way, **SRI methods raise the productivity of land, of labor, of water and of capital** all at the same time. SRI's higher productivity is making more rice available, with prospectively lower prices and with widely distributed benefits. Basically, the **management practices** that are recommended in the name of SRI promote:

- ***The growth and health of rice plant roots*** -- so that they grow larger and deeper, not degenerating for lack of oxygen in the soil, and
- ***The abundance, diversity and activity of soil organisms*** -- bacteria, fungi, earthworms and other soil biota -- that improve soil fertility and contribute to plant growth and health.

In practice, SRI involves some combination of the following changes in rice cultivation practices. These practices are summarized below.

1. ***Raise seedlings in unflooded nurseries (dry nursery bed)***, not planted densely and well-supplied with organic matter. (© FAO/U.Theinsu, 2017, Myanmar)

2. ***Transplant seedlings at a very young age*** – 8 to 12 days old, at most 14 days old, instead of the usual age for seedlings of 3-4 weeks or more. (© FAO/U.Theinsu, 2017, Myanmar)	
3. ***Transplant seedlings quickly, carefully and shallow*** – taking care to have minimum trauma to roots. (© FAO/U.Theinsu, 2017, Myanmar)	
4. ***Transplant seedlings at wider distance*** of 25x25 cm in a square pattern (© FAO/U.Theinsu, 2017, Myanmar)	
5. Transplant *singly* -- rather than in clumps of 3-4 plants (© FAO/U.Theinsu, 2017, Myanmar)	

6. Transplant seedlings in ***un-flooded*** plot. (© FAO/U.Theinsu, 2017, Myanmar)	
7. ***Do not continuously flood the soil*** – soil saturation causes plant roots to degenerate and suppress soil organisms that require oxygen; either apply *small amounts of water* daily, to keep soil moist but not saturated, or *alternately flood and dry* the soil. (© FAO/U.Theinsu, 2017, Myanmar)	
8. ***Weed control*** is preferably done with a simple mechanical hand weeder (Rotary Weeder). This *aerates the soil* as it eliminates weeds, giving better results than either hand weeding or herbicides. (© FAO/U.Theinsu, 2017, Myanmar)	

9. ***Provide as much organic matter as possible to the soil*** – while chemical fertilizer gives positive results with SRI practices, the best yields will come with organic fertilization. This does more than feed the plant: *it feeds the soil, so that the soil can feed the plant*. (© FAO/U.Theinsu, 2017, Myanmar)

The Key Practices in SRI

SRI is most easily visualized in terms of certain practices that are recommended to farmers for trying out on their own rice fields to improve the productivity of their rice crop. These practices are based upon important insights and principles that constitute SRI. The practices discussed below which are recommended for SRI are in effect the 'signature' of SRI. SRI recommendations change what are often age-old methods for growing irrigated rice. This means that even though the practices are simple, they may not be readily adopted. It is important always to emphasize the reasons for making changes in practice: to promote bigger, healthier root systems that support larger, more productive plants that grow in more fertile soil systems.

When establishing a rice crop by transplanting, use very young seedlings-- less than 15 days old, and preferably 8-12 days old in tropical climates. The usual age of seedlings used now is 3-4 weeks, and up to 6-7 weeks in some places. Seedlings older than about 14 days lose much of their potential for profuse growth of roots and tillers (stalks). Note that in colder climates, somewhat older seedlings, even up to 20 days, can be the physiological equivalent of 'young seedlings' because their growth will be slower.

Seedlings for transplanting should be grown in anun-flooded, garden-like nursery, watered by watering can, with a fairly low seeding rate, so that seedling roots have plenty of room to grow. Soil used should be very loose and rich in organic matter, for easy removal.

When taking seedlings out of the nursery, they should be removed very carefully, lifted with a trowel (unless being grown on trays for easy transport to the field). This will keep the seed sac attached to the root. Dirt should not be knocked off from the roots. Seedlings should be

transplanted quickly after being removed from the nursery so that their roots do not dry out, and they should be transplanted in the soil very shallow, just 1-2 cm deep.

Seedlings should not be pushed down vertically into the soil. This inverts their root tips upward. This will delay resumption of growth after transplanting. Root tips that are inverted take a week or more to reorient them downward and start growing again.

Seedlings should be transplanted into the field with wider spacing than usual: (a) putting single seedlings in each hill, instead of 3-6 plants together in a clump as is usually done, and (b) in a square pattern, 25x25 cm or even wider if or when soil fertility is very good due to biological activity. Square-pattern/grid planting permits weeding in perpendicular directions.

Paddy fields should not be kept continuously flooded as this creates oxygen-less (hypoxic) soil conditions that inhibit root growth and prevent the flourishing of aerobic soil organisms, ones that require oxygen. Small amounts of water should be applied daily to keep the soil moist but not saturated; or fields can be alternatively flooded and dried, which requires less work. Both serve the same purpose: keeping the soil moist but aerobic, i.e., oxygenated.

Whenever paddy soils are not kept flooded, weed growth becomes a greater problem. Weeds can be removed by hand or use of a simple mechanical weeding implement -- a rotating hoe or conoweeder -- starting 10-12 days after transplanting. Additional weeding are done every 10-12 days until rice plant growth inhibits further weeds. Active soil aeration enhances plant performance in many ways.

SRI was initially developed with use of chemical fertilizers to enhance soil nutrient supplies. But this requires a cash outlay from the farmer, and plant performance is even better with organic fertilization. We recommend application of compost of decomposed biomass, made from rice straw, weeds, crop residues, lopping from shrubs and trees, kitchen wastes, any available animal manure. Such organic matter is valuable not so only for its nutrient content but for what it can do to stimulate the growth and services of soil organisms. These services include improved soil structure, nutrient cycling, nitrogen fixation, phosphorus solubilization, better water absorption and retention, induced systemic resistance to soil pathogens, etc. These practices are mutually reinforcing. They nurture the growth of roots and canopies (leaves and tillers), and they reinforce each other through better nutrient acquisition and photosynthesis. There are a number of other practices that are beneficial when used together with any cultivation methods and thus complement SRI practices, including:

- **Land preparation:** Soil should be well worked and well-leveled so that there is good soil structure, and plant roots can grow easily. Correct leveling helps farmers to achieve uniform wetting of their soil through irrigation with a minimum application of water.
- **Varietal selection:** Choose a variety, improved or traditional, that is well-suited to local conditions (soil, climate, drainage, etc.), being resistant to anticipated problems like pests or irregular water supply, and having desired grain characteristics.
- **Seed selection:** Only the best seed, with good density and formation, should be used. Submerging the seed in a pail of water, with enough salt dissolved in it to make a salt solution in which an egg will float, enables farmers to separate and discard any light and inferior seeds as these will float. Just use the good seeds that sink to the pail's bottom.

Detail Practices

Nursery Raising

Nursery raising can be done on a bed of two feet length, one foot breath, and two inches depth. One cup (empty condensed-milk cup) of seeds can be spread out sparsely on six nursery beds. Twelve tins (less than two kilograms) were more than sufficient to cover one acre of paddy plot.

Removing the wooden frame after filling the soil (© FAO/U.Theinsu, 2017, Myanmar)

Seed broadcasting (© FAO/U.Theinsu, 2017, Myanmar)

Nursery raising in Foam Boxes
(© FAO/U.Theinsu, 2017, Myanmar)

Nursery raising in plastic trays
(© FAO/U.Theinsu, 2017, Myanmar)

Preparation of transplanting rows by row markers

Before transplanting, the rows are drawn by row markers to make easy for transplanting. This can be done by rakes of different teeth or by rollers.

Transplanting lines drawn by a simple rake
(© FAO/U.Theinsu, 2017, Myanmar)

Transplanting lines drawn by a roll marker
(© FAO/U.Theinsu, 2017, Myanmar)

Uprooting of seedlings

Binding of seedlings tightly making damage to seedlings in traditional practice
(© FAO/U.Theinsu, 2018, Myanmar)

Removing of soil particles attached to the roots by beating, making damage to roots
(© FAO/U.Theinsu, 2018, Myanmar)

Traditionally, nursery is raised in flood plot. The seedlings are uprooted and the soil particles attached to the roots are removed by beating the roots with the fibula. Seedlings are tied very tightly in bundles which causes wounds in tender seedlings.

Transplanting immediately after uprooting is not possible in traditional practice. The seedlings might be carried and transported to other areas, sometimes very far from the nursery.

Transporting from place to place by different means without caring the seedling damage (© FAO/U.Theinsu, 2018, Myanmar)

There is no uprooting of seedlings in SRI practice but just to take a piece of nursery bed. The whole nursery bed can be moved to transplanting plot.

A piece of nursery bed can be hold in the hand (© FAO/U.Theinsu, 2018, Myanmar)

Young seedling with seed sack still attached to the root (© FAO/U.Theinsu, 2018, Myanmar)

Transplanting

In traditional transplanting, the seedlings are transplanted in the flooded field. The flooded condition is not favorable for root growth.

Traditional transplanting in the water unfavorable for root growth (© FAO/U.Theinsu, 2018, Myanmar)

Young seedling with seed sack still attached at the base (© FAO/U.Theinsu, 2018, Myanmar)

One seedling at each point (© FAO/U.Theinsu, 2018, Myanmar)

In SRI method, young seedlings at the age of 8 to 12 days old are transplanted at a wider spacing of 25x25 cm square and one seedling at each hill. The seed sack attached to the stem can be seen easily.

Paddy fields are normally seen yellowish in color after transplanting in traditional practice and more than one seedling can be seen in each hill also.

Paddy fields seen after transplanting in traditional practice (© FAO/U.Theinsu, 2018, Myanmar)

In SRI practice, transplanted field can be seen as if no plant is transplanted beccause of youg seedlings planted at a wider distance.

Paddy fields seen after transplanting in SRI practice (© FAO/U.Theinsu, 2017, Myanmar)

Trasnplanted field is kept under water in traditional practice where as no water is flooded in the plot in SRI practice.

Paddy fields is flooded at all times in traditional practice (© FAO/U.Theinsu, 2018, Myanmar)

Paddy fields is not flooded at all times in SRI practice (© FAO/U.Theinsu, 2018, Myanmar)

Water is not kept in the field until cracks appeare on th soil surface in SRI practice. However, soil moisture is sufficient for plant growth and paddy plants can be seen green and strong.

Although cracks and crusts appeared in the field, still no need of irrigation if moisture is inside the soil and healthy seedling bearing tillers are seen (© FAO/U.Theinsu, 2018, Myanmar)

Weeding and intercultivating

After ten to 14 days of transplanting, the paddy field is irrigated and weeding is done by rotary weeder. This operation is not just only weeding but also turning up of the soil from bottom layer to surface which also aerates the root zone.

Weeding and inter-cultivation at 14 days after transplanting (© FAO/U.Theinsu, 2017, Myanmar)

Earthing up of tillage while weeding, function of weeder (© FAO/U.Theinsu, 2018, Myanmar)

Field seen after weeding (© FAO/U.Theinsu, 2018, Myanmar)

No more water in the field five days after weeding (© FAO/U.Theinsu, 2018, Myanmar)

The water irrigated in the field for weeding and intercultivation will be drained in the soil gradually after weeding operation. No more watering is done till next weeding time. The paddy plants are not kept under submerged condition. Hand weeding is also necessary to keep the paddy field to be free from weeds at all times.

In-country experiences with SRI practice

Some farmes in all States and Divisions are adopting SRI practice by the support and encouragement of Township DOAs since 2016 rainy season. Crop performances are very encouraging and yields are significantly increased. The following pictures show the performance of paddy by SRI practice.

Paddy field at 24 days old after weeding (left) and at 94 days old at near harvest
Aunglan Town, Magway Division (Same paddy field at different ages)
(© FAO/U.Theinsu, 2017, Myanmar)

Paddy field at 14 days old after transplanting (left) and at 115 days old at near harvest
State Institute of Agriculture, Shwebo (Same paddy field at different ages)
(© FAO/U.Theinsu, 2017, Myanmar)

Paddy field at 24 days old after transplanting (left) and at 150 days old at near harvest
Myaybon Town, Rakhine State (Same paddy field at different ages)
(© FAO/U.Theinsu, 2017, Myanmar)

Increased yields per acre in different locations are expressed in the following table.

Sr	Township	Paddy Variety	Yield (basket)/acre	Season
1	PheKhone	Hybrid 903	195	2017 summer
2	Nam Kham	Hybrid 413	164	2017 summer
3	Mai Sat	Sin-shwe-wa	143	2017 summer
4	Chaung Oo	Ninety Day var	135	2017 summer
5	Ye-za-gyo	ManawThukha	132	2017 summer
6	In-taw	Sin-ekayi 3	131	2017 summer
7	Ba-maw	Sin-ekayi 3	130	2017 summer
8	Myaung-mya	Thi-htat-yin	127.5	2017 summer
9	Pha-an	Sin-thukha	126.5	2017 summer
10	Aung-lan	Yadanar-toe	125	2017 summer

Significant Characteristics of SRI

1. Profuse root growth,
2. Proliferation of many tillers,
3. Bearing of many effective tillers with panicles, and
4. Can withstand the lodging effect.

1. Profuse root growth can be seen in SRI method

The two plants shown in the figure are same variety, same age, both 52 days old. The plant in the left-hand with only 5 tillers (stalks) and a meager root system was affected by the crowding and flooding of a conventional practice. Its SRI in the right-hand has many tillers and a large, healthy root system, stimulated by having space and aeration. The same genotype produced quite different phenotypes.

Same variety, same age but different performance
(© FAO/U.Theinsu, 2017, Myanmar)

2. Proliferation of many tillers

An SRI rice plant in Sagaing Division bears 135 tillers at 72 days after transplanting.

Rice plant with 135 tillers
(© FAO/U.Theinsu, 2018, Myanmar)

3. Bearing of many effective tillers with panicles

Many effective tillers were produced in SRI practice in 2008 in Pan Kham, Wa Region, Myanmar. Maximum number of grains per penicle was counted more than 400.

Many effective tillers bearing many grains,
(© FAO/U.Theinsu, 2008, Myanmar)

4. Can withstand lodging and pest incidents

More resistant **to storm damage and** lodging, to being knocked down by strong rain and high winds. This effect has been measured and quantified by. The effect is most clearly understood and appreciated visually, as seen on this page and the next one.

Lodging (front) in conventional plot, not affected (back) in SRI plot (© FAO/U.Theinsu, 2017, Myanmar)

Benefits That Can Be Achieved with SRI

1. Higher grain yields – 20-50%, even >100%,
2. Water savings – 30-50% reductions in irrigation,
3. Reduced costs of production – usually 10-20%,
4. Higher net farmer incomes – 50-100% or more,
5. Shorter crop duration – often 5-10 days or more,
6. Higher milling outturn by 10-20%, due to fewer unfilled grains & less breakage during milling, and
7. Greater resistance to pests and diseases and more tolerance of climatic stresses.

SRI as Climate-Smart Agriculture

- Reduced water requirements – higher crop water-use efficiency benefits both natural ecosystems and people in competition with agriculture for scarce water supplies.
- Less use of inorganic fertilizer – reactive N is “the third major threat to our planet after biodiversity loss and climate change” - already returns are greatly diminishing.
- Less reliance on agrochemicals for crop protection - which enhances the quality of both soil and water.
- Buffering against the effects of climate change - drought, storms (resist lodging), cold temperatures.
- Some reduction in greenhouse gases (GHG) – CH4 is reduced without producing offsetting N2O emissions; also some reductions made in ‘carbon footprint’ with less production, transportation and use of fertilizers.

3.2 Preparation of Homemade Organic Compounds

3.2.1 Indigenous Micro Organism (IMO)

This method is widely used by farmers in Pakistan and India and called *Jiv Amrit* or *Amrit Pani*. By using this method the urine and dung of one cow is enough to inoculate IMO for 30acres. It is not meant to fertilize but rather to culture effective micro-organisms that will improve soil ecosystem and fertility.

Objective

To improve and sustain soil ecosystem, fertility and crop yield in the long run but also escape from dependency on non-renewable external inputs by using *Jiv Amrit* because no further application of other fertilizers is needed after application of two consecutive cropping seasons.

Preparation of Indigenous Micro-organism (IMO)

Ingredients	**Amount**
• Fresh cattle dung	6.5 visses
• Fresh cattle urine	10 liters
• Jaggery (toddy or sugarcane)	1.5 visses
• Chickpea power	1.5 visses
• Soil from 4” depth, underneath bamboo trees	0.5 visses
• Water	50 gallons

All ingredients are put into the 53 gallon plastic-barrel and stirred thoroughly. The barrel is covered with bamboo tray. In dry season, the color turns to ample color with fermented odor in 12 days. In cold season, it takes about 20 days. The liquid can be applied directly to the root zone of the growing plants and also can be used as foliar spray.

Indigenous Micro Organism solution (© FAO/U.Theinsu, 2017, Myanmar)

Apply at least 6 times during one crop season, starting from the initial stage. The more you use the better because it is not a nutrient solution but it contains about 75,000 types of micro-organisms that will help improve the soil ecosystem of your farm and nutrient availability to the crops. Remember that mineral or nutrients are abundant (*See that 78% of atmospheric gas is of N_2 and accounting to 8 tons of N_2 on 1sq. meter. No input comes from outside of the farm in Sustainable Agriculture (SA)*) naturally which are made easily available for the plant with

microbial action. Don't go for mono-cropping, better go for multi cropping -mix cropping pattern. After using this method for 2 years you need not to apply any fertilizer.

Collection of fresh cow urine on cement floor with a small channel (© FAO/U.Theinsu, 2017, Myanmar)

3.2.2 Fish Amino Acid (FAA)

Commercially available fertilizers are cost-effective means of supplementing soil with nitrogen (N) for plant growth and high crop yields however, improper or excessive use of N fertilizer can lead to nitrate pollution of ground or surface water. Producers can minimize this predicament by implementing Best Management Practices (BMPs) for fertilizer use that reduce nutrient losses and avert runoff and leaching from agricultural lands. Natural Farming incorporates the use of indigenous microorganisms (IMO) and fish amino acid (FAA) to increase N availability in soils and improve crop yields while sustaining water quality. This fact sheet addresses the production and use of FAA in Natural Farming.

Fish fertilizer is an awesome product for promoting plant growth. It's high in Nitrogen for growing plants, can be naturally produced, and is an awesome food for microbes! Fungi love this stuff. Fish fertilizer can be expensive in the store, but it is easily produced at home.

Preparation of Fish Amino Acid (FAA)

In the rcipe, fish heads, skins, guts, and meat are broken down by wild microbes in a semi-controlled setting that nurtures positive microbes and turns the fish into a golden liquid fertilizer that is rich in nitrogen and trace minerals. It can take 21 days to be ready for use.

Ingredients	Amount
1. Fish waste	5 visses
2. Jaggery/Molasses (Toddy, Sugarcane)	5 visses

Fresh fish wastes and viseral organs are put in a plastic bucket. The same weight of jaggery or molases is put in the bucket and the two are mixed thoroughly. At least one-third of the portion inside the bucket is left to prevent the overflow of the liquid during the fermentation process.

Cutting of fishes and mixing in toddy jaggery (© FAO/U.Theinsu, 2017, Myanmar)

Fermenting (left) and FAA syrup ready to use (© FAO/U.Theinsu, 2017, Myanmar)

Use of FAA

FAA is applied as a source of nitrogen during the early or vegetative stage of development to boost growth and size. Do not apply FAA if plants are at the reproductive stages of their production cycle when flowering or fruiting is desired.

FAA is diluted with water (1:1,000) or (2-5 ml in one liter of water) or 2 table-spoons in one gallon of water. It can be used in a “cocktail” with other Natural Farming inputs and applied as a light foliar spray or soil drench. For leafy vegetables, spray weekly to improve yields, fragrance, and taste. Avoid spray applications during full sunlight hours to prevent foliar burning and evaporation of the solution before the plant has had a chance to absorb it.

Like all fertilizers, it's most effective to apply fish products when the microbes are active and able to use the nutrients you're providing them. This means warm temperatures and sufficient moisture.

Fish fertilizers can be applied directly to soil, or make great additions to foliar spray, especially when mixed with Effective Microorganisms.

Liquid forms can also work well in hydroponic applications. Dilution rates vary widely, so it's best to check the specifics of the product you're using.

3.2.3. Tobacco-chili- ginger pesticide

Preparation of Tobacco-chili- ginger pesticide

Ingredients	Amount
1. Tobacco (Dried leaves)	0.5 visses
2. Ginger	0.5 visses
3. Chili	0.5 visses
4. Effective Microorganism-EM	1.0 liters
5. Water	50 liters

Tobacco, ginger, and chili are grinded separately and all are put in plastic barrel. One liter of EM and 50 liters of water are added in the barrel and then they all are stirred thoroughly. The barrel is covered with a piece of cloth. After about 10 to 15 days, it can be used to apply for pest control. The liquid extract is sieved and the residues can be used as fertilizer. The liquid is diluted at the ratio of 200 ml in 4 gallons of water.

It can prevent army worms, white fly, thrips, aphids, hairy caterpillar, cut worms, and pod borers, etc.

Dried tobacco leaves (© FAO/U.Theinsu 2017, Myanmar)

Ginger rhizomes (© FAO/U.Theinsu, 2017, Myanmar)

Fresh Chili, (© FAO/U.Theinsu, 2017, Myanmar)

EM concentrate
(© FAO/U.Theinsu)

Under processing
(© FAO/U.Theinsu, 2017, Myanmar)

4. Farmer Field School Session - 3

General Discussion and Field Practice on SRI

Month:	July (Third Week)
Week/Date:	First week
Time/Duration:	Morning three hours and afternoon two hours
Trainer(s):	Facilitator **(**Staff from Department of Agriculture)
Material:	Handout, flipcharts, marker pens

Topics to be covered:

1. Concept of paddy not the aquatic plant: weak growth of paddy plats under submerged condition;
2. Transplanting of ten-day old seedling (Detail descriptions are in the Handbook);
3. Open discussion on the transplanting practice of SRI and individual's opinion and comments are recorded;
4. Group Dynamic Exercise;
5. Special Topic;
6. Review on the individual's activity undertaken and analyzing the strengths and weakness; and
7. Production of individual's action plan to undertake at their farms.

4.1. Group Dynamic Exercise

Group dynamics is that part of the FFS activities which helps to strengthen group cohesion and enhance cooperation. Various ways could be formulated that help the group to become enlivened and motivated, such as role playing, brain teacher, case story and short drama. The message contained within the group dynamics should compromise of communication, leadership mobilization, and problem solving and planning. Below are examples of group dynamic that can be used for FFS:

- Nine dots
- Landing on the moon
- Broken square
- Sale of sheep

- Handcuff
- Story telling

4.2. Special Topics

Special topics offer support to the AESA, where very simple demonstrations will carried out, either in the field or at the meeting place. The topic could be selected from the list provided, but the facilitator can develop more innovative and creative topics relevant to the farmer's needs. The special topics proposed in general covers the following:

- Climate Resilient Crop and Varieties in upland farming
- Climate-smart agricultural ecosystems/soils and their management for CSA
- Appropriate Farming Techniques
- Life Cycle of Pest and Testing on Integrated Pest Management Practices
- Economic Analysis on Cropping Intensification for farming

5. Farmer Field School Session–4

Integrated Pest Management

Month: August

Week/Date: First week

Time/Duration: Four hours

Trainer(s): Facilitator **(**Staff from Department of Agriculture)

Material: Flipcharts and marker pens

Topics to be covered:

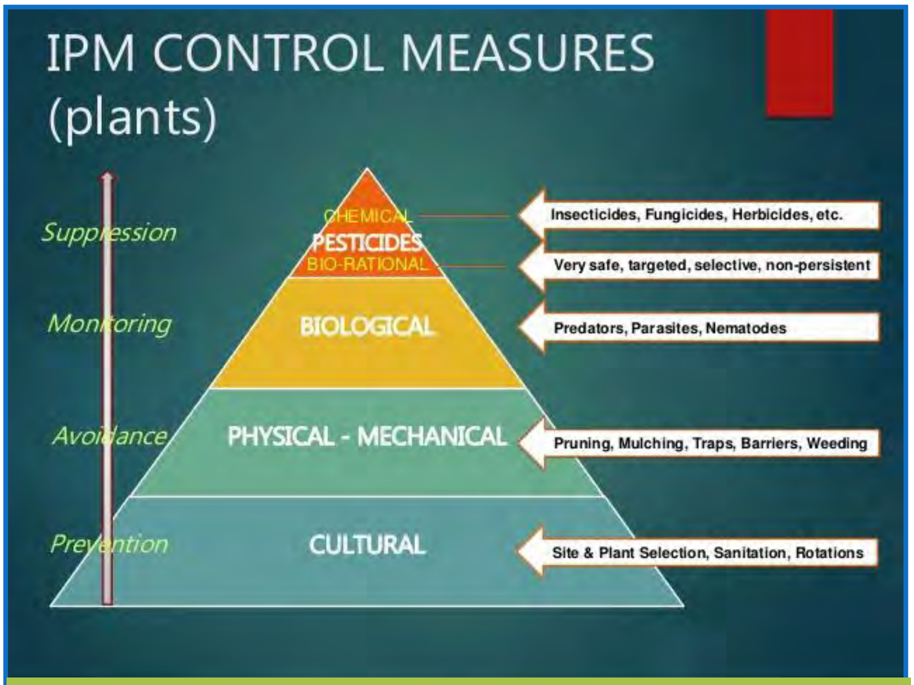
1. Concept of IPM and practices
2. First weeding and inter-cultivating the paddy field after two weeks of transplanting, not beyond 24 days after sowing, by mechanical weeder (herbicide application is strictly prohibited)
3. Application of home-made organic fertilizers (IMO, FAA, EM) at the time of weeding
4. Following manual weeding after rotary weeding if necessary
5. Insect survey, insect collection and identification of beneficial and pests
6. Counting tillers – minimum, maximum and average by marking specific plants for continuous tiller counts
7. Special caring on water management, not to be flooded all the time, breaking the bunds at the lower portion of the field
8. Recording of crop performances in crop management record books
9. Review on the individual's activity undertaken and analyzing the strengths and weakness
10. Production of individual's action plan to undertake at their farms
11. Open discussion on the whole training session of the day and recording of participants feedbacks
12. Second time weeding will be followed after next two weeks, i.e. at the age of about 40 days paddy plant and necessary arrangement is to be done.

Related Training Reference Materials:

5.1. Integrated Pest Management (IPM)

"Integrated pest control is a pest management system that, in the context of associated environment and population dynamics of the pest species, utilizes all suitable techniques and methods in as compatible a manner as possible and maintains pest populations at levels below those causing economic injury" **(FAO, 1967).**

IPM is a systematic strategy for managing pests which considers prevention, avoidance, monitoring and suppression. Where chemical pesticides are necessary, a preference is given to materials and methods which maximize public safety and reduce environmental risk.



Application of pesticideS is the last option in IPM.

(© SATNET training manual, 2011)

The control measures that are involved in this management are generally classified as:

(1) Physical control,

(2) Cultural control,

(3) Biological control, and

(4) Chemical control.

Recently, genetic control – meaning the use of genetically-resistant varieties -- has been highly promoted.

1. Physical Control

Traps (Light traps, Sticker traps), barriers, weeding, mulching, and pruning)

2. Cultural Control

Site and plant selection, sanitations, rotations

3. Biological Control

Predators, parasites, nematodes

4. Chemical Control

Insecticides, fungicides, herbicides (Very safe, targeted, selective, non-persistent)

The IPM concept is based on the principle that it is not necessary to eliminate all the pests but to suppress the pest population to a level at which these pests do not cause significant losses. An integrated strategy for crop pest management includes use of resistant varieties modifying agronomic practices to reduce pest incidence, biological control and other novel approaches for pest suppression and only need based judicious use of chemical pesticides.

5.1.1 Five steps in implementing IPM

Five steps in implementation of IPM (© SATNET training manual, 2011)

a. Inspection and identification

Not all insects found in the farm are pests, some are beneficial insects. It is crucially needed to identify these two types wisely. Even though the pests are found in the farm, if their numbers are not at the threshold level, it does not need any control measures.

b. Findings and recommendations (in written)

All findings are noted and documented in the record book. Suitable recommendations will be provided based on findings.

c. Client communication

Farm owner will be communicated and informed the findings and recommendations for further follow up actions.

d. Implementation

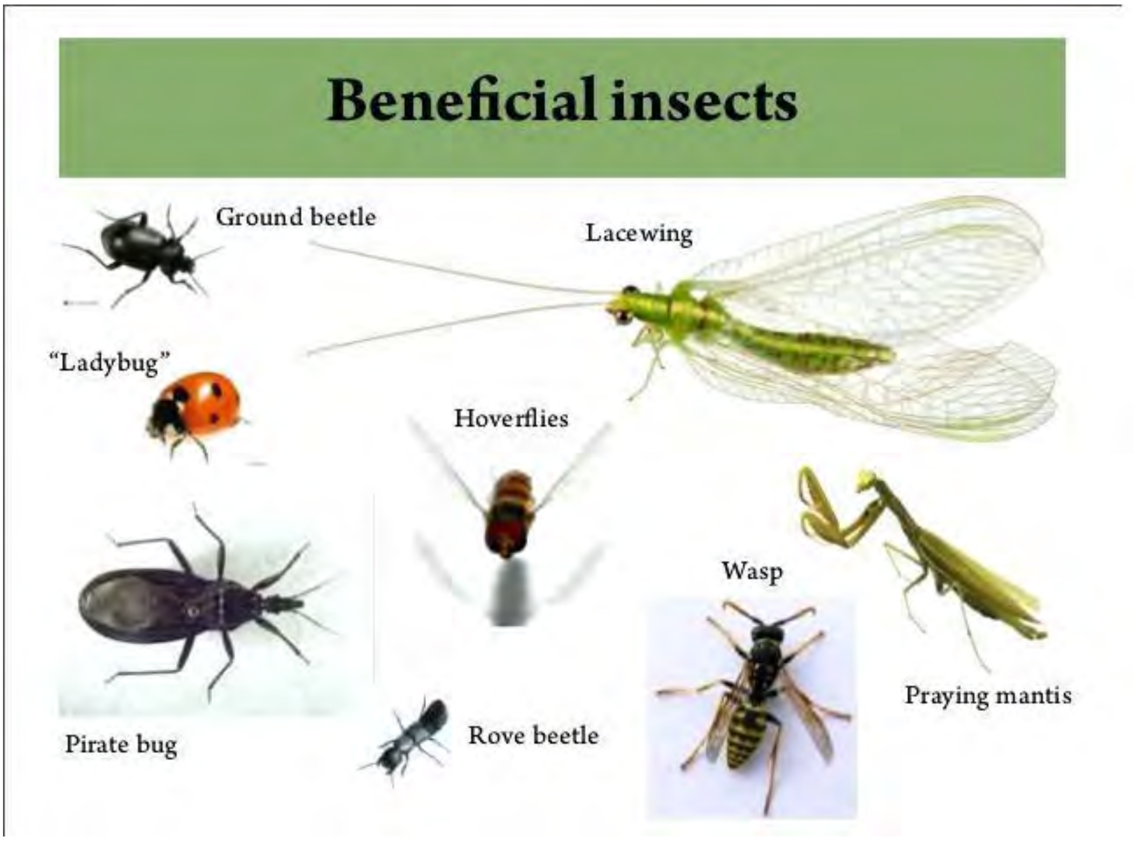
Four levels of control measures will be applied when infestation is above the threshold level.

e. Documentation and follow-up

All the activities of control practices taken in the farm will be documented in farm record book. There will be necessary follow-up actions throughout the whole cropping season constantly.

5.1.2 Practical exercise in the farm in FFS

Step 1: Making field inspections - in sub-groups (four to five persons with gender balance), farmers make observations in the field and insect collection will be made using insect collection nets. Sub-group members count the insects collected and identify the pests and beneficial insects by the aid of Beneficial Insect Chart.



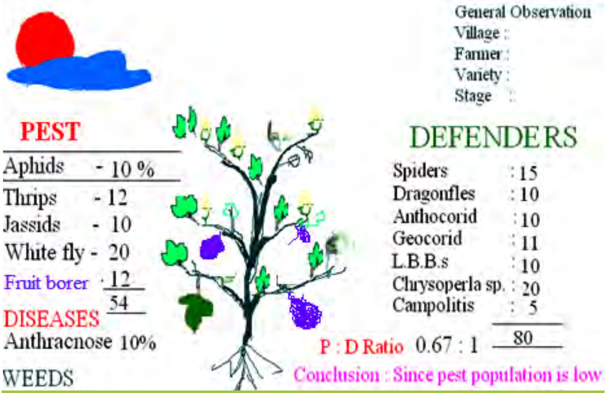
(© Fotsos.com, 2018)

Step 2: Analyzing and recording findings – each sub-group structure, reflects on, records and analyze their findings from the field, including different pests and their population, different beneficial insects and their population, and making drawings of the field situation and elaborate decisions and recommendations.

Step 3: Presenting the feedback - In plenary, each sub-group presents their results and conclusions. Feedback and questions from the other groups require the group to defend their decisions with logical arguments.

Step 4: Discussing actions to take - In a plenary, the participants synthesize the presentations and collectively agree and decide what actions to implement based on the decisions they have taken.

Pest (© SATNET training manual, 2011)



Beneficial insects

Presentation by sketch pictures
(© SATNET training manual, 2011)

Finding with the ratio of (1.0:1.5) pest and pes
(© SATNET training manual, 2011)

Presentation by group's finding and suggestion

6. Farmer Field School Session –5

Agroecosystem Analysis

Month: September

Week/Date: First week

Time/Duration: Four hours

Trainer(s): Facilitator (Staff from Department of Agriculture)

Material: Flip Chart and marker pens

Topics to be covered:

1. Agroecosystem Analysis Exercise – Groups comprising of five Participants will study and make records on the following in Demo Plot: i) the effectiveness of SRI and other CSA practices, ii) plant establishment and tillering, iii) soil organic matter and soil moisture conditions, iv) incidence of weeds and v) overall crop performances and incidences of pest and diseases etc.
2. Recording of findings by groups
3. Group presentations on their findings and responding to questions raised by other groups
4. Making decisions and recording of important points for further actions for improvement
5. Green Manure
6. Importance of water management in tiller formation and tiller numbers
7. Counting tillers in specified plants
8. Keeping of water in the field when the plant age is around 85 DAS (stage of Ear Primordial Initiation – EPI)
9. Application of home-made fertilizers, EM, FAA, and pesticides
10. Recording of crop performances in crop management record books
11. Recording of expenses in financial record book
12. Review on the individual's activity undertaken and analyzing the strengths and weakness
13. Production of individual's action plan to undertake at their farms
14. Open discussion on the whole training session of the day and recording of participants feedbacks

Related Training Reference Materials:

6.1 Agroecosystem Analysis (AESA)

Agroecology is defined as the study of the interactions between plants, animals, humans and the environment within agricultural systems or the study of relation of agricultural crops and environment. Following this definition, an agroecologist would study agriculture's various relationships with soil health, water quality, air quality, meso and micro-fauna, surrounding flora, environmental toxins, and other environmental contexts.

The health of a plant is determined by its environment. This environment includes physical factors (i.e. sun, rain, wind and soil nutrients) and biological factors (i.e. pests, diseases and weeds). All these factors can play a role in the balance which exists between herbivore insects and their natural enemies. If we understand the whole system of interactions, we can use this knowledge to reduce the negative impact of pests and diseases.

Agroecology provides the knowledge and methodology necessary for developing an agriculture that is on the one hand environmentally sound and on the other hand highly productive, socially equitable and economically viable.

In conclusion, an **agroecosystem** is the basic unit of study in agroecology, and is defined as a spatially and functionally coherent unit of agricultural activity, and includes the living and nonliving components involved in that unit as well as their interactions.

Agroecosystem analysis is a thorough analysis of an agricultural environment which considers aspects from ecology, sociology, economics, and politics with equal weight. Agroecosystem analysis is a tool of the multidisciplinary subject known as Agroecology. Agroecology and agroecosystem analysis are not the same as sustainable agriculture, though the use of agroecosystem analysis may help farming system ensure its viability.

Agroecosystem analysis is not a new practice, agriculturalists and farmers have been doing it since societies switched from hunting and gathering (hunter-gatherer) for food to settling in one area. Every time a person involved in agriculture evaluates their situation to identify methods to make the system function in a way that better suits their interests, they are performing an agroecosystem analysis. Agro-ecosystem analysis (AESA) is a tool to assist farmers to develop skills and knowledge about the ecosystems and consequently, how to make better decisions.

AESA can be done by the following steps:

Step 1: Making field observations - in sub-groups (four to five persons), farmers make observations in the field based on a range of monitoring indicators. Emphasis is on

observing the interactions between various factors in the agro-ecosystem. AESA observations should include:

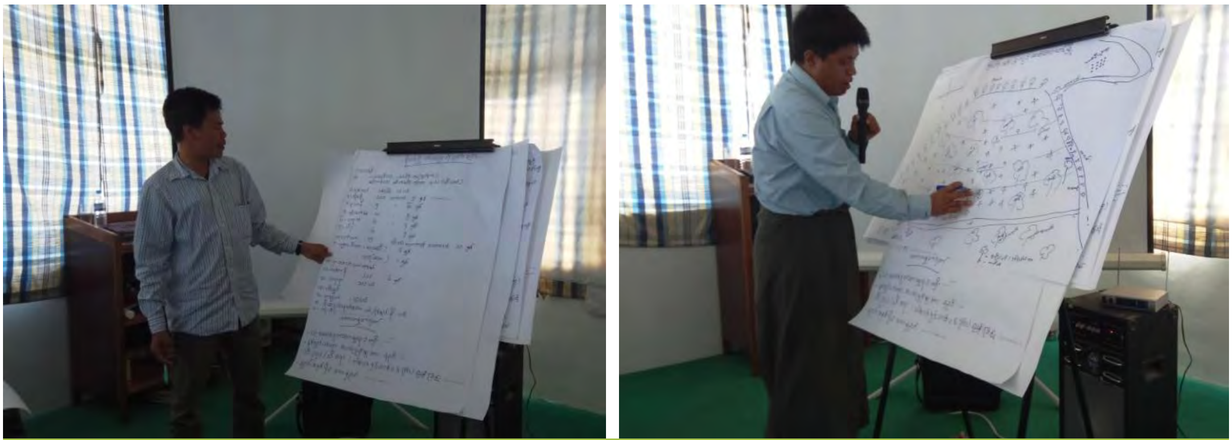
1) Agronomic Data (plant height, no. of leaves /plant, no. of flowers/plant, no. of fruits/plant, weight of harvested fruits)
2) Plant Protection Data (counting insect pests, counting natural enemies, disease incidence)
3) Weed growth (different kinds, prevailing ones, leguminous weeds, weeds leaving high amount of residues)
4) General Data (variety, days after planting, weather condition, soil condition)

Field observations by sub-groups (Pleases note the gender) (© FAO, ToT in 2018)

Step 2: Analyzing and recording findings – each sub-group structure, reflects on, records and analyze their findings from the field, including making drawings of the field situation and elaborate decisions and recommendations.

Recording, reflecting, analyzing, and depicting on findings by groups (©FAO, ToT in 2018)

Step 3: Presenting the feedback - In plenary each sub-group presents their results and conclusions. Feedback and questions from the other groups require the group to defend their decisions with logical arguments.



Sub-group presentations and responding feedbacks from participants (© FAO, ToT in 2018)

Step 4: Discussing actions to take - In a plenary the participants synthesize the presentations and collectively agree and decide what actions to implement based on the decisions they have taken.

6.2 Green Manure

Green manure, also called a cover crop, is a great way to add nutrients to the soil. Green manure involves planting a crop that is meant to be incorporated into the soil to increase its fertility. In agriculture, **green manure** is created by leaving uprooted or sown crop parts to wither on a field so that they serve as a mulch and soil amendment. The plants used for green manure are often cover crops grown primarily for this purpose. Typically, they are ploughed under and incorporated into the soil while green or shortly after flowering. Green manure is commonly associated with organic farming and can play an important role in sustainable annual cropping systems. Green manures are fast-growing plants sown to cover bare soil.

6.2.1 Functions

Green manures usually perform multiple functions that include soil improvement and soil protection. Leguminous green manures contain nitrogen-fixing symbiotic bacteria in root nodules that fix atmospheric nitrogen in a form that plants can use. This performs the vital

function of fertilization. If desired, animal manures may also be added. Depending on the species of cover crop grown, the amount of nitrogen released into the soil lies between 40 and 200 pounds per acre. With green manure use, the amount of nitrogen that is available to the succeeding crop is usually in the range of 40-60% of the total amount of nitrogen that is contained within the green manure crop.

Incorporation of cover crops into the soil allows the nutrients held within the green manure to be released and made available to the succeeding crops. This results immediately from an increase in abundance of soil microorganisms from the degradation of plant material that aid in the decomposition of this fresh material. This additional decomposition also allows for the re-incorporation of nutrients that are found in the soil in a particular form such as nitrogen (N), potassium (K), phosphorus (P), calcium (Ca), magnesium (Mg), and sulfur (S).

Microbial activity from incorporation of cover crops into the soil leads to the formation of mycelium and viscous materials which benefit the health of the soil by increasing its soil structure (i.e. by aggregation).

The increased percentage of organic matter (biomass) improves water infiltration and retention, aeration, and other soil characteristics. The soil is more easily turned or tilled than non-aggregated soil. Further aeration of the soil results from the ability of the root systems of many green manure crops to efficiently penetrate compact soils. The amount of humus found in the soil also increases with higher rates of decomposition, which is beneficial for the growth of the crop succeeding the green manure crop. Non-leguminous crops are primarily used to increase biomass.

The root systems of some varieties of green manure grow deep in the soil and bring up nutrient resources unavailable to shallower-rooted crops.

Common cover crop functions of weed suppression. Non-leguminous crops are primarily used (e.g. buckwheat). The deep rooting properties of many green manure crops make them efficient at suppressing weeds.

Some green manure crops, when allowed to flower, provide forage for pollinating insects. Green manure crops also often provide habitat for predatory beneficial insects, which allow for a reduction in the application of insecticides where cover crops are planted. Some green manure crops (e.g. winter wheat and winter rye) can also be used for grazing. Erosion control is often also taken into account when selecting which green manure cover crop to plant. Some green crops reduce plant insect pests and diseases. *Verticillium* wilt is especially reduced in potato

plants. Incorporation of green manures into a farming system can drastically reduce, if not eliminate, the need for additional products such as supplemental fertilizers and pesticides.

6.2.2 Crops that can be used as Green Manure

Cowpea, Clover (e.g. annual sweet clover) , Fava beans, Rice bean, Groundnut, Millet, Mustard, Sesbania, Sorghum, Soybean, Sunn hemp, a legume widely grown throughout the tropics and subtropics, Velvet bean (*Mucunapruriens*).

Sunn Hemp

Sunn Hemp *(Crotalaria juncea)*, known as brown hemp, Indian hemp, Madras hemp, is a tropical Asian plant of the legume family (Fabaceae). It is generally considered to have originated in India. It is now widely grown throughout the tropics (including Myanmar) and subtropics as a source of green manure, fodder and lignified fiber obtained from its stem. Sunn hemp is also being looked at as a possible bio-fuel. It bears yellow flowers and elongate, alternate leaves.

Sunn hemp following after paddy, blooming yellow flowers
(© FAO/U.Theinsu, 2017, Myanmar)

Sunn Hemp Uses and Benefits

Sunn hemp has been used extensively as a soil improvement or green manure crop in the tropics because of its ability to produce large amounts of biomass in as little as 60 to 90 days. Sunn hemp can reach heights of over 4 feet in 60 days and over 6 feet in 90 days. Biomass production yields as much as 6,000 pounds in 60 days in one acre. Because of this, it has the potential to build organic matter levels and sequester carbon. Also, as a legume it can fix large amounts of nitrogen. Used as a cover crop, sunn hemp can improve soil properties, reduce soil erosion, conserve soil water, and recycle plant nutrients. Other potential uses for sunn hemp are forage, paper fiber, and as alternative fuel crop. It is a source of natural fiber and used for cordage, fishing nets, and ropes.

Sunn hemp at harvest for seeds, heights more than six feet
(© FAO/U.Theinsu, 2017, Myanmar)

6.2.3 How to use green manures

- Sow seeds in rows, or broadcast them across the soil and rake into the surface. It can be broadcasted in the paddy field at near harvest of paddy;
- Once the land is needed for cropping, chop the foliage down and leave it to wilt;
- Dig the plants and foliage into the top 25 cm (10 in) of soil.

After digging in, the site should be left for two weeks or more before sowing or planting out as decaying green materials can hamper plant growth

7. Farmer Field School Session - 6

Exchange Visit

Month: October

Week/Date: First week

Time/Duration: Four hours

Trainer(s): Facilitator (Staff from Department of Agriculture)

Material: Flipcharts, marker pens

Topics to be covered:

1. Visits to other FFS in the Township (Building up the relationship among farmer groups)
2. Observation on the progress in other FFS and making comparisons with each other
3. Sharing of experiences among farmer groups
4. Dissemination of new findings to other farmer Groups
5. Specific discussion during the exchange visits is on CSA based on their experiences in FFS and why the practices in FFS are relevant to CSA

Related Training Reference Materials:

Exchange Visit

An exchange visit is an important part of the FFS. The purpose is to build up the relationship within the FFS group. During the exchange visit, the farmers can compare progress, achievements and even constraints. To some extent, exchange visits also disseminate new findings to other farmers for their benefit. An adequate participation of women and girls in the exchange visits should be ensured.

The exchange visit could be organized based on the local situation as follow:

- FFS to FFS within district;
- FFS to FFS within region;
- FFS to FFS inter region, and
- FFS to FFS inter-country

8. Farmer Field School Session - 7

Farmer's Field Day

Month: November

Week/Date: First week

Time/Duration: Four hours

Trainer(s): Facilitator (Staff from Department of Agriculture)

Material: Flipcharts, marker pens

Topics to be covered:

1. Visitors observation on the performances and achievements undertaken in FFS
2. Presentations on the activities undertaken in FFS by FFS trainees (putting emphasis on CSA)
3. Sharing of technologies and ideas to visitors by FFS trainees
4. Presentations of FFS participants on their experiences throughout the whole school session, emphasizing on why Climate Smart Agriculture becomes important in their farming, climate change effects on the crops, resilience of crops grown in the Demo Plot to the climate changes are because of proper crop and soil management practices.
5. Contribution of opinions, ideas, comments and suggestions from visitors and recording of contributions

Related Training Reference Materials:

Field Day

At the end of each FFS, the participants organize a field day to share their new knowledge with the local community members (from within the village and from neighboring villages), local politicians, government agriculture workers and other concerned stakeholders. Learning booths are prepared and FFS graduates present the FFS topics and findings to the visitors giving an opportunity to share technologies and ideas as well as to reinforce the topics learnt and their benefits.

A field day is an occasion organized by FFS farmers for the purpose of presenting and exposing all activities and achievements to other farmers in the community who did not participate in the FFS. The field day could also be a forum for interactions and sharing experiences. The field day is also useful in raising willingness and can facilitate increased activities and scaling up in the future. To make the field day more useful, the following should be followed:

Venue	At the FFS site where most of the activities were done
Date	Determined by farmers, but at a time when the crop reaches maturity stage
Time	Within FFS period, preferably during crop maturing stage
Location	The FFS group leader should decide on the location and invite farmers from the surrounding community
Participants	Local community members (from within the village and from neighboring villages), local politicians, government agriculture workers and other concerned stakeholders. An adequate participation of women and girls in the Farmer Field Day will be ensured.

9. Farmer Field School Session –8

Post-Harvest Handling

Month: November

Week/Date: First week

Time/Duration: Morning three hours and afternoon two hours

Trainer(s): Facilitator (Staff from Department of Agriculture)

Material: Training materials, flipcharts, marker pens

Topics to be covered:

1. Concept of cropping system and cropping patterns
2. Postharvest practices, storage of seeds/grains (use of airtight zero fly hermetic bags), and postharvest losses of paddy
3. Harvesting of sample plot (6.6' x 6.6') in Demo Plot and calculation of per acre yield by yield component factors
4. Harvesting of the whole Demo Plot followed by threshing, and winnowing
5. Counting of total and effective tillers, and filled grains per panicle in specified plants
6. Varietal selection of green gram and varietal characteristics- farmer's preference is local variety Kyauk-Sane which has good market price
7. Growing of green gram in Demo Plot after paddy with zero tillage (seed soaking with specific of rhizobium inocula for green-gram and adoption of CA practice)(There will be two trials depending on the moisture content of the field: (1) direct broadcasting immediately after paddy harvest and then mulched with straw: (2) just opening of sowing lines, direct seeding in the lines and mulching by straw)
8. Comparison of seed rates of their practice and improved practice
9. Recording of expenses in financial record book
10. Review on the individual's activity undertaken and analyzing the strengths and weakness
11. Production of individual's action plan to undertake at their farms
12. Open discussion on the whole training session of the day and recording of participants feedbacks

Related Training Reference Materials:

9.1 Postharvest Handling

In agriculture, **postharvest** handling is the stage of crop production immediately following harvest, including cleaning, grading, cooling, packing, transporting, and marketing. The instant a crop is removed from the ground, or separated from its parent plant, it begins to deteriorate. Postharvest treatment largely determines final quality, whether a crop is sold for fresh consumption, or used as an ingredient in a processed food product.

9.1.1 Goals

The three main objectives of applying postharvest technology are:

(1) to maintain quality (appearance, texture, flavor and nutritive value)

(2) to protect food safety, and

(3) to reduce losses between harvest and consumption

The most important goals of post-harvest handling are keeping the product cool, to avoid moisture loss and slow down undesirable chemical changes, and avoiding physical damage such as bruising, to delay spoilage. Sanitation is also an important factor, to reduce the possibility of pathogens that could be carried by fresh produce, for example, as residue from contaminated washing water.

9.1.2 Post-harvest losses (grains)

Grains may be lost in the pre-harvest, harvest, and post-harvest stages. Pre-harvest losses occur before the process of harvesting begins, and may be due to insects, weeds, and rusts. Harvest losses occur between the beginning and completion of harvesting, and are primarily caused by losses due to shattering. **Post-harvest losses** occur between harvest and the moment of human consumption. They include on-farm losses, such as when grain is threshed, winnowed, and dried, as well as losses along the chain during transportation, storage, and processing. Important in many developing countries are on-farm losses during storage, when the grain is being stored for auto-consumption or while the farmer awaits a selling opportunity or a rise in prices. Losses can be low when the operation is done carefully but high with carelessness.

Grains are produced on a seasonal basis. In many places there is only one harvest a year. Thus most production of maize, wheat, rice, sorghum, millet, etc. must be held in storage for periods varying from a few days up to more than a year. Storage therefore plays a vital role in grain supply chains. For all grains, storage losses can be considerable but the greatest losses appear to

be of maize. Losses in stored grain are determined by the interaction between the grain, the storage environment and a variety of organisms.

9.1.3 Post-harvest losses

1. Harvesting/field drying	4-8%
2. Transport to homestead	2-4%
3. Drying	1-2%
4. Threshing/shelling	1-3%
5. Winnowing	1-3%
6. Farm storage	2-5%
7. Transport to market	1-2%
8. Market storage	2-4%
Cumulative loss from production	10-23%

9.1.4 Post-harvest loss summary

Crop	%Loss, minimum	%Loss, maximum
1. Cereals	3.9	6.0
2. Pulses	4.3	6.1
3. Oilseeds	2.8	10.1
4. Fruits	5.8	18.0
5. Vegetables	6.8	12.5

9.1.5 Losses at various stages of post-harvest operation

1. Huge post-harvest losses (25-30%) occur in mango in the period between harvesting and consumption
2. Fruits discarded in the field were 1.3%
3. Culled fruits range from 12 to 18%
4. Physiological loses in weight during transportation was 3.68%
5. During ripening in boxes total loss was 7.53%

9.1.6 Attempts for loss reduction

There have been numerous attempts by donors, governments and technical assistance agencies over the years to reduce post-harvest losses in developing countries. Despite these efforts, losses are generally considered to remain high although, as noted, there are significant measurement difficulties. One problem is that while engineers have been successful in developing innovations in drying and storage these innovations are often not adopted by small farmers. This may be because farmers are not convinced of the benefits of using the technology. The costs may outweigh the perceived benefits and even if the benefits are significant the investment required from farmers may present them with a risk they are not prepared to take. Alternatively, the marketing chains may not reward farmers for introducing improvements. While good on-farm drying will lead to higher milling yields or reduced mycotoxin levels this means nothing to farmers unless they receive a premium for selling dry grains to traders and mills.

In one of its studies assessing losses of perishable products through handling or post-harvest operations, the special FAO loss-prevention programme presents the following conclusions: if harvest operations, storing (stacking and/or packaging in warehouse), storage and transport are defective, losses are separated as follows:

Harvesting	5-8 percent
Storing operation	15-20 percent
Storage	5-10 percent
Transport	10-12 percent
i.e. a theoretical total of	35-50 percent

Loss occurs at the front of the food chain—when food rot in fields, or is lost as a result of poor transportation networks, or spoils in markets that lack proper storage and preservation equipment and practices. Post-harvest loss is particularly acute in less-industrialized countries where it claims as much as 50% of fruits and vegetables. As the world's population grows and our available resources shrink, each pound of food produced that goes uneaten is a wasted opportunity to improve the health of people, the environment, and economies.

Reducing post-harvest loss strengthens livelihoods for farmers and families who depend on agriculture for their income. It can also ensure more food gets to more people. If unsustainable food production trends continue, the world will require a 70 percent increase in agricultural yield by 2050. With a global population expected to reach 9 billion by 2050, reducing inefficiencies associated with post-harvest loss will be critical to feeding the population of the future.

Avoiding loss:

Losses can be avoided by following good practices. There is also a wide range of post-harvest technologies that can be adopted to improve losses throughout the process of pre-harvest, harvest, cooling, temporary storage, transport, handling and market distribution. Recommended technologies vary depending on the type of loss experienced. However, all interventions must meet the principle of cost-effectiveness. In theory it should be possible to reduce losses substantially but in practice this may be prohibitively expensive. Especially for small farms, for which it is essential to reduce losses, it is difficult to afford expensive and work-intensive technologies.

Effective management during the postharvest period, rather than the level of sophistication of any given technology, is the key in reaching the desired objectives. While large scale operations may benefit from investing in costly handling machinery and high-tech postharvest treatments, often these options are not practical for small-scale handlers. Instead, simple, low cost technologies often can be more appropriate for small volume, limited resource commercial operations, farmers involved in direct marketing, as well as for suppliers to exporters in developing countries.

The objective of post-harvest handling is, therefore, the creation of an understanding of all the operations concerned from harvesting to distribution so as to enable people to apply the proper technology in each step and in such a way to minimize losses and maintain quality as high as possible during the distribution chain. The farmer must give, among others, special and careful attention to the following steps of the post-harvest chain:

- Market demand for the produce they are planning to grow;
- Market requirements and buyers;
- Knowledge of the fresh produce;
- Cultivation practices;
- Factors affecting post-harvest deterioration;
- Harvesting and field handling;
- Packing in the field;
- Handling and packing in the packing house;
- Common storage and refrigeration;
- Transport;
- Sale to agents, traders or consumers;
- Market handling, and
- Self-life of the produce.

9.2 Estimation of Crop Yields

Generally, there are two methods of estimating crop yields: 1) estimating by harvesting sample plots, and2) estimating by calculating yield component factors.

9.2.1 Estimating by harvesting of sample plots

At the time of harvest, the plants growing in the sample plot size of 6.6 ft by 6.6 ft, that is thousandth of an acre, are harvested, threshed and winnowed. Sampling should be taken from three different places of the good, the fair, and the poor areas. The grains are then measured by baskets which is commonly available in the villages. The estimate of per acre yield will be calculated when the measured amount is multiplied by 1000. The example is as followed.

The measured yield, in paddy, from sample plot is one pyi. When multiplied by 1000, it will be 1000 pyis. There are 16 pyis in one basket, so, these 1000 pyis will be divided by 16 pyis and finally the estimated per acre yield will be 62.5 baskets. This method can be applied in many kinds of crops.

9.2.2 Estimating by calculating yield component factors

a. Paddy

In paddy, yield component factors include plant population in an acre, the number of panicles, number of filled grains per panicle, and the weight of thousand grains. The calculation will be as follows.

$$\text{Yield per acre} = \frac{\text{No. hills in an acre x No. panicles per hill x No. filled grains per panicle x wt. of 1000 grains}}{\text{454 x 46 x 1000}}$$

In the above formula, 454 means that there are 454 grams in one pound and 46 means that there are 46 pounds in one baskets.

Example calculation:

1. If the spacing is 10 inches by ten inches, the number of hills per acre will be 62000.

Assume that there are 10 effective panicles per hill, 100 filled grains per panicle and 24 grams in 1000 grains. So, the calculation will be as follows:

$$\textbf{Yield per acre} = \frac{\textbf{62000 x 10 x 100 x 24}}{\textbf{454 x 46 x 1000}}$$

$$= \textbf{71.3 baskets}$$

2. If the spacing is 8 inches by 8 inches, the number of hills per acre will be 98,000.

Assuming that there are 10 panicles per hill, 110 filled grains per panicle and 24 grams in in 1000 grains. So, the calculation will be as follows:

$$\textbf{Yield per acre} = \frac{\mathbf{98,000 \times 10 \times 110 \times 24}}{\mathbf{454 \times 46 \times 1,000}}$$

= 123.3 baskets

b. Green Gram

$$\textbf{Yield per acre} = \frac{\text{No.Plants in acrex No.pods in a plantxNo.seeds in a podx100 seeds wt in gram}}{\mathbf{454 \times 72 \times 100}}$$

In the above formula, 454 mean that there are 454 grams in one pound and 72 means that there are 72 pounds in one baskets.

The common spacing of green gram is 18 inches by six inches and the plant population will be 58080. Assuming that there are 10 pods in one plant, 10 seeds in one pod, and 100 seeds weights are 7 gram, the calculation of yield per acre will be as follows:

$$\textbf{Yield per acre} = \frac{\mathbf{58080 \times 10 \times 10 \times 7}}{\mathbf{454 \times 72 \times 100}}$$

= 12.4 baskets

10. Farmer Field School Session - 9

Farming As a Business: FAAB

Month: December

Week/Date: First week

Time/Duration: Four hours

Trainer(s): Facilitator **(**Staff from Department of Agriculture)

Material: Flipcharts, marker pens

Topics to be covered:

Group discussion on the following (Groups comprising of five participants) (1) What is agriculture as a business? (2) How can agriculture be done as a business? (3) What is the difference between food crop and cash crop? (4) Why intercropping can optimize output per acre?

2. Group presentations of their outputs and defending feedbacks from participants
3. Documentation of important points for further actions
4. Group discussion on essentials of agriculture as a business (plans of production, keeping of financial record book, keeping the cash flow, knowing of cost of production, main cost drivers and alternatives)
5. Group presentations of their outputs and defending feedbacks from participants
6. Documentation of important points for further consideration
7. Group discussion on their understanding of the market system (role of brokers and traders, price variation in market systems, importance of linkages for market information, market prospects for a crop as recommended in value chain analysis)
8. Group presentations of their outputs and defending feedbacks from participants
9. Determination of ways to improve market system to benefiting to individual farmers and documentation of important points for further actions
10. Presentations of individuals on their activities undertaken in between the FFS sessions
11. Production of individual's action plan
12. Open discussion on the whole training session of the day and recording of participants feedbacks

Related Training Reference Materials:

Farming as A Business (FAAB)

Most of the FFS participants will be subsistence farmers and whatever they grow, they eat. While subsistence farming helps farmers meet their basic food needs, it's a vulnerable lifestyle. If the crop fails, the farmers have no safety net. They will need to get help from outside sources. The FFS approach emphasizes the value of moving from subsistence farming to commercial farming. If the participants make good management decisions, they can feed themselves and create their own safety net. The next time a crop fails, the farmers will remain financially secure because they will have learned how to select the right crops/commodities/enterprises, diversify their activities, save money and maximize profits.

The starting point of the FFS process is a small plot of land that farmers can use to experiment and practice farming techniques. The goal, however, is for the FFS to use this practice and the knowledge it has gained from the learning programme to develop a sustainable commercial activity. The FFS method treats farming as a business. The goal of Farming as a Business is profit maximization. There are following three major factors that contribute to profit maximization:

1. Minimum costs
2. Maximum yield
3. Higher prices

1. Minimum Costs

In order to increase profit, a farmer must first reduce production and marketing costs. Often costs can be reduced without sacrificing crop health or environmental sustainability.

2. Maximum Yield

The farmers will develop good agricultural practices from their study plots. They must use these practices to maximize yield. The farmers will attain higher yields if they:

- Plant in a timely manner
- Use improved/suitable inputs
- Properly manage soil and water use
- Keep the fields free of weeds
- Control pests and disease
- Harvest promptly

3. Higher Prices

Farmers can add value to their products by adding features. Even though the farmers want to cut costs they should be willing to spend on product improvements that will bring higher prices. For example, packaging the product costs money but adds value because consumers will pay more for a clean, easy-to-handle product. Simple agro-processing like rice hurling or maize grinding almost doubles the price at which farmers can sell their product. Alternatively, if the FFS groups are organized under a network, they can decide to hold their produce during the slump period until after harvest-when the prices rise.

The Right Combination:

The goal is to balance the 3 elements to achieve profit maximization. Of course, it is easy to lower costs-a farmer could simply not buy anything! However, this is not a very good business practice because farmers cannot earn profit if they do not invest in their business. Farmers can add value to most products, but they can only charge high prices if consumers are willing to pay for such improvements.

Session Plan:

Goals of the Session: For the group to understand the value of moving from subsistence farming to commercial farming

Materials: Flipcharts, markers

Time: 90 minutes

Step 1: Begin with farmers' thoughts about the farming system in their community.

Facilitator should lead them to talk about general observations about farmers in the village, which might include:

- They usually have small plots,
- They have difficulty controlling diseases and pests in the filed,
- They lack modern farming skills for making production sustainable,
- There is little economic importance attached to farming,
- They do not attach any cost to the factors of production etc.

Step 2: Discuss their understandings of farming and business.

Do they see them as separate ideas? Do they know anyone who has a commercial farming business?

Ask them to contrast farming and business. Do most rural farmers approach farming like a business? What are the common businesses in their community? Is farming one of them?

Step 3: Present the objectives of FAAB.

- For farmers to appreciate that farming is a form of business,
- For farmers to gain the business management skills necessary for a successful FFS business enterprise, and
- For farmers to be able to adapt what they have learned from the FFS process to a successful enterprise.

Step 4: Define and discuss the methods of FAAB.

Explain the three keys for maximizing profit: low costs, maximum yield and high selling prices. What ideas does the group have about how to keep costs low, maximize yield and attain high prices?

This session will take the group through the stages of developing and maintaining a commercial enterprise. First, the group will select its enterprise. Second, it will analyze the profitability and risk associated with the enterprise it has selected. Next, it will create a budget for the enterprise. Last, it will begin planning the business with the goal of profit maximization.

Essentials of Farming as a Business:

a. Keeping the cash flow,
b. Knowing your cost of production, main cost drivers and alternatives,
c. Getting initial investment or loan scheme when most farmers have lack of investment,
d. Understanding the market system: role of brokers and traders, price variation in market systems, principles of contract farming,
e. Discussing and exploring the potential business opportunities for women and the most marginalized farmers to ensure their participation and equal benefits,
f. Business linkage and getting market information, and
g. Determining market prospects for a crop.

11. Farmer Field School Session -10

IPM on Green Gram and General Discussions

Month:	January
Week/Date:	First week
Time/Duration:	Three hours
Trainer(s):	Facilitator **(**Staff from Department of Agriculture)
Material:	Flipcharts, marker pens

Topics to be covered:

1. IPM for green gram and scouting of insect incidence
2. Broadcasting of sunn hemp in green gram plot before the crop harvest
3. Open discussion on the practices (opinion and comments from participants)
4. Review on the activities undertaken by individuals and suggestions from participants
5. Production of individual's action plan

12. Farmer Field School Session - 11

Harvesting of Green Gram and General Discussions

Month: February

Week/Date: First week

Time/Duration: Three hours

Trainer(s): Facilitator **(**Staff from Department of Agriculture)

Material: Flipcharts, marker pens

Topics to be covered:

1. Harvesting of green gram
2. Comparison of yields between traditional and improved practices
3. Estimation of cost/benefit ratio from total costs of cultivation and possible incomes from crops
4. Discussion and planning on recommendations from Value Chain Analysis such as market information, linkages establishment with inputs/outputs market, financial institutions
5. Observation on the growth of sunn hemp
6. Review on the activities undertaken by individuals and suggestions from participants

13. Farmer Field School Session - 12

Graduation Day

Month: March

Week/Date: First week

Time/Duration: Three hours

Trainer(s): Facilitator **(**Staff from Department of Agriculture)

Material: Flipcharts, marker pens

Topics to be covered:

1. Review on the whole FFS training session by participants and their awareness on CSA and its practices
2. Review on the awareness of participants on CA, GAP, IPM, and Agriculture as a Business
3. Development of plans of actions to undertake beyond FFS through replication of the learning.
4. Share lessons learned from the FFS
5. Evaluation of training session by participants
6. Provision of Completion Certificate to participants
7. Ending of FFS successfully

Graduations Ceremony:

This marks the end of the season-long FFS learning cycle. It is organized by the farmers, facilitators and the coordinating offices. FFS farmers celebrate the day with their achievements and acknowledging time taken by farmers. FFS farmers use this forum to share the results and pass on the lessons learnt during the FFS to the public. They display the harvest obtained from the demonstration plot and other training and visibility materials and sometimes they enjoy with music, dancing and refreshment together with other community members. All the farmers (FFS Committee Members) who took part in the FFS activities by attending all the FFS trainings/meetings (with more than 80% of the attendance) and/or planting the given seeds in their own field will be awarded with a FFS Certificate during the graduation ceremony. By doing so other community members can also be attracted to join and continue FFS in their locality.

ANNEX 1

Farmer Field School' Curriculum for Coastal/Delta Zone

Month	Module	Subject and Competences
May	Pre-FFS Introductory Meeting	1. Objectives of FFS, guiding principles, FFS Farmers selection, FFS Committee formation, Selection of Lead Farmer etc. 2. Introduction of participants: Facilitator, technical specialist, participants from the village. 3. Site selection for establishing demonstration plot (in Lead Farmer's Field) also discussion and agreement on size (one acre), treatments to be included and layout of the demonstration plot. 4. Introduction of crops that will be covered in FFS: Paddy, Green Gram and Sunn Hemp (*Crotalaria juncia*). 5. Collection of soil samples for soil analysis that will be sent to soil lab to get the base line data of pH, soil texture, electrical conductivity, organic carbon, nutrient contents (N. P. K. Ca, Mg, S, Zn, B) and Na and related radicals (Cl, CO3 and HCO3).
June	Module 1	1. Concept of Climate Smart Agriculture. 2. Concept of GAP and its practices. 3. Concept of CA and its practices. 4. Analysis of existing farming systems that affect the soil, the crop/plant, and environment from the participant's perspective (putting the points on the flipcharts) and general discussion on that (braining storming session). 5. Introduction to Climate Changes and its effects. 6. Introduction of different cultivation practices of paddy applied in the area (broadcasting, direct seeding by drum seeders, transplanting by BMP/SRI: SRI practice will be applied in FFS as it is one of the CSA practices recommended by FAO). 7. Selection of paddy variety to grow in Demo Plot (Farmer's preference is Paw San Yin and registered seeds are available at Myaungmya Seed Farm and Certified seeds at DOA Labutta). 8. Preparation for nursery raising in Demo Plot by SRI practice (Detail descriptions are in the Handbook). 9. Keeping records on crop managements for each crop and data entry in every training session. 10. Keeping financial records on input costs and general expenditures. 11. Open discussion on the whole training session of the day and recording of participants feedbacks. 12. Production of plans of actions for individuals to replicate the learning from the FFS Demonstration Plot in their own farm.
July (First week)	Module 2	1. Introduction to the principles of SRI. 2. Comparison of seed rates by existing farmers' practices and SRI practice. 3. Germination of seeds (Detail descriptions are in the Handbook).

Month	Module	Subject and Competences
		4. Broadcasting of germinated seeds on the soil in the frames at the rate of one tin of seeds on six frames. 5. Land preparation of Demo Plot for transplanting in next ten days, leveling the field by temporary bunds if necessary. 6. Fertilizer application prioritizing animal dung, compost and organic fertilizer, use of chemical fertilizer should be limited. 7. Preparation of Home-made organic products (Indigenous Microorganism-IMO, Fish Amino Acid-FAA, Preparation of EM, Tobacco-chili-ginger pesticide, etc.). 8. Compost making exercise. 9. Introduction of rearing of earthworms for compost production. 10. Recording of expenditures in financial record book. 11. Review on the individual's activity undertaken at their farms according to their plans in the previous training session. 12. Production of individual's action plans to undertake at their farms. 13. Open discussion on the practices already undertaken in the whole day session and feedbacks from participants.
July (Third week)	Module 3	1. Concept of paddy not the aquatic plant: weak growth of paddy plats under submerged condition. 2. Transplanting of ten-day old seedling (Detail descriptions are in the Handbook). 3. Open discussion on the transplanting practice of SRI and individual's opinion and comments are recorded. 4. Group Dynamic Exercise. 5. Special Topic. 6. Review on the individual's activity undertaken and analyzing the strengths and weakness. 7. Production of individual's action plan to undertake at their farms.
August	Module 4	1. Concept of IPM and practices. 2. First weeding and inter-cultivating the paddy field after two weeks of transplanting, not beyond 24 days after sowing, by mechanical weeder (herbicide application is strictly prohibited). 3. Application of home-made organic fertilizers (IMO, FAA, EM) at the time of weeding. 4. Following manual weeding after rotary weeding if necessary. 5. Insect survey, insect collection and identification of beneficial and pests. 6. Counting tillers – minimum, maximum and average by marking specific plants for continuous tiller counts. 7. Special caring on water management, not to be flooded all the time, breaking the bunds at the lower portion of the field. 8. Recording of crop performances in crop management record books. 9. Review on the individual's activity undertaken and analyzing the strengths and weakness. 10. Production of individual's action plan to undertake at their farms 11. Open discussion on the whole training session of the day and recording of participants feedbacks.

Month	Module	Subject and Competences
		12. Second time weeding will be followed after next two weeks, i.e. at the age of about 40 days paddy plant and necessary arrangement is to be done.
September	Module 5	1. Agroecosystem Analysis Exercise – Groups comprising of five Participants will study and make records on the following in Demo Plot i) the effectiveness of SRI and other CSA practices, ii) plant establishment and tillering, iii) soil organic matter and soil moisture conditions, iv) incidence of weeds and v) overall crop performances and incidences of pest and diseases etc. 2. Recording of findings by groups. 3. Group presentations on their findings and responding to questions raised by other groups. 4. Making decisions and recording of important points for further actions for improvement. 5. Review on participants understanding on CSA based on the practices undertaken in Demo Plot. The level of knowledge and skills of male and female farmers will be assessed, and agreement will be made on how to better involve them in the agroecosystem analysis. 6. Green Manure. 7. Importance of water management in tiller formation and tiller numbers. 8. Counting tillers in specified plants. 9. Keeping of water in the field when the plant age is around 85 DAS (stage of Ear Primordial Initiation – EPI). 10. Application of home-made fertilizers, EM, FAA, and pesticides. 11. Recording of crop performances in crop management record books 12. Recording of expenses in financial record book. 13. Review on the individual's activity undertaken and analyzing the strengths and weakness. 14. Production of individual's action plan to undertake at their farms. 15. Open discussion on the whole training session of the day and recording of participants feedbacks.
October	Module 6	**Exchange Visits** An adequate participation of women and girls in such exchange visits will be ensured. 1. Visits to other FFS in the Township (Building up the relationship among farmer groups). 2. Observation on the progress in other FFS and making comparisons with each other. 3. Sharing of experiences among farmer groups. 4. Dissemination of new findings to other farmer Groups. 5. Specific discussion during the exchange visits is on CSA based on their experiences in FFS and why the practices in FFS are relevant to CSA.
November (First week)	Module 7	**Farmer's Field Day** An adequate participation of women and girls in the Farmer Field Day will be ensured.

Month	Module	Subject and Competences
		1. Visitors observation on the performances and achievements undertaken in FFS, especially paddy crop grown by SRI practice. 2. Presentations on the activities undertaken in FFS by FFS trainees (putting emphasis on CSA). 3. Sharing of technologies and ideas to visitors by FFS trainees, especially SRI practices. 4. Presentations of FFS participants on their experiences throughout the whole school session, emphasizing on why Climate Smart Agriculture becomes important in their farming, climate change effects on the crops, and Paddy grown by SRI practice in the Demo Plot which is resilient to weather changes because of proper crop and soil management practices. 5. Contribution of opinions, ideas, comments and suggestions from visitors and recording of contributions.
November (Third week)	Module 8	1. Concept of cropping system and cropping patterns. 2. Postharvest practices, storage of seeds/grains (use of airtight zero fly hermetic bags), and postharvest losses of paddy. 3. Harvesting of sample plot (6.6' x 6.6') in Demo Plot and calculation of per acre yield by yield component factors. 4. Harvesting of the whole Demo Plot followed by threshing, and winnowing. 5. Counting of total and effective tillers, and filled grains per panicle in specified plants. 6. Varietal selection of green gram and varietal characteristics- farmer's preference is local variety Kyauk-Sane which has good market price. 7. Growing of green gram in Demo Plot after paddy with zero tillage (seed soaking with specific of rhizobium inocula for green-gram and adoption of CA practice) (There will be two trials depending on the moisture content of the field: (1) direct broadcasting immediately after paddy harvest and then mulched with straw: (2) just opening of sowing lines, direct seeding in the lines and mulching by straw). 8. Comparison of seed rates of their practice and improved practice. 9. Recording of expenses in financial record book. 10. Review on the individual's activity undertaken and analyzing the strengths and weakness. 11. Production of individual's action plan to undertake at their farms. 12. Open discussion on the whole training session of the day and recording of participants feedbacks.
December	Module 9	**Farming As A Business (FAAB)** 1. Group discussion on the following (Groups comprising of five participants). 1) What is agriculture as a business? 2) How can agriculture be done as a business? 3) What is the difference between food crop and cash crop? 4) Why intercropping can optimize output per acre? 2. Group presentations of their outputs and defending feedbacks from participants. 3. Documentation of important points for further actions 4. Group discussion on essentials of agriculture as a business (plans of production, keeping of financial record book, keeping the cash flow, knowing of cost of production, main cost drivers and alternatives).

Month	Module	Subject and Competences
		5. Discuss and explore the potential business opportunities for women and the most marginalized farmers to ensure their participation and equal benefits. 6. Group presentations of their outputs and defending feedbacks from participants. 7. Documentation of important points for further consideration. 8. Group discussion on their understanding of the market system (role of brokers and traders, price variation in market systems, importance of linkages for market information, market prospects for a crop as recommended in value chain analysis). 9. Group presentations of their outputs and defending feedbacks from participants. 10. Determination of ways to improve market system to benefiting to individual farmers and documentation of important points for further actions. 11. Presentations of individuals on their activities undertaken in between the FFS sessions. 12. Production of individual's action plan. 13. Open discussion on the whole training session of the day and recording of participants feedbacks.
January	Module 10	1. IPM for green gram and scouting of insect incidence. 2. Broadcasting of sunn hemp in green gram plot before the crop harvest. 3. Open discussion on the practices (opinion and comments from participants). 4. Review on the activities undertaken by individuals and suggestions from participants. 5. Production of individual's action plan.
February	Module 11	1. Harvesting of green gram. 2. Comparison of yields between traditional and improved practices. 3. Estimation of cost/benefit ratio from total costs of cultivation and possible incomes from crops. 4. Discussion and planning on recommendations from Value Chain Analysis such as market information, linkages establishment with inputs/outputs market, financial institutions. 5. Observation on the growth of sunn hemp. 6. Review on the activities undertaken by individuals and suggestions from participants.
March	Module 12	**Graduation Day** 1. Review on the whole FFS training session by participants and their awareness on CSA and its practices. 2. Review on the awareness of participants on CA, GAP, IPM, and Agriculture as a Business. 3. Development of plans of actions to undertake beyond FFS (strengthening of land management practices, caring of avocado and coffee plantation) (Yam harvest can be in January or February). 4. Lessons learned from the FFS. 5. Evaluation of training session by participants. 6. Provision of Completion Certificate to participants. 7. Ending of FFS successfully.

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