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Abbreviations and acronyms

ADB Asian Development Bank
ASEAN Association of Southeast Asian Nations
AusAID Australian Agency for International Development
FAO Food and Agriculture Organization of the United Nations
FDA Food and Drug Administration
FSMS Food Safety Management System
GAP good agricultural practices
GMP good manufacturing practice
GAFSP Global Agriculture and Food Security Program
HACCP Hazard Analysis Critical Control Point
IPM integrated pest management
IWM integrated weed management
ISO International Organization for Standardization
MRL maximum residue limit
PPE personal protective equipment
TCP Technical Cooperation Programme
ToT training of trainers

Acknowledgements

The preparation of this training manual designed for training of farmers on good agricultural practices (GAP) acknowledges the support of the Global Agriculture and Food Security Program (GAFSP) for funding Climate Friendly Agribusiness Value Chain (CFAVC) project in Myanmar with co-funding and collaboration of Asian Development Bank (ADB).

We highly acknowledge the support of FAOR Ms Yuka Makino, Mr Sridhar Dharmapuri Project LTO, Mr Benoist (CFIE) at FAO Headquarter, Mr Tint Khine AFAOR program for technical guidance, support, and cooperation during the course of the manual development. The support of Tha Nwai (AFAOR Admin) and the HR, procurement and logistic teams are commendable inspite of challenging times in the country. Project team support remained crucial especially Le Le Win, Myint Myint Aye and Nem Nei Lhing in terms of value addition and better contextualization of the manual.

We esteem the technical support of Dr Myint Thaung who remained the project consultant for development of integrated crop management (ICM) handbooks for the target crops GAP. His immense knowledge and expertise were very useful for the training manual and will remain a source of learning in the days to come.

We thank the researchers, farmers and GAP stakeholders whose work provided a rich source of secondary information and validation of scientific parameters used in the manual.

Numerous valuable knowledge resources, articles, discussion and research papers were used in the manual. The four interpretive guides of Association of Southeast Asian Nations (ASEAN) GAP proved a valuable source of information, guidance and validation for the three aspects of GAP i.e. food safety, produce quality, environmental management and workers health and safety.

The Food and Agriculture Organization of the United Nations (FAO) has been a main driving force in the promotion of GAP at local, regional and national level both at the policy, implementation and farmers support fronts. FAO has created a great number of documents on GAP, food systems strengthening and resilience which complemented the contents of the manual. FAO GAP training manual/GAP schemes provided precious information for the manual which will be very vital for better understanding of GAP concepts.

Last but not the least, we also appreciate the support of FAO team leaders of various development, emergency and Technical Cooperation Program (TCP) projects in Myanmar who shared valuable information used in the manual development.

This manual would not have been possible without the support of various private organizations, international agencies and individual experts as actors for GAP promotion in Myanmar, ASEAN and other countries.

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Project Team Leader/Senior Agronomist

Introduction

With grant funding of Global Agriculture and Food Security Program (GAFSP), Food and Agriculture Organization of the United Nations (FAO) and Asian Development Bank (ADB) are implementing a joint program designed to contribute to improved income, food and nutrition security through effective capitalization on synergies and complementarities between the two agencies. The project aims at creating an enabling environment that reduces the incidence of poverty, food insecurity and malnutrition among the rural poor of the project area. The development objectives of the project are integrated with ADB funded Climate Friendly Agribusiness Value Chains (CFAVC) project. The program is implemented in the three regions i.e. Mandalay, Sagaing and Magway regions of central dry zone. The project is designed and being implemented to achieve the objectives of creating an enabling environment that reduces the incidence of poverty, food insecurity and malnutrition among the rural poor of central dry zone. Promotion and dissemination of good agricultural practices (GAP)

is one of the project components aiming at improving the GAP frameworks of five target crops (sesame, groundnut, green gram, chickpea and paddy) for improved food safety, produce quality, environmental management and safeguarding workers health and safety. The purpose is to improve the target crops Myanmar GAP version in line with Myanmar guidelines 2018 and recommended practices of Association of Southeast Asian Nations (ASEAN) GAP standards at the pre-harvest and post-harvest crop management stages.

Food safety is of immense importance and has been a major concern of the consumers, more than its nutritive value and quality. The global trade in food commodities has further necessitated compliance to food safety, hygiene and environmental sustainability. Food commodities produced through climate smart ways in terms of compliance to good agricultural and environmentally sustainable standards can enhance produce/product competitiveness in the national and international markets. Moreover, food safety is integral to the food and nutrition security of the local population. Capacity building of relevant stakeholders including GAP farmers is imperative for promotion of GAP at farmers' field level. The current training manual comprise of two volumes, volume one presents general GAP guidelines for food safety, produce quality, environmental management and workers safety, hygiene and welfare in line with Myanmar and ASEAN GAP key criteria and compliance standards, while volume two focuses target crops specific GAP at pre and post-harvest stages including processing, packing/packaging. Additional resources of on GAP standards especially FAO GAP schemes for fruits and vegetables were also consulted with relevant practices included in the manual.

1 Volume 1
Good agriculture practices (GAP) Guidelines − crops

3 The manual at a glance

Purpose of the training manual

The purpose of the training manual is to guide the training of trainers (ToT) trainings offered to the extension staff and lead farmers in the project areas with key focus on the integrated crop management (ICM) practices in the central dry zone of Myanmar. The manual serves as a resource for the trainers, preparing and conducting courses to assist GAP farmers who are interested in obtaining GAP certification and promoting environmental sustainability and socially acceptable practices.

Manual layout and modules composition

Each session of the modules will be carried out with the aid of presentation, illustration, field visits, images/ pictures followed by brainstorming and group work.

Module Session Time Topics /activity

Module 1: Introduction to GAP and food safety

Session 1.1. Welcome, introductions and pre-assessment
30 minutes
Participants introduction in an innovative and interactive manner
1.2.1. Importance and need for food safety
1.2.2. Food safety hazards

Session 1.2. Food safety, food safety hazards types, sources and approaches
2.5 hours
1.2.3. Chemical hazards
1.2.4. Biological hazards and its sources
1.2.5. Physical hazards to food safety
1.2.6. Food safety approaches
Session evaluation-1.2 (20 minutes)

1.3.1. GAP

Session 1.3. Good agriculture practices (GAP), types and standards
02 hours
1.3.2. Global GAP / EUREP GAP
1.3.3. Other GAP standards
Session evaluation-1.3 (15 minutes)

Session 1.4. Terms and terminologies used in GAP and interpretations
30 minutes
1.4.1. Elaborations, discussion, contextualization and reflection on GAP terms and terminologies in a presentation session.

Module Session Time Topics /activity
2.1.1.Orientation of participants on field trip objective and methodology for site mapping
Module 2:
Session 2.1: Site feasibility, selection, site maps using field trip for practical site map preparation
1Hour
2.1.2. Site selection and management
GAP
requirements,
2.1.3. Notes for site mapping, site mapping and feedback session for improvement
objectives and
practices
Evaluation and field trip feedback for session-2.1 (10 minutes)
4MODULE-3, Day-2
Module Session Time Topics /activity
Session 3.1: Suitability, selection and management of planting materials, management of fertilizers and soil additives
3.1.1. Management of planting materials (seeds/seedlings)
1.5 hours
3.1.2: Management of fertilizers and soil additives/amendment
Sessions evaluation-3.1 (15 minutes)
Module 3:
GAP
requirements,
Session 3.2. Suitability, selection and safe management of chemical and agrochemicals
1 hour
3.2.1. Management of agrochemicals and other chemical materials
objectives and
Session evaluation-3.2 (15 minutes)
practices
Session 3.3. Irrigation management; quality, safety and method of applications
30 minutes 3.3.1. Irrigation and water management
Session evaluation-3.3 (10 minutes)
Session 3.4. Harvesting and handling of produce
30 minutes
3.4.1. Harvesting, time, methods, safety and post-harvest management
Session evaluation -3.4 (10 minutes)
MODULE-4 , Day-2
Module Session Time Topics /activity
4.1.1. Safe storage, packing and handling of produce
Session 4.1. Storage methods and standards

1.5
hours
4.1.2. Transportation of stored produce
4.1.3. Building and structures for storage
produce
Module 4:
Evaluation for session-4.1 (15 minutes)
storage,
transport,
Session 4.2. Documentation, record
keeping, traceability and recall 4.2.1. Documentation and record keeping
1Hour
4.2.2. Traceability and recall
packing
Evaluation for session-4.2 (10 minutes)
traceability
4.3.1. Workers training
and recall
4.3.2. Review of practices
Session 4.3. Workers training and
review of practices
02
hours
4.3.3. Personal hygiene and workers
welfare
4.3.4.Waste and energy efficiency
4.3.5. Environmental pollution
Evaluation for session-4.3 (15 minutes)
Post-training evaluation, final feedback and certificates distribution (1 hour)

5Note for the facilitator

Read the sessions carefully and familiarize yourself with the process and activities;
• Prepare all necessary materials and write the training/session objectives on flip chart in advance.
• Use energizers if participants seem to be getting bored. Examples of energizers can be found in **Annex-5.**
• If the participant is an illiterate, the facilitator needs to help them to write his/her response on the sticky notes/flip chart or to use pictures as much as possible.
• Try to avoid talking too much. keep the activities fun and active.
• Correct any incorrect opinions or information given by the participants.
• At the end of the activity, reflect with the participants on what you have learnt together and review the key messages.
• Ensure that everyone participates, and no one dominates in the process.

Training evaluation method

Different training evaluation methods are used in this training including:
• pre and post-tests (**see annex 2**);
• participants' feedback;
• daily evaluation at the end of each day and recap;
• evaluation of each session at the session end; and
• final training evaluation checklist (**see annex 3**).

6Training sessions

Module 1: Introduction to GAP and food safety

Objectives *• To know participants and their expectations and*
• To assess participants' knowledge
Delivery method *Brainstorming and pre training assessment*
Materials needed *Copies of pre-test question sheets*
Time *30 minutes*

1. Welcome participants to the workshop.
2. Ask participants to introduce themselves including name, where he/she comes from and one expectation from the training.
3. Prepare numbers on a piece of paper for each participant to use as a code for pre- and post-tests;
4. Each participant should randomly select from the different numbers and remember his/her code but it should remain confidential.
5. Distribute the pre-test question sheets to the participants and allow them to finish within 15 minutes. remind them to write their code on the pre-test.
6. If the participant is an illiterate, the facilitator needs to help them to write his/her response.

7. Ask participants if there are any clarifications needed for effective pre-assessment.
8. Collect the answer sheets after 15 minutes. Make sure that participants have written their codes on the pre-test sheet.

Objectives *To build the capacity and create an understanding of GAP farmers and concerned stakeholders on food safety, and types of hazards for better prevention of physical, biological and chemical contamination*
Delivery method *Brainstorming, group discussion, presentation and open ended questions*
Materials needed *Flip chart with stand, marker pens, sticky notes*
Time *2.5 hours (150 minutes)*

1. Welcome participants to the workshop.
2. Ask a volunteer from the participants to read the objectives of this session aloud. Then, explain the objectives.
3. Explain to the participants that there are totally six activities in this session. This activity will provide an opportunity to discuss why food safety is important.
4. Ask participants: "how do you think whether the food safety is important or not and why?".
5. Ask the participants to write down their responses on the sticky notes and put them on a flip chart.
6. When the participants finish posting the sticky notes on the flip chart, the facilitator can choose and read some of their interesting responses (may be 4 or 5 responses) and explain to the participants why food safety is important as provided in key information below (topic-1.2.1) to complement their
7answers.
7. Ask participants if there are any questions/clarifications.

Globalization and trans boundary food trade leading to spread of contaminants and food borne diseases in the food chain having harmful effects on human health.
Population growth and growing demand for food, scientific advances leading to improved food safety and food hygiene research, thus increasing awareness of food consumers.
Heavy reliance of mechanical production and increased use of external inputs (pesticides, fertilizers, weedicides).
Increased incidence of food borne diseases and food related morbidities.
Protect human health and minimize the risk of food contamination, regulations were imperative to ensure food safety from residual effects of pesticides, contaminants, pest and diseases through food hygiene protocols.

1. Ask participants to describe their understanding of food safety hazards.
2. Ask the participants to write down their responses on the sticky notes and put them on a flip chart.
3. When the participants finish posting the sticky notes on the flip chart, the facilitator can read the summary of their responses and explain the food safety hazards as provided in key information below (topic-1.2.2) to complement their answers.
4. Ask participants if there are any questions/clarifications.

The major sources of food contamination are soil, water, people, equipment, chemical materials, fertilizers and soil additives, packing material, transportation vehicles and others.
Food safety hazard is caused by chemical, biological and physical agents, conditions or property, which deteriorate the quality of produce, and poses a risk to human and animal health.

1. Ask participants to describe their understanding of chemical hazards.
2. Ask the participants to write down their responses on the sticky notes and put them on a flip chart.
3. When the participants finish posting the sticky notes on the flip chart, the facilitator can read the summary of their responses and explain to the participants what are chemical hazards as provided in key information below (topic-1.2.3) to complement their answers.
4. Ask participants if there are any questions/clarifications.
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agrochemical residues (pesticides, herbicides, fungicides above the MRL);1
non-agrochemical contamination due to fuel, lubricants (oil & grease), detergent, sanitizers;
heavy metals exceeding maximum permitted levels;
naturally occurring plant toxins (aflatoxins);2 and
allergic agents (causing allergy).
Figure 1. Unapproved pesticides is a major source of chemical contamination
Figure 2: Fertilizers with high level of heavy metals poses chemic hazards to food safety

1. Ask participants what they think are the biological hazards and its sources.
2. Write a summary of their responses; biological hazards on one flip chart and its sources on another flip chart.
3. Ask a volunteer from the participants to read them aloud.
4. Explain to the participants what are the biological hazards and its sources as provided in key information below (topic-1.2.4) to complement their answers.
5. Ask 2–3 volunteers from the participants to present the key points of what they have learnt from this activity and facilitate them.
6. Ask participants if there are any questions/clarifications.

1 According to Codex MRL for Agricultural Produce in Myanmar, Maximum limit for heavy metals, Lead: NMT 10.0 mg/kg or 10.0 mg/L (10.0 ppm), Arsenic: NMT 5.0 mg/kg or 5.0 mg/L (5.0 ppm), Mercury: NMT 0.5 mg/kg or 0.5 mg/L (0.5 ppm), Cadmium: NMT 0.3 mg/kg or 0.3 mg/L (0.3 ppm); ASEAN guidelines on limits of contaminants for health supplements.

2 A toxic secondary metabolite produced by some fungi, especially *Aspergillus flavus* and *Aspergillus parasiticus*. Those commonly found in nature are B1, B2, G1 and G2 aflatoxins (https://www.sciencedirect.com/topics/chemistry/aflatoxin)

9

Biological hazards

Hazards caused due to microorganisms such as bacteria, virus, fungi and algae which can be pathogenic (causing illness due to infection or toxins produced by microorganisms) or nonpathogenic

Some microorganisms cause rotting and unpleasant odor and taste in the food if not causing any infection

Sources/causes of biological contaminations

poor personal hygiene;
contact with contaminated soil(s);
untreated human and animal wastes (human feces); and
contaminated water used for irrigation and handling of produce.

Figure 3: Biological hazards are caused by bacteria, fungi, virus and parasites causing illness due to infection

Figure 4: Fungus on potatoes Figure 5: Flies on food that can transmit more than 100 different diseases

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1. Ask participants what they think are the physical hazards to food safety?
2. Write a summary of their responses on a flip chart.
3. Ask a volunteer from the participants to read them aloud and facilitate them.
4. Explain the physical hazards to food safety as provided in key information below (topic-1.2.5) to complement their answers.
5. Ask 2–3 volunteers from the participants to present the key points of what they have learnt from this activity and facilitate them.
6. Ask participants if there are any questions/clarifications.

foreign objects causing illness or injury such as stones, stick, weed seeds, plastics, glass,
wood, metal pieces, paint flakes, cements pieces and other sharp objects;
jewelry, hair clips, pens and other personal items; and
packaging materials such as plastic, cardboard, paper, foil used for packing.

Figure 6: Stone pieces physically contaminate food Figure 7: Electric bulb pieces contaminate food and cause injury to human health

11 Figure 8: Foreign objects made of hard materials poses such as beads cause physical contamination and can be injurious to internal organs

Figure 9: Physical hazards in food

1. Ask participants what they think are the strategies/approaches for better food safety in Myanmar?
2. Write a summary of their responses on a flip chart.
3. After the participants provide the responses, explain to them the current food safety approaches in Myanmar as provided in key information below (Topic-1.2.6) to complement their answers.
4. Ask 2–3 volunteers from the participants to present the key points of what they have learnt from this activity and facilitate them.
5. Ask participants if there are any questions/clarifications.

Introduction of food safety regulations:
Holistic approach to food safety taking into account the whole food chain (production to final sale and consumption using preventive risk based approaches (preventing entry of hazard into the food chain).
Various tools such as GAP, GMP (good manufacturing practice),
[3] the HACCP (Hazard Analysis
and Critical Control Point)[4] approach and the FSMS (Food Safety Management Systems) are followed.
Putting responsibility on each actor along the food value chain, Farmer-Processor-Trader-Consumer for ensuring food safety and produce quality.

[3] GMPs are basic operational, food manufacturing and environmental conditions required for the production, processing of safe foods. GMP integrates the elements of food safety in terms of ingredients, safe handling of products and packaging materials, so that the food products are processed in a safe environment (Source: Food safety programme for processors and food distributers Fact Sheet No. 15 https://www.gov.mb.ca/agriculture/food-safety/at-the-food-processor/food-safety-program/pubs/fs_15.pdf

[4] HACCP is a management system in which food safety is addressed through the analysis and control of biological, chemical, and physical hazards from raw material production, procurement and handling, to manufacturing, distribution and consumption of the finished product (Source: FDA USA)

12Farmer-implementation of GAP including maintenance of record.
Processor-processing of safe-active engagement with regulatory bodies for ensuring food system safety-upgrading facilities to maintain food hygiene.
Food handlers-including transporters, storage, consolidators-ensuring food safety and suitability.
Government-Creating an enabling environment (scientific, technical, financial, infrastructure, regulatory) for effective compliance to food safety regulations and systems under their control.
Consumers-pay meticulous attention to “BEST BEFORE” , direction of storage.

Evaluation for session-1.2 (20 minutes)

- Ask the following questions to the participants if they have understood the session.
- What is your understanding of globalization and food safety?
- What is your understanding of food contamination?
- What are the sources of food borne diseases?
- What is your understanding of food safety hazards?
- What are the major sources of food contaminations?
- Do you know chemical hazard? If yes, what are these?
- Do you know biological hazard? If yes, what are these?
- What are the sources of biological hazards?
- Can pest and domestic animals cause illness to the workers?
- Do you know physical hazards to food safety? If yes, what are these?
- What are the key points of food safety approaches in Myanmar?

Objectives *To orient the training participants about GAP in general, global GAP and other national and international food safety standards in particular*
Delivery method *Brainstorming, group discussion, presentation and open ended questions*
Materials needed
Flip chart with stand, marker pens, sticky notes
Time *02 hours (120 minutes) (Maximum 30 minutes for each activity)*

1. Explain to the participants that there are totally three activities in section-1.3.
2. Ask a volunteer from the participants to read the objectives of session-3 aloud. Then, explain the objectives.
3. Then, explain again to them that this is activity- 1 for section-3 and this activity will provide an opportunity to discuss what is gap & pillars of gap.
4. Ask participants: “what is your understanding of gap?”.
5. Write a summary of their responses on a flip chart.
6. After the participants provide the responses, explain what is gap, what are the benefits of gap practices and four pillars of gap as provided in key information below (topic-1.3.1) to complement their answers.
7. Ask participants if there are any questions/clarifications.

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Good agricultural practices are to be used at every step of pre-production, production and post-production stages i.e. from site, selecting planting material and harvesting as well as post-harvest management (threshing, cleaning, storage, packing/packaging and transportation
Practices related to environmental, economic and social sustainability for on farm

operations/processes, resulting in safe and quality food and nonfood agriculture products
GAP comprises of four pillars; 1. Food safety & Quality; 2. Economic Viability; 3. Environmental suitability; and 4. Social acceptability.

1. Explain to the participants that this is time for activity-2 in section-3 and this activity will provide an opportunity to learn about global GAP.
2. Explain how global GAP was evolved, what does global GAP focuses on, and its 'coverage as provided in key information below (Topic-1.3.2).
4. Ask participants if there are any questions/clarifications.

Developed as private sector standard in 1997 by European supermarket chain and their suppliers representing all stages in the supply chain of fruits and vegetables.
The name was changed to global GAP from EUREP GAP to reflect its global scope.
Global GAP focuses food safety, traceability as well as compliances to workers safety, health, welfare and conservation of environment.
Global GAP covers the standards of good agricultural practices and the process of certification from sowing until leaving the farm gate.

1. Explain to the participants that this is activity-3 and it will provide an opportunity to gain the knowledge about the ASEAN GAP standards and other national GAP including Myanmar GAP.
2. Explain to the participants a brief of ASEAN GAP as well as 4 modules of Myanmar GAP as provided in key information below (Topic-1.3.3).
4. Ask participants if there are any questions/clarifications.

ASEAN GAP standards
Voluntary standards developed in 2006 by ASEAN secretariat for harmonization of national GAP with ASEAN GAP standards and to encourage exports and imports of GAP certified fruits and vegetables among the countries of ASEAN region
The standards regulate the procedures of planting, care, harvesting and post-harvest operations including packaging.
Other national GAP schemes
Brunei GAP was launched in April 2014 under the horticulture farm accreditation scheme by the government.
Cambodia the national GAP standard was approved by the ministry of agriculture, forestry and fisheries on 10 March 2010.
Indo GAP and its certification, SiSakti, was launched in 2004 by the government
Lao GAP fruits and vegetables was launched in May 2014 by the ministry of agriculture and forestry.
My GAP, the Malaysian Good Agricultural Practices Scheme, was launched on 28 August 20013 in place of SALM certification.
Myanmar GAP for fruits & vegetables was issued in 2014 and GAP for 15 field crops was issued and launched in November, 2017. There are four modules in Myanmar GAP; (1. food safety module, 2. environmental management module, 3. produce quality module, 4. workers' health, safety and welfare module)
Philippines GAP for fruits and vegetables farming in the Philippines was launched in 2006 and is known as PhilGAP.
Singapore GAP in Singapore is called GAP-Vegetable Farming (GAP-VF). It is a voluntary scheme that was launched in 2004 and is aimed at intensive vegetable farming.
Thailand the Q GAP Program was launched in 2003 by the Department of Agriculture with the purpose of ensuring that food crops produced in Thailand are safe, wholesome and meet the required standards.
Evaluation for session-1.3 (15 minutes)
Ask the following questions to the participants if they have understood the session.
• What is your understanding of good agricultural practices?
• What are the benefit of GAP practices?
• What are the four pillars of GAP?
• What does global GAP focuses on & its 'coverage?
• What are the four modules of Myanmar GAP guideline?

Objectives *Enabling the participants to understand basic/important terminologies used in GAP standards along with scientific interpretation*
Delivery method *Brainstorming, group discussion, presentation and open ended questions*
Materials

needed
Flip chart with stand, marker pens,
Time *30 minutes*

1. Explain to the participants that this is section-1.4 and this section will provide the knowledge of terms & terminologies used in GAP.
2. Explain a brief of interpretations of terms and terminologies as provided in key information below (Topic-1.4.1).
3. Ask participants if there are any questions/clarifications.

16Module 2: GAP requirements, objectives and practices

Objectives *To orient the training participants in managing the sites of productions for prevention/control of chemical, biological and physical contamination for improved food safety*
Delivery method *Brainstorming, group discussion, presentation and open ended questions*
Materials needed
Flip chart with stand, marker pens, sticky notes
Time *1 hour (60 minutes)*

1. Welcome back participants to the workshop.
2. Ask a volunteer from the participants to read the objectives of session-2.1. Then, explain the objective.
3. Explain to the participants that there are totally two activities in section 2.1. This activity will provide an opportunity to learn the basic requirement for site selection and management.
4. Divide participants into two groups.
5. Ask participants: What are the factors you considered in selecting your farm site for GAP crop production?
6. Ask each group to write down their responses on a flip chart.
7. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
8. After the presentations, explain the basic requirements for site selection and management by using the key information below (Topic-2.1.1) to complement their answers.
9. Ask participants if there are any questions/clarifications.

Site selection should be made keeping in view climatic and soil requirements of the crop.
The history of biological (pathogenic microorganism and chemical (heavy metals). contamination of the site must be recorded through site mapping *(See GAP record keeping method on the presentation slide)*
Source of chemical contamination due to current or previous use of the site for industrial purposes, hospital wastes, livestock farming, and other hazardous waste disposal should be identified and recorded.
Production site situated in proximity of sewerage lines and drainage lines should not be selected.
Testing of site for heavy metals contamination is important for ensuring that the heavy metals level falls within the maximum permitted level.
If a significant risk of chemical and biological contamination is identified, either the site must not be used for production or remedial measures be taken to manage the risk.

17Figure 10: A sample site map Figure 11: Previous use of hazardous chemical and biological materials used be assessed

Figure 12:.The location of organic materials beside waterways used to irrigate or wash produce can lead to biological contamination of produce
Figure 13. Chemicals and bio-pesticides used on crops must be approved by a competent authority in the country where the crop is grown and intended to be traded

Figure 14. Empty chemical containers are not re-used and are kept secure until disposal

Figure 15. Domestic and farm animals must be excluded from the production site, particularly for crops grown in or close to the ground, and from areas where produce is harvested, packed and stored

18Figure 16. For new sites the risk of causing environmental harm on and off the site is assessed for the proposed use

Figure 17. Highly degrade areas must be managed to minimize further degradation

Figure 18. Storage, mixing and loading areas for fertilizers and soil additives should be positioned to minimize the risk of pollution of waterways and groundwater

1. Training participants will be divided in a group of five.
2. Explain the factors to be considered in drawing a site map by using the key information below (Topic-2.1.2).
3. Each group will visit a different production site in the nearby village to draw a sample sketch map.
4. Arrange the local key informants to accompany with them. At least one for each group.
5. After a transect walk of the site, the participants will be encouraged to draw a sample sketch map by indicating all the buildings, sources of current and potential hazards and production sites.
6. Make sure that:
o Farmers do the drawing, not facilitator.
o No one dominates the drawing of the map.
7. After the groups finish the drawing, one from each group will present the site map, followed by discussion and further improvement of the site map.
8. Ask participants if there are any questions/clarifications.
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A site map showing the following aspects should be prepared and kept on record.
• production site
• site slope
• locations of water sources
• storage areas of chemical including fertilizers and pesticides/weedicides and soil additives
• animal manure heaps
• composting sites
• storage areas, buildings and roads.

Evaluation for session-2.1 (10 minutes)

Ask the following questions to the participants if they have understood the session.
• What factors should be considered in selecting your farm site for GAP crop production?
• What should be included in a site map?
• Should we use the site where is a significant risk of chemical and biological contamination for production?

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Module 3: GAP requirements, objectives and practices

Objectives *Develop understanding of the training participants on GAP related safe management of planting materials, management of fertilizers and soil additives*
Delivery method *Brainstorming, group discussion, presentation and open ended questions*
Materials needed *Flip charts with stands, marker pens, butcher papers*
Time *1.5 hours (90 minutes)*

1. Welcome back participants to the training of module-3.
2. Ask a volunteer from the participants to read the objectives of session-3.1 of module-3. Then, explain the objectives.
3. Explain to the participants that there will be two activities in this session. First activity will be a Group work and will provide an opportunity to learn the management of planting materials.
4. Divide the participants into three groups.
5. Each group will identify the factors you considered as per the number indicated in each arrow.
• Group-1: What factors did you consider when selecting seeds?
• Group-2: What did you consider for safety use of chemicals for planting materials?
• Group 3: What should be noted in the record of planting materials?
6. Ask the groups to write their discussion points in a short phrase/word on the butcher papers.
7. Give each group 10 minutes to discuss and write the discussion points on the butcher papers.

8. After 10 minutes, ask representatives of each group to post the butcher papers on the flip charts.
9. When each group finishes posting of butcher papers, the facilitator read out the brief of discussion points.
10. Then, explain the management of planting materials in terms of seed selection, precautions for safety use of chemicals and record keeping practices as provided in key information below (Topic-3.1.1) to complement their answers.
11. Ask participants if they have questions, address them accordingly, and then summarize the session.

Locally adaptable varieties, having desired germination, purity (analytical and genetic), free from seed borne diseases/pathogens and resistant to pest and diseases preferred.
Varieties having climate resilient[5] characteristics can result in high yield under climate prone conditions.
Seeds/planting material can be a source of chemical contamination through chemicals used to treat seeds or control pests during nursery production. To avoid excessive residues, only chemicals approved by a competent authority for use on the produce must be used and withholding periods observed.

[5] Climate resilience of varieties refers to the characteristics to grow and produce under biotic (pests, disease, weeds) and abiotic stresses (drought, heat stress i.e. low or high temperature, water logging i.e. deficient or excessive water, high salinity, heavy metals, and ultraviolet radiation)

21If the planting materials/seed is procured from an external source, record of chemical treatment such as type, dose, method and reason for treatment should be available.
Planting materials/varieties from certified sources and those recommended by DoA will ensure high productivity and produce safety *(See presentation slide for record keeping)*
Record of planting materials /seed should be maintained showing:
• name of variety
• source
• chemical treatment details
• purity and germination (percent)
• date of production.

1. Explain to the participants that this is time for activity-2. This activity will provide an opportunity to learn the management of fertilizers and soil additives.
2. Ask the participants the following questions and write down the brief of their responses on the different flipcharts for different questions:
• Do you know what is the soil testing & how to apply the fertilizers based on soil test result? If yes, raise your one arm.
• Ask the participants (may be 2–3 participants) who know the soil testing to explain their understanding of soil testing and how to apply in their farMs Facilitate a discussion.
• Ask the participants "what did you consider when purchasing the fertilizers to ensure the quality of product? Facilitate them to ensure that everyone discuss, and no one dominates in the process.
• Do you have the record of fertilizers and soil additives used including the product name, source, date and quantity obtained? Facilitate them to speak out their responses.
3. After the discussion, the facilitator read out the brief of discussion points for the participants.
4. Then, explain the management of fertilizers and soil additives as provided in key information below (topic-3.1.2) to complement their answers.
5. ask participants if they have questions, address them accordingly, and then summarize the session.

Fertilizers and soil additives are systematically applied based on the result of soil testing. The registered products are only purchased from licensed suppliers and used for crop production.
If soil testing is not available, nutrient application must be based on recommendations from a competent authority or on soil or leaf or sap testing and the nutritional requirements for the crop grown.
Equipment used to apply fertilizers and soil additives is maintained in working condition and checked for effective operation at least annually by a technically competent person
If a significant hazard from the use of fertilizers or soil additives is identified, measures are taken to minimize the risk of contamination of produce.
Untreated organic materials are not applied in situations where there is a significant risk of contaminating the produce
If a product containing organic materials is obtained from off farm source and there is a significant risk of contaminating the produce, documentation is available from the supplier to
22show that the material has been treated to minimize the risk of contaminating the produce.
Human sewage is not used for production of any fresh produce destined for human

consumption.
Areas or facilities for storage, mixing and loading of fertilizers and soil additives and for composting of organic materials are located, constructed and maintained to prevent contamination of crops by diseases and to minimize the risk of contamination of production sites and water sources.
A record of fertilizers and soil additives obtained is kept, detailing the source, product name, and date and quantity obtained *(see presentation slides for record keeping)*
Figure 19. The risk of chemical and biological contamination of produce from previous use of the site and from adjoining sites must be assessed

Figure 20. Side-dressing produce grown close to the ground, use only fully composted materials or treated proprietary organic products, and do not apply them within two weeks of harvest
Figure 21. Compost and crop residues should be stored away from production sites to avoid produce contamination

23**Evaluation for session-3.1 (10 minutes)**
Ask the following questions to the participants if they have understood the session.
• What should be considered when selecting/purchasing the planting materials/seeds?
• Where planting material should be purchased to ensure high productivity and produce safety?
• What are the factors to ensure the safety use of chemicals for planting materials?
• Should untreated organic material be used if there is any significant risk of contaminating the produce with biological hazards?
• What should be noted in the record of planting materials?
• What should be considered for the effective & safety use of fertilizers?
• What should be considered when purchasing the fertilizers to ensure the quality of product?
• What should be noted in the record of fertilizers & soil additives?

Objectives *Building capacity of the training participant on safe management of agrochemicals used in crop production and other chemical management used in farm operations*
Delivery method *Brainstorming, group discussion, presentation and open ended questions*
Materials needed
Flip charts with stands, marker pens, sticky notes
Time *1 hour (60 minutes)*

1. Explain to the participants that this is time for activity-1 of module 3, section- 2.
2. Ask a volunteer from the participants to read the objectives of this session aloud. Then, explain that this activity will provide an opportunity to learn the safe management of chemicals and agrochemicals.
3. Explain to the participants that there are totally six activities in this session. This activity will provide an opportunity to discuss why food safety is important.
2. Explain to the participants that some key points are same as previous section like purchasing the registered products from the licensed suppliers.
3. Explain to adhere the pesticide/fertilizer laws and regulations of myanmar to minimize the risk of contaminating the environment and harmfulness to human health.
4. Then, ask the participants the following questions and write down the brief of their responses on the different flipcharts for different questions:
• Do you know IPM? If yes, raise your one arm.
• Ask 2–3 participants who know the IPM to explain their understanding of IPM and facilitate a discussion.
• Do you know PHIs? If yes, please raise your one arm.
• Ask 2–3 participants who know the PHIs to explain their understanding of PHIs and facilitate them.
• Do you know “chemical rotation strategy? If yes, raise your one arm.
• Ask 2–3 participants who know the chemical rotation strategy to explain their understanding and facilitate the process.
24• Do you know how to apply the pesticides to ensure the safety? If yes, raise your one arm.
• Ask 2–3 participants to demonstrate how to apply the pesticide in the field in terms of spraying time, wind direction, upper/lower surface of the leaf, wearing PPE, etc. Facilitate the process.

• Do you know chemical residue and MRL? If yes, raise your one arm.
• Ask 2–3 participants to explain their understanding of chemical residue & MRL. Facilitate them to speak out their responses.
• Do you have the record of pesticide applications? If yes, let them (may be 2–3 participants) to describe, “What are noted in the record?
5. After the discussion, the facilitator read out the brief of discussion points for the participants.
6. Then, explain the management of agrochemicals and other chemicals as provided in key information below (topic-3.2.1) to complement their answers.
7. Make sure to correct any incorrect opinions or information given by the participants.
8. Ask participants if they have questions, address them accordingly, and then summarize the session.

To minimize the use of pesticides, Integrated pest management (IPM)method for pests and disease control should be used.
The Pesticide/fertilizer laws and regulations of Myanmar should be strictly adhered to minimize the risk of contaminating the environment and harmfulness to human health.
Purchase only the registered/recommended products from licensed suppliers and used for crop production.
Observe Pre-Harvest Intervals (PHIs) for each type of agrochemical and crop
A chemical rotation strategy and other crop protection measures are to be followed as per the DoA recommendations.
Chemicals are applied according to label directions or a permit issued by a competent authority.
To check that chemicals are applied correctly, produce is tested for chemical residues at a frequency required by customers or a competent authority in the country where produce is intended to be traded. The laboratory used is accredited by a competent authority.
Up to date information on chemical MRL standards for the country where produce is intended to be traded is obtained from a competent authority.
If chemical residues in excess of the MRL are detected in the country where produce is traded, marketing of the produce is ceased. The cause of the contamination is investigated, corrective actions are taken to prevent re-occurrence, and a record is kept of the incident and actions
The mixing of more than two chemicals is avoided, unless recommended by a competent authority.
Equipment used to apply chemicals is maintained in working condition and checked for effective operation at least annually by a technically competent person
Equipment is washed after each use and washing waste is disposed of in a manner that does not present a risk of contaminating the produce.
Surplus application mixes are disposed of in a manner that does not present a risk of contaminating the produce the environment.
The chemicals obtained, stored, application of chemicals are systematically handled and recorded. Fuels, oils, and other non-agrochemicals are handled, stored and disposed of in a
manner that minimizes the risk of contaminating produce.
Chemicals are stored in a well-lit, sound and secure structure, with only authorized people allowed access. The structure is located and constructed to minimize the risk of contaminating produce and equipped with emergency facilities in the event of a chemical spill.
Chemicals are stored in the original container with a legible label and according to label directions or instructions from a competent authority.
If a chemical is transferred to another container, the new container is clearly marked with the brand name, rate of use and withholding period.
Liquid formulations of chemicals are not stored on shelves above powders.
Empty chemical containers are not re-used and are kept secure until disposal.
Empty chemical containers are disposed of according to relevant country regulations and in a manner that minimizes the risk of contaminating produce. Official collection and disposal systems are used where available.
Obsolete chemicals that are unusable or no longer approved are clearly identified and kept secure until disposal.
Obsolete chemicals are disposed of through official collection systems or in legal off-site areas.
Where applicable, a record of chemicals held in storage is kept, detailing chemical name, date and quantity obtained and date when completely used or disposed of.
The application of chemicals is recorded for each crop, detailing the chemical used, reason for application, treatment location, date, rate and method of application, weather conditions, and operator name. *(See presentation slides for record keeping)*

Figure 22. Chemicals and bio-pesticides used on crops must be approved by a competent authority in the country where the crop is grown and

intended to be traded
Figure 23. Chemicals must be stored in a well lit, sound and secure structure, with only authorized people allowed access

Figure 24. Chemicals are applied according to the label directions or a permit issued by a competent authority
Figure 25. Waste management and documentation is an important aspect for environmental safety.

Evaluation for session-3.2 (15 minutes)
Ask the following questions to the participants if they have understood the session.

Objectives *To orient the farmers in ensuring safe irrigation and water management techniques of GAP crops for improved food safety.*
Delivery method *Brainstorming, group discussion, presentation and open ended questions*
Materials needed
Flip charts with stands, marker pens, sticky notes
Time *30 minutes*

1. Welcome back participants to the workshop of session-3.3.
2. Ask a volunteer from the participants to read the objectives of this session aloud. Then, explain the objectives. The different one for different sessions should be requested to read the objectives to ensure everyone participates.
3. Explain to the participants that this activity will provide an opportunity to learn irrigation and water management.
4. Ask the participants the following questions and write down the brief of their responses on the different flipcharts for different questions:
Do you have experience in water testing in your farm? If yes, raise your hand.
Ask the participants (may be 2–3 participants) who have experiences in water testing to share their experiences and facilitate them to speak out their responses by highlighting the questions for timely sample collection, testing and timely receipt of result.
Do you know why soil and water testing is important in GAP crop production? If yes, raise your hand.
Ask 2–3 participants to explain their understanding of the importance of soil and water testing.
Explain the participants that the soil and water testing is important for heavy metals (Lead, Arsenic, Mercury and Cadmium) and macro nutrients (NPK) contents to ensure food safety and better soil fertility management.
Do you have the record of water testing and irrigation practices? If yes, raise your hand.
Ask 2–3 participants to describe, “What are noted in the record? And facilitate them to speak out their practices by asking some more questions like; crop name, date, volume of water applied,.
5. After the discussion, the facilitator read out the brief of discussion points for the participants.
6. Then, explain the irrigation and water management as provided in key information below (topic-3.3.1) to complement their answers.
7. Ask participants if they have questions, address them accordingly, and then summarize the session.

It is important to test the water quality for chemical and biological contamination.
The use of water flowing from livestock farms, hospitals, industries, waste waters and any other source that may contaminate the produce and harm the environment should be avoided for irrigation.
Irrigation use is based on crop water requirements, water availability, and soil moisture levels.
The risk of chemical and biological contamination of produce is assessed for water used before harvest for irrigation, fertigation,
and applying chemicals, and after harvest for handling,
washing, produce treatment, and cleaning and sanitation. A record is kept of any significant hazards identified.
Where the risk of chemical and biological contamination of produce is significant, either a safe alternative water source is used or the water is treated and monitored and a record is kept of the treatment method and monitoring results.
The irrigation system is checked for operational efficiency during each use, according to manufacturer’s instructions or other appropriate methods, and maintained to ensure efficient delivery.
Water used from sources that may cause environmental harm to land and soil, waterways and

sensitive areas is managed or treated to minimize the risk of environmental harm.
Water from toilets and drainage systems are disposed of in a manner that minimizes the risk of environmental harm on and off the site.
Water discharged from the property, including waste water from harvesting, cleaning and handling operations, is managed or treated to minimize off site environmental harm.
Record of water quality testing and irrigation practices is maintained detailing crop, date, location, and volume of water applied or duration of irrigation as well as name of the person administering irrigation *(See presentation slides for record keeping)*
[6] Fertigation is the injection of fertilizers, used for soil amendments, water amendments and other water-soluble products into an irrigation system.

28Evaluation for session-3.3 (10 minutes)

Ask the following questions to the participants if they have understood the session.
• Ask the participants what they have learnt from the session?
• Should we use the water flowing from livestock farms, hospitals, industries and waste waters for irrigation of GAP production and why?
• Can the water lead to environmental hazards in addition to safety hazards?
• Do you know why soil and water testing is important in GAP crop production?
• What should be noted in the record of water testing and irrigation practices?

Objectives *To train the training participants in safe and appropriate harvesting and post-harvest handling of GAP crops*
Delivery method *Brainstorming, group discussion, presentation and open ended questions*
Materials needed *Flip charts with stands, marker pens, butcher papers*
Time *30 minutes*

1. Explain to the participants that this is time for activity-1, session-4 of module-3.
2. Ask a volunteer from the participants to read the objectives of this session. Then, explain that this activity will provide an opportunity to learn the harvesting and post-harvest management.
3. Divide the participants into three groups.
4. Ask each of the groups to answer to the following questions as per the number indicated in each arrow.
5. Ask each of the groups to write the discussion points in a short phrase/word on the butcher papers:
• **Group-1:** What are the factors that can occur the chemical, biological and physical contaminations of produce during harvesting, handling and storage periods?
• **Group-2:** What are the precautions during harvesting period to avoid/reduce the contaminations and post-harvest losses?
• **Group-3:** What are the good practices for equipment and containers used for harvesting/ harvested produce and storage to avoid chemical and biological contaminations?
6. Give each group ten minutes to discuss and write the discussion points on the butcher paper.
7. After ten minutes, ask representatives of each group to present their responses to the participants.
8. Then, explain the harvesting and post-harvest management practices as provided in key information below (topic-3.4.1) to complement their answers.
9. Make sure to correct any incorrect opinions or information given by the participants; and
10. Ask participants if they have questions, address them accordingly, and then summarize the session.

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Appropriate harvesting determines the post-harvest quality, storability and safety of produce.
Chemical, biological and physical contamination of produce can occur during harvesting and handling after harvest due to:
• *dirty and poorly maintained equipment, materials, containers, handling and storage areas, and transport vehicles;*
• *poorly constructed and maintained buildings and structures;*
• *use of non-approved chemicals for treating produce and cleaning and sanitizing of equipment and work areas;*
• *inadequate control of domestic and farm animals and pests; and*
• *poor personal hygiene facilities and standards.*
The crop should be harvested using crop maturity index using crops specific harvesting techniques/methods.
Produce is harvested in the coolest time of the day and harvesting in the rain is avoided if possible.
Produce is removed from the field as quickly as possible.
Harvested produce is placed in the shade if long delays occur before transport.
Produce is packed and stored in covered areas.
Produce is not placed in direct contact with soil or the floor of handling, packing or storage

areas.
Produce is graded and packed according to customer or market requirements.
Containers of harvested produce are not stacked on top of each other unless they are designed to support the container and minimize mechanical damage.
Containers used for storage of produce after harvesting should be covered to reduce moisture loss and exposure to the sun.
Storage containers should be checked for soundness and cleanliness before use and cleaned or discarded as required.
Equipment and tools are suitable for harvesting and are checked for cleanliness before use and cleaned as required to avoid chemical and biological contamination of the produce and minimize physical damage.
Equipment, containers and materials are stored in areas separated from chemicals, fertilizers and soil additives and measures are taken to minimize contamination from pests.
Equipment, containers and materials that contact produce are regularly cleaned and maintained to minimize mechanical damage.
Measures are taken to prevent the presence of pests in and around handling, packing and storage areas.
Protective materials are used where required to protect produce from rough surfaces of containers and excessive moisture loss.

Evaluation for session-3.4 (10 minutes)

Ask the following questions to the participants if they have understood the session.

• What are the factors that can occur the chemical, biological and physical contaminations of produce during harvesting, handling and storage periods?

• What are the precautions during harvesting period to avoid/reduce the contaminations and post-harvest losses?

30• What are the good practices for equipment and containers used for harvesting/ harvested produce and storage to avoid chemical and biological contaminations?

• When of the day should the produce be harvested?

Figure 26. Aflatoxins affected walnuts Figure 27. Aflatoxins affected pods

Figure 28. Aflatoxins affected maize grains Figure 29. Dried chilies affected by Alfatoxins

Module 4: Storage, transport, packing traceability and recall

Session 4.1: Storage methods, standards, transportation, packing and record keeping

Objectives	Building the capacity of training participants in safe storage, transportation, packing and recording keeping
Delivery method	Brainstorming, group discussion, presentation and open ended questions
Materials needed	Flip charts with stands, marker pens, sticky notes
Time	1.5 hours (90 minutes)

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1. Welcome back the participants and explain that this is time for activity-1, session-1 of module-4, session-1.
2. Ask a volunteer from the participants to read out the objectives of this session. Then, explain that this activity will provide an opportunity to learn the safe storage, packing and handling of produce.
3. Divide the participants into three groups.
4. Ask each of the groups to answer to the following questions and write down their discussion points in a short phrases/words on the butcher papers:

• What kinds of packaging materials did you use for storage?

• How did you store your produce for seed quality maintenance?

• Ask the participants which packaging materials and which storage methods are more effective for seed quality maintenance as per your experiences.

5. Give each group 15 minutes to discuss and write the discussion points on the butcher paper.
6. After 15 minutes, ask representatives of each group to post the butcher papers on the flip charts and present their discussion points to the participants.
7. Then, explain the safe storage methods, packing and handling of produce as provided in key information below (topic-4.1.1) to complement their answers.
8. Make sure to correct any incorrect opinions or information provided by the participants.
9. Ask the participants if they have questions and address them accordingly.

Produce should not be stored in the containers previous used for chemicals and other dangerous subsistence and materials.
If there is no permanent silo, super bags, tin boxes and *potes*, a kind of traditional container

used in Myanmar for grain storage and made of bamboo, are used. For export purpose, the prevention measures for storage pests/disease are practised during the storage period to meet the requirements of the different exporting countries.
An inventory of stored produce should be maintained having details such as produce name, quality/grade, weight, date of storage, moisture at the time of storage etc.
Packed containers are to be clearly marked with an identification to enable traceability of the produce to the farm or site where the produce is grown.
For long delays before transport, produce is held at the lowest suitable temperature available.
Lights above areas where produce and packing containers and materials are exposed, are either shatter proof or protected with shatter proof covers. In the event of a light breaking, exposed produce is rejected and equipment and packing containers and materials are cleaned.
Where equipment and tools that may be a source of physical hazards are located in the same building as produce handling, packing and storage areas, the equipment and tools are screened with a physical barrier or are not operated during packing, handling, and storage of produce.
Produce is stored and transported in areas separated from materials and goods that are a potential source of chemical, biological and physical contamination.
Grease, oil, fuel and farm machinery are segregated from handling, packing and storage areas to prevent contamination of produce.
The traps and stimulating foods are put in targeted places and carefully monitor to minimize the risk of contaminating produce. A record is kept of places where the traps and stimulating foods are placed.

1. Explain to the participants that this is time for activity-2, session-1 of module-4, session-1. This activity will provide an opportunity to learn the transportation of stored produce.
2. Ask the participants the following questions and write down the brief of their responses on the different flipcharts for different questions:
• What should we do the transport vehicles before use to avoid the contaminations of produce?
• Do you have the record for the transportation of produce? If yes, please raise your hand.
• Ask 2–3 participants who have the experiences in record keeping practices of transporting produce, “What are noted in the record?
3. Facilitate the participants to speak out their practices by asking some more questions like; date of supply, quantity of produce and destinations for each consignment of produce.
4. After the discussion, the facilitator read out the brief of discussion points for the participants.
5. Then, explain the transportation of stored produce as provided in key information below (topic-4.1.2) to complement their responses.
6. Ask participants if they have questions and address them accordingly then, summarize the session.

Vehicles used for transportation of produce should be checked for cleanliness, foreign objects, pest infestation, chemical contamination, pest infestation as well as making sure that the vehicle is free from moisture.
The vehicle used for transportation of produce should be covered to prevent quality deterioration due to humidity or rain.
Transport vehicles are covered and appropriate temperature conditions are used to minimize quality loss
A record is kept of the date of supply, quantity of produce and destination for each consignment of produce.

1. Explain to the participants that this is time for activity-3, section-1 of module-4. This activity will provide an opportunity to learn the management of building and structures for storage produce.
2. Ask the participants the following questions and write down the brief of their responses on the different flipcharts for different questions:
• Where did you store the produce before selling out?
• How to store your produce in that place? Ask them to explain more details in terms of different kinds of floors where the produce is placed. Facilitate them to speak out their responses.
• Did you use pesticides to prevent the storage pests? If you use, did you follow the recommended dosage and other precautions?
3. After the discussion, the facilitator read out the brief of discussion points for the participants.
4. Then, explain the management of building and structures for storage produce as provided in key information below (topic-4.1.3) to complement their answers.
5. Ask participants if they have questions, address them accordingly, and then summarize the session.

Buildings and structures used for growing, handling and storage of produce are constructed and maintained to minimize the risk of contaminating produce.
Building and structure are constructed separated places from farm animals, animal feed and compost making exist.
The floor of the building is checked before used for cleanliness, foreign objects, chemical contamination, pest infestation and other materials.
The bamboo/timber are placed on the floor of the building with purpose of not being direct contact with the floor.
The building is structured and managed to have in good ventilation and prevention of birds, rats and pest.
Produce is not stored in direct contact with fuels, pesticides, fertilizers including farm implements and other materials.
Recommended pesticides are used during the storage period according to the recommended dosage to prevent the storage pest.
Sewage, waste disposal and drainage systems are constructed to minimize the risk of contaminating the production site and water supply

Evaluation for session-4.1 (15 minutes)

Ask the following questions to the participants if they have understood the session.

• Should we use the containers previous used for chemicals and other dangerous subsistence and materials for GAP crops?
• What are the precautions during storage period in terms of produce quality maintenance and traceability?
• What are the precautions in the areas of produce handling, packing and storage to prevent any contamination of produce?
• What are the precautions for transport vehicles before use to avoid/prevent the contaminations of produce and quality deterioration?
• What should be noted in the record of produce transportation?
• What are the precautions for the buildings and structures used for growing, handling and storage of produce to minimize the risk of contaminating produce?

Objectives *To orient and train the participants about the importance, method of record keeping for traceability and recall of GAP*
Delivery method *Brainstorming, group discussion, presentation and open ended questions*
Materials needed *Flip charts with stands, marker pens, sticky notes*
Time *1 hour (60 minutes)*

1. Explain to the participants that this is time for activity-1, session-2 of module-4. This activity will provide an opportunity to understand the documentation and record keeping practices.
2. Ask the participants the following question and write down their responses on the flipcharts:
• Do you have experience in record keeping practices? If yes, raise your hand.
• Ask all participants who have experiences in record keeping to share their experiences.
• Facilitate them to speak out their responses by highlighting the questions of how many years they kept.
3. After the discussion, the facilitator read out the brief of discussion points for the participants.
4. Then, explain about documentation and record keeping practices as provided in key information below (topic-4.2.1) to complement their answers.
5. Ask participants if they have questions, address them accordingly, and then summarize the session.

The objectives of record maintenance is to ensure effective record keeping for easy, evidence based and timely investigation of quality loss of the produce.
Evidence for implementation of safety measures and GAP practices are available to the auditors and investigators.
Records of good agricultural practices are kept for a minimum period of at least two years (Myanmar GAP Guidelines) of for a longer period if required by government legislation or traders/customers.
Out of date documents are discarded and only current versions are used.

1. Explain to the participants that this is time for activity-2, section-2 of module-4. This activity will provide an opportunity to understand the traceability and recall.
2. Ask the participants the following questions and write down the brief of their responses on the different flipcharts for different questions:
• How do you think whether the traceability is necessary or not in GAP crop production?

• Ask (3–5) participants to explain their understanding of importance of traceability and facilitate a discussion.
• What should be recorded to enable traceability of the produce?
• Ask all participants to explain their understanding and facilitate them.
3. After the discussion, the facilitator read out the brief of discussion points for the participants.
4. Then, explain about the traceability and recall as provided in key information below (topic-4.2.2) to complement their answers.
5. Ask participants if they have questions, address them accordingly, and then summarize the session.

The objective of traceability and recall is to ensure an effective system for identifying, tracing and recalling unsafe produce and removal from sale as well as to identify the cause of contamination and prevent re-occurrence.
Each separate production site is identified by a name or code. The name or code is placed on the site and recorded on a property map. The site name or code is recorded on all documents and records that refer to the site
Packed containers are clearly marked with an identification to enable traceability of the produce to the farm or site where the produce is grown
A record is kept of the date of supply, quantity of produce and destination for each consignment of produce
When produce is identified as being contaminated or potentially contaminated, the produce is isolated and distribution prevented or if sold, the buyer is immediately notified.
The cause of any contamination is investigated and corrective actions are taken to prevent reoccurrence and a record is kept of the incident and actions taken.
Evaluation for session-4.2 (10 minutes)
Ask the following questions to the participants if they have understood the session.
• How many years should the record be kept?
• What is the objective of traceability and recall?
• What should be recorded to enable traceability of the produce?
• What should we do if the produce is identified as being contaminated or potentially contaminated?

Objectives *To highlight the importance and methods of workers training, personal hygiene, air quality, energy efficiency and review of practices for compliance to GAP criteria*
Delivery method *Brainstorming, group discussion, presentation and open ended questions*
Materials needed
Flip charts with stands, marker pens, sticky notes
Time *2 hours (120 minutes)*

1. Explain to the participants that this is time for activity-1, section-3 of module-4. This activity will provide an opportunity to understand the importance of workers training.
2. Ask the participants the following questions and write down their responses on the different flipcharts for different questions:
• Who should be trained for safe and approved handing of produce?
• Why is workers training important for safe and approved handing of produce?
3. After getting the responses, the facilitator read out the brief of their responses for the participants.
4. Then, explain about the workers training as provided in key information below (topic-4.3.1) to complement their answers.
5. Ask participants if they have questions, address them accordingly, and then summarize the session.

Workers/employees at the farm, government staff, farmers, consumers, merchants, brokers and exporters as well as other value chain actors engaged in production, post-harvest management and trading of produce should be properly trained to improve their knowledge and skills for safe and approved handing of produce.
Workers training is immensely important to ensure worker safety, wellbeing, compliance to food safety, produce quality and environmental management as well as to confirm and reinforce the implementation of practices and improvement as necessary.
Keeping in view safe environmental management, workers training is important to prevent or minimize environmental hazards.
Record of training and refresher, exposure should be maintained for traceability *(see presentation slides for record keeping).*

1. Explain to the participants that this is time for activity-2, section-3 of module-4.
2. From the previous modules, you may have noticed/understood that “what is gap, what are the good agricultural practices in terms of site selection, management of planting materials, fertilizers and soil additives, chemicals & agrochemical, irrigation management, harvesting and handling produce, post-harvest management, documentation and trainings.
3. Explain to the participants that the technical advisory team will review all gap practices that you have done at least once each year to ensure the gap practices are properly done.
4. Then, explain more details related to review of practices as provided in key information below (topic-4.3.2).
5. Ask participants if they have questions, address them accordingly, and then summarize the session.

All practices are reviewed by the Technical Advisory Team at least once each year to ensure the practices are done correctly.
Actions are taken to resolve the complaints related to produce quality, and a record is kept of the complaint and actions taken.
A record is kept of practices reviewed and corrective actions taken.
Records of compliance standards to workers safety and wellbeing is available for assessment and verification.
Record of Complaints related to worker health, safety and welfare investigated and actions taken to resolve the complaints.

Figure 30. Protection from the hazardous effects of chemical must be complied with

Figure 31. Posters and signs in the work area help to reinforce instructions for workers

Figure 32.Workers training through demonstration

1. Explain to the participants that this is time for activity-3, section-3 of module-4.
2. Explain to the participants that personal hygiene is of immense importance for food safety and workers health.
3. Then, explain more details related to personal hygiene and workers welfare as provided in key information below (topic-4.3.3).
4. Ask participants if they have questions, address them accordingly, and then summarize the session.

Family and farm workers should be trained in maintaining personal and environmental hygiene to prevent or reduce the risk of physical, chemical and biological contamination by following improved hygiene standards.
Hygiene facilities should be provided to the workers both on site of production and post-harvesting handling.

Written instructions on personal hygiene practices are also displayed in prominent locations and also distributed to them and encourage them to practice.
Toilets and hand washing facilities are readily available to workers and are maintained in a hygienic condition.
For personal hygiene and workers welfare, teamwork activities and educational meetings are conducted.
In case of any accidental injury to the workers, emergency and full medical care should be properly available. First aid kits is highly important to be present at the farm and related sites.
Where employers are required to provide medical and health cover, any serious health issue is reported to the relevant health authority.
Record of workers training should be maintained for recall and review of practices.

Figure. 33. Toilets and hand washing facilities must be readily available to workers and maintained in a hygienic condition

1. Explain to the participants that this is time for activity-4, section-3 of module-4.
2. Explain to the participants that safe, efficient and improved waste water and energy use, efficient operating practices of machinery & equipment and control of feral animals and environmental pests are highly important to prevent or minimize environmental harm.
3. Then, explain more details about waste and energy efficiency as provided in key information below (topic-4.3.4).
4. Ask participants if they have questions, address them accordingly, and then summarize the session.

Efficient and environment friendly practices and safe, and improved waste water and emergency use efficiency is highly important to prevent or minimize environmental harm/damage and conserve native plants, remnant vegetation areas, wild life corridors, banks of waterways and indigenous animal species
Consumption of electricity and fuel is reviewed and efficient operating practices are identified and used.
39Machinery and equipment are serviced to maintain operational efficiency or are replaced.
Measures are used to control feral animals[7] and environmental pests
The generation of offensive odor, smoke, dust, and noise is managed to minimize the impact on neighboring properties.

1. Explain to the participants that this is time for activity-5, section-3 of module-4.
2. Explain to the participants that use of safe, efficient and approved management of farm operations is imperative to maintain air quality and to prevent/minimize environmental pollution.
3. Then, explain more details about environmental pollution as provided in key information below (topic-4.3.5).
4. Ask participants if they have questions, address them accordingly, and then summarize the session.

To maintain air quality, prevent or minimize environmental pollution, it is imperative to use safe and efficient and approved management of farm operations
Workers/employees should be trained to avoid practices contributing to air pollution and record of training be kept on record.
Burning of farm residues, plastic, rubber and aluminum burning should be avoided.
Crop residues instead of burning should be safely used for composting.
Vehicles and farm machinery should be regular checked and maintained for avoiding excessive emissions. If possible, renewable energy sources such as hydro-powered and solar powered should be used to minimize environmental damage.
Actions are taken to resolve complaints related to environmental management, and a record is kept of the complaint and actions taken.
Figure 34. Emissions of air pollutants from primary crop residue burning

Source:
Ravindra, K., Singh, T., Mor, S. 2018. *Emissions of air pollutants from primary crop residue burning in India and their mitigation strategies for cleaner emissions.* https://en.x-mol.com/paper/article/842958.

[7] A feral animal is one that has escaped from a domestic or captive status and is living more or less as a wild animal.

40Figure 35. Excessive vehicular emissions impairs air quality
Figure 36. Burning of plastic and rubber is adding to environmental pollution and acid rains

Source:
Rinkesh. Causes, effects and solutions to vehicular pollution. https://www.conserve-energy-future.com/causes-effects-solutions-vehicular-pollution.php.

Source:
Unpaid PAE Intern. 2013. Kuwaiti tyre burning facility takes part in earth hour by turning office light off. http://www.panarabiaenquirer.com/wordpress/kuwait-tyre-burning-facility-earth-hour/.

Evaluation for session-4.3 (15 minutes)
Ask the following questions to the participants if they have understood the session.
• Who should be trained for safe and approved handing of produce?
• Why is workers training important for safe and approved handing of produce?
• At least how many times will Technical Advisory Team review per year to ensure the practices?
• What should be prepared/done to maintain personal and environmental hygiene both on site of production and post-harvesting handling?
• What should be provided at the farm and related sites in case of any accidental injury to the workers?
• Who is responsible for workers' health, safety and welfare who are working at a farm?
• How do you think whether machinery and equipment should be regular serviced or not? Why?
• How do you think whether burning of farm residues, plastic, rubber and aluminum is a good practice or not? Why?
• How do you think whether vehicles and farm machinery should be regular checked or not? Why?

• What are the good agricultural practices that can control environment hazards?

41 # Volume 2

Good agriculture practices (GAP) for oil seed, pulse and rice/paddy

43 **Module Module 5: Pre-harvest management GAP oil seed crops (sesame & groundnut)**
Module 6: IPM and IWM in oil seed crops (sesame & groundnut)
Module 7. Harvesting and post-harvest management of GAP oil seed crops (sesame & groundnut)

Session Time 5.1. Site selection, land preparation, planting methods and seed selection 1 hour
Session evaluation-5.1 (10 minutes)
5.2. Organic and inorganic fertilizers and soil amendments 1.5 hours
Session evaluation-5.2 (15 minutes)
5.3. Crop rotation and intercropping 1 hour
Session evaluation-5.3 (10 minutes)
5.4. Irrigation and water management 30 minutes
Session evaluation-5.4 (10 minutes)
MODULE-6, day 3
6.1. Integrated pest management (IPM)approach for management of insects pests in oil seed crops
2 hours
Session evaluation-6.1 (10 minutes)
6.2. IPM approach for management plant diseases of oil seed crops 1 hour
Session evaluation-6.2 (10 minutes)
6.3. IWM (Integrated Weed Management) in oil seed crops 1 hour
Session evaluation-6.3 (10 minutes)
MODULE-7, day 3
7.1. Harvesting and post-harvest management
1 hour
Session evaluation-7.1 (10 minutes)
44
Topics /activity
5.1.1. Sites selection and soil requirements
5.1.2. Seed selection, varieties, seed rate and seed treatment
5.1.3. Planting method, time and plant population
5.2.1. Chemical fertilizers, macro and micronutrients management
5.2.2. Organic manures
5.2.3. Soil amendments
5.3.1. Crop rotation
5.3.2. Intercropping
5.4.1. Irrigation water quality
5.4.2. Methods, times and frequency

and irrigation scheduling at critical crop growth stages
6.1.1 What is IPM
6.1.2 Major insect pests of sesame and IPM
6.1.3. Major insect pests of groundnut and IPM
6.2.1. Major diseases of sesame and IPM
6.2.2. Major diseases of groundnut and IPM
6.3.1. What is IWM (Integrated Weed Management)
6.3.2. IWM in oil seed crops
7.1.1. Method and time of harvesting
7.1.2. Threshing, drying and cleaning
7.1.3. Packing, packaging storage and transportation**Module Module 8: Pre-harvest GAP in pulses crops**

Module 9: IPM and IWM in pulses crop

Module 10. Harvesting and post-harvest management of GAP pulses crops

Session Time 8.1. Site selection, land preparation, planting methods and seed selection 1 hour
Session evaluation-8.1 (10 minutes)
8.2. Manuring, fertilizers and soil amendments 1 hour
Session evaluation-8.2 (15 minutes)
8.3. Crop rotation and intercropping 30 minutes **Session evaluation-8.3 (10 minutes)**
8.4. Irrigation and water management 30 minutes **Session evaluation-8.4 (10 minutes)**
MODULE-9, day 4
9.1. Integrated pest management (IPM)approach for management of insects pests in pulses
1 hour
Session evaluation-9.1 (10 minutes)
9.2. Integrated pest management (IPM)approach for management plant diseases in pulses
1 hour
Session evaluation-9.2 (10 minutes)
9.3. IWM (integrated weed management) in pulses 30 minutes
Session evaluation-9.3 (10 minutes)
MODULE-10, day 4
10.1. Harvesting and post-post-harvest management
1 hour
Session evaluation-10.1 (10 minutes)
45
Topics /activity
8.1.1. Sites selection and soil requirements
8.1.2. Seed selection, varieties, seed rate and seed treatment
8.1.3. Land preparation and planting time
8.2.1. Chemical fertilizers, macro and micronutrients management
8.2.2. Organic manuring
8.2.3. Soil amendments
8.3.1. Crop rotation
8.3.2. Intercropping

8.4.1. Irrigation water quality
8.4.2. Methods, times and frequency
9.1.1 What is IPM
9.1.2. Major insect pests of chickpea
and IPM
9.1.3 Major insect pests of green gram
and IPM
9.2.1. Major diseases of chickpea and
IPM
9.2.2. Major diseases of green gram
and IPM
9.3.1. What is IWM (Integrated Weed
Management)
9.3.2. IWM in pulses crops
10.1.1. Method and time of harvesting
10.1.2. Cleaning, sorting and grading
10.1.3. Packing and packaging,
storage and transportation**Module Module 11: Pre-harvest management GAP of rice/paddy**

Module 12: IPM and IWM in rice/paddy

Module 13. Harvesting and post-harvest management of GAP rice/paddy

Session Time 11.1. Site selection, land preparation,
planting methods and seed selection 1 hour
Session evaluation-11.1 (10 minutes)
11.2. Manuring, fertilizers and soil
amendments 1.5 hours
Session evaluation-11.2 (15 minutes)
11.3. Crop rotation and intercropping 1 hour
Session evaluation-11.3 (10 minutes)
11.4. Irrigation and water management 30 minutes **Session evaluation-11.4 (10 minutes)**
MODULE-12, day 5
12.1. Integrated pest management
(IPM)approach for management of
insects pests in rice/paddy
1 hour
Session evaluation-12.1 (10 minutes)
12.2. Integrated pest management
(IPM)approach for management plant
diseases in rice/paddy
1 hour **Session evaluation-12.2 (10 minutes)**
12.3. IWM (integrated weed
management) in rice/paddy 30 minutes
Session evaluation-12.3 (10 minutes)
MODULE-13, day 5
13.1. Harvesting and post-post-harvest
management
1 hour
Session evaluation-13.1 (10 minutes)

Topics /activity
11.1.1. Sites selection and soil
requirements
11.1.2. Seed selection, varieties, seed
rate and seed treatment
11.1.3. Production systems, planting
method and plant population
11.2.1. Chemical fertilizers, macro
and micro nutrients management
11.2.2. Nutrient deficiencies and
management
11.2.3. Organic manuring

11.2.4. Soil amendments
11.3.1. Crop rotation
11.3.2. Intercropping
11.4.1. Irrigation water quality
11.4.2. Methods, times and frequency
12.1.1. What is IPM
12.1.2. Major insect pests of rice/paddy and IPM
12.2.1. Major diseases of rice/paddy and IPM
12.3.1. What is IWM (Integrated Weed Management)
12.3.2. IWM in rice/paddy
13.1.1. Method and time of harvesting
13.1.2. Threshing, drying and cleaning
13.1.3. Milling, grading, packing/packaging and storage

Module 5: Pre-harvest GAP of oil seed crops (sesame & groundnut)

Objectives To train the participant on improved pre-harvest crop management for sesame and groundnut
To orient the participants with key climate smart GAP features at pre-harvest
Delivery method Brain storming, presentation, Q&As and session evaluation
Materials needed Presentation print outs, flip charts, white board, marker pens, butcher papers
Time 1 Hour

Assess the site for chemical, physical and biological hazards.
Avoid sites used previously waste disposal or as livestock farm.
Sites should have sustained availability of irrigation water.
If the risk of contamination is high, an alternative site be selected.
Record the sites details through site mapping **(see annex 4).**

Soil requirements for sesame

Well-drained and medium textured fertile soils with a ph of 5 to 8.
Saline and waterlogged soils are not suitable for sesame cultivation.

Soil requirements for groundnut

Well-drained, coarse textured and sandy loam or sandy clay loam soil with ph of 6.5 to 7.
Soils with high ph (>7.5) cause micronutrient deficiency.
Heavy clayey, sodic and saline soils are not suitable for groundnut cultivation.

1. Divide participants into two groups.
2. Ask participants: what are the factors you considered in selecting your farm site for gap crops production? Especially asking the following key questions for knowledge sharing and support:
• *Are you checking the sites for any hazards?*
• *Do you record site history and site management practices?*
• *Do you conduct soil tests before site selection?*
• *What type of soils are required for sesame and groundnut?*
• *What type of sites should not be considered as fit for GAP crops cultivation?*
• *In case if a site is identified with any current or potential hazard (chemical, biological or physical) what measures are likely to be taken?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain the basic requirements for site selection and management by using the key information under (topic-5.1.1) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Use doa recommended varieties/seeds.
Be free from physical impurities, be resistant to diseases and tolerant to drought.
Use fresh seed not older than two years.
80 percent germination 98 percent physical and analytical purity.

Recommended varieties of Sesame

Growth
Yield
Oil
Type Variety name Cultivation season

cycle (seed to seed)	**potential (kg/ha)**	**Content (percent)**	
Black Theitpan	All season	85–90	605–907 48–50
Black Samone	All season	100–105	605–907 48
Black sesame Sin Yadanar 2	All season	85–90	907–1 210 42–44
Sin Yadanar 3	All season	90–100	605–907 42–45
Sin Yadanar 14	All season	80–85	726–907 42–44
White Sesame	All season	90–95	605–907 45–48
White sesame Sin Yadanar 4	All season	80–85	605–907 45–46
Sin Yadanar 12	All season	80–85	726–907 44–46
Red Sesame			
Red sesame (25/160)	Monsoon, Winter	90–95	605–907 55

Source:
DAR. 2018. Released New Varieties. Department of Agricultural Research, Ministry of Agriculture, Livestock and Irrigation, Nay Pyi Taw, Myanmar, 168 pp.
DAR. 2019. Research outcomes after 65 years of DAR's effort (in Myanmar). Department of Agricultural Research, Ministry of Agriculture, Livestock and Irrigation, Nay Pyi Taw, 202 pp.

Seed rate 5–7 ha/kg for line sowing, 7–10 kg/ha broadcast.
Treat the seeds with doa recommended fungicides.

Recommended varieties of groundnut

Variety name	**Growth cycle (seed to seed)**	**Average yield potential (kg/ha)**	**Shelling percent**	**Oil content (percent)**	**Remarks**
Sinpadaethar-1	95–100	1 121–1 261	74–75	53–54	Short duration/good for irrigated areas
Sinpadaethar-2	105–110	1 261–1 345	70–73	52–53	high yield potential/good for irrigated areas
Sinpadaethar-3	120–130	1 821–2 662	68–70	52–53	Good for irrigated areas, alluvial soils
Sinpadaethar-5	105–120	1 541–1 821	68	50–51	Resistant to leaf spot disease
Sinpadaethar-6	105–115	1 401–1 681	74	48–49	Drought resistant
Sinpadaethar-7	90–95	1 681–1 961	74	49–50	Short duration, high yield potential
Sinpadaethar -8	100–105	1 541–2 241	72–75	47	All season, especially for CDZ
48Sinpadaethar-11	100–105	1 541–2 521	73	48	Resistant to leaf spot, high yield potential
Sinpadaethar-12	105–110	141–1 681	72	46–47	Drought resistant
Sinpadaethar-13	105–110	1 681–2 241	74	44	High yield potential
Magway -16	95–100	2 241–2 802	70	48	Draft resistant & high yield potential
Magway -17	100–105	2 521–2 662	72	44–56	Short duration & high yield

Source; DAR, 2018 & 2019

Use a seed rate (seed without shell) of 75–80 kg/ha (about 1.2 basket/acre of groundnut seed) for spreading and semi spreading types and 95–100 kg/ha (about 1.5 baskets/acre of ground seed acre-1) for bunch and semi bunch types
Treat the groundnut seed with recommended *Rhizobium Inoculum* for effective nodulation and nitrogen fixation (especially on new soils)

1. Divide participants into two groups.
2. Ask participants: What are the factors you considered while selecting seeds, variety, seed quality and seed treatment? Especially asking the following key questions for knowledge sharing and support;
• *Can you name a few of the recommended varieties of sesame and groundnut?*
• *Do you use recommended seed/variety of sesame and groundnut?*
• *What is the source of the seed obtained for sesame and groundnut?*
• *If not what are the constraints and challenges in securing quality seeds and suitable varieties?*
• *Do you know about the recommended seed rate for sesame and groundnut?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain Seed selection, varieties, seed rate and seed treatment for sesame and groundnut by using the key information under (Topic-5.1.2) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Land preparation and planting method-sesame

Clear the land from all type of weeds and instead of burning weeds, dry them and used as crop residues for composting.
Plow the land at the onset of monsoon rains for rain moisture conservation.
One deep plowing (six inches deep), followed by two light harrowing for better soil tilth, followed by leveling.
Planting geometry of row-to-row distance of 12 inches for single type & 15 inches for branching type varieties and plant-to-plant distance of four inches.
The plant population of (250 000–320 000) plants/ha is recommended to get maximum yield.
The seeding depth should be maintained maximum up to 1.5 to 2.0 inches for better germination.

49**Planting time-sesame**

Seasons Monsoon Winter
S H
S H
S H

Land preparation and planting method and time -groundnut

Deep tillage with moldboard ploughs up to the depth of 25–30 cm followed by disc/harrow to level and pack the soil.

Variety types	**Plant x plant distance**	**Row x row distance (inches)**	**Plants population per hectare**	**Seeding depth (inches)**
Erect type	4	12–15	(322 000–258 000)	1.5–2
Bushy/branching type	6	18	(143 000)	1.5–2

Seasons Monsoon Winter
S H
H S

1. Divide participants into two groups.
2. Ask participants: what are the appropriate planting method, time and plant population? Especially asking the following key questions for knowledge sharing and support:
• *How do you plant the seeds of sesame and groundnut i.e. broadcast/row planting?*
• *Do you know about the improved planting schemes for sesame and groundnut?*
• *If yes, please explain?*
• *Do you know about the desirable/recommended plant population of sesame and groundnut and what are the benefits of maintaining an optimum plant population?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them;.
5. After the presentations, explain about planting method, time and plant population by using the key

information under (topic-5.1.3) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Objectives To orient the participants about types, method, time and rate of manures, fertilizers and soil amendments.
To train the farmers for effective and safe application and handling of chemical fertilizers, manures and amendment.
Delivery method Brain storming, presentation, Q&As and session evaluation
Materials needed Presentation print outs, flip charts, white board, markers, butcher papers
Time 1 hour
50

Apply chemical fertilizers on site specific, soil test basis and as per DOA recommendations.
Obtain fertilizers from a registered supplier.
Practise split application of chemical fertilizers in sandy /loose soils.
Apply fertilizers to the soil when soil moisture is sufficient to avoid loss of nutrients and toxicity to the plants.
Keep record of fertilizer, as requirement for GAP certification as per **Annex 1**; and
Apply soil amendments such as gypsum when if the soil is saline/alkaline i.e. Ph is alkaline (>7.5).

Chemical fertilizers-sesame (if soil test are not available)

Macronutrients

Nitrogen: @46–100 kg/ha as narrow band 5-8 cm to the side of the plants and 3–5 cm deeper than the seed in three equal split doses i.e. as basal dose, at vegetative and flower initiation stages from available and recommended nitrogenous fertilizers.
In case of broadcast application, incorporate fertilizer in the soil
Phosphorus: @90–100 kg/ha as broadcast or band application. In case of broadcast application, fully incorporate fertilizers into the soil to reduce the risk of phosphorus loss through runoff and leaching below the root zone.
Apply **phosphorus** as basal dose during land preparation in rain-fed areas and split (50 percent at sowing and 50 percent at flower initiations) in irrigated areas.
Potash: @30–50 Kg/ha as band or side dressing, if broadcasted, then incorporate in the soil for better uptake.
As potash uptake is more active during the early growth phases, apply full dose at sowing except in coarse textured (sandy) soil due to high rate of leaching.
Compound fertilizers
@ NPK 23:13:13 kg/ha for rain-fed areas and 35:23:23 NPK kg/ha for irrigated lands

Micronutrients

Apply on soil test basis and only when deficiency is recorded.
Sulphur @ 45 kg/ha from Ammonium sulfate (21 percent N, 24 percent S), Sulfate of potash (SOP - 50 percent K2O, 18 percent S), Magnesium sulphate (26.63 percent S), N-P-K + with 18-4-5-15-S.
Magnesium @20 kg of MgSO4/ha as basal dose from Magnesium sulphate (26.63 percent S).
Calcium be applied in areas with heavy metal (especially Cadmium) presence causing stress in sesame plants.
Boron deficiency is widespread in sesame and should be applied where sever deficiency is noted.
Zinc @ 2.5 percent ZnO from source like $ZnSO_4$.
Manganese @5 kg/ha of MnSO4.

Organic manures

Organic manures such as FYM, Bokashi compost @ 5t/ha FYM or vermicompost @ 10 t/ha.
Also practise as per the guidelines given in crops GAP standards for green manuring by using the GM crops for adding organic matter to the soil to:
- *improve soil texture;*
- *microbial activities;*
- *structure and friability; and*
- *adding N and other micronutrient to the soil.*

51**Soil amendments (Gypsum)**

Use gypsum ($CaSO_4$ $2H_2O$) 250 kg gypsum ha^{-1} for correction of soil sodicity, salinity improving soil stability, water penetration into soil, and more rapid seed emergence.

Chemical fertilizers-groundnut (if soil tests are not available)

Macronutrients

Nitrogen: @ 20–40 N kg ha^{-1} for rainfed crop@ 30-50 kg/ha for irrigated crop as split application with 50 percent as basal dose, and two split applications with 25 percent at 30 DAE and remaining 25 percent at 70 DAE as top dressing.
In case of broadcast application, incorporate fertilizer in the soil.

Phosphorus: @75 kg P_2O_5 ha^{-1} for highest pod yield, shelling percentage and oil contents in 2 equal split doses; 50 percent as basal dose and 50 percent at 30 DAE.
Broadcasting and incorporation is an efficient method for increased phosphorus use efficiency
Potash: @25–50 kg K_2O ha^{-1} rain-fed crop and 40–75, K_2O ha^{-1} for irrigated crop as band application in cool season with application before or during sowing time except in coarse textured (sandy) soil due to high rate of leaching of K.
In case of broadcasting of K fertilizers, incorporate fully in the soil.

Compound fertilizers

@ NPK at the rate of 17:34:54 kg/ha

Micronutrients

Micronutrient should be applied on soil test basis, when deficiency is recorded.
Incorporate in the soil if broadcasted for better nutrient use efficiency and minimization of nutrient loss.
Sulphur @ 30–40 kg/ha as band or application in rows in three equally split doses i.e. at sowing, flowers initiation and pod formation stages.
Calcium @ 250–500 kg/ha from gypsum as top dressing or band or rows application near the pigging zone as calcium improves pods initiation and pods quality.
Magnesium @ 20 kg of MgSO4/ha if deficiency is recorded especially in sandy and strongly acid soils.
Manganese @ 2 percent MnSO4 @ 500 liter at 30, 50 and 70 DAS as foliar application.
Zinc @ 2 percent $ZnSO_4$ as foliar application at 30, 50 and 70 DAS.
Copper @ 2 kg Cu ha^{-1} as CuSO4, CuS and Bordeaux mixture in seed dressing, rows or foliar spray 0.1 percent $CuSO_4$, if Cu deficiency is observed.
Molybdenum @ of 0.5–1 kg/ha ammonium or sodium molybdate or seed pelleting with Mo at 100 g ha^{-1}.
Boron @ 0.5–1 kg/ha B as borax or boric acid prior to bloom stage or foliar application of 0.05–0.1 percent aqueous solution of boric acid.

Organic manures

Organic manures such as FYM, Bokashi compost @ 6–10t/ha FYM or vermicompst @ 2.5 t/ha.
Practise green manuring as per GAP standards for green manuring using GM crops for

- *adding organic matter to the soil;*
- *improving soil texture;*
- *improving microbial activities;*
- *improving structure and friability; and*
- *adding N and other micronutrient.*

52**Soil amendments (Gypsum)**

Use gypsum (CaSO4 2H2O) 500–1000 kg/ha of gypsum for correction of soil sodicity, salinity improving soil stability, water penetration into soil, and more rapid seed emergence.

1. Divide participants into two groups.
2. Ask participants: What type of chemical, organic fertilizers and soil amendments to be applied to sesame and groundnut crops? Especially asking the following key questions for knowledge sharing and support;

• Do you apply chemical fertilizers to sesame and groundnut crops, if yes, what type of chemical fertilizers are applied?
• If yes, what is normally the time and method of chemical fertilizers application?
• How do you assess the crop nutrient requirements?
• Have ever conducted soil tests for nutrient deficiency or excess in soils selected/cultivated with sesame and groundnut?
• Do you apply organic manures and if yes what type of and at what rate manures are applied by you?
• Why soil amendments are important for soils and under what soil conditions?
• Do you know the rate of soil amendments application for different sites/crops?

3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about on organic and inorganic fertilizers/manures and soil amendments by using the key information under (Topic-5.2.1) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Objectives To train the participant on improved crop rotations for increased ecological based farming system
To train the participant on improved crop intercropping as resilient cropping patterns
Delivery method Brain storming, presentation, Q&As and session evaluation

Materials needed Presentation print outs, flip charts, white board, markers
Time 30 minutes

Crop rotation is a systematic and sequential cultivation of different crops in the same field site unlike continuous cropping in which the same crop is cultivated year after year. Crop rotation also result in effective utilization of soil nutrients and soil moisture, reduced insects pests and disease problem. Farm income can be effectively diversified and sustained in view of climate change effect on agriculture

53**Principles of crop rotations**

Deep rooted vs shallow rooted-sesame-chickpea-green gram for efficient nutrient uptake and utilization.
Legume vs non-legume such as sesame should be cultivated after chickpea/green gram/groundnut for maintaining soil fertility.
Pathogens/nematode resistant crops and crops requiring heavy irrigation follow crops sensitive to certain pathogens, parasite (nematode) and less water and labor-intensive crops should follow labor intensive.

Intercropping growing two or more crops simultaneously on the same field. Intercropping is termed as m*ixed intercropping* (*mixed cropping*) when two or more crops are grown simultaneously with no distinct row arrangement. It is called *row intercropping* (*intercropping*) when two or more crops are grown simultaneously where one or more crops are planted in rows.

Principles of intercropping

The associating crop should be complimentary to the main crop.
The subsidiary crop should be of shorter duration and of faster growing habits, to utilize early slow growing period of main crop.
The component crops should require similar agronomic practices.
Erect growing crops should be intercropped with cover crop.
Erosion permitting crop should be intercropped with erosion resisting crop.
The component crops should have different rooting pattern and depth of rooting.

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1. Divide participants into two groups.
2. Ask participants: what are crop rotation and intercropping and what are the key principles and benefits of crop rotation? Especially asking the following key questions for knowledge sharing and support.

• Do you practise crop rotation in sesame and groundnut cropping systems?
• If yes what is the type of rotating crops and what crops are included in rotation for sesame and groundnut growing areas?
• Can you name some useful crops to be included in crop rotation and why?
• What is intercropping and its key benefits?
• What important considerations should be kept in mind while planning intercropping?

3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about crop rotation and intercropping by using the key information under (topic-5.3.1, 5.3.2.) To complement their answers.
6. Ask participants if there are any questions/clarifications.

Objectives *• To train the participant on importance of irrigation water quality and safety for GAP certified crops*
• And to orient them on improved irrigation methods, time and scheduling of efficient crop irrigation techniques
Delivery method *Brain storming, presentation, Q&As and session evaluation*

Materials needed
Presentation print outs, flip charts, white board, markers
Time *30 minutes*

Test water quality for heavy metals to ensure safe food production.
Record of water quality test and keep record for verification.
The water flowing down from livestock farms, hospitals, industries, waste water and any sources that may cause environmental harm must not be used for irrigation purpose.
The irrigation, fertigation and water management of the crop should be recorded.

1. Divide participants into two groups.
2. Ask participants: what is the irrigation water quality and what key considerations should be kept in mind while irrigating crops cultivated with gap? Especially asking the following key questions for knowledge sharing and support:
• *Do you know why water testing is important in case of crops cultivated as GAP certified?*
• *Have you ever tested water quality?*
• *If yes, what specific elements are normally tested?*
55• *If no, what are the key constraints for not conducting water quality testing?*
• *What type of water sources should be avoided for irrigating GAP certified crops?*
• *Do you keep record of water quality and irrigation management of your crops?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain irrigation water quality and safety by using the key information under (topic-5.4.1) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Sesame
Susceptible to drought /water stress and water logged conditions.
Sensitive/critical stages for irrigation are seedling, flowering, and grain filling stages.
Heavy rain at flowering drastically reduce yield, and if cloudy weather persists for long time, cause severe bacterial blight infection.
The crop should be irrigated lightly to avoid inundation of water in the field for a long time
Irrigation be discontinued when the plants complete flowering (70–80 days depending on variety).
If a dry period occurs prior to planting, heavy pre-sowing irrigation followed by next irrigation 4 to 5 weeks later.
Irrigation needed when the plants indicate leaf drooping by mid-day.
Groundnut
Drought tolerant but need irrigation at germination, flowering, peg formation and pod filling stages.
Irrigation at the time pegging is highly important for ensuring effective peg penetration in the soil.
Reduced soil moisture besides drastic yield reduction also causes infection of pods by *Aspergillus flavus (aflatoxins).*
High Susceptibility to drought at (1–2 weeks) at growth stage of the plants from planting to emergence,
Low susceptibility during early vegetative growth (5–6 weeks) from emergence to pegging.
High susceptibility during nut development /fruiting (8–9 weeks) from flowering/pegging to pod formation.
Moderate susceptibility during maturation (5–6 weeks) at growth stage from plants pod formation to harvest.

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1. Divide participants into two groups.
2. Ask participants: what are the methods, times and frequency and irrigation scheduling? Especially asking the following key questions for knowledge sharing and support:
• *How often do you irrigate sesame and groundnut crops?*
• *How do you know that it is time to irrigate the crops?*
• *Do you know about the critical stages of crops irrigation?*

• *Do you know about the improved methods of irrigation to avoid water losses and increasing water use efficiency?*

3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about the methods, times and frequency and irrigation scheduling at critical crop growth stages by using the key information under (topic-5.4.2) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Figure 37. Critical growth stages for sesame crop irrigation
© Munir
Source (left to right):
Hata, N., Hayashi, Y., Ono, E., Satake, H., Kobayashi, A. & Muranaka, T. 2013. Differences in plant growth and leaf sesamin content of the lignanrich sesame variety "Gomazou" under continuous light of different wavelengths. Plant Biotechnology, 30: 1–8. https://doi.org/10.5511/plantbiotechnology.12.1021a.
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Figure 38. Groundnut relative drought susceptibility
© Munir
Figure 39. Critical growth stages of groundnut for irrigation
© Munir
Source (left to right):
StoneyCreekFarm. 2014. How to Plant Seeds for the Garden. https://stoneycreekfarmtennessee.com/plant-seeds-garden/.
Stephen Albert. Peanut Seed Starting Tips. https://harvesttotable.com/peanut-seed-starting-tips/.
Agristudyinfo. 40 Important Terms Related to Specific Crops. https://www.agristudyinfo.com/important-terms-related-to-specific-crops/.
Mr Farmer. 2017. How to grow peanuts. https://www.bgfermer.bg/Article/6185234.
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Module 6: IPM and IWM in oil seed crops (sesame & groundnut)

Objectives • *To orient the participants about major insect pests of oil seed crops (sesame and groundnut)*
• *Enable them to learn about the basic approaches and principles of IPM for insect pests management in oil seed crops (Sesame and groundnut)*
Delivery method *Brain storming, presentation, Q&As and session evaluation*
Materials needed
Presentation print outs, flip charts, white board, markers
Time *1 hour*

IPM means the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms (FAO).

IPM principles

practise crop rotation and intercropping the minimize pest infestation through cultural methods;
use adequate cultivation techniques such as seedbed sanitation, timely sowing, optimum plant population, use of conservation tillage, thinning and direct sowing;
use pest resistant/tolerant cultivars and standard/certified seed and planting material;
practice field sanitation i.e. removal of affected plants or plant parts, regular cleansing of machinery and equipment;
protect and enhance beneficial organisms;
ensure field observation where feasible warning, forecasting and early diagnosis of insect pests;
biological, physical and other non-chemical methods must be preferred over chemical methods if they provide satisfactory pest control;
pesticides should only be applied as a last resort when there are no adequate non-chemical alternatives and use of pesticides is economically justified; and
only when the level of infestation exceeds the economic threshold level, then apply sites/problem specific pesticides be applied with least side effects on human, health, predating /useful insects.

1. Divide participants into two groups.
2. Ask participants: What is IPM and what are its key elements/principles? Especially asking the

following key questions for knowledge sharing and support;
• *What measures do you take when the crop is infested with insect pests and diseases?*
• *Do you use only agrochemicals for control/prevention of insect pests and diseases in sesame and groundnut or other methods such as cultural, biological and mechanical are also used?*
59• *What are the key difficulties/challenges you are facing in using IPM?*
• *Do you know the Economic Thresh-hold Level of different insects/pests?*
• *Can you name a few useful insect predating on harmful ones?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain IPM and its principles by using the key information under (Topic-6.1.1) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Insect Pest IPM (integrated pest management)
Leaf webber,
roller and
capsule borer
early sown (first week of July) in monsoon crop is less infested than late sown crop;
intercrop with Mungbean, pearl millet and groundnut;
rotate insecticides and apply DoA recommended products from registered suppliers;
used control through Parasitoids; and
enhance predators**:** *Eocanthecona furcellata*, *Cincindella* spp., lacewing, ladybird beetle, spiders, red ant, etc.
Leaf hopper
treat the seed with DoA recommended pesticides;
remove and destroy infected plants; and
rotate insecticides and apply DoA recommended products from registered suppliers.
collect and destroy infested plant parts, egg masses and young larvae during gregarious phase;
erect bird perches @ 40–50/ha to facilitate predation of larvae.
install one light trap ha^{-1} to catch the adults;
Common hairy
caterpillar
rotate insecticides and apply DoA recommended products from registered suppliers;
provide hiding sites and alternative habitats such as mulches and other ground covers;
plant small flowering plants on borders, hedges, and other perennial habitats as source of food and shelter for caterpillar; and
no indiscriminate use of synthetic pesticides.

1. Divide participants into two groups.
2. Ask participants: what are the major insects pests of sesame and their control through ipm method? Especially asking the following key questions for knowledge sharing and support:
• *Have you ever observed insects' pests including vertebrate pests such as rodents and*
60*porcupines or any other pest damaging sesame crops?*
• *If yes, can you name them?*
• *Which of the observed pests is the major problem in the sesame field?*
• *What control measures do you adopt to prevent/control the sesame pests?*
• *Do you know the low cost and environment friendly methods of sesame insect pests control?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about major insect pests of sesame and ipm by using the key information under (topic-6.1.2) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Figure 40. Sesame leaf webber and the damage symptom

Figure 41. Sesame *sphingid* moth and its larva

61Figure 42. Leaf hopper Figure 43. Damage symptom of phyllody in sesame

Insect Pest IPM (integrated pest management)
Groundnut leaf
miner
Tobacco
caterpillar
Red hairy
caterpillar
Gram pod
borer
Aphids, thrips
and jassids
use resistant/tolerant cultivar;
grow trap crop such as sunflower and castor bean on borders or in groundnut field (1 plant 20/m);
practise context specific crop rotation and intercropping to discourage host and alternate hosts of the pest;
destroy egg masses on trap crops and groundnut plants by hand, encouraging larvae predation by birds by providing perches in the field (10-15 ha^{-1});
apply neem seed kernel extract @ extract obtained from 10 kg neem seed powder ha^{-1}; and
rotate insecticides and apply DoA recommended insecticides from registered suppliers.

1. Divide participants into two groups.
2. Ask participants: What are the major insects pests of groundnut and their control through IPM method? Especially asking the following key questions for knowledge sharing and support;
• Have you ever observed insects' pests including vertebrate pests such as rodents and porcupines or any other damaging groundnut crop?
• If yes, can you name them?
• Which of the observed pests is the major problem in the groundnut field?
• What control measures do you adopt to prevent/control the groundnut pests?
• Do you know the low cost and environment friendly methods of groundnut insect pests control?
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about major insects pests of groundnut and IPM by using the key
62information under (Topic-6.1.3) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Figure 44. Symptom of damage caused by groundnut leaf miner and binder

Objectives *• To increase knowledge of the participants about the major diseases of oil seed crops*
• To train the participants in oil seed crops (sesame and groundnut) diseases control through IPM
Delivery method *Brain storming, presentation, Q&As and session evaluation*
Materials needed
Presentation print outs, flip charts, white board, markers
Time *1 hour*

Diseases IPDM (integrated pest and disease management)
Sesame Phyllody Sesame black
stem rot,

groundnut collar
rot, legume root
rot
intercrop sesame with pigeon pea;
use disease resistant cultivars;
practise crop rotation and intercropping to discourage alternate host of the disease pathogen;
remove and burn infected plants;
seed treatment with DoA recommended pesticides;
application of DoA recommended pesticides; and
practices planting in September as early planting exposes the plant to disease infestation.
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1. Divide participants into two groups.
2. Ask participants: what are the major diseases of sesame and ipdm (integrated pest and disease management)? Especially asking the following key questions for knowledge sharing and support:
• *Are diseases major problem in sesame?*
• *If yes, what type of diseases are common in sesame?*
• *What measures to you take to prevent/control the diseases in sesame?*
• *Do you know measures other than use of agrochemicals for diseases control in sesame?*
• *If yes, please tell about those measures used in the field?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about diseases of sesame and ipdm by using the key information under (topic-6.2.1) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Figure 45. Different symptoms of phyllody disease

Diseases IPDM of groundnut
Groundnut leaf
spot
Rust
Collar rot
Dry root
rot/Stem rot
removal of infected plant debris;
crop rotation should be followed;
seed treatment with DoA recommended pesticides;
growing tolerant varieties viz., sin;
practise chemical control by only using DoA recommended pesticides and application regimes;
rotate pesticides for application;
64Aflatoxin
contamination
growing tolerant varieties;
light but frequent irrigation (if available) during pod and seed development stages and application of calcium;
avoiding mechanical damage to pods during weeding, harvesting, curing, threshing and storage;
surveillance and timely management insect pests and insect vectors;
harvesting at optimum maturity;
rain late in the growing season generally leads to an increase in fungal growth and aflatoxin contamination; and
crop rotation.
Post-harvest aflatoxin mitigation strategies
appropriate drying, drying the pods to <8 percent moisture content,
removal of immature, discoloured and damaged pods from the produce,
not mixing the gleanings (leftover pods collected from the soil) with main produce and protection from storage insect pests;
immature pods should be removed from the haulms before feeding them to livestock;

equipment sanitization; and
separation of infected and healthy pods.
How to minimize contamination in storage
store under cool dry conditions;
use pallet in store for putting the bags in storage to avoid dampness;
store is water proof;
maintain high level of hygiene;
use good quality materials for packing and packaging (gunny bags to
facilitate aeration;
not exposed to insect and pests especially rodents; and
maintain good aeration in the storage.

1. Divide participants into two groups.
2. Ask participants: what are the major diseases of groundnut and ipdm (integrated pest and disease management)? Especially asking the following key questions for knowledge sharing and support.
• *Are diseases a major problem in groundnut?*
• *If yes, what type of diseases are common in groundnut?*
• *What steps do you normally take to control the diseases in groundnut?*
• *Do you know measures other than use of agrochemicals for diseases control in groundnut?*
• *If yes, please tell about those measures used in the field?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about the diseases of groundnut and ipdm by using the key information under (topic-6.2.2) to complement their answers.
6. Ask participants if there are any questions/clarifications.
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Figure 48. Early leaf spot and late leaf spot of groundnut

Figure 47. Groundnut leaf spot

Figure 46. Inspection for pests and diseases in a groundnut field
Figure 49. White collar rot and rust disease of groundnut

Figure 50. Pods infected by *Aspergillus flavus* and A. parasiticus (a) Closeup of pods shells (b) and peanut kernels (c) showing symptoms of infection. Section (d) shows sporulation (spore production) on the surface of peanut seeds.

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Objectives *• To orient the participant about major weeds in oil seed crops*
• To train the participants in weeds management through IWM (Integrated Weed Management)
Delivery method *Brain storming, presentation, Q&As and session evaluation*
Materials needed
Presentation print outs, flip charts, white board, markers
Time *30 minutes*

IWM involves a combination of cultural, mechanical, biological, genetic, and chemical methods for effective and economical weed control (Swanton and Weise 1991). IWM uses the best mix of principles, practices, technologies, and strategies to control weeds and takes into consideration environmental, social, and economic impact of the combined control strategies (Casimero *et al.*, 1995).
Various methods as integrated weed control encompasses:
• herbicide application
• land fallowing
• cultural control
• mechanical control
• biological control.

1. Divide participants into two groups.
2. Ask participants: What is IWM and what are its principles? Especially asking the following key questions for knowledge sharing and support;

• Do you think that weeds are a major problem in oil seed crops (sesame and groundnut)?
• How and at what stage do you control weeds in oil seed crops (sesame and groundnut)?
• Do you use any method other than weedicides for weed control?
• If yes, please tell about those methods of weeds control?
• What is IWM and tell us about your use of the IWM?
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about IWM and its principles by using the key information under (Topic-6.3.1) to complement their answers.
6. Ask participants if there are any questions/clarifications.

• hand pulling/cultural control
• control by mechanical means
• control by water management
68• control by land preparation
• control by crop competition
• biological weed control
• chemical control-use of herbicides/weedicides as pre plant, pre-emergence and post emergence.

1. Divide participants into two groups.
2. Ask participants: what are the major weeds in oil seed crops (sesame and groundnut)? Especially asking the following key questions for knowledge sharing and support;
• What are the major weeds in sesame and groundnut crop?
• Do you think that the weeds reduce the crop yield if yes, please explain?
• What cultural, biological and mechanical method can be used for effective weeds control in sesame and groundnut?
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about major weeds in oil seed crops and IWM by using the key information under (Topic-6.3.2.) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Figure 51. Devil's horse whip, *Achyranthes aspera* and Velvet leaf, *Abutilon indicum*

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Figure 54. Spiny amaranth, *Amaranthus spinosus* and Basil, *Ocimum gratissimum*

Figure 53. *Isachne globosa* and Awnless barnyard grass, *Echinochloa colona*

Figure 52. Indian pennywart, *Centella asiatica* and Leucas, *Leucas lavandulifolia*71

Figure 57. Purple nutsedge, *Cyperus rotundus* and *Scirpus juncoides*

Figure 56. Puncture vine*, Tribulus terrestris* and Wild cassia*, Cleome viscose*

Figure 55. Niruri, *Phyllanthus niruri* and Wild jute, *Corchorus trilocularis*72

Figure 59. *Cocculus hirsutus* and *Celosia argentia*

Figure 58. Purple Red spiderling, *Boerhavia diffusa* and Snake weed, *Euphorbia hirta*

Module 7. Harvesting and post-harvest management of GAP oil seed crops (sesame & groundnut)

Objectives *To train the participants on safe and efficient harvesting and post-harvest management of oil seed crops for compliance to crops GAP standards*
Delivery method *Brain storming, presentation, Q&As and session evaluation*
Materials needed *Presentation print outs, flip charts, white board, markers*
Time *1 hour*

Timely harvesting and stacking is essential for quality sesame and reduced shattering losses;
Harvest the crop early morning when the dew drops evaporate.
Use sharp tools (sickles) to avoid shaking of the plants and reduce shattering losses.
Harvest close to the soil surfaced and avoid uprooting the plants for leaving the crop residues for improving soil structure and texture as stubble mulch.
Equipment and tools are suitable for harvesting and should be checked for cleanliness before use and cleaned as required.
Harvest the crop at the coolest time of the day to avoid quality deterioration in the heat but avoid harvesting during rain.

Harvesting of sesame

When plant turns to a golden hue with capsules gradually turning yellow or the colour of sesame field turns yellow- at 70 to 100 days after seeding (75 percent capsules are ripened i.e. have turned brown) and the lowest capsules on the stem are about to split open.

Harvesting of groundnut

When 75 percent pods are mature.
When inside portion of pod develop brown to black markings while immature show fresh white appearance and when the pod colour turns dark brown;.
Harvest safely to avoid damages to the pods to prevent *aflatoxins* infection;
Harvested produce should not be placed in direct contact with soil.
Manual methods of hand hoe or ox drawn plough but extreme care should be taken not to injure the pods/seeds.
hand pulling/hand harvesting well drained, sandy and loam soils.
The method should be used during the rainy season when the soil is moist and soft.
While pulling the plants, care should be taken that the plant (s) are held firmly and uprooted entirely.

1. Divide participants into two groups.
2. Ask participants: what are the improved methods and right time of harvesting oil seed crops (sesame and groundnut)? Especially asking the following key questions for knowledge sharing and support:

- *What are the major indicators for harvesting groundnut and sesame crop?*
- *How do you know the crop is ready for harvesting?*
- *What tools do you use for harvesting and do you think that the tools used are appropriate for quality harvest of the crop?*
- *What are the key challenges in crop harvesting in terms of labor, time and equipment?*

3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain method and time of harvesting for sesame and groundnut by using the key information under (topic-7.1.1) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Figure 60. Sesame crop ready for harvest Figure 61. Over ripening leads to cracking of capsule resulting in shattering losses

Figure 62. Mature groundnut saddle area Figure 63. Mature groundnut with dark brown pericarp

Figure 64. Immature to underdeveloped pods
Figure 66. Aflatoxins affected pods
Figure 68. Groundnut harvesting through hand pulling

Figure 65. Aflatoxins affected pods

Figure 67. Safely harvested groundnut safely

Figure 69. Groundnut harvesting using toothed hoe

Figure 70. Delayed harvesting result in sprouting of nuts in the ground

Threshing and winnowing of sesame

Dry in the sun before threshing and thresh on a concrete floor/ canvases/tarpaulin
Beat the plants gently with sticks, collect the seed and clean by winnowing until the seeds are

separated from the chaff and other inert matters.
Protect the seed from humidity to avoid contaminations
Remove inert material, weed seeds and other foreign materials

Threshing and winnowing of groundnut

Dry the bundles before threshing.
Thresh on a concrete floor/ canvases/tarpaulin spread on the ground to be free from soil, gravel, dust and other inert materials.
Beat the plants gently with stick, collect seed and clean them by repeated winnowing until the seeds are separated from the chaff and other inert matters.
Sun dry for about 6–8 days to maintain the desired flavor and quality.
Reduce moisture up to 8–10 percent by curing for safe storage and quality.
Hand shelling is preferred over mechanical shelling to avoid damaged to the seeds/grains.

1. Divide participants into two groups.
2. Ask participants: What are the improved method of threshing, drying and cleaning of oil seed crops (sesame and groundnut)? Especially asking the following key questions for knowledge sharing and support;
• *How are you threshing sesame and groundnut after harvesting?*
• *Do you dry the harvested crop before threshing?*
• *If yes, how and for how long the crop is dried?*
• *Do you assess the moisture contents of the crop before threshing?*
• *After threshing do you dry and clean the seeds and if yes, how do you assess the seeds/grains are ready for storage?*
• *Do you clean the grain/seeds of sesame and groundnut, what in specific you remove from the seeds/grains?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group
to present the key points of their responses and facilitate them.
5. After the presentations, explain about threshing, drying and cleaning by using the key information under (Topic-7.1.2) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Sesame

Clean after at seed moisture 6–10 percent through sun drying for seven days before bagging and transporting.
Store seeds under moisture-free conditions at a relative humidity of approximately 50 percent and at low temperature (below 18°C).
Bags must be sterilized before using them for storage.
The traps and stimulating foods can be put stores and carefully monitor to minimize the risk of contaminating produce.
Check every two weeks at least once in two weeks for damage by insect, rodents, or dampness or moisture. If any damage is observed, necessary measures have to be taken.
For traceability and recall, mark the containers with identification number, name of the product, variety, year of production, percentage of inert matter, location of production and source of planting materials.
Markings and labels should be waterproof to prevent its deterioration.

Groundnut

Remove damaged, diseased, shrunk /shriveled nuts, discoloured, rotten, immature, germinated, other inert materials and soil.
Pack in polythene lined gunny bags at 6–8 percent moisture with name of the variety, year of production, farm brand name / location, moisture when packed, weight and GAP certification tags.
Ensure storage to be rodent proof.
Transport vehicles should be checked before used for cleanliness, availability of proper tarpaulins to cover the cargo, foreign objects and other materials, chemical contamination, pest infestation and must also checked to make sure to be dry without any moisture in the vehicles.

1. Divide participants into two groups;
2. Ask participants: what are the improved method of packing/packaging, storage and transportation of sesame and groundnut produce? Especially asking the following key questions for knowledge sharing and support;
• *Do you consider moisture content for proper drying of sesame and groundnut seeds/grains?*
• *If yes, for how many days, do you keep the seeds/grain for drying?*
• *What moisture content is suitable for seeds/grain for short term and long term storage?*

• *How do you pack the seeds/grains?*
• *Do you mark each pack/package with any mark of identification, if yes, what type of marking is done on the bags?*
• *Have you faced the problem of damage or quality deterioration of sesame and groundnut in the storage, if yes, please tell about the issues?*
• *What type of precautionary measures, do you take for safe storage of sesame and groundnut?*
773. Ask each group to write down their responses on a flip chart;
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about packing/packaging, storage and transportation by using the key information under (topic-7.1.3) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Module 8: Pre-harvest GAP of pulse crops (chickpea and green gram)

Objectives • *To train the participant on improved pre-harvest crop management of pulse crops*
Delivery method *Brain storming, presentation, Q&As and session evaluation*
Materials needed *Presentation print outs, flip charts, white board, markers*
Time *1 hour*

Assess the site for chemical, physical and biological hazards which can cause food contamination.
Avoid selection of sites which are previously used for disposal of hospital waste, industrial waste and livestock farm.
Sites should have sustained availability of irrigation water.
If the risk of chemical, biological and physical contamination is high and cannot be controlled, the site must not be used for production and postharvest handling of produce. An alternative site should be selected and assessed for risk.
Record the sites details through site mapping **(See annex 4).**

Soil requirements for chickpea

Well-drained, sandy loam or silt loam soils with pH of 6–8.
Saline soils are not suitable as the plant cannot access the nutrients from the saline layer of the soil.

Soil requirements for green gram

Well-drained loamy to sandy loam soils with pH of 6.3–7.2, pH >7.5 cause micronutrient deficiency.
Heavy clayey soil are not suitable as it restricts root growth.

1. Divide participants into two groups;
2. Ask participants: what are the factors you considered in selecting your farm site for gap crop production? Especially asking the following key questions for knowledge sharing and support:
• *Are you checking the sites for any hazards?*
• *Do you record site history and site management practices?*
• *Do you conduct soil tests before site selection?*
78• *What is the purpose and benefit of soils test?*
• *What type of soils are required for chickpea and green gram?*
• *What type of sites should not be considered as fit for GAP crops cultivation?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about sites selection and soil requirements for pulse crops (chickpea and green gram by using the key information under (topic-8.1.1) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Use doa recommended varieties seeds.
The seed should be free from physical impurities, resistant to diseases, tolerant to drought;
Use fresh seed not older than two years.
Seed germination should not be less 80 percent, with physical and analytical purity of 98 percent.
Inoculate the seeds with recommended rhizobium inoculant for improved nodulation.
Keep record of seed (type and source).

Recommended varieties chickpea

95–100 1 546–1 933 50 Suitable for Sagaing, Magway, Mandalay & Bago regions

80–85 1 546–1 933 25–28 Suitable as a sequential crop after rice, white seed colour

80–85 1 546–1 933 25–30 Suitable as a sequential crop in upland areas, white seed colour

80–85 1 546–1 701 15–20 Resistant to pests & diseases , suitable as a sequential crop after rice,

90–95 1 933–2 242 30–35 Resistant to fusarium wilt, suitable as a sequential crop in upland areas, white seed colour,

75–85 1 546–1 933 35–41 Short duration, heat tolerant, resistant to fusarium wilt, suitable as a sequential crop after rice & irrigated areas, white seed colour,

90–95 1 933–2 320 36–40 Resistant to fusarium wilt, suitable as a sequential crop in upland areas, big seed size, white seed colour

80–85 1 933–2 088 32–50 Resistant to fusarium wilt, white seed colour, big seed size, potential for export market & suitable as a sequential crop in upland areas

83–89 1 933–2 242 30–40 Big seed size, red seed colour

85–90 1 933–2 010 35–45 Potential for export market, white colour seed

95–100 1 933–2 320 35–45 Resistant to fusarium wilt, big seed size,

Seed rate and method of sowing chickpea

Small 20 30 (12 inches) 10 (4 inches) 323 000 5 to 8 50–60

Medium 20–30 35 (14 inches) 15 (6 inches) 185 000 5 to 8 60–90

Large 30–40 50 (20 inches) 20 (8 inches) 97 000 5 to 8 90–120

Extra large >40 55 (22 inches) 20 (8 inches) 88 000 5 to 8 120–150

Source:

DAR. 2018. Released New Varieties. Department of Agricultural Research, Ministry of Agriculture, Livestock and Irrigation, Nay Pyi Taw, Myanmar, 168 pp.

DAR, 2019. Research outcomes after 65 years of DAR's effort (in Myanmar), Department of Agricultural Research, Ministry of Agriculture, Livestock and Irrigation, Nay Pyi Taw, 202 pp

ICRISAT. (2020). Myanmar's chickpea farmers reap the fruits of decades-long research collaboration by Dr Pooran Gaur. Research Program Director – Asia Program, Asia Program. https://www.icrisat.org/myanmars-chickpea-farmers-reap-the-fruits-of-decades-long-research-collaboration/#:~:text=Myanmar%20has%20witnessed%20a%20chickpea,to%201%2C400%20kg%2Fha.

Recommended varieties of green gram

All season 71–75 1 614–2 017 Big seed size
Monsoon season 65–75 1 452–1 614 Draft resistance
Monsoon & post-
monsoon
65–70 1 775–2 017 Big seed size
All season 55–60 1 210–1 614 Resistant to yellow mosaic
Monsoon season 65–70 1 614–2 017 Big seed size, resistant to yellow
mosaic disease
All season 60–65 1 614–2 017 Resistant to yellow mosaic disease
All season 65–70 1 775–2 017 Resistant to yellow mosaic disease

Source:

DAR. 2018. Released New Varieties. Department of Agricultural Research, Ministry of Agriculture, Livestock and Irrigation, Nay Pyi Taw, Myanmar, 168 pp.

DAR. 2019. Research outcomes after 65 years of DAR's effort (in Myanmar), Department of Agricultural Research, Ministry of Agriculture, Livestock and Irrigation, Nay Pyi Taw, 202 pp.

Seed rate and method of sowing green gram

Monsoon 18 4 20–30 215 200 1–1.5
Post monsoon
(winter) 12 4 30–40 322 000 1–1.5
Seed rate for both seasons crop with broadcast method
of sowing 60–80 NA 1–1.5

Source:

DOA-Extension Division. 2006a. Varietal characteristics of rice, oilseed crops and pulses crops. Department of Agriculture, Ministry of Agriculture, Livestock and Irrigation, Nay Pyi Taw, Myanmar.

DOA-Extension Division. 2006b. Production technologies for achieving target yields of paddy, maize, groundnut, sesame, sunflower, black gram, green gram and pigeon pea. Department of Agriculture, Ministry of Agriculture, Livestock and Irrigation, Nay Pyi Taw, Myanmar.

1. Divide participants into two groups.
2. Ask participants: What are the factors you considered while selecting seeds, variety, seed quality and seed treatment? Especially asking the following key questions for knowledge sharing and support;

• *Can you name a few of the recommended varieties of chickpea and green gram?*
• *Do you use recommended seed/variety of chickpea and green gram?*
• *If not what are the constraints and challenges in securing quality and certified seeds of recommended varieties?*
• *Do you know about the recommended seed rate for chickpea and green gram?*

3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about seed selection, varieties, seed rate and seed treatment of chickpea and green gram by using the key information under (Topic-8.1.2) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Land preparation chickpea and green gram

Clear the land from all type of weeds and instead of burning weeds, dry them and used as crop residues for composting.
2–3 ploughing followed by harrowing using tractor mounted ploughs; animal mounted moldboard ploughs (oxen/donkeys) or by handheld hoes.
Summer ploughing (before monsoon rains) for moisture conservation in rain-fed areas.

Time of sowing chickpea and green gram

Chickpea and green gram sowing and harvesting
Oc

De
Jan Feb Mar Apr May Jun Jul Aug Sept
t Nov
c
Chickpea Green gram-post-monsoon Green gram-winter Green gram-monsoon H S
S P
P S P
S P

1. Divide participants into two groups.
2. Ask participants: what are the appropriate planting method, time and plant population? Especially asking the following key questions for knowledge sharing and support:
• *How do you plant the seeds of chickpea and green gram i.e. broadcast/row planting?*
• *Do you know about the improved planting schemes for chickpea and green gram?*
• *If yes, please explain?*
• *Do you know about the desirable/recommended plant population of chickpea and green gram*
81*and what are the benefits of maintaining optimum plant population per acre/hectare?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about land preparation and planting time for pulse crops (chickpea and green gram by using the key information under (topic-8.1.3) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Objectives *• To orient the participants about types, method, time and rate of manures, fertilizers and soil amendments for chickpea and green gram*
• To train the farmers for effective and safe application and handling of chemical fertilizers, manures and amendments
Delivery method *Brain storming, presentation, Q&As and session evaluation*
Materials needed *Presentation print outs, flip charts, white board, markers*
Time *1 hour*

Apply chemical fertilizers on site specific, soil test basis and as per DOA recommendations.
Obtain fertilizers from a registered supplier.
Practise split application of chemical fertilizers in sandy /loose soils.
Apply fertilizers to the soil when soil moisture is sufficient to avoid loss of nutrients and toxicity to the plants.
Keep record of fertilizer, as requirement for GAP certification as per **Annex 4**.
Apply soil amendments such as gypsum when if the soil is saline/alkaline i.e. Ph is alkaline (>7.5).

Chemical fertilizers-chickpea (if soil test are not available)

Macronutrients

Nitrogen: @ starter dose of 20 kg N ha^{-1} as a starter dose for inoculated seed with Rhizobium as basal dose through top dressing. In case of broadcast application, incorporate fertilizer in the soil.
Phosphorus: @ 40 kg/ha as basal dose at sowing using broadcast or band application. In case of broadcast application, fully incorporate fertilizers into the soil to reduce the risk of phosphorus loss through runoff and leaching below the root zone.
Potash: @ 30 kg/ha as broadcast, followed by incorporation in the soil for better uptake. As Potash uptake is more active during the early growth phases, apply full dose at sowing except in coarse textured (sandy) soil due to high rate of leaching.
Compound fertilizers
@ NPK 18-36-10 kg/ha^{-1}

Micronutrients

apply on soil test basis and only when deficiency is recorded;
Sulphur 20 kg S ha^{-1} through single super phosphate (SSP), gypsum or pyrite;
Boron 1.0-2.5 kg Borax ha^{-1} or foliar application of 0.25 kg Borax ha^{-1};
Zinc 0.5 percent Zinc Sulfate mixed with 0.25 percent lime ha^{-1}; and
Iron Foliar application 0.5 percent (w/v).

82**Organic manures**

Organic manures such as FYM or Bokashi compost 15t/ha FYM or vermicompst 2 t/ha.
Also practice as per the guidelines given in crops GAP standards for green manuring by using the GM crops for adding organic matter to the soil to:
○ *improve soil texture;*
○ *microbial activities;*

○ *structure and friability; and*
○ *adding N and other micronutrient to the soil*

Soil amendments (Gypsum)

Use gypsum ($CaSO_4$ $2H_2O$) 5 tonne gypsum ha^{-1} for correction of soil sodicity, salinity improving soil stability, water penetration into soil, and more rapid seed emergence.

Chemical fertilizers-green gram (if soil tests are not available)

Macronutrients

Nitrogen: 25 kg N ha^{-1} as starter dose at the time of sowing if the seeds are inoculated with Rhizobium through band or row application.
In case of broadcast application, incorporate fertilizer in the soil.
Phosphorus: 45 kg P_2O_5 ha^{-1} as basal dose or split application in sandy soils @ 50 percent as basal dose and 50 percent top-dressed at the branch initiation stages.
If broadcasted, incorporate the fertilizers in the soil for increase P uptake.
Potash: @75 kg K_2O ha^{-1} as basal dose through band application or top dressing.
If broadcasted, fully incorporate the fertilizer in the soil for better uptake.

Compound fertilizers

Rainfed crop @12.5 kg N + 25 kg P2O5 + 12.5 kg K_2O +10 kg S ha^{-1} and @ 25 kg N + 50 kg P2O5 + 25 kg K2O + 20 kg S ha^{-1} for irrigated lands

Micronutrients

Micronutrient should be applied on soil test basis, when deficiency is recorded
Incorporate in the soil if broadcasted for better nutrient use efficiency and minimization of nutrient loss
Sulphur 30 kg/ha
Boron 5 kg/ha B as borax or boric acid
Zinc 2 percent $ZnSO_4$ as foliar application
Iron 15 kg Ferrous Sulphate

Organic manures

Organic manures such as FYM or Bokashi compost 6-10t/ha FYM or vermicompst 8 t/ha
Practise green manuring as per GAP standards for green manuring using GM crops for
○ *adding organic matter to the soil;*
○ *improving soil texture;*
○ *improving microbial activities;*
○ *improving structure and friability; and*
○ *adding N and other micronutrient.*

Soil amendments (Gypsum)

Use gypsum (CaSO4 2H2O) 300 kg/ha of gypsum for correction of soil sodicity, salinity improving soil stability, water penetration into soil, and more rapid seed emergence

1. Divide participants into two groups.
2. Ask participants: what type of chemical, organic fertilizers and soil amendments to be applied to chickpea and green gram crops? Especially asking the following key questions for knowledge sharing and support:

• What type of chemical fertilizers do you apply to chickpea and green gram?
• If you apply chemical fertilizers, then what is normally the time and method of chemical fertilizers application?
• How do you assess the crop nutrient requirements?
• Have ever conducted soil tests for nutrient deficiency or excess in soils selected/cultivated with chickpea and green gram? What are the findings of the soil test conducted for nutrients?
• Do you apply organic manures and if yes what type of and at what rate manures are applied by you?
• Why soil amendments are important for soils and under what soil conditions?
• Do you know the rate of soil amendments application?

3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain organic and inorganic fertilizers/manures and soil amendments by using the key information under (topic-8.2.1, 8.2.2, 8.2.3.) To complement their answers.
6. Ask participants if there are any questions/clarifications.

Objectives *• To train the participant on improved crop rotations for increased ecological based farming system*
• To train the participant on improved intercropping as resilient cropping patterns
Delivery method *Brain storming, presentation, Q&As and session evaluation*
Materials needed *Presentation print outs, flip charts, white board, markers*

Time *30 minutes*

Crop rotation is a systematic and sequential cultivation of different crops in the same field site unlike continuous cropping in which the same crop is cultivated year after year. Crop rotation also result in effective utilization of soil nutrients and soil moisture, reduced insects pests and disease problem. Farm income can be effectively diversified and sustained in view of climate change effect on agriculture.

Principles of crop rotations

Deep rooted vs shallow rooted-sesame-chickpea-green gram for efficient nutrient uptake and utilization.

Legume vs non-legume such as sesame should be cultivated after chickpea/green gram/groundnut for maintaining soil fertility.

Pathogens/nematode resistant crops and crops requiring heavy irrigation follow crops sensitive to certain pathogens, parasite (nematode) and less water and labor-intensive crops should follow

labor intensive.

Intercropping growing two or more crops simultaneously on the same field. Intercropping is termed as m*ixed intercropping* (*mixed cropping*) when two or more crops are grown simultaneously with no distinct row arrangement. It is called *row intercropping* (*intercropping*) when two or more crops are grown simultaneously where one or more crops are planted in rows.

Principles of intercropping

The associating crop should be complimentary to the main crop.

The subsidiary crop should be of shorter duration and of faster growing habits, to utilize early slow growing period of main crop.

The component crops should require similar agronomic practices.

Erect growing crops should be intercropped with cover crop.

Erosion permitting crop should be intercropped with erosion resisting crop.

The component crops should have different rooting pattern and depth of rooting.

1. Divide participants into two groups;
2. Ask participants: what are crop rotation and intercropping and what are the key principles and benefits of crop rotation? Especially asking the following key questions for knowledge sharing and support;

• Do you practice crop rotation in chickpea and green gram cropping systems?

• If yes what is the type of rotating crops and what crops are included in rotation for chickpea and green gram growing areas?

• Can you name some useful crops to be included in crop rotation and why?

• What is intercropping and its key benefits?

• What important consideration should be kept in mind while planning intercropping?

3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain crop rotation and intercropping in pulse crops (chickpea and green gram by using the key information under (topic-8.3.1, 8.3.2.) To complement their answers.
6. Ask participants if there are any questions/clarifications.

Objectives *• To train the participant on importance of irrigation water quality and safety for GAP certified crops*

• And to orient them on improved irrigation methods, time and scheduling of efficient crop irrigation techniques

Delivery method *Brain storming, presentation, Q&As and session evaluation*

Materials needed

Presentation print outs, flip charts, white board, markers

Time *30 minutes*

Test water quality for heavy metals to ensure safe food production.
Record of water quality test and keep record for verification.
The water flowing down from livestock farms, hospitals, industries, waste water and any sources that may cause environmental harm must not be used for irrigation purpose.
The irrigation, fertigation and water management of the crop should be recorded.

1. Divide participants into two groups.
2. Ask participants: what is the irrigation water quality and what key considerations should be kept in mind while irrigating crops cultivated with gap? Especially asking the following key questions for knowledge sharing and support:
• *Have you ever tested water quality?*
• *If yes, what specific elements are normally tested?*
• *If no, what are the key constraints for not conducting water quality testing?*
• *What type of water sources should be avoided for irrigating GAP certified crops?*
• *Do you keep record of water quality and irrigation management of your crops?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain irrigation water quality by using the key information under (topic-8.4.1) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Chickpea
The crop is sensitive to long spell of drought which greatly reduce pod formation, reduce yield and deteriorate quality of chickpea
Chickpea suffers from drought and high temperatures during reproductive development resulting in the production of fewer pods and seeds and reduced yields
The crop should be irrigated at critical growth stages i.e. germination to seedling emergence, nodes development and branching, flowers initiation, pods initiation and development and pods maturity
86Irrigation should be stopped beyond pods maturity
Light irrigation should be practised depending on the soil moisture and rainfall, avoid heavy irrigation which causes manifestation root disease in case of standing water in the field.
Green gram
The crop is also sensitive to water logging, therefore uniform irrigation to avoid water inundation in the field is highly important.
Irrigation after emergence, flowering and pod setting resulted in highest green gram seed yield.
The critical stages for crop irrigation are:
• 7 to 10 days after crop emergence;
• irrigation at pre-flowering stage (1-7 days before flowering or 30-40 days after planting); and
• irrigation at pod development stages;

1. Divide participants into two groups.
2. Ask participants: what are the methods, times and frequency and irrigation scheduling? Especially asking the following key questions for knowledge sharing and support:
• *How often do you irrigate chickpea and green gram crops?*
• *How do you know that it is time to irrigate the crops?*
• *Do you know about the critical stages of crops irrigation?*
• *Do you know about the improved methods of irrigation to avoid water losses and increasing water use efficiency?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain methods, times and frequency and irrigation scheduling at critical crop growth stages of chickpea and green gram by using the key information under (topic-8.4.2) to complement their answers.
6. Ask participants if there are any questions/clarifications.
87
Figure 71. Critical growth stages of green gram irrigation- best practices

Source (left to right):

Dr Jekyll. 2015. Chickpeas germination time lapse. Garbanzos. https://www.youtube.com/watch?v=lEkeWGRUPK0
Grains Research and Development Corporation. 2016. Grownotes. https://grdc.com.au/resources-and-publications/grownotes/crop-agronomy/chickpeagrownotes.
Agrii. 2020. Chickpea Flower. https://twitter.com/AgriiUK/status/1281127236431753217/photo/1.
Gaur, P.M., Tripathi, S., Gowda, C.L.L., Ranga, R.G.V., Sharma, H.C., Pande, S., Sharma, M. 2010. Chickpea Seed Production Manual. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 28 pp. https://www.icrisat.org/TropicalLegumesII/pdfs/ChickpeaManual_full.pdf.
Nativeplanttrust. 2022. Cicer arietinum — chick-pea. https://gobotany.nativeplanttrust.org/species/cicer/arietinum/.
Figure 72. Critical growth stages of green gram for irrigation

Source (left to right):
Indiagardening.com. 2022. How to plant moong beans in a pot | growing mung beans. https://indiagardening.com/how-to-grow/how-to-plant-moong-beans-in-a-pot-growing-mung/.
Wallpaperflare.com. 2022. Mung bean flower, wild flowers, plant, green, roadside, close-up. https://www.wallpaperflare.com/mung-bean-flower-wild-flowers-plant-green-roadside-close-up-wallpaper-ahpoy.
Asiafarming.com. 2022. Green Gram Growing and Cultivation Practices. https://www.asiafarming.com/green-gram-growing-cultivation-practices.

Module 9: IPM approach

Objectives *• To orient the participants about major insect pests in pulse crops (chickpea, green gram)*
• Enable them to learn about the basic approaches and principles of IPM for insect pests management in Pulse crops (chickpea and green gram)
Delivery method *Brain storming, presentation, Q&As and session evaluation*
Materials needed *Presentation print outs, flip charts, white board, markers*
Time *1 Hour*

Integrated pest management (IPM) means the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms (FAO).

IPM principles

Practise crop rotation and intercropping the minimize pest infestation through cultural methods.
Use adequate cultivation techniques such as seedbed sanitation, timely sowing, optimum plant population, use of conservation tillage, thinning and direct sowing.
Use pest resistant/tolerant cultivars and standard/certified seed and planting material.
Practise field sanitation i.e. removal of affected plants or plant parts, regular cleansing of machinery and equipment.
Protect and enhance beneficial organisms.
Field observation where feasible warning, forecasting and early diagnosis of insect pests.
Biological, physical and other non-chemical methods must be preferred over chemical methods if they provide satisfactory pest control.
Pesticides should only be applied as a last resort when there are no adequate non-chemical alternatives and use of pesticides is economically justified.
Only when the level of infestation exceeds the economic threshold level, then apply sites/problem specific pesticides be applied with least side effects on human, health, predating /useful insects.

1. Divide participants into two groups.
2. Ask participants: what is ipm and what are its key elements/principles? Especially asking the following key questions for knowledge sharing and support:
• What measures do you take when the crop is infested with insect pests and diseases?
• Do you use only agrochemicals for control/prevention of insect pests and diseases in chickpea and green gram or other methods such as cultural, biological and mechanical are also used?

• What are the key difficulties you are facing in using IPM?
• Do you know the Economic Thresh-hold Level of insect pests damages?
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about ipm and its principles by using the key information under (topic-9.1.1) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Insect Pest Integrated pest management (IPM)

Gram pod borer

Early sowing, especially of short-duration varieties is helpful in avoiding pod borer damage.
Intercropping coriander with chickpea provides nectar sources for adult parasitoids and improves natural control of *H. armigera*.
Bird perches (10–15 ha^{-1}) can be installed in the field to attract predatory birds.
Bio-rational pesticides such as *Bacillus thuringiensis* (Bt), entomopathogenic fungi (*Metarhizium anisopliae*), etc, are generally safe for human beings and for the environment. These products are commercially available in the market and farmers can even produce them with a minimum cost.
If the insect population is not controlled by the above mentioned method, then apply DoA recommended insecticides.

Termites

frequent intercultural operations and irrigation before sowing;
field sanitation, timely disposal of crop stables and undecomposed plant parts;
undecomposed FYM should not be applied;
two-three deep ploughing could also help control the pest;
destroy the termite bunds in and around the field and kill the queen and complimentary form; and
seed treatment with DoA recommended insecticides.

Blister beetle

Manual collection or collection with insect net and killing of adults in kerosenized water appears to be the only possible solution.

Spiny pod borer

conserve natural enemies like *Tetrastichus* sp.and *Bracon hebetor;*
ETL (Economic Threshold Level) is 10 percent affected parts;
deep summer ploughing in 2–3 years to eliminate quiescent pupa;
early sowing, short duration varieties;
avoid closer plant spacing;
grow tall sorghum as comparison crop to serve as biological bird perches;
collect and destroy larvae and adults to the extent possible;
install pheromone traps at 50 m @ 5 traps/ha for each insect pest;
install bird perches @ 50/ha;
setting of light traps (1 light trap/5 acre) to kill moth population;
conserve green lacewing, predatory stink bugs, spider, ants; and
90in case the pest is not controlled through the aforementioned method, then spray DoA recommended insecticides.

1. Divide participants into two groups.
2. Ask participants: what are the major insects' pests of chickpea and their control through ipm method? Especially asking the following key questions for knowledge sharing and support:
• Have you ever observed insects' pests including vertebrate pests such as rodents and porcupines or any other damaging chickpea crop?
• If yes, can you name them?
• Which of the observed pests is the major problem in the chickpea field?
• What control measures do you adopt to prevent/control the chickpea pests?
• Do you know the low cost and environment friendly methods of chickpea insect pests control/prevention?
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about insect pests of chickpea and ipm by using the key information under (topic-9.1.2) to complement their answers.
6. Ask participants if there are any questions/clarifications.

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Figure 75. Damaged pods of black gram

Figure 74. Larvae of spotted pod borer, larva and adult

Figure 73. Different stages of *Helicoverpa armigera*

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Figure 78. White fly and Blister beetle

Figure 77. *Spodoptera litura*, aphids and thrips on black gram

Figure 76. Different stages of spiny pod borer94

Figure 80. Circular bore hole by gram pod borer and termite damage

Figure 79. Gram pod borer larva and damaged fruit of chickpea

Insect Pest IPM
Note: See above as the insect pests of green gram and chickpea at 9.1.2.

Note: Refer to the insect pests of green gram and chickpea at 9.1.2.

Objectives *• To increase knowledge of the participants about the major diseases of pulse crops (chickpea and green gram)*
• To train the participants in pulse crops disease control through IPM
Delivery method *Brain storming, presentation, Q&As and session evaluation*
Materials needed *Presentation print outs, flip charts, white board, markers*
Time *1 Hour*

Diseases IPM
Cercospora
leaf spot Powdery
mildew
Root rot and
leaf blight
Yellow
use disease resistant varieties;
practise crop rotation and clean cultivation (weeds control and control of alternate hosts of the pathogen);
avoid over irrigation (inundation of water in the field);
rotate insecticides and apply DoA recommended pesticides from obtained from registered suppliers; and
remove and destroy infected plants.
mosaic

1. Divide participants into two groups.
2. Ask participants: what are the major diseases of green gram and ipdm (integrated pest and disease management)? Especially asking the following key questions for knowledge sharing and support:
• Are diseases major problem in green gram?
• If yes, what type of diseases are common in green gram?
• How to control the diseases?
• Do you know measures other than use of agrochemicals for diseases control in green gram?
• If yes, please tell about those measures used in the field?
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about green gram diseases and IPM by using the key information under (Topic-9.2.1) to complement their answers.
956. Ask participants if there are any questions/clarifications.

Figure 81. *Cercospora* leaf spot and Powdery mildew

Figure 82. *Cercospora* Root tot symptom and yellow mosaic virus

Diseases IPM
Fusarium wilt
Deep ploughing during summer and removal of host debris from the field can reduce the level of inoculum.
Follow crop rotation measures continuously. Exclude chickpea from the crop rotations in infested fields for at least three years.
Follow six year crop rotations with sorghum.
Always use disease free seeds.
Avoid sowing when temperatures are high.
Use resistant varieties (e.g., Yezin-5, Yezin-6, Yezin-8 and Shwenilonegyi and 929). Red seed (erect type) is more tolerant than white seed but farmers don't like as the seed is small.
Apply FYM 10-15 cart load ha^{-1}
.
96Seed treatment with DoA recommended pesticides.
In case damages above THL, apply DoA recommended pesticides/fungicides.
Dry root rot:
deep ploughing in summer;
grow cultivars resistant to dry root rot;
drought should be avoided;
sowing should always be done on the recommended time;
germinating and young seedlings should be saved from high temperatures; and
seed treatment and spot drenching with DoA recommended pesticides/fungicides.

1. Divide participants into two groups.
2. Ask participants: what are the major diseases of chickpea and ipdm (integrated pest and disease management)? Especially asking the following key questions for knowledge sharing and support:
• *Are diseases major a problem in chickpea?*
• *If yes, what type of diseases are common in chickpea?*
• *How to control the diseases?*
• *Do you know measures other than use of agrochemicals for diseases control in chickpea?*
• *If yes, please tell about those measures used in the field?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about major diseases chickpea and IPM by using the key information under (topic-9.2.2) to complement their answers.
6. Ask participants if there are any questions/clarifications.
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Figure 83. Chickpea plot infected with Fusarium wilt and mealy bugs on the stem

Figure 84. Fusarium wilt and dry root rot of chickpea

Objectives *• To orient the participant major weeds in pulse crops (chickpea and green gram)*
• To train the participants in weeds management through IWM (Integrated Weed Management)
Delivery method *Brain storming, presentation, Q&As and session evaluation*
Materials needed *Presentation print outs, flip charts, white board, markers*
Time *30 minutes*

Integrated weed management (IWM) involves a combination of cultural, mechanical, biological, genetic, and chemical methods for effective and economical weed control (Swanton and Weise 1991). IWM uses the best mix of principles, practices, technologies, and strategies to control weeds and takes into consideration environmental, social, and economic impact of the combined control strategies (Casimero *et al.*, 1995).
Various methods as integrated weed control encompasses;
98• herbicide application
• land fallowing

• cultural control
• mechanical control
• biological control.

1. Divide participants into two groups.
2. Ask participants: what is IWM and what are its principles? Especially asking the following key questions for knowledge sharing and support:
• Do you think that weeds are a major problem in oil seed crops (chickpea and green gram)?
• How and at what stage do you control weeds in oil seed crops (chickpea and green gram)?
• Do you use any other method other than weedicides for weed control?
• If yes, please tell about those methods of weeds control?
• What is IWM and tell us about your use of the IWM?
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about IWM and what its principles by using the key information under (topic-9.3.1) to complement their answers.
6. Ask participants if there are any questions/clarifications.

hand pulling/cultural control;
control by mechanical means;
control by water management;
control by land preparation;
control by crop competition;
biological weed control; and
chemical control-use of herbicides/weedicides as pre plant, pre-emergence and post emergence.

1. Divide participants into two groups.
2. Ask participants: what are the major weeds in pulse crops (chickpea and green gram? Especially asking the following key questions for knowledge sharing and support:
• What are the major weeds in chickpea and green gram crop?
• Do you think that the weeds reduce the yield?
• What cultural, biological and mechanical method can be used for effective weeds control in chickpea and green gram?
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about weeds and IWN in pulse crops by using the key information
under (topic-9.3.2.) To complement their answers.
6. Ask participants if there are any questions/clarifications.

Figure 85. Devil's horse whip, *Achyranthes aspera* and Velvet leaf, *Abutilon indicum*

Figure 86. Indian pennywart, *Centella asiatica* and Leucas, *Leucas lavandulifolia*

Figure 89. Niruri, *Phyllanthus niruri* and Wild jute, *Corchorus trilocularis*

Figure 88. Spiny amaranth, *Amaranthus spinosus* and Basil, *Ocimum gratissimum*

Figure 87. Isachne globosa and Awnless barnyard grass, *Echinochloa colona*

Figure 92. Red spiderling*, Boerhavia diffusa* and Snake weed, *Euphorbia hirta*

Figure 91. Purple nutsedge, *Cyperus rotundus* and *Scirpus juncoides*

Figure 90. Puncture vine, *Tribulus terrestris* and Wild cassia, *Cleome viscose*

Figure 95. *Ludwigia hyssopifolia* and *Scirpus grossus*

Figure 94. *Schoeoplectus juncoides* and *Spheoclea zeylanica*

Figure 93. *Cocculus hirsutus* and *Celosia argentia*104

Figure 99. *Cyperus iria* and *Cyperus difformis*

Figure 98. *Echinochloa colona* and *Echnichloa crus-galli*

Figure 97. *Eclipta prostrata* and *Fimbristilis miliacea*

Figure 96. *Ischaemum rugosum* and *Leptoochloa chinensis*

Module 10. GAP for harvesting and post-harvest management of pulse (chickpea and green gram)

Objectives *To train the participants on safe and efficient harvesting and post-harvest management of pulse crops in compliance to crops GAP standards*
Delivery method *Brain storming, presentation, Q&As and session evaluation*
Materials needed *Presentation print outs, flip charts, white board, markers*
Time *1 Hour*

Timely harvesting and stacking is essential for quality and reduced shattering losses
Harvest the crop early morning when the dew drops evaporate
Use sharp tools (sickles) to avoid shaking of the plants and reduce shattering losses
Harvest close to the soil surfaced and avoid uprooting the plants for leaving the crop residues for improving soil structure and texture as stubble mulch;
Equipment and tools are suitable for harvesting and should be checked for cleanliness before use and cleaned as required
Harvest the crop at the coolest time of the day to avoid quality deterioration in the heat but avoid harvesting during rain

Harvesting of chickpea

When leaves fall (senesce), pods colour turn yellow, plants become dry, seed feels hard and rattles within the pod even some top pods may still be green
Harvesting should be at 14 percent seed/grain moisture to avoid losses
Harvesting can be done manually or through harvester.
Harvesting in humid conditions is desirable to reduce seeds losses due to shattering

Harvesting of green gram

Green gram crop should be harvested when 75 percent–85 percent of pods are mature
Late harvesting can result in shattering losses during the harvest
Harvest at seed moisture content (14 percent to 16 percent).
Harvesting should be avoided during the middle of the day because of high shattering losses.
Manual or mechanical harvesting can be applied.
Harvested produce should be placed in cleaning floor, tarpaulin sheets, mats or concrete floors.
Once harvested, the pods are placed outside for sun drying about 2–3 days

1. Divide participants into two groups.
2. Ask participants: what are the improved methods and right time of harvesting oil seed crops (sesame and groundnut? Especially asking the following key questions for knowledge sharing and support:
• *What are the major indicators for harvesting chickpea and green gram crop?*
• *How do you that the crop is ready for harvesting?*
• *What tools do you use for harvesting and do you think that the tools used are appropriate for quality harvest of the crop?*
• *What are the key challenges in crop harvesting in terms of labor, time and equipment?*
1053. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about harvesting of chickpea and green gram by using the key information under (topic-10.1.1) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Threshing , drying and cleaning of chickpea and green gram

Chickpea

Threshing should be done as soon as the pods are dry.

The dried stalk with pods should be beaten gently with a stick until pods are opened.
Harvested produce should be placed on clean floor or tarpaulin sheets, mats or concrete floors to prevent physical, chemical and biological contamination.
Once harvested, the pods be placed outside for sun drying for about 2–3 days.
Seeds are cleaned and dried up to 8–9 percent of seed moisture content and properly stored

Green gram

Thresh when the pods are dry.
The dried stalk with pods should be beaten gently with a stick until pods are opened. Seeds are cleaned and dried up to 8–9 percent of seed moisture content and properly stored
After harvesting, the seed should be cleaned rapidly to remove green pods, leaf material, debris, etc., prior to storage, since these could create drying and storage problems.
Grading of seed size, identification of seed colour and unfilled grains, removal of dusts, sands and small gravel should be done by machine or manually.
Seeds are systematically graded and packed according to different specifications

1. Divide participants into two groups;
2. Ask participants: what are the improved method of threshing, drying and cleaning of pulse crops (chickpea and green gram)? Especially asking the following key questions for knowledge sharing and support;

• *How are you threshing chickpea and green gram after harvesting?*
• *Do you dry the harvested crop before threshing?*
• *If yes, do you consider the appropriate moisture contents of the crop before threshing?*
• *After threshing do you dry and clean the seeds and if yes, how do you assess the seeds/grains ready for storage?*
• *Do you clean the grain/seeds of chickpea and green gram, what in specific you remove from it?*

3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about threshing, cleaning and grading by using the key information under (topic-10.1.2) to complement their answers.
6. Ask participants if there are any questions/clarifications.

The cleaned and well-dried chickpea seeds should be packed and packaged in polythene lined gunny bags with name of the variety, year of production, farm brand name / location, moisture when packed, weight and GAP certification tags.
Vacuum packaging for export markets are desirable as it preserves the produce for longer period and protects from damages during transportation and storage.
As a climate smart GAP, it is recommended to use biodegradable material for packaging chickpea and green gram.
Avoid storage at high seed moisture content, high temperature and high relative humidity.
The storage facility should be clean and designed to promote good sanitation standards for food safety and to prevent product degradation and cross-contamination.
Storage building should be rodent proof and in case there is risk of rodent infestation, take preventive/protective measures such as closing all the holders at the doors roof etc., where pests can enter and also repairing cracks in walls where pests can hide.
All the damaged, diseased, shrunk /shriveled nuts, discoloured, rotten, immature, germinated, other inert materials and soil are removed.
Keep the storage facility well ventilated to prevent water condensation of dampness.
Pellets should be used for each stack and regular turning over of the stakes be done to avoid buildup of moisture and fungus in the underneath bags.
Transport vehicles should be checked before use for cleanliness, availability of proper tarpaulins to cover the cargo, foreign objects and other materials, chemical contamination, pest infestation and must also checked to make sure to be dry without any moisture in the vehicles.
Produce is stored and transported in areas separated from materials and goods that are a potential source of chemical, biological and physical contamination.

1. Divide participants into two groups.
2. Ask participants: what are the improved method of packing/packaging, storage and transportation of chickpea and green gram? Especially asking the following key questions for knowledge sharing and support:

• *Do you consider moisture content for proper drying of chickpea and green gram seeds/grains?*
• *If yes, for how many days, do you keep the seeds/grain for drying and what moisture content is attained through seeds/grains drying?*

• *How to you pack the seeds/grains?*
• *Do you mark each pack/package with any mark of identification, if yes, what type of marking is done on the packages/packs/bags?*
• *Have you faced the problem of damage or quality deterioration of chickpea and green gram in the storage, if yes, please tell about the issues?*
• *What type of precautionary measures, do you take for safe storage of chickpea and green gram?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about packing, packaging, storage and transportation by using the key information under (topic-10.1.3) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Module 11: Pre-harvest good agricultural practices for rice/paddy

Objectives • *To train the participant on improved pre-harvest crop management of rice/ paddy*
Delivery method *Brain storming, presentation, Q&As and session evaluation*
Materials needed *Presentation print outs, flip charts, white board, markers*
Time *1Hour*

Assess the site for chemical, physical and biological hazards which can cause food contamination.
Avoid selection of sites which are previously used for disposal of hospital waste, industrial waste and livestock farm.
Sites should have sustained availability of irrigation water.
If the risk of chemical, biological and physical contamination is high and cannot be controlled, the site must not be used for production and postharvest handling of produce. An alternative site should be selected and assessed for risk.
Record the sites details through site mapping (See annex 1 for site record).

Soil requirements paddy

Loam, silt loam, sandy loam, and silty clay loam soils with a pH of 5.5–7.0.
Fertile riverine alluvial soils and clay loam soils in monsoon lands have the high moisture retention capacity and are the best for rice cultivation.

1. Divide participants into two groups.
2. Ask participants: what are the factors you considered in selecting your farm site for gap crop production? Especially asking the following key questions for knowledge sharing and support:
• *Are you checking the sites for any hazards?*
• *Do you record site history and site management practices?*
• *Do you conduct soil tests before site selection?*
• *What type of soils are required for rice/paddy?*
• *What type of sites should not be considered as fit for GAP crops cultivation?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about sites selection and soil requirements by using the key information under (topic-11.1.1) to complement their answers.
6. Ask participants if there are any questions/clarifications.

use DOA recommended varieties seeds;
the seed should be free from physical impurities, resistant to diseases, tolerant to drought
use fresh seed not older than two years;
seed germination should not be less 80 percent, with physical and analytical purity of 98 percent; and
keep record of seed (type and source).

Recommended paddy varieties in Myanmar

Variety name	**Growth cycle (day)**	**Yield potential (kg/ha)**	**Plant height (inch)**	**Prominent traits**

Aye Yar Min 140−145 3 608−4 639 53 Suitable for irrigated & rain-fed areas, soft & smooth eating quality
135−140 5 155−6 186 41 Suitable for irrigated & rain-fed areas
SinThu Kha 138−140 4 639−6 701 42 Resistance to bacterial blight
Shwe Ma Naw 115−117 4 124−5 155 30 Resistance to bacterial blight, suitable for irrigated areas,
Ma Naw Thu Kha
Manaw Hayi 140−145 3 093−4 124 55 Resistance to bacterial blight, suitable for irrigated/rain-fed areas
Shwe Pyi Htay 125 4 639−5 155 39 Aromatic, resistance to bacterial blight, suitable for monsoon rice in irrigated/rain-fed areas
Palae Thwe 135−140 4 124−5 155 47 Resistance to bacterial blight & blast, suitable for irrigated areas
Yadanar Toe 120−125 5 155−7 217 49 Resistance to lodging, suitable for irrigated/rain-fed areas
Sin Aye Gayi - 3
125−130 4 124−5 155 48 -
Yeanelo - 3 120 2 577−6 186 44 Suitable for the irrigated areas where water-saving irrigation is practiced
Yeanelo - 5 116 4 639−5 155 50 Drought tolerance, resistance to bacterial blight
Yeanelo - 7 116 3 093−6 186 47 Drought tolerance, resistance to bacterial blight
Mhaw Bi- 2 135−240 4 124−5 155 48 -
Shwe Thwe Yin 105−115 4 124−5 155 36 -
Yet- 90 95 5 155−6 186 30 Suitable for irrigated/rain-fed areas,
Yeanelo - 4 117 4 639−5 155 47 Drought tolerance, blast resistance,
Yeanelo - 6 110 4 639−7 217 47 Drought tolerance, blast resistance

Planting geometry and sowing method

Season	**Planting geometry** Row to row (inches)	Plant to plant (inches)	**Seed rate (kg/ha)**	**Plant population ha^{-1}**	**Seeding/seedling depth (inches)**
	8	6	32−52	322 000	1.5
Transplanting					
	8	8	52	242 000	1.5
	9	6	52	287 00	1.5
Wet seeding	-	-	77	-	-
Dry seeding	-	-	103	-	-
SRI	10	10	4	155 000	1.0

Source:
MOALI. 2018. Myanmar GAP Guideline; Department of Agriculture. Ministry of Agriculture, Livestock and Irrigation: Nay Pyi Taw, Myanmar, 2018. https://www.moali.gov.mm/en

DOA-Rice Division. 2016. Pamphlet of Rice Production Technologies for Monsoon and Pre-monsoon Seasons. Department of Agriculture, Ministry of Agriculture, Livestock and Irrigation, Nay Pyi Taw, Myanmar

Seed treatment

Exposure to high temperature: In order to break seed dormancy expose seeds to (40−42°C) for 1−2 days before sowing.
Seed soaking: Seed soaking is beneficial for maximum germination. The seeds should be soaked for 4–8 hours in clean water and re-dried through spreading on a clean mat/tarpaulin. The seed should be sown 1–2 days after priming.
Pre-germination: dipped in water for 12 –24 hours until small shoots appear at the end of the seed.
Carefully drain water to avoid damage to the pre-germinated seeds.
Dry the seeds in a bag should be put for 24 hours in a shady area with good air circulation.
The temperature during drying should not increase than 42 ^{0}C as increased temperature may cause damage to the seeds.
The roots should not exceed five mm at the time of sowing either through broadcast or drum seeding.

1. Divide participants into two groups.
2. Ask participants: what are the factors you considered while selecting seeds, variety, seed quality and seed treatment? Especially asking the following key questions for knowledge sharing and support:
• *Can you name a few of the recommended varieties of rice/paddy?*
• *Do you use recommended seed/variety of rice/paddy?*
• *If not what are the constraints and challenges in securing quality and certified seeds of recommended varieties of rice?*
• *Do you know about the recommended seed rate for rice/paddy?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about seed selection, varieties, seed rate and seed treatment of rice/paddy by using the key information under (topic-11.1.2) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Production systems

Based on the different agro-ecological zones of Myanmar, rice is cultivated under different systems according to the climatic conditions, seasonality aspects, soil type and fertility status, rice varieties performance and water management perspectives, which give a comparative advantage to the country in terms of diversity of rice cropping systems.

Nursery raising and transplanting

1. WBM (Wed bed method):

When water availability is high.
A seed rate of 30−50 kg for transplanting to 1 hectare of land is sown in the properly puddled and level bed.
110One metre wide and with a convenient length, soil is raised 5−10 cm above the field level.
Pre-germinated seeds are broadcasted in the plot with proper drainage system for removal of surplus water.
Organic matter (compost/FYM) and other inorganic fertilizers are applied as basal dressing for increased seed vigor and easy uprooting of seedlings.
Depending on the soil and local climate, normally 15−21 days old seedlings are transplanted to the main field.

2. Dry bed method (DBM):

The nursery is prepared in dry conditions at site which is fully exposed to sun light and has uninterrupted access to irrigation water.
One tenth of the field sites is spared for nursery cultivation.
The bed is prepared through removal of weeds and breaking clods by making it more friable.
Bed level should be 5−10 cm high with 1 metre width and convenient length.
Well-decomposed crop residues, free of weed seeds are spread over on the nursery bed to facilitate easy uprooting.
Ensure timely irrigation to avoid damage to the roots and keep the bed partially wet at the time of uprooting.
Nursery of 15−21 days old is transplanted into the field.

Dapog method (DM):

Dapog or mat method of nursery raising is especially appropriate for growing short duration varieties and thus less exposed to shocks due to transplanting.
A 100-metre square field is prepared.
A seed rate of 40−50 kg is sown for a land of one hectare.
Insert sheets such as banana leaves or plastic sheets cover the surface by making proper boundaries using bamboos shoots or banana sheath
The seed is cultivated @ 1 kg 1.5 m^{-2}. Water is sprinkled after sowing, followed by pressing down by flat wooden plank to embed the seeds and make the surface smooth
The bed should be kept moist to prevent water stress. The seedlings are transplanted after 9-14 days to the main field.

Transplanting of seedlings

Seedlings should be transplanted before 25 days after sowing as transplanting of old seedlings may result in low yield.
In case the seedlings are long, then tips of the seedlings can be cut for easy handling and transplanting.

Rice production systems:

SRI: method of rice cultivation for increasing rice production using reduced planting density, use of much organic manures, using non-flooded/aerobic field conditions and young seedlings planted at wider spacing in a square pattern and managing the crop with intermittent irrigation that keeps the soil

moist but not inundated and using weeders for weed control and improving aeration (look for details in rice GAP standard).

Direct rice seeding:

Direct seeded crops require less labor and tend to mature faster than transplanted crops.
In this method, plants are not subjected to stresses such as being pulled from the soil and re-establishing fine rootlets. However, they have more competition from weeds.
Depending on the land preparation method used, direct seeding can be done in two ways:

111*1. Dry direct seeding*

Broadcasting

Broadcast 60−80 kg of seeds uniformly by hand or in furrows in 1 ha of field.
Make shallow furrows by passing a furrower along the prepared field.
After broadcasting, cover the seeds using a spike-tooth harrow.

Drilling

precision equipment, such as the turbo happy seeder, can be used to drill seeds;
drill 80−100 kg of seeds ha^{-1};
seeds are placed by the machine into both dry and moist soil, and then irrigated;
a smooth, level seedbed is necessary to ensure that seeds are not planted at depths greater than 10−15 mm;
in this technique, fertilizers can be applied at the same time as the seed; and
manual weeding also is easier in machine-drilled crops than in broadcast crops.

Dibbling

Dibbling or hill planting is usually practised along mountain slopes or where plowing and harrowing are difficult.
Use a long wood or bamboo pole with a metal scoop attached at the end for digging holes.
Drop the seeds into the holes and cover them with soil.

2. Wet direct seeding

Broadcasting

Broadcast 80−100 kg/ha of pre-germinated seeds to recently drained, well-puddled seedbeds or into shallow standing water.
If water in the field is muddy, allow 1−2 days for it to dry before broadcasting.

Drum seeding

It operates best on a well-leveled, smooth, and wet seedbed. However, seeders may be clogged if the soil is sticky or if the machine is poorly designed.
Prepare 80 kg of pre-germinated seeds ha^{-1}
.

Land preparation paddy

Primary tillage: To prepare the land primary tillage should be done after the harvest of the previous crop or at the end of the fallow period. The land should be tilled at appropriate moisture conditions for easy and uniform tillage.
Primary tillage can be done through animal or tractor drawn implements such as disc plow, moldboard plows, tined or rotavators upto the depth of 100−150 mm.
Secondary tillage: Secondary tillage is undertaken after primary tillage by tilling the soil 3−4 times up to 50−75 mm depth, depending the nature of soil and other conditions such as cloddiness, level of weed infestation, the need, type and method of fertilizers application as well as the need for puddling.
Implements used for secondary tillage include disc and peg tooth harrows, tined cultivators, rotavators.

Planting geometry and sowing method

Season	**Planting geometry Seed** Plant to Row to row (inches) plant **rate (kg/ha)** (inches)	**Plant population ha^{-1}**	**Seeding/seedling depth (inches)**
8 6 32−52	322 000	1.5	
Transplanting			
8 8 52	242 000	1.5	
9 6 52	287 000	1.5	
112Wet seeding	- - 77	- -	
Dry seeding	- - 103	- -	

SRI 10 10 4 155 000 1.0
Source:
MOALI. 2018. Myanmar GAP Guideline. Department of Agriculture. Ministry of Agriculture, Livestock and Irrigation: Nay Pyi Taw, Myanmar, 2018. https://www.moali.gov.mm/en.
DOA-Rice Division. 2016. Pamphlet of Rice Production Technologies for Monsoon and Pre-monsoon Seasons. Department of Agriculture, Ministry of Agriculture, Livestock and Irrigation, Nay Pyi Taw, Myanmar.

1. Divide participants into two groups.
2. Ask participants: What are the production systems, land preparation and planting time of rice/paddy? Especially asking the following key questions for knowledge sharing and support;
3. Ask each group to write down their responses on a flip chart.
• *Are you aware of the different rice production systems?*
• *If yes, which system do you use for rice cultivation?*
• *Do you know about climate smart techniques of growing rice with less water but enhanced quality?*
• *How do you grow rice/paddy nursery?*
• *Do you know about the recommended seed rate and planting methods of various rice production systems?*
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about production systems, land preparation and planting time of rice/paddy by using the key information under (Topic-11.1.3) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Objectives • *To orient the participants about types, method, time and rate of manures, fertilizers and soil amendments for rice/paddy*
• *To train the farmers for effective and safe application and handling of chemical fertilizers, manures and amendment*
Delivery method *Brain storming, presentation, Q&As and session evaluation*
Materials needed
Presentation print outs, flip charts, white board, markers
Time *1 Hour*

Apply chemical fertilizers on site specific, soil test basis and as per DOA recommendations;
Obtain fertilizers from a registered supplier.
Practise split application of chemical fertilizers in sandy /loose soils.
Apply fertilizers to the soil when soil moisture is sufficient to avoid loss of nutrients and toxicity to the plants.
Keep record of fertilizer, as requirement for GAP certification as per **Annex 4**.
113Apply soil amendments such as gypsum when if the soil is saline/alkaline i.e. Ph is alkaline (>7.5).

Chemical fertilizers for rice /paddy (if soil test are not available)

Macronutrients

Nitrogen:
@ 120−240 kg/ha as split application (30 percent as basal application, 20 percent at 10 DAT and 50 percent at 36 DAT i.e. nearly at the panicle initiation stage)
Administer as spilt application for lowering nitrogen losses and increased nutrient use efficiency.
Splitting of nitrogen can be increased in coarse textured sandy soils under flooded/irrigation systems or high rainfall areas as well as when the crop is of longer duration

Phosphorus:
@ 60−90 kg P_2O_5 ha^{-1}
Phosphorus deficiency has been reported on very acidic or very alkaline soils

Potash:
@ 50 kg/ha
Apply at the last puddling and before transplanting or the fertilizers
Can also be top dressed within 10-15 days after direct seeding.

Compound fertilizers
@ NPK 150:50:50 ha^{-1}

Micronutrients

Apply on soil test basis and only when deficiency is recorded.
Zinc @ 25–30 kg zinc sulphate ha^{-1}, Zinc fertilizers should not be mixed with phosphate fertilizers.
Iron @ 25 kg $FeSO_4$ ha^{-1} between the rows.

Boron @2−3 kg/ha of boron compound should be applied in clayey soils and 3-5 kg/ha in sandy soils.
Manganese @ 2−5 kg/ha $MnSO_4$ or MnO through multiple application

Organic manures

Organic manures such as FYM or Bokashi compost @ 10 t/ha FYM or vermicompst @ 2 t/ha
Also practise as per the guidelines given in crops GAP standards for green manuring by using the GM crops for adding organic matter to the soil to

- *improve soil texture*
- *microbial activities*
- *structure and friability*
- *adding N and other micronutrient to the soil.*

Soil amendments (Gypsum)

Use gypsum ($CaSO_4$ $2H_2O$) 5 tonne gypsum ha^{-1} for correction of soil sodicity, salinity improving soil stability, water penetration into soil, and more rapid seed emergence.

1. divide participants into two groups;
2. ask participants: What type of chemical, organic fertilizers and soil amendments to be applied to rice/paddy? Especially asking the following key questions for knowledge sharing and support;

• *What type of chemical fertilizers do you apply to rice/paddy?*
• *If yes, what is normally the time and method of chemical fertilizers application?*
• *How do you assess the crop nutrient requirements?*
• *Have ever conducted soil tests for nutrient deficiency or excess in soils selected/cultivated with rice/paddy? If yes, can you share the findings of the soil tests and expert recommendations?*
• *Do you apply organic manures and if yes what type of and at what rate manures are applied by you?*
• *Why soil amendments are important for soils and under what soil conditions?*
• *Do you know the rate of soil amendments application?*

3. ask each group to write down their responses on a flip chart;
4. when all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them;
5. after the presentations, explain about chemical fertilizers, manures and soil amendment in rice/paddy by using the key information under (Topic-11.2.1, 11.2.2, 11.2.3) to complement their answers; and
6. Ask participants if there are any questions/clarifications.

Objectives • *To train the participant on improved crop rotations for increased ecological based farming system*
• *To train the participant on improved intercropping as resilient cropping patterns*
Delivery method *Brain storming, presentation, Q&As and session evaluation*
Materials needed *Presentation print outs, flip charts, white board, markers*
Time *30 minutes*

Crop rotation is a systematic and sequential cultivation of different crops in the same field site unlike continuous cropping in which the same crop is cultivated year after year. Crop rotation also result in effective utilization of soil nutrients and soil moisture, reduced insects pests and disease problem. Farm income can be effectively diversified and sustained in view of climate change effect on agriculture

Principles of crop rotations

Deep rooted vs shallow rooted-sesame-chickpea-green gram for efficient nutrient uptake and utilization
Legume vs non-legume such as sesame should be cultivated after chickpea/green gram/groundnut for maintaining soil fertility
Pathogens/nematode resistant crops and crops requiring heavy irrigation follow crops sensitive to certain pathogens, parasite (nematode) and less water and labor-intensive crops should follow labor intensive

Intercropping growing two or more crops simultaneously on the same field. Intercropping is termed as m*ixed intercropping* (*mixed cropping*) when two or more crops are grown simultaneously with no distinct row arrangement. It is called *row intercropping* (*intercropping*)

when two or more crops are grown simultaneously where one or more crops are planted in rows.

Principles of intercropping

The associating crop should be complimentary to the main crop.
The subsidiary crop should be of shorter duration and of faster growing habits, to utilize early slow growing period of main crop.
The component crops should require similar agronomic practices.
Erect growing crops should be intercropped with cover crop.
Erosion permitting crop should be intercropped with erosion resisting crop.
The component crops should have different rooting pattern and depth of rooting.

1. Divide participants into two groups.
2. Ask participants: what are crop rotation and intercropping and what are the key principles and benefits of crop rotation? Especially asking the following key questions for knowledge sharing and support:
• *Do you practise crop rotation in rice/paddy cropping systems?*
• *If yes what is the type of rotating crops and what crops are included in rotation for rice/paddy growing areas?*
• *Can you name some useful crops to be included in crop rotation and why?*
• *What is intercropping and its key benefits?*
• *What important consideration should be kept in mind while planning intercropping?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about crop rotation and intercropping by using the key information under (topic-11.3.1, 11.3.2.) To complement their answers.
6. Ask participants if there are any questions/clarifications.

Objectives • *To train the participant on importance of irrigation water quality and safety for GAP certified crops*
• *And to orient them on improved irrigation methods, time and scheduling of efficient crop irrigation techniques*
Delivery method *Brain storming, presentation, Q&As and session evaluation*
Materials needed *Presentation print outs, flip charts, white board, markers*
Time *30 minutes*

Test water quality for heavy metals to ensure safe food production.
Record of water quality test and keep record for verification.
The water flowing down from livestock farms, hospitals, industries, waste water and any sources that may cause environmental harm must not be used for irrigation purpose.
The irrigation, fertigation and water management of the crop should be recorded.

1. Divide participants into two groups.
2. Ask participants: what is the irrigation water quality and what key considerations should be kept in mind while irrigating crops cultivated with gap? Especially asking the following key questions for knowledge sharing and support:
• *Have you ever tested water quality?*
• *If yes, what specific elements are normally tested?*
• *If no, what are the key constraints for not conducting water quality testing?*
• *What type of water sources should be avoided for irrigating GAP certified crops?*
• *Do you keep record of water quality and irrigation management of your crops?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about irrigation water quality management by using the key information under (topic-11.4.1) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Full irrigation is not necessary for young plants and light irrigation is recommended.
If the rice field is dry during tillering stage (20−30 days or 30 days after transplanting), it may increase weed development.
Irrigation with 2−4 inches deep is recommended to control weed development.
Drainage is done at 20 days after flowering and 7 to 10 days before harvesting to ensure timely maturity of the crop.
See diagram below for critical crop growth stages for irrigation of rice/paddy.

1. Divide participants into two groups.
2. Ask participants: what are the methods, times and frequency and irrigation scheduling for rice/paddy? Especially asking the following key questions for knowledge sharing and support:
• *How often do you irrigate rice/paddy?*
• *How do you know that it is time to irrigate the crop?*
• *Do you know about the critical stages of crops irrigation especially for rice/paddy?*
• *Do you know about the improved methods of irrigation to avoid water losses and increasing water use efficiency?*
1173. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about irrigation regimes for rice/paddy by using the key information under (topic-11.4.2) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Figure 100. Critical stages for irrigation of rice crop
Source:
JICA. 2016. Handbook on upland rice cultivation. Ministry of Agriculture and Irrigation (Sudan) & Japan International Cooperation Agency (JICA) Capacity Building for the Implementation of the Executive Program for the Agricultural Revival.
118Figure 101. Critical stage wise water requirement of paddy crop
1400
1240
Water requirements (mm)
1200
1000
800
600
458 417
400
200
125
200
40
0
NURERY MAIN FIELD
PREPARATION
PLANTING TO
PANICLE
INITIATION
PANICLE
INITATION TO
FLOWERING
Plant Growth Stages
FLOWERING
TO MATURITY
TOTAL
Source:
Kumar, K. P., Barik, D. K. 2015. Comparison of Agricultural Yield with and Without A Canal Head Regulator. International Journal of Advanced Technology in Engineering and Science, 3(9), 19-30.

119Module 12: IPM and IWM in rice/paddy

Objectives *• To orient the participants about major insect pests of rice/paddy*
• Enable them to learn about the basic approaches and principles of IPM for insect pests management in rice/paddy
Delivery method *Brain storming, presentation, Q&As and session evaluation*
Materials needed
Presentation print outs, flip charts, white board, markers
Time *1 Hour*

IPM means the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment. IPM emphasizes the growth of a healthy crop with the

least possible disruption to agro-ecosystems and encourages natural pest control mechanisms (FAO).

IPM principles

Practise crop rotation and intercropping the minimize pest infestation through cultural methods.
Use adequate cultivation techniques such as seedbed sanitation, timely sowing, optimum plant population, use of conservation tillage, thining and direct sowing.
Use pest resistant/tolerant cultivars and standard/certified seed and planting material.
Practise field sanitation i.e. Removal of affected plants or plant parts, regular cleansing of machinery and equipment.
Protect and enhance beneficial organisms.
Field observation where feasible warning, forecasting and early diagnosis of insect pests.
Biological, physical and other non-chemical methods must be preferred over chemical methods if they provide satisfactory pest control.
Pesticides should only be applied as a last resort when there are no adequate non-chemical alternatives and use of pesticides is economically justified.
Only when the level of infestation exceeds the economic threshold level, then apply sites/problem specific pesticides be applied with least side effects on human, health, predating /useful insects.

1. Divide participants into two groups.
2. Ask participants: What is IPM and what are its key elements/principles? Especially asking the following key questions for knowledge sharing and support;
• *What measures do you take when the crop is infested with insect pests and diseases?*
• *Do you use only agrochemicals for control/prevention of insect pests and diseases in rice/paddy or other methods such as cultural, biological and mechanical are also used?*
• *What are the key difficulties you are facing in using IPM?*
• *Do you know the Economic Thresh-hold Level of insect pests damages to rice/paddy?*
1203. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about IPM and its principles by using the key information under (Topic-12.1.1) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Insect Pest IPM

Rice stem
borer and rice
leaf folder
picking egg masses;
weeding in the field;
safe disposal of stubbles and straw through desiccation in the sun and then using in compost making;
deep ploughing and pulverization to kill pupae and larvae in the soil;
use light traps to catch stem borer moths;
use potash fertilizers;
encourage the natural enemies;
planting or seeding times may be delayed to avoid the peak emergence of moths from the diapausing population, but fields planted later than neighbouring fields may suffer high late season damage;
use *Trichogramma japonica* was used to control rice stem borers as successfully experimented by PPD; and
use DoA recommended pesticides obtained from registered suppliers.
Rice Thrips Plant hoppers
Grow resistant cultivars after consulting with DOA or DAR.
Flooding the field to submerge rice for two days.
Dusting the seedlings with wood ash at a rate of 0.3kg/m2 in the morning. The wood ash breaks down the skin of the thrip.
Adult thrips can also be reduced by catching them using a fine net such as a mosquito net or scarf. Drag the net lightly over the surface of the plants and kill any thrips collected.
Rice seedlings normally recover from thrip damage provided water and fertilizer are supplied. After thrips infestation, use Nitrogen fertilizer (0.2 kg/m2) to improve tiller growth.
Encourage establishment of biological control agents: predatory thrips,

coccinellid beetles, anthocorid bugs, and staphylinid beetles.
Used DoA recommended pesticiedies for seed treatment.

1. Divide participants into two groups.
2. Ask participants: What are the major insects pests of rice/paddy and their control through IPM method? Especially asking the following key questions for knowledge sharing and support;
• *Have you ever observed insects' pests including vertebrate pests such as rodents and porcupines or any other damaging rice/paddy crops?*
• *If yes, can you name them?*
• *Which of the observed pests is the major problem in the rice/paddy field?*
121• *What control measures do you adopt to prevent/control the rice/paddy pests?*
• *Do you know the low cost and environment friendly methods of rice/paddy insect pests control/prevention?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about major insect pests of rice/paddy and IPM by using the key information under (Topic-12.1.2) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Figure 102. Egg mass of pink stem borer (left) and yellow stem borer (right)

Figure 103. Damage symptoms of rice stem borers

122Figure 104. Adult rice thrips and silvery feeding marks

Figure 105. Different life stages of brown plant hoppers
Figure 106. Different life stages of white-backed plant hoppers
123

124

Figure 109. Yellow stem borer and rice leaf folder

Figure 108. Brown plant hoppers at the base of the hill and the hopper burn in paddy field

Figure 107. Making space for better ventilation and spraying to control the brown planthopper125
Figure 112. *Spodoptera litura* larva and short-horned grasshopper

Figure 111. Stink bug and the leaf hopper

Figure 110. Rice leaf butterfly larva and rice skipper larvaFigure 113. Spodoptera Amsacta sp egg mass and newly hatched larva

Objectives • *To increase knowledge of the participants about the major diseases of rice/paddy*
• *To train the participants in rice crop disease control through IPM*
Delivery method *Brain storming, presentation, Q&As and session evaluation*
Materials needed *Presentation print outs, flip charts, white board, markers*
Time *1 Hour*

Diseases IPM
Bacterial
blight
plant the resistant variety sin thu kha;
plant 8″ x 6″ spacing to avoid overlapping leaves;
early planting: Sow in 1st week of June-July;
do not overuse nitrogen fertilizer (urea 46 percent); 112 lb/acre;
use 28 lb/acre of potassium as basal dressing (45 percent K2O);
remove infested plants, weeds, debris, which can serve as host of bacteria;
and
desiccate straw left from previous crop and use it for FYM compost or
Bokashi compost.

Rice blast
use Sin-thu-kha - 2, Sin-thwe-latt and Shwe Myanmar as resistant to rice blast;
restricted nitrogen fertilizer applications are needed to avoid serious outbreaks of blast;
control of irrigation water has also been used to reduce blast damage;
close spacing also often increases the severity of the disease;
field sanitation and synchronized planting reduce carryover and/or spread of disease; and
use DoA recommended pesticides.

Rice false smut
deep plough to at least six inches and practise sun drying the field during the summer;
126use certified disease-free seeds;
spray DoA recommended pesticides; and
remove alternative hosts, including grassy weeds, especially Common barnyardgrass (*Echinochloa crus-galli*) and Jungle rice (*Echinochloa colona*).

Rice stem rot
plough the land frequently before sowing or transplanting;
applications of lime have been used to reduce soil pH;
periodically, drain the fields to reduce the number of sclerotia;
use the correct balance between nitrogen and potassium fertilizers. It is best to split applications;
collect straw and other debris after harvest and burn it with the stubble, or plough everything into the soil;
rotate with forage or legume crops;
use disease resistant varieties/strains; and
spray DoA recommended pesticides.

1. Divide participants into two groups.
2. Ask participants: what are the major diseases of ric/paddy and ipdm (integrated pest and disease management)? Especially asking the following key questions for knowledge sharing and support:
• *Are diseases major problem in rice/paddy?*
• *If yes, what type of diseases are common in rice/paddy?*
• *How do you control the diseases?*
• *Do you know measures other than use of agrochemicals for diseases control in rice/paddy?*
• *If yes, please tell about those measures used in the field?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about rice/paddy diseases and ipm by using the key information under (topic-12.2.1) to complement their answers.
6. Ask participants if there are any questions/clarifications.
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Figure 116. Different kinds of rice blasts

Figure 115. Spore balls are initially orange and turn greenish black when mature

Figure 114. Spodoptera Stem rot symptom caused by *M. salvinii* and *sclerotia*

Figure 117. Bacterial leaf blight symptoms

Figure 118. Bacterial ooze and dried up bacterial ooze

Objectives • *To orient the participant about major weeds in rice/paddy*
• *To train the participants in weeds management through IWM (Integrated Weed Management)*
Delivery method *Brain storming, presentation, Q&As and session evaluation*
Materials
Presentation print outs, flip charts, white board, markers

needed

Time *30 minutes*

IWM involves a combination of cultural, mechanical, biological, genetic, and chemical methods for effective and economical weed control (Swanton and Weise 1991). IWM uses the best mix of principles, practices, technologies, and strategies to control weeds and takes into consideration environmental, social, and economic impact of the combined control strategies (Casimero *et al.,* 1995).
Various methods as integrated weed control encompasses;
○ *herbicide application*
○ *land fallowing*
○ *cultural control*
○ *mechanical control*
○ *biological control*.
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1. Divide participants into two groups.
2. Ask participants: what is IWM and what are its principles? Especially asking the following key questions for knowledge sharing and support:
• *Do you think that weeds are a major problem rice/paddy?*
• *How and at what stage do you control weeds in rice/paddy?*
• *Do you use any other method other than weedicides for weed control?*
• *If yes, please tell about those methods of weeds control?*
• *What is IWM and tell us about your use of the IWM?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about IWM and its principles by using the key information under (topic-12.3.1) to complement their answers.
6. Ask participants if there are any questions/clarifications.

hand pulling/cultural control;
control by mechanical means;
control by water management;
control by land preparation;
control by crop competition;
biological weed control; and
chemical control-use of herbicides/weedicides as pre plant, pre-emergence and post emergence.

1. Divide participants into two groups.
2. Ask participants: what are the major weeds in rice/paddy? Especially asking the following key questions for knowledge sharing and support;
• *What are the major weeds in rice/paddy?*
• *Do you think that the weeds reduce the yield?*
• *What cultural, biological and mechanical method can be used for effective weeds control in rice/paddy?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about weeds and IWM in rice by using the key information under (Topic-12.3.2.) to complement their answers.
6. Ask participants if there are any questions/clarifications.
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Figure 121. Indian isachne globosa and awnless barnyard grass, *Echinochloa colona*

Figure 120. Indian pennywart, *Centella asiatica* and Leucas, *Leucas lavandulifolia*

Figure 119. Devil's horse whip, *Achyranthes aspera* and Velvet leaf, *Abutilon indicum*
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Figure 124. Indian Puncture vine*, Tribulus terrestris and* Wild cassia, *Cleome viscose*

Figure 123. Indian Niruri, *Phyllanthus niruri* and Wild jute, *Corchorus trilocularis*

Figure 122. Indian Spiny amaranth, *Amaranthus spinosus* and Basil, *Ocimum gratissimum*133

Figure 127. *Cocculus hirsutus* and *Celosia argentia*

Figure 126. Red spiderling, *Boerhavia diffusa* and snake weed, *Euphorbia hirta*

Figure 125. Purple nutsedge, *Cyperus rotundus* and Scirpus juncoides134

Figure 130. *Ischaemum rugosum* and *Leptoochloa chinensis*

Figure 129. *Ludwigia hyssopifolia* and *Scirpus grossus*

Figure 128. Schoeoplectus juncoides and *Spheoclea zeylanica*135

Figure 134. Wild rice and *Echinochloa colona*

Figure 133. *Cyperus iria* and *Cyperus difformis*

Figure 132. *Echinochloa colona* and *Echnichloa crus-galli*

Figure 131. *Eclipta prostrata* and *Fimbristilis miliacea*
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Figure 137. *Leptoochloa chinensis* and *Schoeoplectus juncoides*

Figure 136. *Fimbristilis miliacea* and *Scirpus grossus*

Figure 135. *Cyperus difformis* and *Cyperus iria*Figure 138. *Echinchloa crus-galli* and *Cleome viscose*

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Module 13. GAP for harvesting and post-harvest management rice/paddy

Objectives *To train the participants on safe and efficient harvesting and post-harvest management of rice/paddy for compliance to crops GAP standards*
Delivery method *Brain storming, presentation, Q&As and session evaluation*
Materials needed *Presentation print outs, flip charts, white board, markers*
Time *1 Hour*

Harvesting at appropriate moisture level (below 26 percent) and subsequent drying up to 15 percent, improves milling and reduce quantitative and qualitative losses.
Harvest when the panicles turn yellow and the grain moisture contents comes down to 20–26 percent at which 80 percent of grain can be recovered from the panicles.
The crop reaches to harvesting 25–35 days after flowering by when about 75 percent of spikelet turn yellow, the grain is filled and tight, grain colour changes from green to olive green to yellow.
Water should be drained out 7–10 days before harvesting to ensure uniform maturity and efficient harvesting operations.
In case of manual harvesting, use cut the straw with sharp sickle only 4–5 cm from the ground level.
Leaving bigger portion of straw as stump may provide shelter for stem borer.

1. Divide participants into two groups.
2. Ask participants: what are the improved methods and right time of harvesting in rice/paddy? Especially asking the following key questions for knowledge sharing and support:
• *What are the major indicators for harvesting rice/paddy?*
• *How do you that the crop is ready for harvesting?*
• *What tools do you use for harvesting and do you think that the tools used are appropriate for quality harvest of the crop?*
• *What are the key challenges in crop harvesting in terms of labor, time and equipment?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.

5. After the presentations, explain about harvesting of rice by using the key information under (topic-13.1.1) to complement their answers.
6. Ask participants if there are any questions/clarifications.

Threshing , drying and cleaning of rice/paddy

Various methods can be used for threshing rice i.e. manual through hand, crushing with foot or by simply swinging, beating and whipping actions against cleaned framed objects.
Clean the grain of chaffs, foreign materials.
Thresh the crop on the same day of harvest if the rice straw are not wetted from overnight rain or heavy dewfall.
The crop should be field dried before threshing. If the crop is harvested late morning, then afternoon, half of the day, the crop should be threshed.
To reduce grain losses due to beating effects, wider canvass should be used with raised edges dried soon after threshing.
Appropriate drying is key to the produce quality in terms of taste, aroma, nutrition value and long shelf life.
Dry the grain for 24 hours after threshing, otherwise the grain quality will be lowered due to breaking in the milling.
The recommending moisture for sale is 15 percent of seed moisture while it should be 13 percent for storage.
Ensure that the spread grain is turned over at regular interval (every 30 minutes) using rakes to ensure uniform drying.
Slow drying with moderate temperature is good for preventing cracking as quick drying result in broken grains during milling.
The surface temperature should not exceed above 36℃ or must be kept lower than 36℃. High temperature can also damage the seed embryo, which in turn decrease seed viability in case of using the grain as seed.
For drying of milling rice, about (200–400) baskets of paddy can be dried up to 15 percent of seed moisture content at 40–50ºC within 8–10 hour.
Remove foreign all foreign matter including broken grain, immature grain, shriveled grains for attaining high milling recovery.
As estimated that to increase mechanical efficiency of milling by five percent and energy consumption if percentage of foreign matter is less than one percent.
Winnowing trays or sieves should be used and mechanical cleaner for efficient cleaning.
Small stones which cannot be removed by winnowing, should be picked by hand.

1. Divide participants into two groups.
2. Ask participants: what are the improved method of threshing, drying and cleaning rice/paddy? Especially asking the following key questions for knowledge sharing and support:
• *How are you threshing rice/paddy after harvesting?*
• *Do you dry the crop before threshing?*
• *If yes, do you know the appropriate moisture contents of the crop before threshing?*
• *After threshing do you dry and clean the seeds and if yes, how to you assess the seeds/grains ready for storage?*
• *Do you clean the grain/seeds of rice/paddy, what in specific you remove from it?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to

present the key points of their responses and facilitate them.
5. After the presentations, explain about threshing, drying and cleaning paddy/rice by using the key information under (topic-13.1.2) to complement their answers.
6. Ask participants if there are any questions/clarifications.

High milling recovery, if foreign matter, broken and immature grains are removed before milling.
The post-harvest losses can be reduced through feeding of clean, dried and pure grain is fed to the machine besides avoiding damages to grain and milling machines as well as fuel/energy consumption.
Milled rice appear as whole grains, broken grains, off types (grain of other varieties), coloured grains and unmilled rice.
Milled rice should be graded based on different parameters such as moisture content, head rice and broken grains percentage, defectives, impurities, foreign matters, unmilled paddy, immature grains, broken grains.
If the moisture content of milled rice is high, there is risk of mould development and grain

losses.
Appropriate storage is important to prevent losses caused by biotic and abiotic factors. The grain moisture content should maintained not more than 14 percent on weight basis.
The bags of grains should not put directly on the floor but on a rack 20 cm above the floor.
Produce should not be stored in the containers previously used for chemicals and other dangerous substances and materials.
For export purpose, the prevention measures for storage pests/disease are practised during the storage period to meet the requirements of the different exporting countries.
Transport vehicles should be checked before use for cleanliness, availability of proper tarpaulins to cover the cargo, foreign objects and other materials, chemical contamination, pest infestation and must also checked to make sure to be dry without any moisture in the vehicles.
Different rice varieties should be stored separately, appropriately labelled with name of the variety, quality/grade, date of storage and quantity.

1. Divide participants into two groups.
2. Ask participants: what are the improved method of packing/packaging, storage and transportation of rice/paddy? Especially asking the following key questions for knowledge sharing and support:
• *Do you consider moisture content for proper drying of rice/paddy seeds/grains?*
• *If yes, for how many days, do you keep the seeds/grain for drying?*
• *How do you pack the seeds/grains?*
• *Do you mark each pack/package with any mark of identification, if yes, what type of marking is done?*
• *Have you faced the problem of damage or quality deterioration of rice/paddy in the storage, if yes, please tell about the issues?*
• *Why cleaning is important for quality milling of rice/paddy?*
140• *What type of precautionary measures, do you take for safe storage of rice/paddy?*
3. Ask each group to write down their responses on a flip chart.
4. When all groups finish writing their responses on a flip chart, ask one volunteer from each group to present the key points of their responses and facilitate them.
5. After the presentations, explain about milling, grading, packing/packaging and storage by using the key information under (topic-13.1.3) to complement their answers.
6. Ask participants if there are any questions/clarifications.

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Annexes

Annex 1: Term and terminologies used in GAP

Term/Terminology Definition

Accreditation
The formal recognition by an independent body, generally known as an accreditation body, which is a certification body operates according to international standards.

Active ingredient Ingredient of a plant protection product that is chemically and biologically active

Aflatoxin
A toxic secondary metabolite produced by some fungi, especially *Aspergillus flavus* and *Aspergillus parasiticus*. Those commonly found in nature are B1, B2, G1 and G2 aflatoxins.

Assessment An appraisal of procedures or operations based largely on experience and professional judgment.

Audit
The International Organization for Standardization (ISO) defines an audit as a systematic, independent and documented process for obtaining audit evidence and evaluating it objectively to determine the extent audit criteria are met.

Audit & inspection A systematic, independent and document process for assessing compliance to GAP standards.

Audit evidence
All the information collected during the course of an audit, which serves as the basis for the auditor to make an opinion and determine compliance with the requirements (standard) being audited against. Such evidence includes records, factual statements and other verifiable information (e.g. observation of work activities and physical examination of products, materials and equipment) that is related to the audit criteria being used. There must be sufficient audit evidence for the auditor to submit a final opinion.

Biodiversity
The variability among living organisms from all sources, including 'inter alia' terrestrial, marine and other aquatic systems, and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

Broken kernels
Whose lengths are at least 2.5 parts of a whole kernel, but less than the length of head rice. This includes split kernels that retain less than 80 percent of the whole kernel.

Calibration Determination of the accuracy of an instrument, usually by measurement of its variations from a standard, to ascertain the necessary correction factor.

Certification The provision by an independent body of written assurance (a certificate) that the product, service or system in question meets specific requirements.

Certification body A third party auditing organization that audits facilities against a specific international standard or code.

Checklist
An inspection and audit tool with documented questions that reflect the requirements, procedures, or policies of an organization. For GAP inspections/audits it can be used by producers, producer groups, certification bodies or organizations (approved by GLOBALG.A.P. as appropriate) which help producers to implement GAP standards towards obtaining certification (or GLOBALG.A.P. certification).

Compliance Criteria (CC)

Control Points (CP)

Control Points and Compliance Criteria (CPCC)

Dry paddy rice Dry season Flowering date or blooming date Food safety Good agricultural

practices (GAP)	
Hard rice	
Hazard (as it relates to food safety):	
Hazard (as related to GAP)	
Hazard Analysis Critical Control Point (HACCP)	
Hazardous substances	
Hazardous/toxic	
Hygiene	
Internal controls	
Mature rice grain	Information provided to further illustrate each control point and how to successfully address the requirement(s) identified in the control point.
	Each of the requirements requested by a standard (or GLOBALG.A.P. standards) to implement good agricultural practices. Within the GLOBALG.A.P. standards, control points are classified as Major Musts, Minor Musts, or Recommendations.
	The comprehensive set of control points and compliance criteria that define the standard against which a producer's performance is measured both internally and externally.
	Paddy rice with the moisture of less than 15 percent for trade rice.
	The period of rice growing off rainy season.
	The day that not less than 80 percent of rice plants in the field are blooming.
	The assurance that food will not cause harm to the consumer when it is prepared and consumed according to its intended use.
	Practices that address environmental, economic, and social sustainability for on-farm processes, resulting in safe and quality food and non-food agricultural products (FAO).
	Broken kernel whose length is more than those of brokens, but not reach the length of the whole kernel. This includes split kernels that retain at least 80 percent of the whole kernel.
	A biological, chemical, or physical agent that could contaminate food at any stage and cause an unacceptable health risk.
	A biological, chemical, physical or any other property that may result in a situation that is unsafe for workers, consumers, or the environment.
	A food safety system that identifies hazards, develops control points throughout the flow of food, sets critical limits, and monitors the effectiveness of these control measures.
	Explosive substances such as flammable substances, oxidizing agents and peroxides, toxic substances, substances causing diseases, radioactive substances, mutagenic substances, corrosive substances, irritant substances; and other substances, either chemicals or anything which may cause harmful to humans, animals, plants, properties or environments.
	A substance or any articles including chemicals, microorganisms or microbial toxins which may be harmful to human, animal, plant, property or environment.
	good practices indicate conditions and measures for the production processes necessary to achieve a produce that is safe and suitable for consumption
	The various engineered and managerial means-both formal and informal established within an organization to help the organization direct and regulate its activities in order to achieve desired results; they also refers to the general methodology by which specific management processes are carried out within an organization.
	Rice kernel that developed completely to ripening stage and is ready to be harvested. At least three quarters of the grain of the panicle turn yellow
146**Milling quality of paddy**	
Off type rice Pest Pesticide	
Plot	
Quality Management	

System (QMS)
Record Red kernels Risk Risk assessment Sample/Sampling Self-assessment Standard
Traceability Verification Visual inspection
Volunteer rice plant
Weedy rice Wet paddy rice
The amount of whole kernels and head rice obtained from a milling test calculated as percentage by weight of paddy.
Rice plant of other varieties grown in the rice field, but excluding weedy rice.
Any type of plant, animal or microorganism that causes damages to plants, plant produces and plant products.
A hazardous substance used in agriculture regulated by the Department of Agriculture in line with Pesticide Law (Pyidaungsu Hluttaw Law No. 14/2016)
An area in which a crop is planted and is not connected to other areas. In case the area I connected to others, the production management including inputs, cultural practices and personnel of the area is clearly distinctive
The organizational structure, procedures, processes and resources needed to implement quality management.
A document containing objective evidence illustrating activities being performed and/or results achieved
Rice kernels that have red bran layer covering the kernel wholly or partly.
The chance that a condition or set of conditions will lead to a hazard
An estimate of the probability, frequency and severity of the occurrence of a hazard.
Selecting a portion of a group of data in order to determine the accuracy or propriety or other characteristics of the whole body of data.
Internal inspection of the production system and the registered product carried out by the producer or a sub-contractor, based on GLOBALG.A.P. checklist (or checklist from another GAP scheme).
A document that provides requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes and services are fit for their purpose (ISO).
The ability to retrace the history, use or location of a product (e.g. origin of materials, processes applied or distribution or placement after delivery) by means of recorded identification markers.
Confirmation by examination of evidence that a product, process or service fulfils specified requirements.
An inspection of external appearances of an entity such as a produce, product or apparent environment condition. This is examined by eyes but other sensory evaluation may be applied depending on the quality factors to be inspected. Additional tools such as a magnifying glass could also be used. Inspection of working procedure and process are also included.
Rice plant that germinated from those seeds remained in the field from the previous season.
The weed, which has its plant and kernel similar to rice. The grain is normally shattered from its panicle before the harvest of rice.
Paddy, which is harvested and immediately threshed without exposing to moisture reducing process. Normally the moisture of this paddy is not less than 18 percent by weight.
147**Wet season** The period of rice growing during rainy season
Whole kernels Rice kernels that are in whole condition without any broken parts, including kernels which have at least nine parts
Worker
Any person or a farmer who has been contracted to carry out a task. This includes farm owners and managers, as well as family members carrying out tasks on the farm.

Source:
National Bureau of Agricultural Commodity and Food Standards Ministry of Agriculture and Cooperatives. 2008. Good agiricultural practices for rice. https://www.acfs.go.th/standard/download/eng/GAP_rice.pdf .

Annex 2: Pre/Post- training assessment questions

Module- 1
Section 1: Mark the following statements true /False whichever is applicable
S.No Statement Options (True/False)

1. 1 If a significant risk of chemical or biological contamination of produce has been identified, the site should not be used for production of fresh produce under any condition.
2. 2 If planting material is produced on the farm, then the requirement is to keep records only of the planting materials.
3. 3 While storing chemicals, liquid chemicals should be stored below powders.
4. 4 Untreated organic material does not pose any significant risk of contaminating the produce with biological hazards.
5. 5 If approved chemicals are used, there is no risk of contaminating either the soil or the produce.
6. 6 A review of practices at farm level is generally done at least once a year. If the farm is doing well and there are no customer complaints, there is still a need to review practices.
7. 7 All environmental hazards as in the case of food safety hazards also affect the health of the consumer of the produce, which makes these critical for food safety as well.
8. 8 Good Agricultural Practices can significantly minimize the environmental hazards.
9. 9 Water can be the cause of food safety hazards but not quality hazards
10. 10 Water, if contaminated, can be used for irrigation purposes but not for washing purposes.
11. 11 It is acceptable to use a slightly higher concentration of pesticides than those recommended so as to be doubly sure that the pests are destroyed.
12. 12 Workers' health, safety and welfare are the responsibility of the farm owners
13. 13 It is the workers' choice whether or not they wear protective garments provided by the farm owner.
14. 14 Pest and domestic animals can cause illness to the farm workers.
15. 15 A quality plan is required in both food safety and produce quality modules
16. 16 Bacteria causing plant disease also generally affect food safety.
17. 17 Water can also lead to environmental hazards in addition to safety hazards in fruits and vegetables.
18. 18 GAP covers two aspects for food safety and produce quality.

Section 2: Answers the following questions briefly

1. 1. List one chemical hazards that lead to adverse health effects on consumers.
2. 2. List one good agricultural practices that will help minimize food safety hazard –pesticide residues.
148 3. 3. 4.
5. 4. List one key point that is very important for food safety after pesticide application at pre-harvest.
List one agricultural practices to control environment hazards.
6. 5. List one hazards that could lead to workers' health and safety issues
6. List four modules of Myanmar GAP guidelines.

a.
b.
c.
d.

Section 3: Tick the correct answer

High risk crops are:

a. those grown on land assessed as having risks
1. 1
b. produce such as sprouts and cut fruits
c. all of the above
d. none of the above.

For practicing GAP:

a. there will be no restriction with respect to environmental requirements
2. 2
b. the national environmental policy shall be followed
c. none of the above.

With respect to domestic animals:

3. 3
a. there should be restriction on their movement in the production and produce handling areas of the farm
a. no restriction of their movements required as they can graze the wild plants
b. none of the above.

Integrated pest management:

a. should totally replace chemical pesticides
4. 4
b. should be practised to minimize the use of pesticides
c. all of the above
d. none of the above.

Records of GAP should be kept for:

a. 2 years
5. 5
b. more than 2 years if required by legal requirements
c. all of the above

d. none of the above.

Training on application of pesticides

a. shall be required for every handler of the chemicals and application equipment

6. 6

b. will not be required for the producer even if she/he does the work

e. all of the above

f. None of the above.

149**Product traceability and recall:**

a. shall be mandatory for GAP practicing farmers

7. 7

b. may not be implemented by individual farmers

g. all of the above

h. None of the above.

Section 4: Write True (T) or False (F)

1. 1 There shall be a pre-decided time gap between a pesticide spray and harvesting
2. 2 Harvesting should be done at the coolest time of the day
3. 3 Planting material should be purchased from a certified source
4. 4 It is not necessary to comply with all criteria classified as critical
5. 5 All records used by a producer group can be controlled by itself
6. 6 GAP standard can be mandatory or voluntary as decided by the country.

Answers Key

Section 1: Mark the following statements true /false whichever is applicable

Question Correct answer

1 True
2 False
3 True
4 False
5 False
6 True
7 True
8 True
9 False
10 False
11 False
12 True
13 False
14 True
15 True
16 True
17 True
18 False

150**Section 2: Answers the following questions briefly**

1

1. Pesticides, herbicides, fungicides
2. Fuel, lubricants, sanitizers
3. Detergent, heavy metals exceeding maximum permitted levels, plant toxins, allergic agents

2

a. Purchase the registered and recommended product from the licensed dealer
b. Ensure to apply pesticides with recommended dose, at the appropriate time and with appropriate method of application
c. Observe PHI (Post Harvest Interval)

3 a. Observance of PHI (Post Harvest Interval) contribute to food safety

4

a. Avoid burning of farm residues, plastic, rubber and aluminum burning
b. Use of crop residues instead of burning
c. Regular check of vehicles and farm machinery

5

a. Chemical hazard
b. Biological hazard
c. Physical hazard

6

a. Produce quality
b. Food safety
c. Environment management
d. Workers health, safety and welfare

Section 3: Tick the correct answer

1 a
2 b
3 a
4 b
5 c
6 a
7 a

Section 4: Write True (T) or False (F)

1 True
2 True
3 True
4 False
5 False
6 True

Annex 3: Evaluation and feedback

Name:_____

Profession/Designation:_____

How do you evaluate the quality of the Workshop in general?

a. Excellent
1. 1
b. Very good
c. Adequate
2. 2 **Was the subject of the Workshop useful and relevant to your needs?**
1513. 3
4. 4
5. 5
6. 6
7
8
9
10
11
12
a. Very useful
b. Somewhat useful
c. Not useful

Do you feel that the training manual on crops GAP will be useful and relevant information?

a. Very useful
b. Somewhat useful
c. Not useful

Were the training presentations useful and relevant?

a. Very useful
b. Somewhat useful
c. Not useful

Did you find the Group work sessions relevant and useful?

a. Very useful
b. Somewhat useful
c. Not useful

Did you find the Field visit relevant and useful?

a. Very useful
b. Somewhat useful
c. Not useful

Do you feel that the learning will be useful for GAP promotion in the target regions

a. Very useful
b. Somewhat useful
c. Not useful

Were the organizational arrangements up to your requirements

a. Consultation material (Yes/No)
b. Food and accommodation (Yes/No)
c. Venue(Yes/No)
d. Participatory and interactive (Yes/No)

How do you evaluate the training duration?

a. More than enough
b. Enough
c. Not enough

How well participation and interaction were encouraged throughout the session?
a. Very good
b. Good
d. Bad
How helpful were materials and resources distributed?
a. Very good
b. Good
c. Bad
Any other comment and recommendations

_____
_____
_____
_____

Please fill and return the proforma to the trainer

Annex 4: GAP Check Lists

FORM-1
CHECK LISTS FOR FARMERS'FIELD
Site Inspection

S.No	**Parameter Required**	**Compliance /Record Keeping/Documentation**
1	Name of Crop	
2	Total Sown Area	
3	Area of GAP Registered Crops/Plant Population	
4	Land Preparation before Sowing Time	
5	Land Preparation after Sowing	
	Surrounding Areas	
1	Surrounding Areas of GAP field	
2	Are there any other crops cultivated in surrounding areas of GAP field? YesNo	
3	Distance between GAP field & Toilet	
	Seed Selection	
1	Name of Crop Variety	
2	Any plant parts for plant propagation	
3	Seed/Plant Propagation Source	
	Cultivation Method	
1	Row & Plant Spacing	
2	Status of Inter-cropping YesNo	
3	Crop Duration	

Fertilizer Application Inspection Record

S.No.	**Parameter**	**Fertilizer Used**	**Fertilizer rate (kg/acre)**	**Frequency Mode of application**	**Application Date**
1	Fertilizer used before sowing				
2	Fertilizer used after sowing				
3	Farmyard Manure used				
4	Soil additives & other supplements used for GAP crop				

FORM-1
CHECK LISTS FOR FARMERS'FIELD
Pesticides/Fungicides Application Inspection Record

S.No.	**Parameter**	**Pesticides/ Fungicides**

Used
Pesticides/
Fungicides
rate
(kg/acre)
Frequency Mode of
application
Applicatio
n Date
1 Pesticides/Fungicides used before field inspection
2 Pesticides/Fungicides currently used
3 Pesticides/ fungicides storage methods
4 Warehouse existences

Irrigation & Source of Irrigation Water

Sr.No. Parameter Inspection Record
1 Source of irrigation water
2 Distance between irrigation source & GAP field
3 Irrigation System

Postharvest Practices
1 Packaging & Cleaning
2 Storage & Transportation
3 Warehouse existences for harvested crops

Personal Hygiene and Worker welfare
1 Total number of workers
2 Number of workers who received the trainings on “Systematic Pesticide Application Methods”
3 Number of workers who received other trainings
4 Compliance of Personal Hygiene
5 Existences of housing for the workers
6 Work done for personal hygiene and worker welfare

FORM-2

CHECK LISTS FOR FARMERS’FIELD

C- Compliance NC- Non Compliance NA- Nail

1. Site Selection C NC NA
1 The site and its surrounding areas used for production of GAP crops are not contaminating with any chemical and biological hazards.
2 The layout map of the site and a record are kept of official document of land use permission (Form-7).

2. Irrigation
154 1 The results of water test are kept. (rain water, water from river, stream, creeks, tube well & ponds, underground water)
2 The water used for irrigation are not coming from livestock farms, hospitals, industries, waste water and any sources that may cause environmental harm.

3. Seed/Seedling
1 A record is kept of source of supply, amount of supply and the date of supply for seeds, seedlings and plant propagations.
2 A record is kept of chemicals used for seeds, seedlings and plant propagations.

4. Fertilizers and Soil Additives
1 The fertilizers and soil additives used for GAP crop production are free from chemical and biological contaminations that may be harmful on and off the site.
2 The results of soil test are kept.
3 The farm manure are used after making thoroughly compost and a record is kept.
4 The registered products (fertilizers & soil additives) are only purchased from licensed suppliers and used for crop production.
5 Areas or facilities for storage, mixing and loading of fertilizers and soil additives and for composting of organic matter are located, constructed and maintained to minimize the risk of environmental harm on and off the site.

6 Produce is stored in areas separated from the chemicals.

FORM-2

CHECK LISTS FOR FARMERS'FIELD

C- Compliance NC- Non Compliance NA- Nail

5. Agrochemical and Other Chemicals C NC NA

1 Compliance of Integrated Pest Management System – IPM

2 The registered chemicals are only purchased from licensed suppliers and used for crop production.

3 Compliance of Post-Harvest Intervals (PHIs)

4 Compliance of recommended dosage & systematic application methods.

5 Systematic chemical application methods are observed and followed exactly.

6 Compliance of using PPE by the workers whenever they use pesticides.

7 Chemicals are carefully disposed in the areas of separate

places far away from water sources & a record is kept of all actions taken.

8 After pesticide application, personal hygiene practices are observed and followed exactly. Pesticide spraying equipment are also cleaned.

9 Work done for precaution measures for recently pesticide sprayed areas.

10 Chemicals are stored in the areas separated from other materials and goods.

11 The chemicals obtained, stored, used, application and disposals of chemicals are systematically handled and recorded. A record is kept of all actions taken.

12 Fuels, oils, and other non-agrochemicals are handled, stored and disposed of in a manner that minimizes the risk of contaminating produce.

6. Agriculture and Other Related Materials

1 The farm machinery & farm implements are cleaned.

2 Equipment, materials that contact produce and containers used for storage and other materials are cleaned not to contaminate the produce.

3 Waste, chemicals, other dangerous subsistence and materials are clearly identified and are not used for storage and holding produce.

CHECK LISTS FOR FARMERS'FIELD

C- Compliance NC- Non Compliance 7. Harvesting and Handling Produce 1 Compliance of proper harvesting method at good maturity stage.

2 Harvested produce is not placed in direct contact with soil or the floor of handling, packing areas.

3 Packaging materials are cleaned and systematically stored.

4 Before storage of produce, the warehouses are carefully cleaned.

5 Water used for cleaning of produce & any parts of produces are clean.

6 Identification and compliance of recommended places for having meals.

8. Storage and Transport

1 Harvested produce is not stored and transported in direct contact with animals, chemicals & fertilizers.

2 Transport vehicles are checked before used & cleaned.

3 Transport vehicles are also checked for chemical waste, pest infestation and other materials.

9. Building and Structure

1 Building and structure used for packaging, handling and storage of produce are constructed and maintained to minimize the risk of

NA- Nail

C NC FORM-2

NAcontaminating produce or separate places for those actions are identified and measures are taken.

10. Animals and Pest Control

1 Domestic and farm animals are excluded from the production site particularly for the areas where produce is harvested, packed and stored.

11. Documents and Records

1 Records of good agricultural practices are kept for a minimum period of at least two years. A record is kept of current practices taken in the format form.

• Authorized person for chemical use/application

• Risk assessment record

• Record of practices taken

• Seed, seedlings & any plant parts used for plant propagation
• Chemicals stored/ used for crop production

CHECK LISTS FOR FARMERS'FIELD

C- Compliance NC- Non Compliance NA- Nail

C NC NA

• Pesticide application
• Fertilizers & soil additives
• Record of irrigation
• Chemicals obtained & used after harvesting
• Action plan for personal hygiene & Plant Protection
• Training Attended
• Review of practices
• Other records (field maps,.)

12. Traceability and recall

1 Packed containers are clearly marked with an identification and registration number to enable traceability of the produce to the farm or site where the produce is grown.

13. Training

1 Employers and workers are trained to have appropriate knowledge in their area of responsibilities relevant to good agricultural practices.

14. Personal Hygiene and Worker welfare

1 Written instructions on personal hygiene practices are displayed in prominent locations or are provided to workers.

2 All actions taken are emphasized on personal hygiene of the workers from packaging sites & packaging, washing and produce treatment is clean.

3 Toilets, water used for washing & cleaning for personal hygiene practices are easily provided to workers.

4 All actions taken are emphasized on personal hygienic and worker welfare.

Annex 5: Games and energizers

A. Introductory exercises

1. Stand up if this applies to you

This is a good activity to help participants get to know each other.

• Start with participants sitting.
• Ask participants to stand if a statement applies to them. For example;
o Stand if you were born in this township or village.
o Stand if you enjoy watching football.
o Stand if you have children.
o Stand if you enjoy listening to music.
o Stand if you like eating mohinga (Myanmar food).
• Ask participants to sit down after each statement.
• Think of funny statements but be careful not to embarrass participants or make them feel uncomfortable.
• Then, ask them to introduce themselves.

2. Match the cards and introduce each other

• The facilitator chooses a number of well-known phrases, and writes half of each phrase on a piece of paper or card.
• For example, they write 'Happy' on one piece of paper and 'Birthday' on another.
• The number of pieces of paper should match the number of participants in the group.
• The folded pieces of paper are put into a hat.
• Each participant takes a piece of paper from the hat and tries to find the member of the group with the matching half of the phrase.
• Then, the partners introduce each other.

3. Gesture with your name

This is a good activity to help participants get to know each other's at the beginning of a workshop:

• Ask participants to sit or stand in a circle.
• Explain that each person must say their name and then perform a gesture, which they feel expresses something unique about them.
• Demonstrate a couple of gestures yourself such as reaching out your arms, hiding your face behind your hands (to represent shyness, for example), bowing (to represent politeness) or kicking a pretend ball (to represent interest in football).
• Explain that after each introduction the next participant should introduce him or herself .
• Then, all the participants who went before him or her, including each participant's name and gesture saying "this is…" repeating the name and gesture.
• For each introduction, participants should say "hello…" and perform the name and gesture of the participant they are meeting.
• Participants then take turns to introduce themselves this way.

158**B. Energizers**

1. Robots

• Divide the participants into groups of three.
• One person in each group is the robot controller and the other two are the robots.
• Each controller must manage the movements of their two robots.
• The controller touches a robot on the right shoulder to move them to the right, and touches them on the left shoulder to move them to the left.
• The facilitator begins the game by telling the robots to walk in a specific direction.
• The controller must try to stop the robots from crashing into obstacles such as chairs and tables.
• Ask participants to swap roles so that everyone has a chance to be the controller and a robot.

2. Move to the Spot

This can be an enjoyable game, as long as it does not go on for too long. It should probably be brought to an end after three or four peoples have had the chance to be the leader. The danger is that people will stick close to their spots.

• Clear the center of the room or find an open space outside.
• Each group member is instructed to choose and stand in an open spot.
• Instruct people to walk around and do one of the following;
○ say hello to all those who wearing red/blue;
○ look up as you walk;
○ walk backward;
○ hop (or skip or jump);
○ make a sound or whistle;
○ keep one (or both) eye(s) closed; and
○ in as much of a straight line as possible.
• When you say stop, everyone must run to his or her original spot. The person who reaches their place first is the next leader (as facilitator keep an eye out for this) and can instruct the group to do whatever they wish.

3. The longest line

This game requires a lot of space and may need to be done outdoors.

• Divide into teams of eight to ten people.
• Each team must have the same number of members.
• Explain that the task is to create the longest line using participants own bodies and any clothing or things in members pockets.
• Participants are not allowed to collect other things from the room/outside.
• Give a signal for the game to start and set a time limit, such as two minutes.
• The team with the longest line wins.

4. Line-ups

• Participants arrange themselves in a long line, following a description:
• Participants stand around, freely.
• Explain that you will give a description and participants should form a long line according to the description.
○ Line up from tallest to shortest person: point out which end is the tallest and which is the shortest.
159○ Line up according to their birth date: on one side the earliest birthday in the year and on the other side the latest birthday in the year.
○ Line up according to the distance between the workshop or
○ Line up according to the number of people living in the household.
• When everyone is in place, ask them to greet their neighbors to the left and right.
• Choose another description, and ask participants to line up according to that one.
• Continue until participants have changed neighbors a few times.
• Thank the players and review what happened.

5. Fruit salad

• The facilitator divides the participants into an equal number of three to four fruits, such as oranges and bananas.
• Participants then sit on chairs in a circle.
• One person must stand in the center of the circle of chairs.
• The facilitator shouts out the name of one of the fruits, such as ‘oranges’, and all of the oranges must change places with one another.
• The person who is standing in the middle tries to take one of their places as they move, leaving another person in the middle without a chair.
• The new person in the middle shouts another fruit and the game continues.
• A call of ‘fruit salad’ means that everyone has to change seats.

6. Banana game

• A banana or other object such as a bunch of keys is selected.

• The participants stand in a circle with their hands behind their backs.
• One person volunteers to stand in the middle.
• The facilitator walks around the outside of the circle and secretly slips the banana into someone's hand.
• The banana is then secretly passed round the circle behind the participant's backs.
• The job of the volunteer in the middle is to study people's faces and work out who has the banana.
• When successful, the volunteer takes that place in the circle and the game continues with a new person in the middle.