Farmer Field School for

Sustainable Seed Potato Production

A Facilitator's Guide

This document provides a comprehensive guide and technical knowhow to farmers for sustainable seed potato production using a ten point utilizing a bottom-up approach to knowledge acquisition targeting the Badulla and Nuwara-Eliya Districts of Sri Lanka

Preface

Potato (*Solanum tuberosum* L.) ranks fourth among the world's food crops and is the staple food of almost half of the world's population. In Sri Lanka, average national potato production is around 80,000 Mt and the extent under cultivation is approximately 5,000 ha. At present, potato is extensively cultivated in the highlands of Nuwara-Eliya district in the up-country wet zone (WU3) and of Badulla district in the up-country intermediate zone (IU3D). Sri Lanka imports 140,000 tons of potato for consumption every year at a cost of 70 million USD as the local potato production is not sufficient to meet the demand which leads to increased outflow of foreign exchange. The absence of specific climatic conditions for tuber bulking in potato is a major constraint to expand the cultivated extent in Sri Lanka. Hence, productivity improvement is the only alternative to increase local potato production. Use of quality seeds free from tuber borne diseases and improved cultivation techniques are prerequisites to increase the productivity of potato.

Annual seed potato requirement in Sri Lanka is 12,000 Mt and 80 % of this is produced by farmers as self-seed production and the government sector contributes 08 % while the balance 12 % of the total requirement is imported to the country. The average yield of potato in Sri Lanka remains around 16 Mt/ha which is below the potential yield of 20 Mt/ha, mainly due to the use of poor quality seeds by farmers. To achieve success in sustainable high quality self-seed potato production, management of the problems such as land preparation, selection of seed potato, cultivation, understanding the diseases and pest occurrences, using modern technical knowhow blended with traditional knowledge and experiences will be very helpful.

Rehabilitation of Degraded Agricultural Land Project (RDALP) has decided to support the farmer education programme on Good Agricultural Practices (GAP) in seed potato production to increase productivity of potato whilst controlling pronounced land degradation in potato growing areas due largely to the rugged topography and high soil disturbance associated with potato cultivation in highland of Sri Lanka. The interaction between the different components of land resources determines the productivity and sustainability of any land-use system. Sustainable Land Management (SLM) interventions should be suited to the specific biophysical and socio-economic conditions of the potato cultivation lands and could be practiced by farmers.

The Farmer Field School (FFS), a group based adult learning approach which teaches farmers how to experiment and solve problems independently is used to guide farmers in Nuwara Eliya and Badulla districts, which are the main potato production areas in the country. This guide is prepared for FFS facilitators who guide the learning process and facilitate experiential learning opportunities to the FFS participants to empower seed potato farmers on Good Agricultural Practices to produce quality seed potato. Content of this guide is presented in three main parts to enhance user friendliness to the facilitator. The first part gives the introduction to farmer field Schools. The second part provides the topics on the technical subjects of sustainable seed potato production while the third part includes the necessary attachments required for the implementation of seed potato production farmer field schools.

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Farmer Field Schools

Introduction.

In order to improve agricultural productivity, standard of living and food security, farmers must implement sustainable farming practices combining their experience and modern techniques to optimize limited resources. Farmers, as adults prefer to improve their knowledge and skills by practicing themselves instead to be taught top-down methods.

The Farmer Field School (FFS), a group based adult learning approach which teaches and guides farmers how to experiment and solve problems independently is ideally suited for this and helps, additionally, to build relationships between farmers, entrepreneurs, suppliers, the private sector and researchers. At an FFS, often described as a school without walls, farmers are empowered to make scientific decisions by sharing experiences through group discussions. In this approach, problems are considered as challenges and both the facilitators who facilitate sharing of knowledge and experiences among group members to enhance the ability to take correct decisions at correct time and the farmers identify different opportunities to solve any potential problems in the field through research processes.

Participants in an FFS share experiences through group discussions on various agro-ecosystem analysis practically conducted at farmer's field and improve decision making leading to better crop management, yields, sales, value-addition etc.

Principles of the Farmer Field School approach

Participants decide what to study.

The decision on what to study in the group discussion rests with the members in the FFS. This ensures that the discussion and the decisions taken are relevant to their burning local needs. The facilitator's job is to guide participants through the learning process by creating hands-on exercises.

Learning is by doing (experiential learning)

Experiential learning is fundamental to the FFS approach. It is widely accepted that people learn best by doing. Thus, the saying, "Tell me, and I forget. Show me, and I remember. Involve me, and I understand."

Learning is field/enterprise based

One critical component of FFS is a farmer field for a group study. All FFS activities are organized in this field enabling participants to carry out experiments and observe, collect, and experience in their surrounding instead of through textbooks, pictures or other extension materials. Study field should be a convenient place reachable by all the group members and be owned by a flexible and supportive minded farmer of the FFS group.

Learning is based on facilitation, not teaching

The role of the facilitator is crucial for successful learning and empowerment since FFS does not focus on teaching but on guiding FFS members through the learning process. To foster the learner-centered process, the facilitator remains in the background, listening attentively and reflectively, asking questions and encouraging participants to explore more in the field, and present their ideas. The facilitator must stimulate FFS members to think, observe, analyse, and discover answers by themselves.

Trained facilitators guide the learning process, not by teaching but by mentoring and supporting the participants to take responsibility for their own learning. In the discussions, the facilitator contributes and moderates the group to reach a consensus on proper decisions and actions.

Problem based -curriculum driven process

Problems are presented as challenges, not constraints for FFS groups and they learn different analytical methods to help them gain the ability to identify and solve any problem they may encounter in their daily life as well.

Characteristics of farmer field school.

Farmers as experts

In the FFS concept Farmers "learn by doing". They carry out their own comparative studies of different farming activities by themselves, involving practically in their field which leads to becoming experts on the particular practice they are investigating.

Learning process follows the seasonal cycle

FFS group sessions are synced with the seasonal cycle of the crop calendar. This gives the opportunity for the farmer to practice immediately what is learnt effectively.

Farmers generate their own learning material

FFS Farmers generate their own learning materials, drawings and posters during the group sessions, based on field observations and experiments. These materials are consistent with local conditions, and learners know their meaning since they were produced by them. Even illiterate farmers can prepare simple diagrams to illustrate their points.

Group capacity building

FFS farmers acquire skills on communication, problem solving and discussion methods by conducting group sessions. Successful activities of FFS require farmers to apply effective leadership skills with the ability to communicate their findings to the community.

Regular group meetings

FFS Farmers meet at agreed regular intervals. For example, for the seed potato production, 10 group sessions are planned. The frequency of meetings is determined by the critical events of crop management.

Objectives of the FFS

The objectives of the FFS are as follows:

- To empower farmers with the knowledge and skills to make them experts in their own fields.
- To increase the expertise of farmers to enhance their capacity to make critical and informed decisions on what works best for them, based on their own observations and to explain their reasoning that makes their farming profitable and sustainable.
- To analyze and identify problems in the production systems, experiment possible solutions, and eventually encourage them to adopt the most suitable practices.
- To sensitize farmers in new ways of thinking and problem solving.
- To introduce and adapt GAP- Good Agricultural Practices

Facilitator in FFS

FFS facilitators are selected from various domains including extension workers, government workers, farmer organization staff, previously trained farmers, etc. Their role is to encourage active exploration and understanding of how farming systems work and FFS functions. They introduce new ideas through guided exercises and stimulate discussion "by farmers, for farmers", without dominating the scene. Facilitators go through rigorous, season-long training conducted by "master trainers" and follow the same "learning-by-doing" approach as the farmers and eventually training in FFS, helping to improve flow of information and knowledge sharing.

Role of facilitator in FFS

- Organize and conduct the FFS
    - Determine site - (farmer -innovative, reputed among other farmers, owner willing to help others, good economic situation, easy access to other farmers, availability of irrigation facility throughout season, field with good soil condition, availability of space for FFS meetings)
    - Conduct baseline survey for all participants as in the given format (Appendix 1).
    - Conduct preparation meeting - (please see FFS time table for topics : Appendix 2)
    - Identify participants - 25-30 farmers who have agreed to participate in all FFS sessions, cultivating same crop, near FFS site (with in the first few sessions farmers who joined for free benefits will dropout and group size will be convenient to handle).
    - Encourage farmers from different age groups without gender bias.
    - Conduct FFS group sessions (please see FFS Curriculum for Sustainable Seed Potato Production for session topics: Appendix 3).
- Conduct pre and post evaluation (please see sample ballot box questions for pre evaluation of Sustainable Seed Potato Production: Appendix 4)
- Guide the learning process
- Create learning opportunities (suggest simple studies when necessary)

- Answer question with question to enlighten education opportunities (e.g.- if farmer brings a caterpillar specimen and asks 'what is this?', facilitator asks 'what they are doing in the plant?', 'how many of them?', 'do they eat leaves or some other part of plant?', 'do you have previous experiences?', etc. until farmer understands weather the problem is serious or minor and if necessary, discuss control methods as well).
- Summarize presentations with technical guidance for important points learned during FFS (use notes for facilitators given at the end of exercises).
- Keep an eye on group to select co - facilitators or farmer leaders (farmers with good understanding, good presentation ability, clear speaking, etc.) for future FFS.
- Facilitate activities associated with FFS
    - Identify technical problems which farmers face in their fields or nearby fields and forecasting issues which affect crop health by analyzing the weather condition to address in the FFS sessions
    - Develop curriculum for FFS sessions according to field conditions.
    - Invite resource persons to give technical details.
    - Advice coordinator to write short report on activities, farmers' responses, suggested solutions etc. in each FFS session.
- Give attention to basic requirements of FFS
    - Materials required as given in each exercise
    - Provide refreshment if needed
    - Arrange Covid-19 protection materials (face masks, hand washing facilities, sanitizer, etc.)
- Maintain communication with other stake holders such as local government officers, NGOs, public sector, other relevant organizations, etc.
    - To organize funding for future FFS
    - To increase market opportunities for FFS production
    - To introduce value addition methods from relevant institutes
- Implementing FFS activities using information communication technologies (ICT) under pandemic conditions like Covid 19 situation
    - Develop and maintain WhatsApp group
    - Develop and maintain Face book group and page

Implementation of Farmer Field School

The successful implementation of any FFS program depends on the pre-planning by clearly understanding the objectives and activities of the program. Implementation process has many steps involving the facilitator and the farmers who have different responsibilities to fulfil to achieve the objectives.

Steps:

1. Site selection
2. Farmer selection
3. FFS orientation
4. Conducting FFS Session
5. Using ICT to facilitate FFS activities
6. Promoting FFS activities
7. Monitoring and evaluation of FFS

1. Site selection

Selection of the site is the initial activity of implementing FFS program. Selecting site for FFS depends on the objectives of the FFS and for seed potato production it should satisfy the following criteria:

- Sites where farmers who cultivate potato as their primary source of income are concentrated.
- There should not be any soil erosion, land degradation, productivity loss or any other issues relevant to potato cultivation.
- Farmers of the site should be learning oriented and be able to form as groups easily
- Village level officers' groups should be supportive.
- Availability of active involvement of private sector for marketing and extension is preferable.

2. Farmers Selection

The FFS is a group-based learning approach which has many advantages. The group formation is important to share and disseminate technology amongst the farmers. The following advantages result from group formation:

- Groups from a similar community facilitate better communication.
- Groups are useful for scaling up future activities.
- Groups are formed based on similar interests of farmer.

Initially, a meeting should be organized with farmers, farmer leaders, village level officers and other stake holders to introduce and explain the FFS methodology, advantages, and opportunities of FFS briefly aiming

to identify potential farmers to form a stable FFS group. If any already functioning groups are available they can be used.

Following points should be considered when selecting farmers for FFS:

- Interested in learning new technologies.
- Willing to share their knowledge with other farmers.
- Able to participate for the entire FFS project.
- Full time farmers without gender discrimination.
- Young farmers who are interested.
- Farmers who have smart phone or any other devices with internet connection with some basic knowledge on ICT are preferable.
- Any other interested persons in seed potato production.

3. FFS Orientation

The first FFS farmer meeting for the selected farmers should be conducted one month prior to the cultivation season. In this meeting, the prevailing conditions, requirements, opportunities and constrains related to sustainable seed potato production should be identified using participatory approach. After the above discussion, the learning process of FFS approach, the benefits of FFS, minimizing the constraints, satisfying needs, the opportunities and sustainability of the cultivation are explained in detail to the participants. Experts of Integrated Pest Management (IPM) on seed potato and FFS approach could be invited to explain.

During this meeting a group leader with good leadership qualities should be appointed to represent the FFS group. In addition a host farmer who provides the farm with following criteria should be selected to conduct the FFS sessions.

- Willing to allow the use of his farmland voluntarily to conduct the FFS.
- Having good leadership qualities
- Willing to work with other farmers.
- Respected by community members, cooperative and influential.
- Having a farm with following requirements
    - Freely accessible to the FFS members.
    - The size of the entire plot should be sufficiently large to allow experimentation plots but not too big intimidating other farmers.
    - Enough space near to the field should be available appropriate for holding FFS meetings.
    - Should be secure.

Sub groups should be formed consisting of 5-6 farmers and each subgroup should be given the opportunity to host the program in rotational manner which will improve the leadership qualities of the farmers to enhance sharing of knowledge and experiences among farmers. Sub groups leaders,

Information Technology leader, Record keeper, and Treasurer should be appointed in this meeting to lead the identified activities in the process.

4. Conducting FFS session

The approach used in Potato IPM FFS is 'learning by doing' where farmers can learn from their own experiences. Potato fields become the classroom for study, and the source of knowledge. Responsibilities of conducting FFS activities are by the facilitator and the host team of the week who is selected by the group members. A single Potato IPM FFS session, limited to 3-4 hours, preferably held in the morning, once a week, involves the following main activities:

I. Brief recap of the previous session.

II. Agro Eco System Analysis (AESA)

III. Group dynamics

IV. Special Topics

V. Evaluation of the day's program and next session planning.

Table 1: Suggested timetable of a FFS session

Time (min)	Activity	Responsible
5	Prayer	Host team
5	Brief Recap	Host team
90	Main Activity of the day (AESA at later stage)	Facilitator
30	Group Dynamics	Host team
60	Special Topic	Facilitator
5	Review of day's activities	Host team
10	Planning for next week	Host team
5	Announcements, marking attendance	Host team

I. Brief recap of the previous session

The previous week's host team conducts the recap session before starting the activities of the day to review the previous week's session according to the timetable, summarizing the main ideas shared , the recommendations and any other the key findings. The recap should not take more than 5 minutes.

II. Agro Eco System Analysis (AESA)

The equilibrium or balance of the environment depends on the interaction of various environmental components. This equilibrium breaks down because of non-eco-friendly farming practices for instance use of pesticides to control pests, destroy beneficial organisms.

AESA is a tool to assist farmers to develop skills and knowledge about agro eco systems and consequently, to make better decisions. Participants should be divided into sub groups to conduct the AESA. AESA in SPP is conducted as potato plants pass through different growth phases during the season. Farmers draw what they have observed, discuss their drawings and analyze the agro ecosystem and make decisions with consensus among farmers (figure 1). This is extremely important for understanding the interaction and reciprocal relationships between components in the potato field ecosystem. Here, farmers can easily make decisions regarding the sustainable management of their fields.

OBJECTIVES

1. To get an understanding of potato crop ecosystems by the participants.
2. To improve observational, analytical and decision-making ability of the participants.

The AESA is comprised of various components:

- Location
- Date
- Crop age (DAS)
- Variety
- Beneficial insects
- Harmful insects
- Diseases
- Weeds
- Plant height
- Soil depth
- Weather conditions
- Other specified factors

Understanding the components and interactions of the ecosystem will enable farmers to manage the crop environment properly to ensure better yields while protecting the environment.

Figure 1: Methodology of AESA

Exercise on understanding the Agro Eco System Analysis (AESA)

Ecosystem analysis involves determining whether there are any threats to the good health of the crop. Conducting an agro eco-system analysis at regular intervals helps to identify diseases, pests, nutrient deficiencies and other conditions that affect the growth of the crop. Hence, the corrections can be made accordingly. Ecosystem analysis is a major activity in every FFS. By conducting AESA and

By the end of exercise, farmers will understand the concept of an agro ecosystem, its components and interactions between each component, what will happen to the balance of the ecosystem if we change one or more of the components.

observing potato crops during each phase of their growth farmers will understand the potato ecosystem and improve their observational, analytical and decision-making skills (Appendix 3). Hence, farmers will make rational decisions such as whether it is time to use fertilizer, whether a pest management measure is required, etc. on crop management, increase their income and avoid unnecessary expenditure especially on pesticides.

TOOLS & MATERIALS

- Observation forms (A sample observation form is provided in Appendix 5)
- poster papers, adhesive tape, markers, crayons/colored pencils, colored cards, notebooks, rulers
- Clear plastic bags

Time: 90 minutes.

STEPS

1. Facilitator explains the objectives of the AESA activity to participants.
2. Discuss the necessity of observing potato plants and the eco system, frequency and method of making observations and collecting information including previous experiences of participants.
3. After participants get adequate knowledge on how to conduct field observations, divide group in to sub groups of 5-6 farmers and ask them to make their field observations and to note down anything of importance including the following:
    a. Condition of the plants, height, number of leaves, branches etc.
    b. Pest incidence - presence of insects, population, insect damage and severity on plants etc. and natural enemy populations
    c. Disease incidence - diseased plant parts, severity of the disease etc.
    d. Weather conditions.
    e. Soil conditions such as wet or dry.
    f. Conditions at the edge of the field.
    g. Conditions in neighboring plots if available.
4. Provide plastic bags for collecting leaf, insect or soil specimens from the field ecosystem (do not give hints).
5. Participants come back to meeting place, discuss and analyzes the agro ecosystem, summarize information and draw their observations on poster paper, showing environmental relationships of soil, water, weather, pests, disease, weeds etc. on potato plant growth and the influence on the eco system.
6. Give one example after five minutes (e.g. plants can be categorized as producers since all plants produce food using sunlight and water).
7. Let them complete and facilitator should visit all groups and help to develop all components. (Producers, plant feeders, natural enemies, organic matter, decomposers, nutrients.)

8. When sub groups come to the conclusions and convert this in to picture (sample given in figure 2) ask each group to present the outcomes of their discussions to the whole group.
9. After all sub groups have made their presentations, discussions should continue with all participants about interactions between each component.
10. Keep the ecosystem drawings for comparison with observations made at the following meetings.

Notes for facilitator

During presentation ask the following questions

1. What happens to system?
    - If sunlight is blocked somehow (relate it to cultivation in shady places in field such as under the tree where sunlight is poor).
    - If there are no plants
    - If there are no pests
    - If there are no natural enemies (relate it to application of broad-spectrum insecticides).
    - If there are no decomposers

2. Are there any signs of disease on potato plants?
3. Are there any signs of pest damage on potato plants?
4. How does the weather affect plant growth?
5. How are the conditions in the plot compared with the previous observation?
6. What crop management practices do you plan for the week?

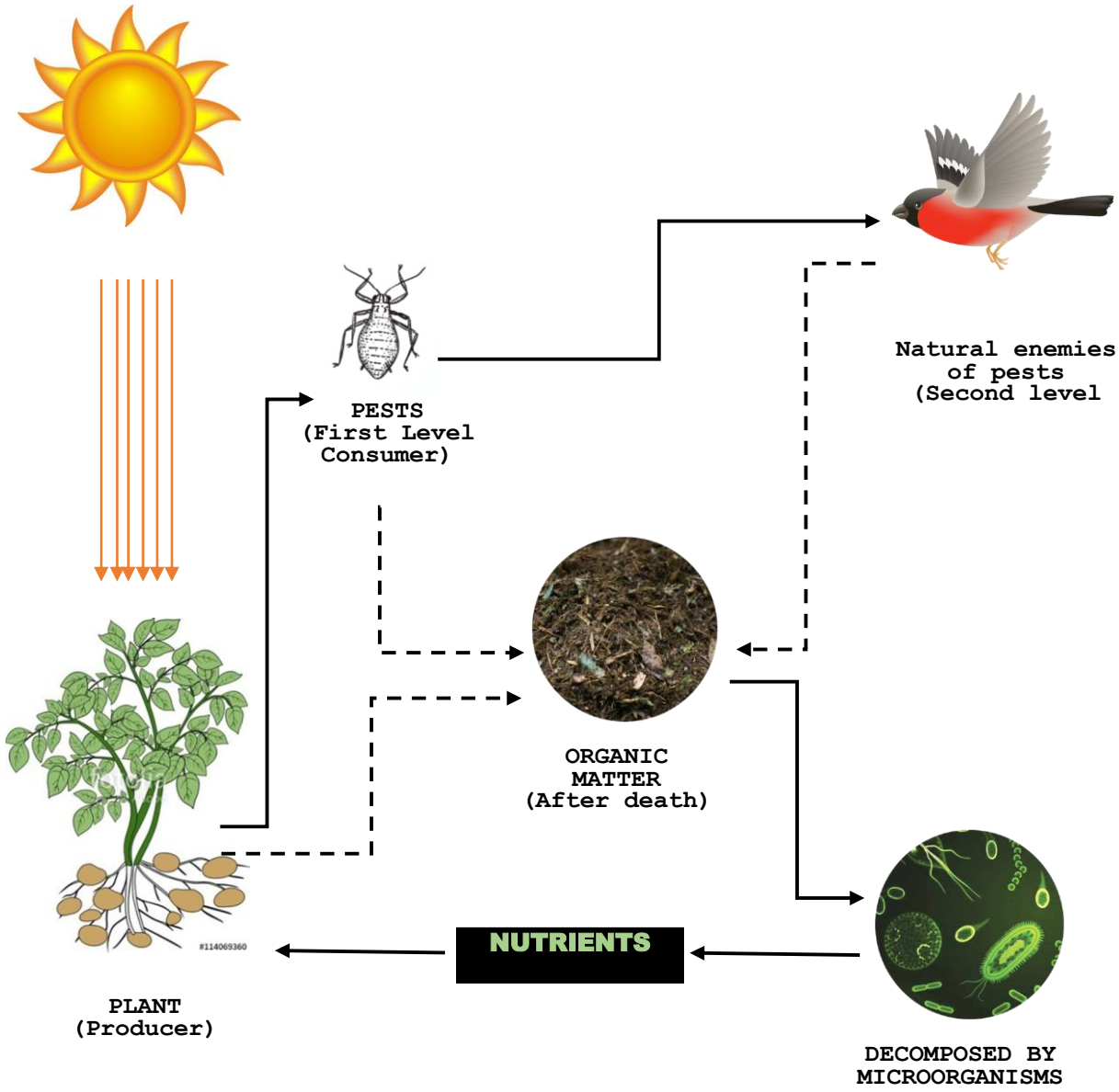

Figure 2: Components in Agro Eco System and interactions

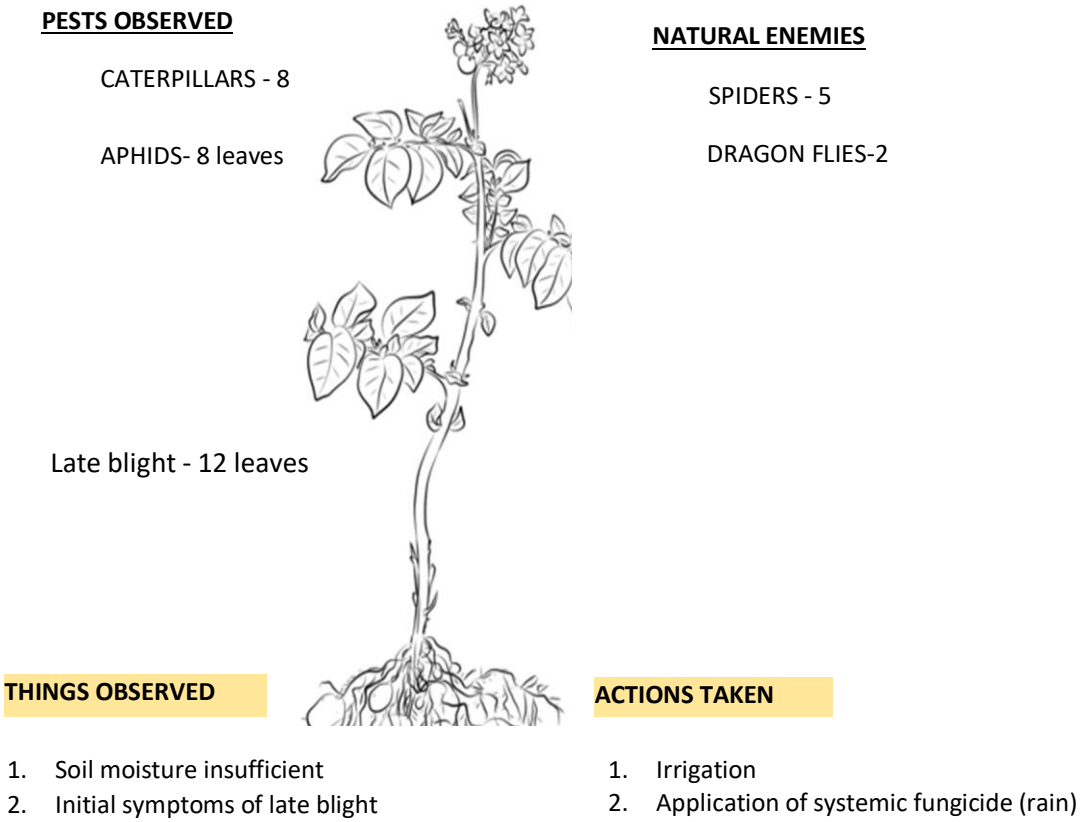

Figure 3: Sample AESA drawing

III. Topics and special topics of the session

Adults learn best through a learning-by-doing approach, where new knowledge is built upon past experience, but there is still basic technical information that is needed before hands-on activities can begin. Therefore, the "topic of the day" is used to introduce new information or to bring out the underlying basic science of the known information that is technical or requires specialized skill that they need about a subject before beginning an activity and to enhance the farmers' technical knowledge. When the topic of the day is any subject of concern to participants, it is referred to as a "special topic". If the facilitator lacks the specific expertise, he should invite an external specialist to lead the discussion.

In each FFS session one or more topics will be conducted. Usually these special topics are a response to a problem identified or anything that interested the farmers during the field observations in AESA that could affect the seed potato production. Facilitator prepares and discusses the special topic related to the issue. The special topics and sequence of the topics in this curriculum are given in PART II of this guide and an innovative and creative facilitator can develop more topics relevant to the farmer's needs. Therefore, it is suggested that more topics should be added to enrich this curriculum. It is preferred to allow the farmers to decide what topics are needed to be included in the session.

IV. Group Dynamics

In Farmer Field School (FFS) sessions facilitator will include a group dynamics exercise to help create a good atmosphere and develop a closer relationship and trust between farmers and facilitator that help strengthen group cohesion and enhance cooperation. There are many games and exercises that can be used to enhance group dynamics. Some group dynamics improve the capacity to learn and take decisions. The messages contained within the group dynamics comprise of effective communication, leadership mobilization, problem solving, planning ability, feeling free to experience, reflect and change and can be exercised as role play, brainstorming, case story, short drama, clapping, riddles etc.

The type and content of the dynamics will vary from group to group. It depends on the creativity and talents of members. Suitable innovation which contributes to sharing important learning experiences should be encouraged. Since many people enjoy this activity to relax, it is important to add messages that reflect FFS learning during this time. Group dynamics also help illiterate people to understand key learning experience and concepts. Below are examples of group dynamics that can be used for FFS:

Clapping:

"Clapping" is commonly used in FFS sessions to get the attention of the participants.

Role play on healthy seed potato production

This "Role Play on Healthy Seed potato production" will make FFS participants understand about the benefit of good seed and what would happen if someone is not aware of producing good seed. It is a role play by a group of participants (preferably 6) who pretend to be bad seeds and blame their bad qualities on the farmer who did not take proper measures during the production process.

Objectives

1. To create understanding on the importance of quality seed.
2. To learn about management practices which help producing quality seed.

Duration

- 20 minutes

Methodology

- Selects 6 participants from the group.
- Explain the role they have to act in the role play that is acted in the middle of the circle while the other participants sit in a circle and watch
- The role of the 1st participant is a depressed man wearing rags and pretends to be a man with broken legs. He will be crying and saying "I'm sick and my legs are broken, I can't bear this pain. Nobody cares for my pain. Please listen to my words of suffering" (then the 1st person disappears).
- The 2nd participant now appears, crying and says: "Look at my weak body. I was not given a proper shelter. The soil where I lived was poor and degraded. Now my body is deformed and useless" (then sits down weeping)

- The 3rd participant come to act with broken legs and says: “I could not get sufficient food because the farmers did not apply recommended fertilizer throughout the life cycle. Now I am sick as I am always stressed of the scarcity of food and water” (then sits down weeping).
- Then the 4th participant comes crying and says: “The farmer did not control weeds in the field. So those weeds took away a large portion of my food and now, I could not breathe and grow up properly” (then sits down weeping).
- The 5th participant shows up and says: “I will live not much longer. I’m infected by disease because the farmer did not protect me. See, these holes in my body have developed due to insect infestation. Oh! Oh!” (then sits down weeping)
- Next, the 6th participant appears, saying: “My body is filled with water. During storage, I became exposed to insects and diseases. You see my rotten body, oh! What a bad smell. I’ll die very soon.” (will sit down weeping)
- The first participant comes to the role again, saying “now you have listened to my painful story. Actually I am a seed and all those bad things happened to me. I would not be able to give you a good result if you don’t put extra effort to make me healthy, like selecting a good land, good fertilization, water management, weed control and pest management. You cannot hope for that. If you think so you are just wasting your money.
- Finally facilitator comes in and leads a short discussion on healthy seeds.

Some guidelines for discussion

1. What happened to the 2nd, 3rd, 4th, 5th and 6th seed and why?
2. What messages did we get from the 1st person during his last visit?
3. What have we learnt from this role play?
4. Why do we have to take extra care for our seeds?

Brainstorming:

Either in small groups or as a big group, give participants an issue or problem to discuss about and deliberate on exhaustively. Accept all ideas during the discussion. After a thorough deliberation on the issue or problem, the entire group comes up with a consensus as a final output.

Objectives: This method is suitable when tackling issues and problems that need or call for group decision-making. It is particularly helpful when participants are expected to actively join in the deliberation and share their ideas, experiences as well as knowledge about the issue on hand. A group of not less than five and not more than ten members should give the best results.

V. Evaluation of the group session and next session planning

At the end of each group session following steps should be carried out.

- Discuss with the participants to review the main issues covered by the FFS including the main recommendations.
- Discuss what went well and where improvements or adjustments can be made (these views should be incorporated in next session planning).
- Select a special topic for the following session.
- Decide the materials and other requirements for the next session and hand over the responsibility to the host team of following session.
- Confirm the date and time of the subsequent meeting.

5. Using ICT to facilitate FFS activities

Information and Communication Issues are much less in the use of digital world than the physical world and to meet the communication requirement of the target audience, efficient ICT applications and tools must be selected and used, to achieve desired objectives and effective communication. Controlling the spread of COVID-19 virus is challenging when carrying out the learning process physically while maintaining social distance. Minimizing face-to-face encounters with individuals or groups will minimize the spread of the virus, and the fact that such communication applications can be used effectively during isolation and quarantine situations will help to protect the public by preventing exposure to people who have or may have a contagious disease.

Among information and communication technologies, web and mobile communication technologies are widely used in data and information transmission. Social networking sites such as WhatsApp, Viber, Imo and Facebook are some of the popular mobile applications and these software applications have made the information and communication platform easy and efficient among different stakeholders allowing two-way communication. Easy installation and use of these software applications on Internet-enabled mobile devices like laptop computers, tablets, smartphones, smart watches, etc. and at present where the mobile phone has become a basic necessity for the daily needs of human beings, the subject of information technology has achieved a revolutionary advancement with the availability of such two-way communication platforms.

WhatsApp is a messaging app that lets users to text, chat, and share media, including voice messages and video, with individuals or groups. WhatsApp groups should be developed according to the objectives and the communication needs of the Farm Field Schools. To strengthen the communication needs further and to support monitoring and evaluation while maintaining social distance Face book social networking site is used which is popular and free. Face Book allows registered users to create profiles, upload photos and videos, send messages and keep in touch with friends, family and colleagues allowing them to share their thoughts, ideas and experiences and anyone with a phone number or email address can join Facebook. Unlike email or instant messaging, which are relatively private, information shared on Facebook are more public, which means they'll usually be seen by many other people. To implement activities of the Farmer Field Schools under pandemic conditions like Covid-19, Information communication mechanism using WhatsApp and Facebook is developed (Appendix 6).

6. Promoting FFS activities

In communities where FFS is new, it is vital to make a clear impression about FFS and show the community members what they can expect in FFS sessions by giving them some FFS experience by carrying out exchange visits and/or field days. This will promote the new technologies demonstrated in the host farm among other farmers in the community who did not participate and will encourage and motivate them to follow these practices

I. Field Day

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

- Venue: At the FFS site where most of the activities were done.
- Date: Determined by farmers, but at a time preferably during harvesting of seed potato.
- Time: Within FFS period.

II. Exchange Visits

An exchange visit is an important part of the FFS. The purpose is to build up relationship with other FFS groups and to know their activities and performances. This also provide opportunity for members to compare themselves with the host FFS, exchange ideas, techniques and methodologies, achievements and constraints between FFS groups leading farmers to think in new ways.

III. Field Study

Farmers are doing science without realizing it. When they see or receive new technologies, (ex- neighbors getting higher yields) they start thinking and collecting information. Next they test it in a part of the field, do observations, gather data like growth, pest and diseases, yield, etc. and compare with the past experiences. Depending on the results they accept or reject the new technology. In other words this is a simple scientific method of field study.

Farmer studies are location specific experiments where farmers can compare new ideas, new technologies and new products and this is the best way to encourage farmers to improve their skills in designing and conducting experiments to accept new technological developments. See Appendix 7 for facilitating farmer participatory field study on fertilizer application for potato. Following are some examples of experiments that can be conducted in Potato IPM FFS:

- Granulosis virus against potato tuber moth
- Natural enemies of leaf miner flies
- Examining the qualities of soil and organic fertilizer
- Selective fungicide use for late blight control
- Latent infection of bacterial wilt

7. Monitoring and Evaluation (ME) in FFS

Monitoring in FFS is the process of collecting and analyzing information to track the extent to which the implementation and performance of FFS activities is being carried out according to the objectives. Monitoring begins with the implementation of the programme and continues throughout the programme implementation period systematically involving all stakeholders. The aims are to improve efficiency and overall effectiveness of the project, keep the FFS learning on track in achieving its outcomes successfully, to guide management decisions and adjust to situations that could arise on the way.

Evaluation in FFS is assessing the overall results and performance of the programme. Evaluation focuses on expected and achieved accomplishments, examining the results chain (inputs, activities, outputs, outcomes and impacts).The aims of evaluation are determining the relevance of the activities, promoting the adoption of the activities implemented and identifying the strengths and weaknesses of the learning approaches / methodologies used. In particular, the evaluation should identify whether or not the learning process has led the participants to gain the intended knowledge, attitudes and skills related to their training. It can be conducted at the end of an FFS session, or mid-way, or at the end of an FFS programme. The data collected for the evaluation of the FFS will lead to taking proper decisions on the future improvement of the quality of subsequent learning cycles.

In the FFS, ME should be participatory, engaging and allowing all actively involved programme stakeholders, specially farmer participants and the programme team, to analyse and reflect critically on their experiences, and plan for future goals and activities. A participatory approach in ME will increase the efficiency of the programme and strengthen the FFS learning process by giving the participants a sense of ownership and responsibility when conducting the project. Since the primary functioning group is the FFS in this programme, facilitators and farmers are the main implementers of ME (FFS group level). They have the primary responsibility for monitoring and evaluating the farmers' and facilitators' performance throughout the FFS learning season.

The second ME Team comprise of the master trainers and programme managers (project level) who provide backstopping support to facilitators, help strengthen their capacity the and monitor and evaluate their performance.

The ME plan should be developed with project stakeholders and needs to be carried out at all stages of the FFS cycle. Indicators are used to assess project performance and achievement and can be quantitative, (number of people, number of ha, % of adoption), or qualitative (perceptions, opinions, categories).

The monitoring plan can be presented in a monitoring matrix based on the indicators. The monitoring plan will include guidance on what to monitor, how to monitor, who should do the monitoring, where will the monitoring take place and when and how often indicators will be monitored in relation to the FFS cycle.

Some key indicators of successful FFS

FFS group

- Ideal membership is 20-30
- Clear objectives and goals of the group

- Availability of activity plan and implementation
- Well planned daily timetable

Facilitator

- trained in FFS methodology by qualified FFS master trainer
- Trained in facilitation and participation skills
- Facilitator must be available and accessible for the farmers
- Peer to peer interaction and with good attitude towards farmers opinion
- Creative and innovative
- Technically capable
- Resourceful
- Accountable to farmers

Group management

- Good leadership
- Good time keeping
- Attendance (70-80%) minimum by all members
- Good attendance during each session
- Learning and group norms-available and strictly followed
- Equal treatment of women within the group
- Transparency in financial management and decision-making
- Time table of sessions being followed
- All members understand group rules

Conducting sessions

- Should have a learning site including field trials
- Demand driven topic choice
- Agro-ecosystem analysis (AESA) carried out regularly
- Curriculum agreed on by farmers based on their preferences
- Farmer confidence
- Farmer ownership of process and participation in decision making
- Able to seek and share information (within and outside group)
- Farmer understanding FFS concepts and technical issues
- Active, motivated and confident members
- Active participation by all FFS members
- Sense of innovativeness
- Well informed decision making capacity

Maintaining documents

- Good documentation of planned activities
- Membership records
- Enterprise records well-kept

- Attendance-records/register well kept
- Monitoring and evaluation-documented
- Minutes/records of each session well kept
- Using documented observations and results for decision-making
- Adoption and adaptation of improved practices by members

The main motivation for farmers to join FFS is the possibility of obtaining new knowledge on farming practices and technology, based on the desire to increase production and, potentially, cash income. Pre evaluation is done at the beginning of the Farmer Field School where farmers' understanding of important aspects of cultivation and the knowledge level is evaluated. It is not really a test of farmers' knowledge, but a way of identifying gaps in their knowledge to prepare them for what they expect to learn in future Farm Field Schools.

Post evaluation is done to assess the changes in knowledge and attitudes of farmers after participating in the FFS program. Post evaluation helps farmers to identify successful farming practices used for FFS and participatory approach leads to share these findings among them.

Participatory Evaluation methods, such as the ballot box method could be used for pre and post evaluation. Questions similar to those asked in the pre-evaluation could be used with the same level of difficulty during the post evaluation.

Ballot Box system

The ballot box is a non-threatening method used for pre and post evaluations of knowledge and skill in FFS. This is an out of the ordinary system and gives a novel experience to the farmers.

A ballot box test typically consists of 15-20 questions depending on the number of participants. In this method, questions, prepared with much thought to reveal the conflict in the farmers mind, are asked using live or preserved samples (not by using pictures). The questions are written in large letters. Each question has three answers with ballot box / pockets below each answer.

Farmers choose their answer by voting with a piece of paper which is put in to the ballot box. The piece of paper may have a farmer's name or number on the attendance sheet to identify and asses the individual’s knowledge, but not necessarily. Here individual farmers are not checked and only the number of farmers who know the answers is determined. Participants do not need to know how to write or read to be able to participate in the activity. In cases where some participants cannot read, facilitators must make it a point to walk with those concerned and assist them by reading out the questions to them. Appropriate topics should be discussed, depending on the results of the test. A sample question paper for ballot box test is given in Appendix 4.

PART- II: Special Topics for Seed Potato Production FFS

TOPIC 01: Understanding the potato plant

Potato (*Solanum tuberosum*) is thought to have originated in the Peruvian region of the Andes in North America. It is estimated to have been grown in these areas for about 4,000 years. Europeans spread the crop around the world making potato one of the world's most grown crops. It is the 4th largest food crop cultivated in the world.

Potato is a perennial crop with stem, leaves and roots, flowering in the stem apex and producing seeds in the fruit. The buds in the base of the stem that grow into the ground are called stolon. Food accumulation takes place at the end of a stolon, producing potato tubers. Therefore, the potato tuber is known as a modified stem.

Plants are mainly propagated from these tubers, and can be propagated by true seeds as well. Understanding of the growth stages of the plant is important for proper crop management and for obtaining high yields.

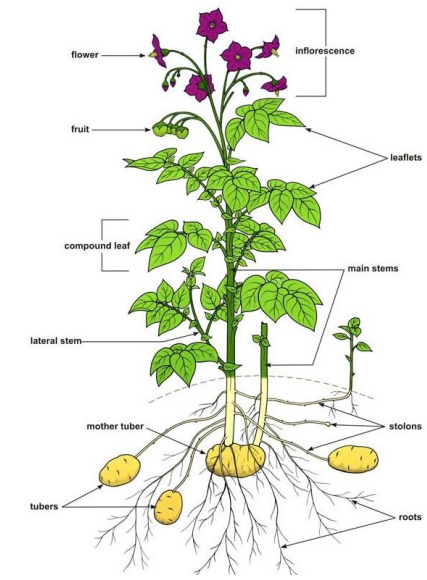

Figure 4: Potato Plant

1.1. The growth stages of the potato plant

Although it is difficult to distinguish the different growth stages of the potato plant, there are several stages of growth. Knowledge on growth stages will help for proper crop maintenance and better yield.

1.2. Growing of buds (sprouting)

Potato sprouts do not grow immediately after harvesting. There is nearly a three months dormancy period and the apical bud in the tuber, begins to grow at the end of the dormancy period. Sprouting begins quickly at higher temperatures, and lateral buds (these are called as eyes) begin to grow fast when the apical bud is removed. These sprouting tubers must be stored under appropriate environmental conditions for better bud growth. After planting the buds emerge from the soil in about 14-21 days, and during this time the food stored in the tuber is used for plant growth.

1.3. Vegetative growth stage

During this stage, the stem, leaf and roots of the plant are formed. Once roots are developed, necessary nutrients are obtained from the soil. In most cultivated varieties in Sri Lanka, the duration of vegetative growth stage is 30-50 days.

1.4. Tuber initiation stage

In 30-50 days after the vegetative growth of the plant, growth of the white color stolon starts. Effective stolon growth takes place in about 10-15 days from initiation. At this stage, the plant grows rapidly, requiring adequate nutrients and adequate water.

1.5. Tuber enlargement stage

During this period, the growth of the plant slows down, food accumulation and enlargement in tubers occur. It is important to have plenty of sunlight and high temperature (28^0C) in day time and a low temperature (14^0C) at night. Nutrients and water should be provided in sufficient quantities at this stage.

1.6. Tuber maturation stage

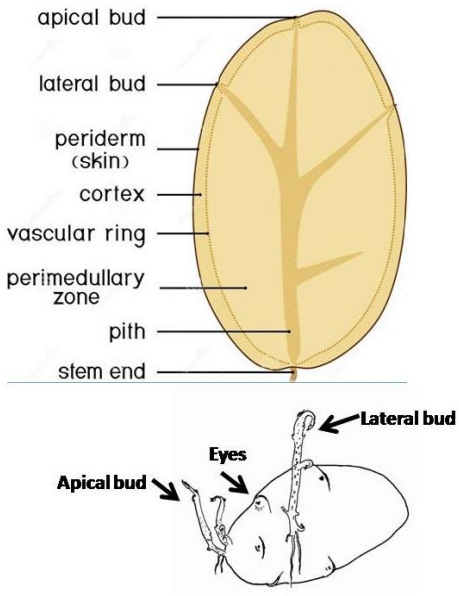

Figure 5: Potato tuber and its longitudinal section

Time taken for tuber maturation depends on verity. When the leaves of the plant mature and turn yellow, and the starch buildup in tubers has increased the bark of the tubers becomes stiff. Therefore enough potassium fertilizer must be available to the plant. When the leaves turn yellow, irrigation should be stopped and tubers are mature enough for harvesting in 10-14 days.

Potato tubers are modified stems, so the buds (eyes) can be seen. These eyes are the lateral buds that grow as stems of the plant. Roots originate at the eyes and therefore have a fibrous root system with no tap root. Roots that develop from potato tubers are weak and do not penetrate deep into the soil.

Understanding the potato plant and tuber

All parts of plant have specific functions. Roots absorb water and nutrients while anchoring the plant to soil. Leaves produce food using water and energy from the sun. Stems distribute water, nutrients and food produced in leaves to other parts of the plant.

Farmers should know the functions of each part of the plant, to adopt necessary management practices to increase yields.

EXERCISE 1:

Materials -

- A few fully grown potato plants having all parts of the plant
- Poster papers, crayons, pencils, erasers, pointed marker pens

Steps

- Explain the objectives of the exercise
- Divide the whole FFS group into sub groups of 5-6 farmers
- Instruct the team to uproot potato plants from farmer field carefully, without damaging any parts (if plants are not available in the field, facilitator should provide a plant)
- Ask farmers to draw a picture of the potato plant on a poster paper and discuss and write about the functions of each part of the plant (complete table 1)

By the end of this exercise, farmers should be able to identify the structure and function of each part of the plant and tuber and understand how to maximize the function of each part to increase the yield

- Instruct farmers to explain the role of each part of a potato tuber and cut a longitudinal (from apical bud to stem end) section and draw a picture
- Present one of the drawings to the whole group and discuss

Notes for the facilitator

Draw an empty table with headings and ask farmers to complete the table as follows:

Table 2: Function of each part of potato plant

Plant part	Function	Points to emphasize
leaves	Food production	*Requires sunlight and water. *Select lands with good sunlight and irrigation facilities
Roots	Absorb nutrients and water and anchor the plant in the soil	Proper land preparation should be done to ensure growth of healthy root system
Stem	Bare branches and leaves. Distribute water and nutrients all over the plant.	* Ensure plants health by managing water, soil and nutrients
Stolon	Produce tubers for propagation.	
Tubers	Food accumulation and planting material.	

Discuss by asking following questions from farmers to aware about correct practices

Question	Answer
▪ How to get more leaves, stems and stolons from a plant	Removing apical bud at planting will remove the apical dominancy and stimulate lateral buds to grow producing more stems, more leaves and more stolons
▪ How to get more food production	remove shade, proper management practices such as fertilization and irrigation
▪ How to get good root system	Proper land preparation to get soft soil, improve drainage
▪ How to get more healthy seed tubers	Use recommended plant spacing to reduce big tuber formation, earthing up to protect from tuber moth, fertilization and irrigation on time

Topic 02: Sustainable Land Management (SLM)

Sustainable land management refers to the use of land resources, including soil, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions. Sustainable soil and land management interventions should be suited to the specific biophysical and socio-economic conditions in a given area and could be practiced by farmers and other land users.

SLM includes practices to:

- control soil erosion
- increase soil-water storage
- manage and improve soil fertility;
- prevent and reduce land degradation and restore degraded soils
- increase soil organic matter

A major factor responsible for causing soil degradation is soil erosion. Soil erosion reduces the ecological functions of soil: mainly biomass production, crop yields due to removal of nutrients for plant growth, the loss of plant nutrients and organic matter via eroded sediment reduces the fertility and productivity of the soil. This leads to a vicious cycle whereby farmers apply more fertilizers to compensate for the loss of fertility. Sustainable soil and land management practices provide options to manage soil, water, and plants, and their interactions under a specific set of biophysical and socio-economic conditions.

The interaction between the different components of land resources determines the productivity and sustainability of any land-use system. Land productivity depends directly on soil productivity and health. Healthy soils provide plants with the support and nutrients they need to grow and provide the foundation for agricultural production systems.

EXERCISE 1: Soil erosion in potato cultivation

Cultivation of potato crop leads to high soil degradation and erosion since it involves intensive soil tillage throughout the cropping period. Many farmers cultivating potato crop do not pay much attention to soil conservation. Even though, soil formation takes thousands of years, it takes very little time to wash away or erode from field. There are various methods to control soil erosion, but some of these methods cannot be used in potato cultivation. Therefore farmer should know the suitable soil conservation methods to apply in potato cultivation.

At the end of this exercise farmers should be able to understand that loose soil will wash away quickly and understand suitable methods to control soil erosion in potato cultivation.

Materials: 3 empty plastic water bottles (1.5 liter) per group, about 1 kg of loose soil obtained from land prepared for potato cultivation, soil with grass obtained from a land naturally covered by grass (sod), straw or dried grass as mulch, demy papers, marker pens.

Time: 45 minutes

Steps:

- Explain the objectives of the exercise.
- Divide the whole group into sub groups of 5-6 farmers.
- Instruct the farmers to do the following experiment
    - Cut three plastic bottles horizontally and use the bigger part.
    - Put soil samples in to the cut plastic bottle as follows
        1. Loose soil
        2. Loose soil and spread straw or dried grass as mulch on top of the soil
        3. Sod
    - Set the plastic bottles slightly slanted and keep three transparent jars beneath to catch the water.
    - Add same amount (500 ml each) of water to the bottles using a watering can and observe the difference in the color of the water collected in the jars (**figure 6)**.
- Invite small groups to discuss soil erosion on their land and list possible measures to prevent it.
- Instruct each sub group to write down and presents to the whole group.
- Discuss with the whole group.

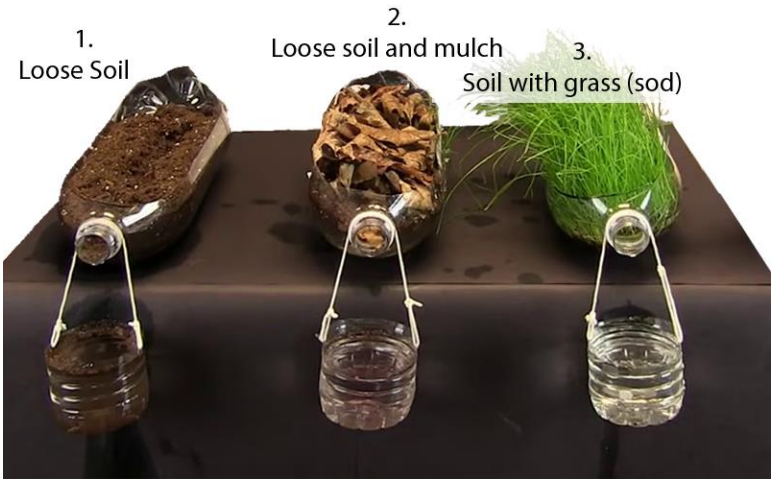

Figure 6: Testing for soil erosion

Notes for the facilitator

- What is soil erosion?
- How to minimize soil erosion when preparing land for cultivation?
- Is mulching in potato cultivation to control soil erosion advisable?
- What methods can be used for soil conservation on sloping lands to cultivate potato?
- Discuss advantages and disadvantages of different soil conservation methods and their applicability in potato cultivation.

EXERCISE 2: Understanding soil composition and water retention capacity

Land degradation causes a decrease in the potential of the soil productivity directly affecting the food security. Physical, chemical and biological factors cause soil degradation. Physical factors such as rainfall, flooding and loosening of the soil due to land preparation cause soil erosion and soil structure changes due to compaction at various places in the field. Soil degradation can be caused by chemical factors such as acidity, salinity, decreased cation retention and reduced soil nutrients, as well as biological factors such as depletion of soil organic matter and loss of soil biodiversity. The typical soil suitable for potato cultivation should contain sand, loam and silt in a ratio of 25:25:50 respectively.

At the end of this exercise, farmers should be able to understand that soil erosion reduces the potential of soil productivity and the methods to correct it.

Materials: 5 Transparent empty plastic water bottles (750 ml) per group, soil samples taken from various locations on the farm (e.g. from uncovered slopes, beds prepared for potato cultivation, thick grass cover etc.), 25 liter of water, permanent marker pens, notebooks and pens, plastic buckets, gloves, polythene bags, a bottle of artificial vinegar

Part 1 - Identifying the soil composition

Steps

- Explain the objectives of the exercise.
- Divide the whole group into sub groups of 5-6 farmers.
- Instruct the farmers to do the following experiment
    - Collect a small amount of soil (about 100 g) in bags from different places in the field and to label the appearance of vegetation from where the sample is obtained.
    - Place crushed soil samples in separate bottles until the bottle is half full.
    - Add enough water only to dissolve the soil.
    - Add a teaspoon of vinegar to each bottle.
    - Close the bottle, shake well to dissolve the soil and keep on the table.
    - Mark the soil level with a permanent marker pen deposited in 40 seconds. This is the amount of sand in the soil.
    - Mark the amount deposited again after 6 hours. The added deposit is the amount of silt in the soil sample.
    - Again mark the amount deposited after 01 day. This added deposit is the amount of clay in the soil.
    - The percentage of sand, silt and clay can be calculated by dividing each height from the total height and multiplying by 100.
- Enter the results in the table below.

Part 2- Understand the amount of water retained in the soil

Materials: 03 funnels and 03 empty plastic water bottles (1.5 liter) per group,

Steps

- Use the rest of the soil samples used in the above exercise.
- Cut the empty water bottles horizontally.
- Place the funnel or top part of the bottle turned upside down over the bottom part of the bottle and place filter paper or cloth in it.
- Put about 50g of soil on top of it.
- Add 50 ml of water to the soil in the funnel as shown in the **figure 7**.
- Measure the amount of filtered water in each soil sample after the water leakage from the funnel has stopped.

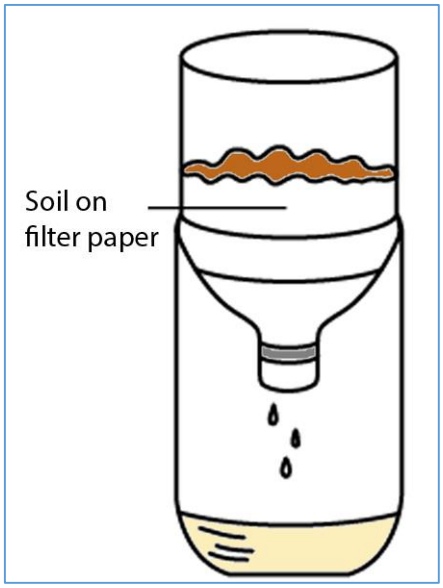

Figure 7: Testing for soil water retention

- Enter the results in the table below.

Place	1	2	3	4	5
% of Sand					
% of Silt					
% of Clay					
Amount of water drained out (ml)					
The amount of water retained (ml = 50ml - ml of water drained out)					
Appearance of vegetation at the place where soil samples were taken					

Notes for the facilitator

- Can the reasons for the change of soil composition from place to place be identified?
- Does water retention vary according to the soil composition?
- Which composition of soil retains maximum water?
- What are the methods to correct the soil composition?
- How to prevent soil erosion?
- What steps can be taken to protect the physical, biological, and chemical properties of the soil? (reducing soil erosion, fertilizer management, adding organic matter etc.)

TOPIC 03: Selection of suitable land for seed potato production

Factors affecting the quality of seed potato such as soil health, sunshine, drainage, irrigation, previous crops, water flow from other lands, etc. should be considered when selecting a suitable land for seed potato production.

EXERCISE 1: Criteria to be considered when selecting lands for seed potato production

High-quality healthy seeds are required for the production of seed potato than for the production of consumption potato. Number of factors should be considered when selecting a suitable land for quality seed potato cultivation. 'Selecting a suitable land is half the battle won'.

Materials

Notebooks, poster papers, marker pens.

Time

30 minutes for the exercise and 10 minutes for facilitator guided discussion.

Steps

- Explain the objectives of the exercise.
- Divide the whole group into sub groups of 5-6 farmers.
- Ask sub groups to discuss and note down the characteristics of a suitable land for producing seed potatoes.
- Instruct them to write the characteristics in big letters on the poster paper to make it clearly visible to the whole group.
- Present each drawing to the whole group and discuss.
- Facilitator may add more information if necessary.

At the end of this exercise, farmer should be able to reason out what type of land is suitable for seed potato production

Notes for facilitator

Factors to be emphasized

- **Previously cultivated crop**

Solanaceae family crops such as potato, brinjal, chili, capsicum and tomatoes are susceptible to similar pest and diseases. Cucurbitaceae family crops are susceptible to bacterial wilt caused by Ralstonia solanacearum which is a serious threat to potato. If these crops are cultivated in the same field in earlier seasons, the seed potato crop can be infected through contaminated soil and there is a possibility of spreading those diseases to other fields through seed tubers. In cases where such lands are difficult to find, it is advisable to select land with minimum infection of soil borne diseases in previous seasons.

- **Availability of irrigation facilities**

Potato needs adequate water for good growth and therefore, it is advisable to provide enough irrigation facilities specially during Yala (dry) season.

- **Minimum soil erosion**

Since soil is loosened several times in potato cultivation, potato is recognized as a high soil erosive crop. In this case, land where the slope is greater than 60% (without terraces) should not be selected for potato cultivation. Proper soil conservation methods should be adopted to prevent soil erosion in potato cultivation. At the time of land preparation and other crop management practices like weeding, fertilization and earthing-up, arrangements should be made to minimize soil erosion.

- **Good soil structure, texture, color and depth**

Soil depth, structure and texture are important soil physical properties. Sandy loam soils that extend up to at least 60 cm depth is highly suitable for potato cultivation since drainage and nutrient retention are efficient in these soils. Farmers can improve water and nutrient retention by adding organic matter into the soil which also provides micro nutrients to the potato plants.

Table 3: Brief description and importance of soil physical properties

Soil property	Importance	Ideal
Soil depth	Potato tubers develop in soil. Better penetration of stolon and spread of fibrous roots depend on soil depth. More roots mean more water and more nutrients for the plants.	Higher than 60 cm
Soil structure	Water movement in soil depends on shape and size of the soil clods. Soil structure can be changed due to farm operations like irrigation, land preparation etc.	
Soil texture	Percentage of silt, sand and clay determine the texture of soil. Texture effect on aeration, water retention and nutrient retention, as well as root growth.	Sandy loam (locally known as light soil)
Drainage	Important to maintain moisture and air in the soil.	Around 50% of water and 50% air.
Soil color	By observing soil color, we can get an idea of drainage, aeration and porosity of soil.	without dull yellow and blue mottles

- **Good sunlight**

Potato plant should receive good sunlight during daytime for proper growth and tuber formation. Potatoes grown in shady conditions are more prone to diseases and pests.

- **Upland with good drainage**

Paddy fields should not be selected for the production of potato seed tubers as paddy fields are poorly drained and increase water content in potato tubers. Breaking down of dormancy and spoiling of tubers result due to excess water in tubers. Therefore, only highlands with good drainage and irrigation facilities should be selected for seed tuber production. In Badulla district, consumption potatoes are commonly cultivated in paddy fields (lowlands), especially during the Yala (Dry) season.

- **Water flowing into the field from outside**

Most diseases of potato are spread by contaminated soil and water. Pathogens can be present in the water coming from lands cultivated with other Solanaceous crops, so the selected land must be protected from water moving through such fields.

EXERCISE 2: Understanding the soil depth in the fields

Potato plants that emerge from tubers have a fibrous root system which are weak and cannot penetrate hard soil. Loose soils facilitate easy penetration of stolon into the soil. Soil depth plays an important role to facilitate plants to develop healthy and well spread root system.

At the end of this exercise, farmers will develop the skill of measuring soil depth of their lands in a simple manner and understand how importance of soil depth in potato cultivation.

Materials

- Notebooks, poster papers, marker pens.

Time

- 30 minutes.

Steps

- Explain the objective of the exercise
- Visit a nearby fallow field with the group when the field is wet
- Ask them to uproot a small soft weed plant with a taproot (Themberia or Hulangthala-local names)
- Observe the shape and length of the tap root

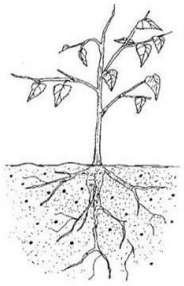

Figure 9: Well-developed root system in light soil

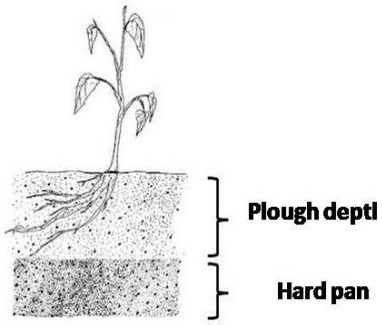

Figure 8: Root bending as a result of low plough depth

- If the taproot is bent as in figure 4, measure its length from the soil surface to bending point.

- Dig the soil up to above length, using a hoe and see/feel the soil compaction
- Draw growing pattern of root on a poster paper
- Discuss how to improve soil depth during land preparation to provide better soil environment for root growth.

EXERCISE 3: Understanding the soil texture

Soil texture depends on percentages of sand, silt and clay in a soil. Soil texture effects many characteristics of soil such as water and nutrient holding capacity, air movement, compaction etc. Sandy soil holds more air but low water and nutrients while clay soils do the reverse. The best soil for potato cultivation is a loamy texture with 40-50% air space (volume basis).

At the end of this exercise, farmers will know how to identify soil texture in their own lands as well as ways to improve it as a good agriculture soil.

Materials

- Three dry soil samples collected from different places like a paddy field, upland (try to find good loamy soil), and a farmer's own land, water, a piece of flat wood (40x40 cm).

Time

- 45 minutes.

Steps

For one soil sample:

- Explain the objectives of the exercise
- Take 25-30g soil (size of a small lime fruit) to your hand.
- Add water little by little and mix properly to form a small ball
- Squeeze it and release the soil ball
- If it loosens it contains more sand and if it forms a ball it contains more clay. If so, follow step in figure 5
- Try to feel texture by rubbing soil with a drop of water in between thumb and forefinger
- Follow the same procedure for all three samples
- Discuss how they can improve different soils, to have a healthy crop.

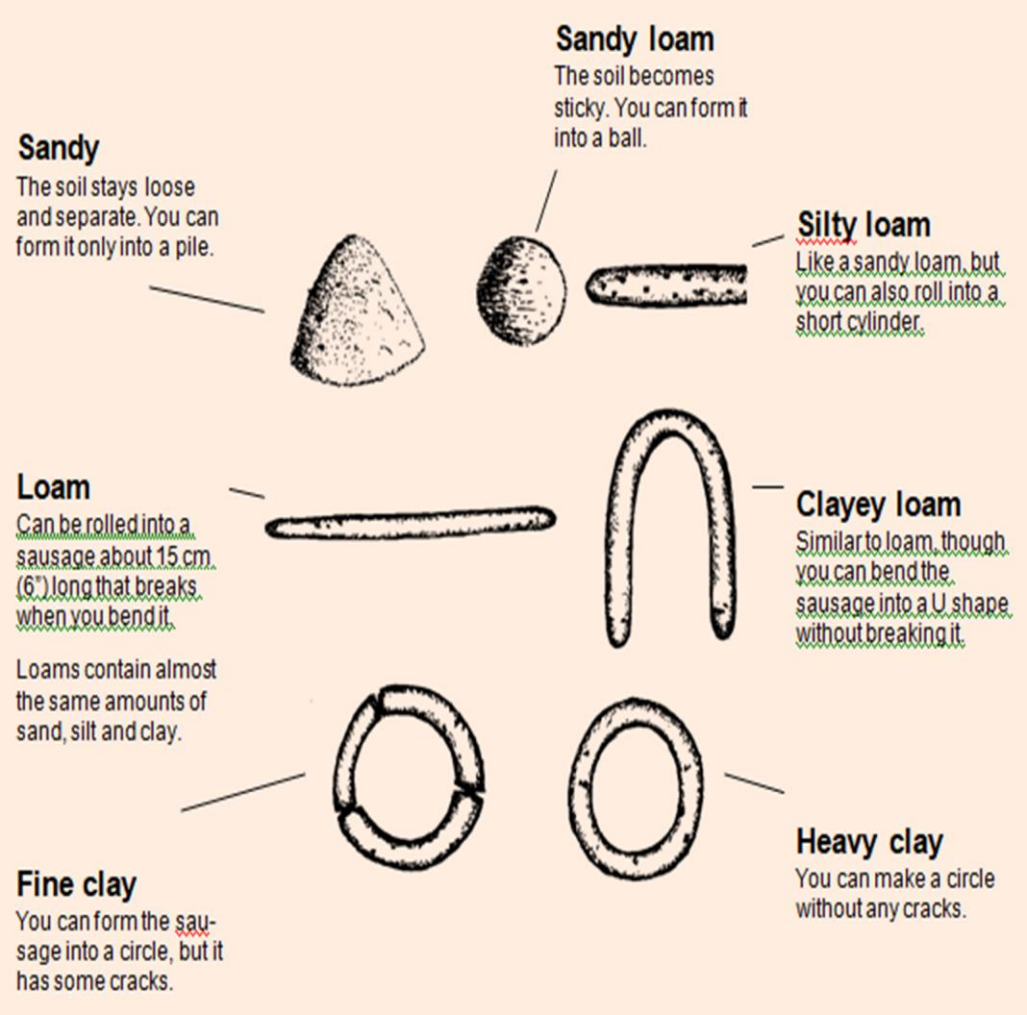

Figure 10: Identification of soil texture

Source: Agricultural compendium for rural development in the tropics and subtropics

EXERCISE 4: Understanding soil color and related soil characters

Most farmers use soil color to determine organic matter content in the soil. If it is dark, farmers think it contains more organic matter but that is not always true. The top soil layer in uplands is black or dark in color and can contain more organic matter. However, its lower layers are not rich in organic matter.

At the end of this exercise farmers should be capable of judging their soil color and related soil characteristics

Materials

- Dry soil samples from upland, paddy field, top soil, sub soil and soil with poor drainage.
- Poster papers, markers.

Time

- 45 minutes.

Steps

- Explain the objective of the exercise
- Make sub groups of 5- 6 farmers
- If time permits, go to the field and collect soil samples from different places like upland, paddy fields, top of the slope and downhill, at different depths or can use samples collected previously
- Eye estimate the color of different samples. Fill the following table in a big paper, as a group exercise

Table 4: Identification of soil color

Color	Personal experiences related to color (organic matter, water holding capacity, appearance of crop, root growth, erosion, etc)

Notes for the facilitator

Table 5: Soil color related conditions

Eye estimated soil color	Soil condition	Suitability for potato seed production
Dark	Good drainage and high organic matter. Good texture and structure. Good water and nutrient holding capacity	Good
Reddish brown or orange	Aeration, drainage and water movement is good and, usually rich in nutrients. But some acidity problems can be there	Good
Dull yellow and blue mottles	Water table fluctuates up and down. Poor drainage and aeration, especially, in rainy seasons	Not good
Gray	Poor drainage and aeration	Not good.

Source: Discovery Based Learning in land and water management FAO

EXERCISE 5: Collecting soil sample for pH and nutrient testing

By the end of this exercise, farmers should know how to collect, dry and pack a soil sample correctly for laboratory analysis.

The pH value between 5-5.5 is most suitable for potato cultivation and maintaining this value can maximize the efficiency of fertilizer and suppress soil borne diseases up to some level. If soil pH is below 5, lime should be added two weeks before planting to rectify the soil pH. The amount of nutrients in the soil can vary from place to place, and the yield can be increased by testing soil nutrients and providing the required dose of fertilizer.

Soil testing is an essential part of soil resource management. Each sample collected should properly represent the land that is being tested. Since results from the laboratory analysis depend on the accuracy

of the sample taken, it is advisable to collect a greater number of samples to get the final sample which will give a better representation of the whole field.

Materials

- Soil auger or mamoty, hoe, plastic buckets or polythene bags, labels, pencils.

Time

- 45 minutes.

Steps

- Explain the objectives of the exercise
- Divide the field into homogeneous units based on visual observations and farmer's experience
- Remove surface debris, if present
- Insert the auger to a depth of 15 cm and draw the soil sample.
- If auger is not available dig a V-shaped hole, about 15 cm deep (fig 10)
- Cut a ½ - 1 inch thick slice from the top of the exposed face of the V shaped hole up to the bottom
- Collect at least 10 to 15 samples from the field and put in a bucket or tray.

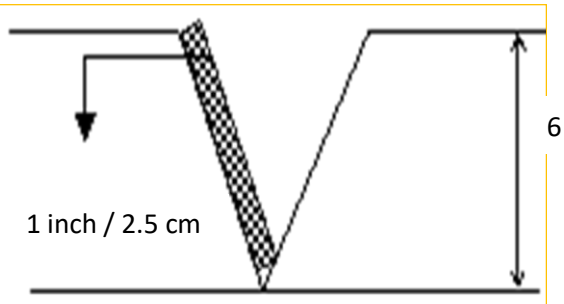

Figure 11: Collecting soil sample

After collection

- Mix the samples thoroughly and remove other materials such as plant roots, pebbles and gravel, etc.
- Dry in the shade
- Break soil clods and sieve through 2 mm net
- Reduce to half a kilogram
- Place the sample in a clean double polythene bag.
- Label the bag with information such as date of collection, name of the farmer, farm location, sample number, cultivated crops in previous two seasons, crop to be grown in next season, and the name of the sample collector.

Notes to the facilitator

In general, collect at least 10 samples from different places in the field with uniform conditions. Mix well, dry and take one kg of sample for every two hectares of land and send it to the laboratory. It is recommended to collect 10 samples from 1000 m^2 of seed potato field following the zigzag method.

Consider the following before starting

- Collect samples during fallow period (no crops)
- Follow zig-zag pattern for better representation of the land
- Divide land based on slope, soil color, drainage, previous fertilizer use, lime or gypsum application, etc. and take samples separately
- Do not take samples from dried irrigation canals or close to the compost pits
- Go for 15 cm depth for crops with shallow root systems as shown in fig 10.
- Collect samples always with farmer because the farmer knows the history of the field.

Methods used to reduce the sample

I. Quartering

Spread the sample evenly and divide it into four equal parts. Remove two diagonal parts and the remaining two are mixed and the process is repeated until the desired sample weight is obtained.

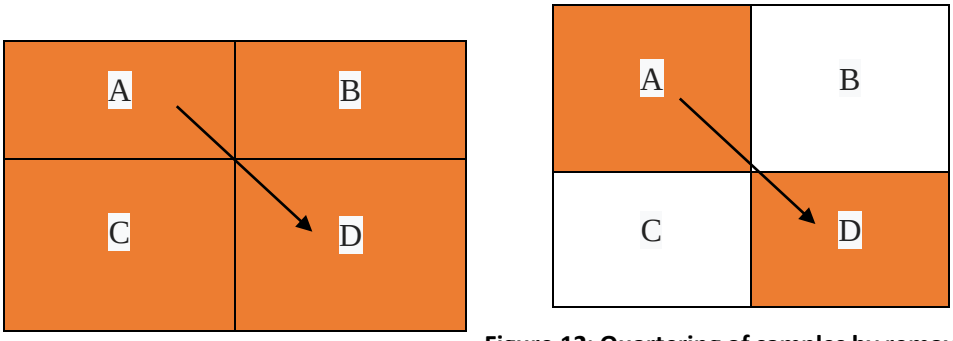

Figure 12: Quartering of samples by removing two diagonal parts

II. Compartmentalization

Spread the sample evenly and divide it into small squares (fig 11). Collect a small amount of soil from the middle of each square. This procedure is repeated until the desired sample weight is obtained.

©	©	©
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Figure 13: Dividing soil sample into small squares

TOPIC 04: Selection of quality seed potatoes

EXERCISE 1: Selection of quality seed potato

All the tubers of a plant are not same in size and should be graded according to their size. The ideal size of tubers for seed potatoes is 28-55 mm diameter. Uniformly sprouted seeds should be used for planting to get a uniform crop. There should be at least 4-5 buds in a tuber, which are 2-3 cm long, thick and well grown.

By the end of this exercise, farmers should gain practical knowledge to select good quality and healthy seeds.

Materials

- Healthy potato tubers in different sizes, disease infected tubers, poster papers and markers.

Steps

- Explain the objective of the exercise.
- Divide farmers into sub groups of 5-6 farmers.
- Provide suitable size seed tubers mixed with different size and diseased tubers.
- Instruct them to select the proper size seed tubers and write down reasons for selecting or rejecting tubers.
- Ask each group to present their results and discuss with the other groups.
- Finalize the results with facilitator-guided discussion.

Notes to the facilitator

- **Healthy seed tubers**

Seed potatoes used for seed multiplication should be selected based on the recommended procedure to prevent pests and diseases since fungal, bacterial and viral diseases and insect pests which are harmful to potatoes spread to other fields through seed tubers.

- **Seed tuber size**

Potato tubers come in several sizes and must be graded according to their size. Cost for seed per hectare is high when large tubers are used for cultivation since the number of tubers per kilogram is less. Tubers that are 28-55 mm in diameter are recommended for planting and 2 to 2.5 tons is required for a hectare.

- **Uniform spouting**

The potato seeds used for transplanting should be uniformly sprouted. There should be 4-5 sprouts that are 2 to 3 cm long and thick. This ensures uniform cultivation and ease in management.

TOPIC 05: Land preparation and planting

EXERCISE 1: Proper land preparation

The soil should be ploughed up to a depth of 15-20 cm and the soil clods should be crushed to a smooth texture. Ploughing soil to the right depth will improve aeration and drainage, and when exposed to sunlight it reduces soil borne pests and diseases. The most suitable method for planting potatoes is in ridges and furrows. The depth of furrow should be 15 cm and planting depth should be 5 cm.

By the end of this exercise, farmers should know proper land preparation and planting of seed potato tubers for seed tuber production.

Materials

- Poster papers, markers.

Time

- 45 minutes.

Steps

- Explain the objective of the exercise
- Divide farmers in to sub groups of 5-6 farmers
- Ask them to write the importance of ploughing (1st land preparation) and making ridges (2nd land preparation) in land preparation, how the land is prepared (making ridges along/cross the slope) and the time of application of compost and lime
- Ask each sub groups to present the information to the entire group
- Finalize with facilitator-guided discussion

Notes to the facilitator

- Ask the reasons for each activity and explain the reasons if they are not correct.
- Most of the farmers make ridges along the slope which contribute to high soil erosion. Explain the correct method.
- Plant spacing is 30 to 45cm between ridges x 15 cm between plants to obtain maximum number of good size seed tubers.
- Explain the importance of planting depth.

TOPIC 06: Water management and soil conservation

EXERCISE 1: Water management in potato cultivation

Adequate soil moisture with good drainage is very important for the healthy growth of a crop. This should be ensured by identifying the water requirement and providing irrigation at the required time for the crop.

By the end of this exercise, farmers can compare their irrigation practices and can select the irrigation method that is best suited to their land.

Land should be protected and maintained with proper soil conservation methods to prevent soil erosion which is induced by improper irrigation. Sprinkler irrigation is an efficient method of irrigation in potato cultivation to minimize soil erosion. It is advisable to use sprinklers in the morning to dry the foliage quickly to prevent late blight disease.

Materials

- Poster papers and markers.

Steps

- Explain the objectives.
- Divide farmers in to sub groups of 5-6 farmers.
- Ask them to write down the method they use to irrigate potato lands.
- Discuss good and bad experiences such as soil erosion, weed control, cost etc.
- Fill the table given below.
- Ask each group to present their methods to the whole group.
- The facilitator can summarize advantages and disadvantages of all methods discussed.

Table 6: Comparing irrigation methods

Irrigation method they use	Soil erosion Low/medium/high	Methods used to prevent erosion	Advantages	Disadvantages
Rain fed			Ex. No cost	Not sure about time.
Using hose pipe				
Sprinklers				
Filling beds and draining.				
Fill furrows and spread by hand/plate				
Other methods 1				
2				

TOPIC 07: Soil nutrient management

EXERCISE 1: Understanding nutrient requirement and its importance in potato cultivation

Potatoes are highly sensitive to nutrients. The nutritional requirements of crops should be properly managed to achieve higher yields. The required nutrients should be provided at the correct time and it is very important to apply organic fertilizer when planting. The amount of inorganic fertilizer to be supplied at each stage is calculated assuming that the recommended organic matter has already been applied before planting.

By the end of this exercise, farmer will be able to understand the nutrients required by the potato plant, the right time of application and how these nutrients are supplied

Materials

- Note books, markers, poster paper.

Time

- 60 minutes.

Steps

- Explain objectives.
- Divide group into sub groups of 5-6 farmers.
- Ask the farmers to discuss and write the method of fertilizer application for potato cultivation and fill table 6.
- Each team presents to the whole group before discussing methods.
- Summarize the result with a facilitator guided discussion.

Notes to the facilitator

- Explain different fertilizers and their uses
- pH value can be increased up to 5 - 5.5 by applying lime to the soil two weeks before planting if pH value is less than 5. This increases fertilizer absorption efficiency.

Explain the importance of organic fertilizer (A brief discussion)

i. Improving Soil Conditions (change of hardness, aeration, soil life, sustainability of soil.)

ii. Supply micro nutrients to the plant

iii. Increasing the efficiency of the fertilizer by increasing the cation exchange capacity (humus acts as nutrient holder as clay).

iv. Improve water holding capacity.

Ask each group to fill the following table (provide them empty table).

Table 7: Reasons and time for fertilizer application

* Farmer method of calculation. **local names

Time of application	Type of fertilizer	Amount in Kg (50 Kg box of seed potato*)	Objective
Two weeks prior to planting.	**Organic matter (poultry manure, cow dung)**		
One day before planting	**Urea**		Development of plant
	TSP		Develops roots and stimulates stolon and initiation of tubers.
	MOP		Development of plant
	Other types (fertilizer mixtures)		
Two weeks after planting	**Urea**		Optimum plant growth
	Other types (vitamins, foliar applications etc.)**		
	fertilizer mixtures		
Four weeks after planting	**Urea**		Develops plant and stimulates food deposition in tubers.
	MOP		Develops tubers and increase hardness of the peel.
	Other types fertilizer mixtures		

Factors to be considered when applying fertilizer

- Always apply fertilizer only when the soil is moist.
- Remove weeds in the field before applying fertilizer.
- Mix the fertilizer with soil immediately after fertilizer application.

Table 8: Fertilizer recommendation of department of agriculture for potato

For 1000 m^2 (1/4 ac) of seed potato				
Apply 01 MT of organic manure one week before planting				
Time of application	Type and amount (Kg)			
	Urea	TSP	MOP	Total
Basal	5.5	27.0	12.5	45.0
Two weeks after planting	11.0	-	-	11.0
Four weeks after planting	16.5	-	12.5	25.0
Total	**33.0**	**27.0**	**25**	**85.0**

EXERCISE 2: Identification of different types of fertilizers

Use of organic fertilizer helps potato cultivation in many ways. It helps to retain water and inorganic fertilizer, provides micronutrients, increases air space in soil and improves drainage. Farmers who use inferior quality compost end up applying partially decomposed materials most of the time.

At the end of exercise, farmers should know how to select good quality organic manure, and different appearances of inorganic fertilizer.

There are many inorganic fertilizer mixtures available in the market but all are not suitable for potato cultivation. Farmers should be capable of identifying suitable inorganic fertilizer and quality compost for better management of fertilizer application.

Materials

- Different kinds of organic fertilizer samples available in market, Urea, MOP, TSP, poster papers, markers.

Time

- 45 minutes.

Steps

- Explain the objective.
- Divide group in to sub groups of 5-6 farmers.
- Distribute fertilizer samples to all groups.
- Ask the farmers to inspect, discuss and fill the table given below in poster paper.

- Each sub group presents to the whole group and discuss.
- Summarize findings with facilitator guided discussion.

Table 9: Characteristics of different fertilizer

Type	Color	Odor	Condition of the fertilizer	Available nutrients	Can / cannot use
Organic					
1.					
2.					
3.					
4.					
Inorganic					
1.					
2.					
3.					
4					

TOPIC 08: Identification and control of pests and diseases

Plant diseases

In general, a plant becomes diseased when it is continuously disturbed by some organism that results in an abnormal physiological process that disrupts the plant's normal structure, growth, function, or other activities. Fungi, bacteria and viruses are major causes for plant diseases, and these organisms are so small that, they are often unseen by the naked eye.

Fungi

The majority of plant disease are caused by fungi. Fungi filaments are a basic structure with many cells. They reproduce by breaking down into pieces or spores produced from filaments. Fungi enter plants by actively piercing the plant tissue, through natural pores or through wounds in plants. Fungal diseases are spread by water, wind, soil, infected seeds or by farm tools and equipment.

Bacteria

Bacteria are miniature cellular organisms smaller than fungi and reproduce by spores or cell splitting. Reproduction is very fast in a favorable environment. Bacteria enter in to the plant through wounds or natural pores in the plant or through insect vectors.

Viruses

Viruses are much smaller organisms than bacteria. Viruses are obligatory parasites living inside of other organisms. Virus needs living cells for their reproduction. It can spread from one plant to another through insects such as aphids, thrips, white flies, or by seeds or planting materials.

Disease Control

Diseases are the result of an interaction between the causal agents, host plant and the environment. This interconnection is known as the disease triangle.

To develop a disease in a plant

- ability of pathogen to damage the plant,
- susceptibility of the plant to a pathogen, and
- favorable environment for development of pathogen are necessary and measures taken to control plant diseases should aim to break the interconnections.

How to manage the causal agent

- Prevalence of disease in the field by sanitation of field, removal of infected plants, selection of disease-free fields, use of clean water and use of healthy seeds or planting materials.
- Breaking long-term survival of the causal agent by crop rotation.
- Increase the number and function of favorable soil micro-organisms using organic fertilizers and prevent pathogens from entering into the field.
- Effect of host plant on disease control
- Establishment of a uniform and healthy crop using healthy seeds.
- Increase plant resistant using the right type and amount of fertilizer.
- Use of varieties resistant to diseases.
- Manipulating environmental factors
- Avoid heavy rainy period for cultivation.
- Improve drainage by preparing raised beds.
- Maintain proper spacing between plants to reduce moisture in the micro environment around crops.

Disease Control methods

a. Biological control

Disease causal agents have natural enemies in the environment comprising mostly fungi or bacteria that inhabit healthy soil or organic matter and they parasitize on the causal agents or compete with them for food and space. Hence, when cultivating potatoes, make use of good quality organic fertilizer to control pathogens.

b. Chemical control

Contact fungicides can prevent infections and control fungal spore germination. At the first application of fungicides, farmer has to decide the type, concentration and time of reapplication.

Time of fungicide application

Fungicide application depends on the environmental factors since the effectiveness of the fungicide is highly dependent on weather conditions.

- Inspect the cultivation at least three days a week. This will help to identify disease initiation, severity and the way it occurs. Symptoms initiation is the best time to apply systemic fungicides.
- Disease management should be determined based on the prevalence of the disease in the field.

Type of the fungicides to be applied

- When contact fungicides are applied, it is important to wet the foliage thoroughly.
- During the rainy season, it is better to mix fungicides with a sticker to increase the retention period in foliage.
- It is important to apply systemic and contact fungicides alternatively.
- It is advisable to apply a systemic fungicide after two applications of contact fungicides.
- When more symptoms appear in cultivation, a systemic fungicide should be applied and should be re-applied after 14 days. Pathogen will develop resistance to the fungicide when a same systemic fungicide is applied continuously.

How to apply

- For successful disease control, the whole plant should be well covered with fungicides.
- A suitable liquid sprayer should be used and, proper pressure in the tank and travel speed of the applicator must be maintained (Pressure is 400 pound per square inch, travel speed is 30-35 meters per minute).
- Make sure that the water used is free of pathogens and the pH is between 4-6.5.
- Care should be taken to apply the concentration mentioned on the fungicide label.

Frequency of application

- Since systemic fungicides remain in plants, the time between two applications is longer than for contact fungicides.
- It is difficult to grow potatoes without fungicides. This is essential specially for the control of late blight. However, care must be taken to prevent misuse of chemicals to protect environment and consumers from chemical hazards.

Notes for the facilitator

Spraying of agrochemicals

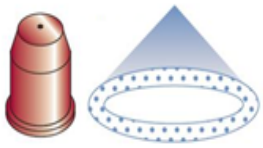
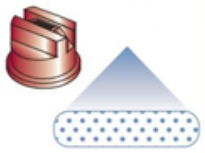
Application of chemical spray is a key part in pest and disease management program. Selection of agrochemicals, time of application, concentration and equipment used for application are important for effective pest/disease management program. Most farmers use manually operated knapsack sprayers. Spray nozzles play a major role in delivering correct quantities of agrochemicals to the target. Hence, nozzle selection or use of correct nozzle types is most important in chemical spraying.

To maximize the effectiveness of spraying, following questions should be considered before spraying.

- What are you spraying for?
- What type of crops are you spraying?
- Is the pest / disease in the foliage or in soil?

- What products are you spraying and its mode of action?
- What nozzle type and spray volume are you using?

Table 10: Guideline for selecting nozzles and sprayers

Type of Pesticide	Type of Nozzle	Nozzle and Spray Pattern	Approximate Pressure (Bars)
Insecticides and Fungicides	Hollow cone nozzle		3
	Flat fan nozzle		3

- Do not apply pesticides to drain off from the leaves
- Never use four hole or five hole hollow cone nozzles for application of pesticides
- Maintain 50 cm distance between the nozzle and the target spray surface

Pesticides are dangerous chemicals to use and when spraying pesticides, the spray operator should be aware about the hazards and the possibility of polluting environment. Use of personal protective equipment (PPE) is prerequisite in pesticide spraying. Most of the information and suitable PPE are mentioned in the pesticide label. As spraying can be on crops of varying heights determine which parts of the body is most liable to be exposed to pesticide drift and select appropriate protective equipment and clothing such as goggles, respirator, gloves, hat, boots, long sleeved shirts, long trousers etc. during mixing and application of pesticides. Smoking and eating should be totally avoided while handling pesticides.

Important diseases of seed potato in Sri Lanka

Potato bacterial wilt, potato late blight and diseases in potato tubers mainly affect potato cultivation in Sri Lanka and farmers require a good knowledge of how to respond to these problems in the field.

EXERCISE 1: Identification of potato bacterial wilt

By the end of this exercise, farmers should be capable of identifying bacterial wilt symptoms and conduct ooze test to confirm the disease.

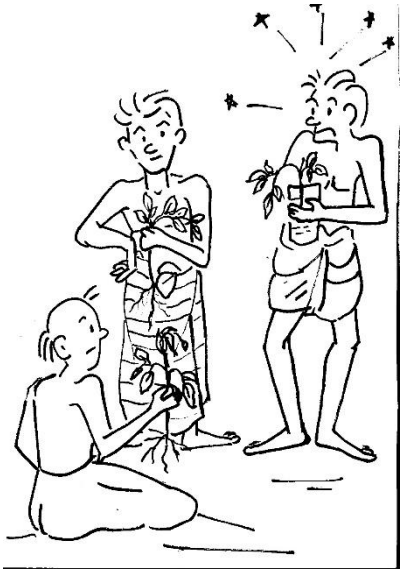
The disease is caused by bacteria *Ralstonia solanacearum*, which also affects other cultivated Solanaceous crops such as tomatoes, chilies, capsicum, brinjal and cucurbits such as bitter gourd. Bacterial wilt is a very important disease as it spreads through potato tubers. Some farmers use fungicides to control bacterial wilt which is not effective. Only cultural methods can be used to suppress the problem.

Materials

- Poster papers, small knife, note books, transparent colorless glass, clear water.

Steps

- Explain the objectives.
- Divide the farmers into sub groups of 5-6 farmers.
- Instruct the farmers to inspect the potato cultivation and to collect some wilted plants that are suspected to be infected by bacterial wilt.
- Advised them to inspect thoroughly and note down the reasons for suspecting the infection as bacterial wilt in a poster paper.
- Tell each sub groups to present the information to the whole group.
- Fill the technical gaps through a facilitator-guided discussion.
- Explain and demonstrate the ooze test method to confirm the disease.
- Instruct the small groups to practice the ooze test.



- Conduct a discussion among the farmers on the "methods used by farmers" to control the disease and their success. (fill the given table during the discussion)

Table 11: Practices used by farmers to manage Bacterial wilt

Practices used by farmers	Whether it is successful or not	Recommended or not by DOA
(Ex. Selection of healthy seed tubers.)		

Notes for facilitator

To control bacterial wilt:

- Select disease free lands based on farmers experience and previous crops grown.
- Use healthy seed potatoes (obtain seeds from a trusted person or institution)
- Do not cultivate potatoes or other Solanaceae crops in a same land continuously. Cultivate cereals (Maize), cabbage, knolkhol, beet, leeks, etc. as rotation crops except any cucurbits.
- Removal of previous crop residues and weeds before planting
- Use good quality organic manure
- Prevent water flowing in from infected fields

- Use clean water for irrigation.
- Avoid picking tubers for seeds from diseased plants and surrounding potato plants when harvesting.
- Ooze test: To properly diagnose bacterial wilt, the bacterial streaming test which is simple, inexpensive, and environmentally friendly and can be used in the field. A horizontal cut is made in the lower stem and the cut stem is immersed in water. Within a few minutes, bacterial exudate emerges from the cut end, forming the white streamers in the water. This only occurs with bacterial wilt and not with any other type of pathogen or abiotic cause.

EXERCISE 2: Identification of diseases in potato tubers

Many fungal, bacterial and viral diseases and pests spread through potato tubers. Hence, seeds that are not infected only should be used for cultivation. Farmers should have knowledge and skills to identify diseases in order to select healthy seed tubers for planting.

By the end of this exercise, farmers should be capable of identifying tuber related major diseases.

Materials

- Tubers infected with bacterial wilt, Erwinia soft rot, Fusarium dry rot and scab, knives, poster papers, markers, note books.

Time

- 45 minutes.

Steps

- Explain the objectives.
- Divide the farmers into sub groups of 5-6 farmers.
- Distribute numbered potato tubers with diseases among groups (for each group –1. soft rot, 2. bacterial wilt, 3. dry rot, 4. scab).
- Instruct them to observe inside and outside of the tuber and note and write symptoms in the table given below.
- Explain symptoms observed, to whole group and discuss.

Table 12: Identification of diseases

Tuber number	Symptoms identified	Disease	control measures	Whether successful or not

Notes for facilitator

Bacterial wilt in tubers

Symptoms of Bacterial wilt are not clearly visible from the outside of the tuber. However, brown or black vascular zones can be observed in a tuber cross section. When tubers are cut and pressed by hand, a white solid substance ooze out from the brown or black area.

Management of bacterial wilt

- Diseased tubers should never be used as seeds or for storage
- Due to the high temperature in storage, damage can increase and spread to healthy tubers
- Disease cannot be controlled by fungicides and any chemicals are not recommended in Sri Lanka
- Severity can be reduced by cultural methods that are explained in bacterial wilt exercise.

Erwinia Soft rot

The causal agent of this disease is *Erwinia caratovora* bacteria. Damage is severe with heavy rains and high soil moisture. Storage of infected tubers can cause massive damage to seed potatoes. The major symptom is wet rot of the infected tuber. The inside of the rotten tubers becomes watery and have a strong odor. Healthy tubers become infected when they get in contact with the infected tubers. Symptoms are hardly visible from the outside, but when infected tubers are planted in the field, the buds will rot. Rotting of tender buds at soil level will destroy the crop completely.

Controlling Erwinia soft rot

- Immediately after harvesting, thoroughly inspect the tubers which are used for seeds and if there are any injuries or rot, throw such tubers away.
- Dry tubers before storing.
- Prevent seed stores from getting wet.
- Regularly inspect stored tubers (once every two weeks) and remove rotten tubers immediately.
- Take care when cutting tubers. Apply a fungicide on the cut surface and leave to dry.
- Ensure proper drainage of the field.
- Use well decomposed organic fertilizer only. (non-decomposed organic matter creates a favorable environment for Erwinia)

Scab disease

This is caused by a bacterium *Streptomyces scabaies*. It can be easily identified by the raised scabby areas observed on the outer surface of the tuber. Use of such tubers should be avoided for planting to control the spread of the disease. A soil that is too dry can lead to more infections. Unnecessary increase of soil pH (alkalinity) is another factor which can increase the severity of the disease.

Controlling scab disease

- When choosing a tuber, choose scab free tubers.
- Check the pH of the soil before cultivation starts and apply lime only if necessary (pH between 5 and 5.2 is ideal for potato. pH around 8 can increase the risk of scab)
- Avoid the soil getting dried with proper and timely irrigation.

Table 13: Important tuber diseases in seed tuber production

Infected seed tubers are not good for planting.	
Figure	**Disease**
	**Scab (***Streptomyces scabies)* A shallow or surface scab is a superficial, roughened or russet area on the tuber. Slight protuberances with depressed centers might form and are covered with a small amount of corky tissue.
	**Soft rot (***Erwinia carotovora*) Symptoms of soft rot include soft, wet, rotted, tan or cream-colored tissues. Rot begins on the tuber surface and progresses inward. Infected tissues are sharply delineated from healthy tissue by dark brown or black margins. Infected tubers should be removed immediately.
	**Bacterial wilt** (*Ralstonia solanacearum*) Cross-section of infected potato tubers may reveal a grey-brown discoloration of vascular tissues, also called the vascular ring. As infection progresses, the discoloration may extend into the pith or cortex of the tuber. A milky-white sticky exudate (ooze), which indicates the presence of bacteria cells, might also be observed from freshly-cut sections of infected tubers.
	**Dry rot (**Fusarium spp) Initially, lesions appear as brown to black flecks on the tuber surface. Lesions later form large, hollow cavities. Frequently, the lesions appear wrinkled on the tuber surface with numerous white tufts of mycelium. Infected tubers may completely decay with time.

EXERCISE 3: Identification of potato late blight

By the end of this exercise, farmers should be capable of identifying the disease correctly, and explain method of fungicide application to manage disease.

Potato late blight (*Phytophthora infestans*), is one of the most important fungal diseases in potato cultivation. The crop is vulnerable to damage at any growth stage but more likely to be completely destroyed during the rainy season. Seed tubers from highly infected crops can spread the disease because they can carry the inoculum. Infected leaves will turn black and appear rotten and dried up. A white fungus can be seen on the underside of these leaves if examined in the humid morning. Infected shoots turn black and dry. Extremely damaged plants rot and collapse completely. Infected tubers have brown dry spots. The disease spreads rapidly and if unattended, the entire crop will be destroyed. The pathogen spreads through infected seed tubers, spores, infected soils and water as well as through susceptible plants in the field.

It is impossible to control the disease by simple procedures such as uprooting diseased plants and picking infected parts. Therefore, the use of fungicides is essential for the management of the disease.

Materials

- Notebooks, poster papers, and markers, (if samples are not available in the study field facilitator has to bring from outside and make sure to dispose properly after training).

Steps

- Explain the objectives
- Divide farmers into sub groups of 5-6 farmers.
- Visit the study field and collect late blight infected leaves and stems
- Instruct them to observe and note symptoms on leaves and stems (different stages of disease development)
- Ask them to draw the pattern and color of lesions on poster papers to show the development of the disease
- Write the management practices they use to control the disease
- Explain the symptoms observed, to the whole group and discuss management practices.

Note for facilitator

Application of fungicides to manage late blight

Application of fungicides is the most popular method when potato plants emerge from the soil. This method can save new plants from disease. Fungicides repeatedly used should be determined according to the results of the previous application. Application of fungicides should be started as soon as the initiation of disease.

Initial fungicide application

- Do not mix two or more fungicides together
- Apply a systemic fungicide first. The reasons for this are as follows.
    - When the disease is present in a few plants, there are fungal spores in the surrounding atmosphere and the disease can develop inside the plant without symptoms.
    - As the plant grows rapidly during its early stages of development, only systemic fungicides can control pathogens that have already entered the plants.
- Application of systemic fungicides can help to prevent blight from seeds
- Maintain cultivation of all plants at the same growth stage.
- Since plants are small at the beginning, less fungicide is required and the cost is less

Measures to achieve maximum efficacy of fungicides

- Use good sprayers.
- Mix fungicide with clean water.
- Apply fungicides uniformly from top to bottom of the plants.
- Use right concentration and volume.

Potato pests

Potato tuber moth

The tuber moth is about 8-10 mm long and larval stages can damage potato tubers and leaves. When potato tubers increase in size, they are sometimes exposed to the air. The tuber moth lays eggs on the surface of exposed tubers or on leaves. The larva enters into the leaf or tubers and eats the flesh.

Larvae emerge from eggs laid on leaves and move into tubers through the stem. They also attack stored tubers.

Aphids

These are small insects and the availability of a large number of host plants make control very difficult. They spread either through wafting on the wind, or by contamination through human touch. Virus diseases can spread when they suck plant sap from the leaves. Aphids cause damage to potato cultivation by sucking sap and indirectly spreading viral diseases.

EXERCISE 4: Identification of potato pests

Potato tuber moth and viral vector aphids can be considered as important pests in seed potato production, among the few insects that directly damage potatoes in Sri Lanka.

By the end of this exercise, farmers should know how to identify potato tuber moth and aphids and explain management methods, as well.

Materials

- Magnifying glasses, notebooks, poster papers, knives, markers, plastic bags.

Time

- 45 minutes.

Steps

- Explain the objectives
- Divide the group in to sub groups of 5-6 farmers
- Ask them whether they know tuber moth and its damage and to explain symptoms.
- Write down on a poster paper.
- Instruct them to visit the field and look for tuber moth damaged leaves and if possible, damaged tubers.
- Collect samples and draw them. Discuss symptoms.
- Collect aphids, and damaged leaves. Observe them using magnifiers and draw pictures.
- Present to the whole group.
- Discuss management strategies.

Note for facilitator

- Store seed potato tubers in a place where moth cannot enter into.
- Spray recommended insecticides to control tuber moth.
- Do proper earthing up and prevent tubers getting exposed to the air.
- Carefully inspect the tubers used for planting and remove any damaged ones.

TOPIC 09: Harvesting, processing and storing seed potato tubers

Three-month potato varieties can be harvested within 80-90 days. When 70% of crop canopy turns yellow, the time is right for harvesting. Subsequently stems are cut off (dehaulming) 10 days prior to harvesting to prevent further growth and to prevent fungal infections. By doing this the peel become hard and improves the quality of the seed tuber. Irrigation should not be done during this period. After dehaulming, exposed tubers should be covered with soil immediately or the potato tuber moth can lay eggs in the eyes of the tubers.

Harvest must be done early in the morning on a dry day. Diseased plants marked during the rouging out process should be harvested separately and should not be mixed with healthy tubers. Healthy tubers should be dried for about 2 hours in the field.

Processing

Harvested tubers are placed in 4-6-inch-high trays. This stock should be graded according to tuber size. Rotten tubers should be removed frequently. Care should be taken not to damage the skin of the tubers when handling.

Grading of seed potato can be done according to the following diameter of the tubers:

- Smaller than 25 mm - not good
- 25-28 mm - good
- 28-55 mm - ideal
- More than 55 mm - not economical

By the end of exercise, farmers should explain and practice correct methods of harvesting, processing and storage of seed potato tubers.

Storage of seed potato

The tubers should be properly stored under suitable conditions until dormancy breaks. Seed tubers should be placed in a store where the relative humidity is around 70-90%, well ventilated and under diffused light. The storeroom must be insect and rodent proof. Seed tubers must be mixed with fungicides and insecticides to prevent pest and disease development in stores. Damaged and infected tubers must be removed hence, frequent checks are compulsory.

EXERCISE 1: Harvesting, processing and storing of seed potato tubers

Harvesting, processing and storing of seed potato is a very important operation unlike in the production for consumption. Although farmers follow all proper methods to produce, at this point they must be very careful to follow the correct procedure to obtain healthy seed potatoes.

Materials

- Poster papers, markers.

Time

- 60 minutes.

Steps

- Explain objectives.
- Divide group in to sub groups of 5-6 farmers.
- Ask them to discuss and write the methods they follow to harvest, process and store seed potato.
- Write collected information in the table given.
- Discuss with whole group.

Table 14: harvesting, grading and storing

Activity		Reason
Harvesting. a. At 70% yellowing b. Dehaulming c. Stop irrigation		
Selection and Grading a. b. c.		
Storing a. Tray sizes b. No of layers		

Note for facilitator

- Explain reasons for all above steps

TOPIC 10: Setting up of next crop

Conduct short discussion

Since soil in potato fields is loosened during harvesting, the risk of soil erosion is very high especially in rainy periods. Therefore, immediate action should be taken to prevent soil erosion such as cultivating legume crops (cowpea, horse gram) or cereals (maize). It is economical to use the land immediately for another crop without spending extra effort on land preparation.

Ask farmers

- Why do we cultivate next crop immediately after harvesting?
- What crops do they prefer to cultivate after harvesting?
- Advantages and disadvantages of planting other crops immediately after harvesting.

TOPIC 11: Farm record keeping

Record keeping

Farming is a business and good farm record-keeping helps the farmer to plan and do realistic forecasting. Record-keeping provides valuable information on which methods work. The farmer can better predict from records kept from previous years such as price changes, availability of inputs on time, yields, income, pest and disease status and many more.

EXERCISE 1: Importance of record keeping

Many farmers cannot list the inputs and associated costs that they have used in production. The inability to recall or record what went where or how much was spent on production operations is the first sign of trouble. Simple record keeping provides the solution to most of the problems farmers face during production, not only financial matters but also pest and disease problems and other management problems too.

Two main types of records that a farmer must keep in a farm are financial and production records.

Financial records concern the financial dealings of the farm. These records show farm income and expenditures such as record of produce sales, operating expenses, equipment purchases, etc.

Production records include crop yields, quantities of inputs, crop health history, pesticide application (why, what and how often), etc. Keeping and analyzing accurate production records are essential aspects of farm management to make decision in future crops.

Materials

- Poster papers, markers

Steps

- Explain objectives of the exercise
- Divide group in to sub groups of 5-6 farmers
- Simply ask the importance of record keeping and to write the answers on poster papers.
- Next ask them to discuss the required important information and the reason and write on poster papers
- Present to whole group and discuss
- Finalize the type of information needed by FFS farmers to keep records.
- Convert to simple format
- Facilitator should develop further and distribute printouts to famers and ask them to start record keeping.

By the end of exercise farmer should know

- Importance of record keeping
- How to develop a simple format for record keeping
- Simple analysis

Notes for facilitators

Financial records:

Land preparation cost, seed cost, fertilizer and other inputs like agro-chemicals cost, operating cost, labour cost, income, etc.

Production records:

Pest and diseases by name, agro-chemicals used, weather throughout the season, etc.

PART III - Appendices

Appendix 1: Baseline survey on Seed potato cultivation- Badulla and Nuwara Eliya districts

A. Information of data collecting officer

a. Name of office:- District - NE ☐ BAD ☐

b. Position:- ☐ AI ☐ ADA ☐ DD ☐ Other - .....

c. Educational qualification:- ☐ O/L ☐ A/L ☐ Bsc ☐ Msc

d. Professional qualification:- ☐ Diploma(agri) ☐ other .....

e. Years of experiences in potato cultivation:-

f. AI range :- number of potato farmers attending programme:-

B. Information of Famer

a. Name :- Gender:- ☐ M ☐ F Age Y ☐

b. Address:-

c. Education :- ☐ O/L ☐ A/L ☐ Degree

d. Years of experiences in potato cultivation ☐

e. Years of experiences in seed potato cultivation. ☐

f. Use of smart phone ☐ no ☐ own ☐ Family member

g. Mobile phone ☐ no ☐ Yes

h. Internet access :- ☐ Data ☐ Wi-Fi

C. Information of his/her last season potato cultivation. (2019)

a. Year (2019) :- season: ☐ Yala ☐ Maha

b. Cultivated area :- ☐ ha

D. Seed Potato

c. Seed potato :- Varity:- number of boxes

d. Source of seed potato ☐ own ☐ friend ☐ imported ☐

e. Seed cost Rs .....

E. Land preparation

a. Method used ☐ manual ☐ Tractor ☐ other P. indicate

b. type of plough:-

c. Plowing depth ☐ inches

d. What is the correct depth ? inches

e. Why this depth ....

f. Do you apply lime ☐ yes ☐ no why? .....

g. Rate .....Kg/hc

F. Planting

a. What is the suitable size of seed potato to plant? D =

b. Seed potato with how many emerged buds-suitable?- ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

c. Do you remove apical bud before planting? ☐ Yes ☐ no

d. Why? .....

e. Method of planting - ☐ ridge and furrow ☐ other p. indicate .....

f. Planting depth? ..... inches

G. Fertilizer application

a. Type used:- ☐ strait ☐ mixtures

b. Strait fertilizer - (for cultivated area)

	Urea Kg	MOP Kg	TSP Kg	time of application
Basal				
1st top dressing				
2nd top dressing				
3rd top dressing				

c. Mixtures (for cultivated area)

Type/ Trade name	Basal	1st top	2nd top		time of application

d. Source :- ☐ ASC ☐ privet dealers

e. Application of *vitamins*.(Farmer's word)

Type	amount	reason/ why applied

f. Compost added :- ☐ no ☐ yes ☐ amount kg

H. Pest and Diseases management

a. Type of sprayer use:- Knapsack ☐ hand operated ☐ power

b. Type of nozzle - 1 ..... 2.....

c. Diseases management - how many applications /last season ☐

name of disease	preventive or control	chemical applied	formulation +	dosage ++	crop stage	cost Rs

+ EC, WP etc ++ ml/l or g/l

d. Pest management - how many applications /last season ☐

name of pest	preventive or control	chemical applied	formulation +	dosage. ++	crop stage	cost Rs

+ EC, WP etc ++ ml/l or g/l

I. Irrigation

a. Water supply method ☐ rain fed ☐ irrigation

b. Water source ☐ natural water flow ☐ well

c. Method ☐ sprinkler ☐ plate method ☐ flood & Drain

d. advantages and disadvantages of irrigation method as she/he think ?

Advantages	**Disadvantages**

J. Record keeping

a. Do you keep records of your cultivation? ☐ Yes ☐ No

b. What type of records?

☐ Expenses ☐ Pest and diseases ☐ Chemical ☐ Fertilizer

i. p. Indicate others .....

c. What is your total profit last season? Rs .....

notes :-

Appendix 2: Sample FFS timetable for seed potato production

FFS session	Time	Topics
1	5 weeks before planting	• FFS orientation for selected members. • Introduction of FFS concept • Pre evaluation of farmers knowledge on potato cultivation by ballot box system
2	4 weeks before planting	• Sustainable Land Management (SLM) • Selection of suitable land for seed potato production
3	3 week before planting	• Understanding the potato plant • Selection of quality seed potato • Land preparation and planting
4	1 week before planting	• Water management and soil conservation • Soil nutrient management– Basel fertilizer • Identification of diseases in potato tubers • Record keeping
Crop Establishment		
5	2 weeks after planting	• Understanding Agro eco system analysis (AESA) • Removing unhealthy plants • Identification and management of potato late blight. • Soil nutrient management -top dressing.
6	4 weeks after planting	• AESA • Removing unhealthy plants. • Identification and management of bacterial wilt
7	6 weeks after planting	• AESA • Special topic on available pests or diseases and management • Water management and soil conservation.
8	8 weeks after planting	• AESA • Special topic on available pests or diseases and management • Earthing-up: why, how and when
9	10 weeks after planting	• AESA • How to get ready for harvesting including dehaulming, processing and storing.
10	12 weeks after planting	• AESA • Pest and diseases management during storage. • Setting up next crop.

*Note: Farmer self-conduct AESA at 3,5,7,9 and 11 weeks after planting for self-learning and if any special issues found, communicate with other members through WhatsApp group.

Appendix 3: Curriculum for Farmer Field School of Sustainable Seed Potato Production

Topic	**Learning Out puts**	**Content**	Training Methods	Teaching aids	Time (minutes)
General topics					
Introduction of the project activities	• Understand the project objectives and implementation strategies	• Project objectives. • Project area identified. • Direct and indirect benefits. • Role of stakeholders.	• Lecturer let	• PPT	15
Introduction to Farmer Field School	• Understand the Farmer Field School (FFS) concept • Understand the importance of the FFS • Understand the role of facilitators and farmers agreed to participate for FFS program	• Concept of the FFS. • Characteristics of FFS. • Advantages of FFS. • Role of facilitator and farmer. • Activities in a typical day session in FFS.	• Lecturer let • General discussion • Brain storming	• PPT • Video clip	60
Establishment of FFS	• Formation of FFS group	• Advantages of grouping • Identify the major role and responsibilities (leader, reporter, members) • Group norms	• Group work	• Flip chart • Record book	165 (40 minutes in 1st Session and 10 minutes will be allocated in each other sessions)

Introduction to COVID 19 preventive measures	• Respect and follow the health regulations	• Basic information of COVID 19. • Health regulations and instructions. • Running FFS under the COVID 19 situation.	• Role play • Lecturer let • General discussion.	• Video clip	75 (5 minutes will be allocated in each session)
Information Technology for FFS	• To be able to communicate through WhatsApp and Face book	• Advantages of IT for FFS. • Usage of WhatsApp for sharing knowledge, problem solving and M&E. • Sharing information and field event for wider audience through FB • supporting mechanism.	• Demonstration	• Smart mobile devices	60 (10 minutes in 1st FFS and 30 minutes in 2nd FFS. 5 minutes in four FFS)
Special topic					
Selection of suitable land for seed potato production	• Improve farmers' knowledge to select suitable land for seed potato production. • Understand the soil characteristics and issues in relation to seed potato production and methods to mitigate those issues. • Develop skill for collecting, drying and packing a soil sample correctly for laboratory analysis.	• Factors to be emphasized when selecting land for seed potato production. • No Solanaceae crops such as Brinjal, Chilies and tomatoes are cultivated in previous three seasons. • Availability of irrigation facilities. • Minimize soil erosion. • Good soil structure, texture, color and depth. • Methods to improve the soil structure for better production. • Good sunlight. • Upland with good drainage.	• Lecture let • Group exercises	• PPT • Flip chart	120

		• No outside water flows through the selected land. • Disease free lands.			
Record keeping.	• Understand the importance of record keeping. • Familiarize with simple record keeping formats. • Understand the analyzing of data • Understand the participatory monitoring and evaluation methodologies.	• Importance of record keeping. • Simple format for record keeping. • Simple analyzing method for record keeping. • Create baseline information. • Develop criteria to measure the progress in various stages of the crop. • Participatory monitoring and evaluation.	• Lecture let • Group exercises	• Flip chart	120
Understanding of Potato Plant	• Understand the parts and characteristic of the potato plant. • Understand the growth pattern of the potato plant and interrelation with management practices. • Gain practical knowledge of growing**.**	• Growth stages of potato plant. • Growing of buds (sprouting). • Vegetative growth stage. • Tuber initiation stage. • Tuber enlargement stage • Tuber maturation stage. • Characteristic of the potato tuber.	• Lecture let • Group exercises	• Flip chart	120
Proper land preparation and soil management for higher production	• Understand the soil characteristics and relationship with the fertility. • Methods to minimize soil degradation and improve soil characteristics for Crop cultivation	• Soil characteristics – • Soil texture and structure • Soil color and fertility • Measurement of soil PH and other nutrient levels. • Type of fertilizer.	• Lecture let • Group exercises	• Flip chart	120

Proper water management	• Understand the efficient water management technologies. • Understand the water conservation technologies	• Sprinkler irrigation. • Hose irrigation	• Lecture let • Group exercises	• PPT • Flip chart	120
Selection of quality seed potatoes and planting	• Improve farmers' knowledge to select healthy good quality seed potato. • Understand the importance of proper land preparation. • Develop skills for proper land preparation. • Understand the importance of proper planting of seed potato. • Develop skills for proper planting of seed potato.	• potato tubers (Size) • healthy seed tubers • Uniform spouting • Correct plowing depth • Ridge and furrow preparation • Correct spacing • Correct planting depth	• Lecture let • Group exercises	• Video • Flip chart	120
Nutrient management of potato cultivation	• Understand the role of nutrient and its importance. • Improve knowledge on nutrient application in seed potato cultivation. • Understand the various type of chemical and organic fertilizer and their special features.	• Role of nutrients and importance of nutrients. • Soil pH and soil fertility. • Application of organic manure. • Application of recommended fertilizer. • Issues of unbalanced fertilizer use.	• Lecture let • Group exercises	• Flip chart	120
Pest and disease management in potato cultivation	• Improve knowledge to identify pests & diseases in seed potato production. • Improve knowledge to manage pest & disease in seed potato production.	• Important pests & diseases of potato seed production. • Pest & disease control measures. • Selection of recommended pesticides & application in proper method.	• Lecture let • Group exercises	• PPT • Video • Flip chart	120

Harvesting, processing and storage of seed potato tubers	• Develop knowledge & skill to identify correct time of harvesting & correct method of harvesting of seed potato. • Develop knowledge & skill for grading, packing & storage of seed potato	• Importance of correct harvesting of potato for seed. • Grading packaging & storing of seed potato. • Introduce seed plot techniques.	• Lecture let • Group exercises	• PPT • Video • Flip chart	120
Other management practices	• Awareness of roughing out. • Awareness of correct earthing up practice.	• Rouging out • Earthing up • Maintenance of number of stems	• Lecture let, • Group exercises	• Flip chart	30
Maintenance of potato seed quality	• Production of quality potato seeds.	• Basic requirements of quality seed production	• Lecture let	• Flip chart	30
Setting up of next crop.	• Understand the next crop after harvesting potato	• Importance of next crop • Selection of next crop	• Group discussion		30
Evaluation in end of the season.	• Find the profit / loss of the crop. • Analyze the production and other features with the inputs utilized.	• Calculate the profit. • Analyze the result with the farmer group. (Participatory approach)	• Lecture let • Group exercises		60
Special note to the Facilitator					
Agro eco-system analysis	• Understand the Agro Eco system. • Analysis of Agro Eco system (AESA) and crop management decision making.	• Components of agro eco- system. • Interactions between each component. • How to do observation, collect data and summarize.	• Group exercises	• Flip chart	90

		• Participatory decision making on crop management, based on data collected. (Guided by facilitator)			
Group formation and participatory decision making	• Understand the group formation technologies and participatory decision making.	• Formation of a new group or selection of an existing good group. • Develop leadership among the group. • Dividing the responsibilities among the group members. • Creating sense of ownership among the group members. • Training need assessment and planning for the farmer field school. • Farmer field selection to conduct FFS continuously through the season. • Learning contract with group members(FFS norms)	• Group discussion		30
Regional support system to assist FFS groups and field level facilitators.	• Understand the importance of regional support system and establishment	• The importance of regional supporting system. • How to establish regional supporting system.			
Field study	• Understand the importance of field study. • To be able to arrange field study.	• How to develop field study. • Examples of field studies.	• Lecture let • PPT		
Group Dynamics	• Understand the group dynamic exercisers	• Group dynamic exercises.	• Clapping • Role play • Brain storming • Group exercises		30

Appendix 4: A sample question paper for ballot box test.

1. Place potato tuber as a sample.

   This is

   a. A modified stem to store food.

   b. It is a modified root to store food

   c. A seed

2. Suitable for seed (sample should be present)

   a. (Large Potatoes)

   b. (Medium sized potato)

   c. (Sufficient tubers for seeds)

3. Lands suitable for planting seed potatoes are

   a. Land where water is convenient.

   b. Paddy field.

   c. Both paddy and land are suitable

4. When selecting lands for seed potato cultivation

   a. The crops grown last seasons were not important.

   b. No Solanaceae crops for the last three seasons is suitable.

   c. Land cultivated with Solanaceae crops in last season are suitable

5. Soil Suitable for potato cultivation

   a. A loamy soil that drains well

   b. Soil with more clay

   c. Soil with more sand

6. Ideal soil pH value, suitable for potato cultivation

   a. 5 - 5.5

   b. 7.00

   c. 4.00

7. Applying lime to the soil

   a. To combat worms

   b. To bring the pH of the soil to a suitable level

   c. To improve drainage

8. Best spacing for planting tubers.

   a. 45 x 15 cm.

b. 60 x 45 cm.

c. 45 x 30 cm.

9. The height of a ridge is usually

a. 12 inches

b. 15 inches

c. 20 inches

10. Depending on how the soil sample feels at hand (Provide a jar of soil and water. Be sure to moisten the thumb and forefinger with water.

a. Sandy soil

b. Clay is more soil.

c. Loom is a soil.

11. Place a few leaves with late blight. This

a. Is a viral disease

b. Is a fungal disease.

c. A bacterial disease.

12. Place a cut potato stem in a transparent glass of water. This is used

a. To identify nutrient deficiencies

b. To identify fungal diseases

c. To identify bacterial wilt.

13. If the tuber plant of the above set is infected with bacterial wilt.

a. A white ooze drains from the stem end.

b. The water becomes brown.

c. Water does not change color.

14. Bacterial wilt can also spread from tubers. Which one is the diseased tuber? (Cut three tuber samples and place.)

a.

b.

c.

15. To prevent this disease

a. Fungicides should be applied to infected tubers.

b. Infected tubers should not be used at all.

c. The diseased part should be cut and planted.

16. When applying basal fertilizer for potatoes

a. Apply one day before planting

b. Apply at the time of planting

c. Fertilizer should be applied one week after planting

17. For the cultivation of potatoes

a. Application of organic fertilizer is essential.

b. No organic fertilizer required

c. chemical fertilizer is sufficient

18. The damage of potato tuber moth starts

a. Before the tubers uproot if exposed.

b. After storing the tubers

c. In both cases

19. When harvesting a tuber crop

a. All tubers should be removed at the same time

b. Only healthy plants should be harvested first.

c. The diseased plants should be removed first and the healthy plants afterwards.

20. When storing potatoes for seeds

a. Tubers should be stored as soon as they are harvested.

b. The tubers should be dried for two hours

c. The tubers should be kept in the dark

Appendix 5: Sample AESA data collection format

Date of AESA:

Group:

Weather (Cloudy, rainy, bright sunlight):

Age of crop days:

Last week management activities:

General appearance of crop:

No	Description		Observation Points										Average
			1	2	3	4	5	6	7	8	9	10	
1	Pests	Mites											
2	Natural enemies	Spiders											
		Lady bird beetles											

3	Diseases	Bacterial wilt											
		Late blight											
4		Plant height (cm)											
5		No of stems											
6		Number of leaves/											
7		Weeds around plant											
8		Soil moisture as feel to hand											

Appendix 6: Proposed Information Technology mechanism for implementing activities of the Farmer Field Schools under pandemic conditions like Covid-19

1. WhatsApp messaging software application

According to the objectives of the Farmer Field Schools and the communication needs of the groups, WhatsApp groups should be developed as follows.

I. For the members of the Farmer Field Schools

II. For the members of the board of the experts

i. WhatsApp group for the members of the Farmer Field Schools

A WhatsApp group for all the members of the Farmer Field Schools usually comprising of maximum 25 members should be developed and it should be administered by the facilitator of the Farmer Field School. There should be individual WhatsApp accounts for all the members and they should be included in this WhatsApp group.

Role of the members in WhatsApp group of the Farmer Field Schools

- All members are required to post their messages related to the pre-identified activities according to the plan using a variety of media (text, images, text, video, etc.).
- Members should post problems/issues observed in farmer field as soon as possible.
- Conducting effective discussion forum to make correct decision for posted issues of members by sharing knowledge and experiences of group members while maintaining active and live discussion.
- Adhere to the messages, notices, instructions etc. given by the facilitator.

Role of facilitator in WhatsApp group of the Farmer Field Schools

- Development, administration and maintenance of the WhatsApp group.
- Acquire enough knowledge and understanding on the objectives, methodology and action plan of the project and technology of the project activities.

- Providing messages with technical information required to improve the technical knowledge of the members.
- Posting the technical information, media materials and notices posted by board of the experts WhatsApp group to the farmer field schools WhatsApp group.
- Forwarding the issues addressed by the members posted on the farmer field schools WhatsApp group to the board of the experts WhatsApp group to get the experts advisory and sharing their advice to the WhatsApp group of the farmer field schools.
- Facilitate discussion forums to make the right decision by sharing the knowledge and experiences among the members of the farmer field schools.
- Provide constant attention on both WhatsApp groups to take necessary actions to achieve project success with efficient communication.

ii. WhatsApp group for the members of the board of the experts

Technical experts like pathologists, entomologists, agronomist etc. should be included in this WhatsApp group who will post technical messages and alerts accordingly to sync with the crop calendar periodically and advisory to the issues of farmer field school members. In addition, project officials should also be included in this group to post required messages, notices etc. to monitor and implement the project activities. Furthermore, this group should include all the facilitators of the Farm Field Schools who coordinate between the WhatsApp groups of the project for sharing knowledge and experience among members of the farmer field schools and the board of experts.

2. Facebook social networking site

The information shared on Facebook are more public and will be seen by many other people. Information communication mechanism of the Farmer Field Schools using different approaches of the Facebook social networking site are described below.

I. Facebook Groups

A profile account is required to create a Facebook group or help manage one. Groups are a place to communicate about shared interests with certain people. Facebook groups can be created for anything and the group's privacy settings can be customized depending on whom to join and see the group. When joining a group on Facebook, content from that group will start to show in the News Feed of the profile account. These are closed private groups administrated by the facilitators of the relevant farmer field school and all the members of the related farmer field school and other technical and project officials will be invited. Only the members of this private group are allowed to share information and experience on this Facebook group as posts and comments. Facilitator of the farmer field school should cover all activities and issues time to time by using proper reporting system. Technical experts can post important messages, technical information, and alerts to the group to improve knowledge and attitudes of the members. Project officials have access to monitor the project activities and evaluate farmer field schools and they can post notices to notify the members to implement the project activities according to the action plan.

II. Facebook Pages

A profile Facebook account is needed to create a Facebook Page or help manage one. When someone likes or follows a Page on Facebook, they can start seeing updates from that Page in their News Feed. Technical information, news, events and activities of the project will be posted and only the board of experts are allowed to post in this page. All the members of the project should be encouraged to like the page. This page is open for public who clicked on like and follow and will get information and updates on the project activity and they can comment on the posts.

Appendix 7: Field Study on use of DOA recommended fertilizer application

Department of Agriculture (DOA), Sri Lanka, has provided fertilizer recommendations (straight fertilizers) for potato cultivation but farmers who consider the amount recommended is not sufficient do not follow these recommendations and they tend to use higher quantities of mixed fertilizers. This practice leads to nutrient accumulation in soil resulting in environmental pollution and increased cost of cultivation. Convincing these farmers to use DOA recommendation is a challenging process. Therefore, following experiment is proposed to be conducted in FFS under the management and supervision of farmers in their own fields to get firsthand information on correct fertilizer practices.

Aim:-

Compare the effect of using straight fertilizer and mixed fertilizer on potato plant growth, occurrence of pest and diseases and tuber yield/quality.

Objectives

- To make awareness for farmers about planning a simple experiment
- To understand either mixed or straight fertilizer increases yield
- To evaluate the cost effectiveness
- To convince farmers on the usefulness of DOA recommendation

Materials: - poster papers, note books, markers

Step 1: Preparing idea matrix

- Explain objectives of the exercise
- Divide farmer group in to sub groups of 5-6 farmers
- Ask them to write answers to the following questions
  - Why do you use mixed fertilizer?
  - Why you do not use straight fertilizer?
- Write farmers' answers in the note book and finally on the poster paper
- Present to whole group and discuss.
- Facilitator can summarize those answers in an idea matrix given below;

Idea matrix

Idea matrix is a tool which encourages farmers to consider all possible effects of selected topic. Farmers can fill the idea matrix by asking "what are the possible influences when using ..... fertilizer?" Influences may be on crop yield, on ecosystem, pest and diseases or social or economic aspects.

Sample Idea matrix - Use of Straight fertilizer

Idea	Source of each idea	What do we think
Increase diseases	Own experiences	Need to be tested
Low yield	Own experiences	Need to be tested
Lots of fertilizer can be wasted	News paper	Possible but how to observe
Urea increase diseases	Friend	Need to be tested

Sample Idea matrix - Use of Mixed fertilizer

Idea	Source of each idea	What do we think
High yield	Own experiences	Need to be tested
Low diseases	Neighbor farmer	Need to be tested
Healthy plant	Neighbor farmer	Need to be tested

Hypothesis

This type of farmer participatory action research has a single hypothesis. In this experiment the hypothesis to be tested is "use of mixed fertilizer increases yield". All other observations made are treated as minor objectives.

Step 2: Field implementation

Selecting a land for experiment

It is preferred to do a comparative study using two adjacent plots of 500m^2 each. Try to select a flat land to maximize soil uniformity. Collect soil samples in both plots before imposing treatments and analyze for pH, EC, P and K. In Treatment 01, follow the exact DOA recommendation in type and quantity of fertilizer. In Treatment 02 farmer has the freedom to apply desired quantity of whatever fertilizer available in the market or to follow the fertilizer practice developed by his own experiences. Collect soil samples after harvesting and do the same analysis.

- Treatment 1 - straight fertilizer (DOA recommendation)
- Treatment 2 - mixed fertilizer (farmer practice)

Note

In both treatments verity, spacing, size of tubers, planting method, irrigation and all other management practices, must be equal other than the fertilizer.

Treatment 1 Straight fertilizer	Treatment 2 Mixed fertilizer

Ask other farmers to start same experiment in their own lands.

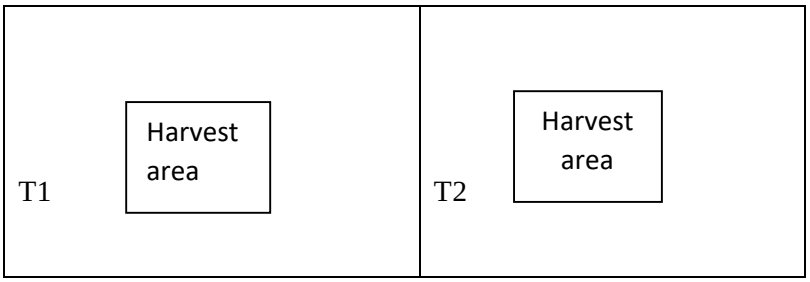
Step 3: Preparation of observation matrix

This matrix helps us to understand what kind of observation should be made and how. Observation matrix is based on idea matrix. This should be completed before the start of the study.

Example – observation matrix

What should be observed	How	When
Yield	Crop cut	At harvest
Diseases	Randomly selected 10 plants	Weekly
Pests	Randomly selected 10 plants	Weekly
Plant height	Average of 10 plants	Weekly
Number of stems	Average of 10 plants	Weekly

Crop cut – demarcate a same size area in the middle of each plot



Step 4: Evaluation

At the end of the season when all the farmers have completed their data collection according to the observation matrix, they can make collective decisions on all major/ and minor hypotheses.

Evaluation matrix.

Different types of observation produces different types of opinion on yield, insect damages, disease levels, cost etc. Weekly observations on some aspects can be summarized using their averages. Yield data can be used directly.

Evaluation matrix evaluate ideas formulated at the beginning. Conclusions can be made by adding results to the evaluation matrix.

Sample evaluation matrix

Idea to be tested	**Results**		**Conclusions**
	T1	**T2**	
Mixed fertilizer increases the yield	100 kg	128 kg	Yes mixed-fertilizer increases the yield
Cost of fertilizer	Rs 1000	Rs 4500	But not cost effective
Number of stems/ plant	Average 3	Average 3	No difference

All the farmers' results should be evaluated to get the final conclusion.

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