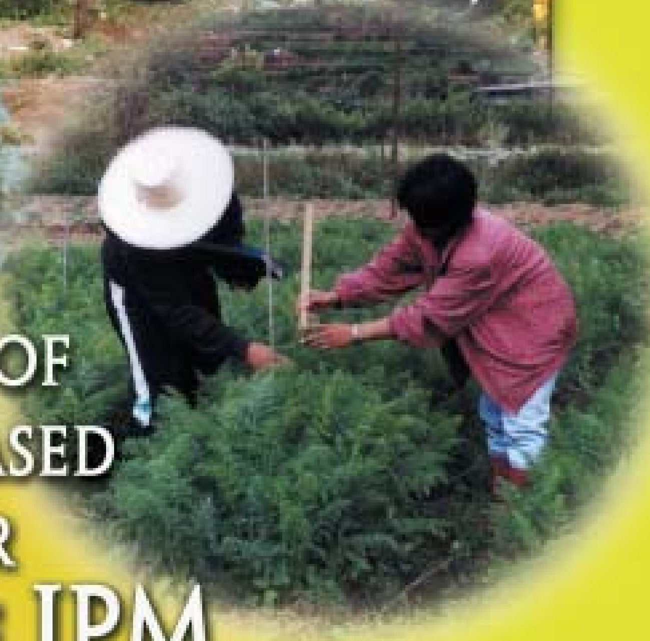


FIELD GUIDE OF DISCOVERY-BASED EXERCISES FOR VEGETABLE IPM

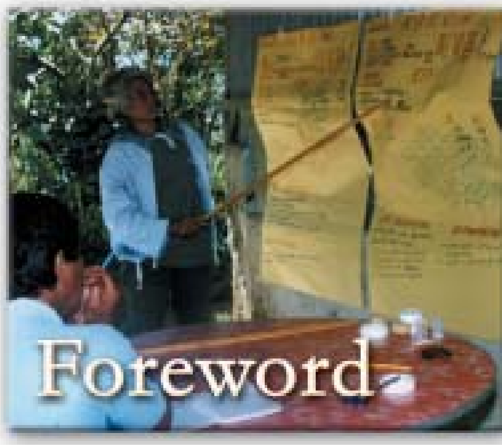
• VOLUME II •

KASAKALIKASAN,
the Philippine National IPM Program

Cordillera Highland Agricultural Resources
Management (CHARM) Project

ASEAN IPM Knowledge Network

SEAMEO Regional Center for Graduate Study
and Research in Agriculture (SEARCA)



Foreword

This ***Field Guide of Discovery-based Exercises for Vegetable IPM (Volume II)*** is a compilation of exercises based from experiences of KASAKALIKASAN field trainers from local government units and nongovernment organizations for almost a decade of experiences in conducting season-long farmer field schools (FFSs) for vegetable IPM in the Cordilleras. Exercises in this field guide invite discovery, comparison, and analysis that help our field trainers stimulate learning process of farmers, sharpen their decision-making skills, and strengthen their capacity to apply appropriate IPM principles in vegetable production.

Included in this new volume are supplemental and additional discovery-based exercises in integrated crop, soil, pest, and disease management as well as in seed production, harvest and postharvest management. Technical experts from Benguet State University (BSU) and specialists from CHARM, KASAKALIKASAN, and ASEAN IPM worked together to enrich this field guide.

This field guide is copublished by the Philippine National IPM Program (KASAKALIKASAN), the Cordillera Highland Agricultural Resources Management (CHARM) Project, the ASEAN IPM Knowledge Network (ASEAN IPM), and the SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA). We are pleased to note that CHARM and KASAKALIKASAN, together with ASEAN IPM, are making enormous and valuable contributions in promoting sustainable agriculture in the Philippines and within the ASEAN region.

LEONARDO Q. MONTEMAYOR
Secretary of Agriculture

Field Guide of Discovery-based Exercises for Vegetable IPM (Volume II)

Compiled and edited by:

DAMASO P. CALLO, JR.,
LANDIS B. TEOFILO and
HARRIET A. TAULI

Published jointly by:

KASAKALIKASAN, The Philippine National IPM Program,

Cordillera Highland Agricultural Resources Management (CHARM) Project,

The ASEAN IPM Knowledge Network (ASEAN IPM), and

The SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA)

Field Guide of Discovery-based Exercises for Vegetable IPM (Volume II). This field guide is based from experiences shared by farmer field school (FFS) facilitators of KASAKALIKASAN in the Cordilleras, which have been tried and proven to be effective in the conduct of season-long training activities for vegetable production in the Philippines.

Published jointly by
KASAKALIKASAN, The Philippine National IPM Program, Diliman, Quezon City, Philippines;
Cordillera Highland Agricultural Resources Management (CHARM) Project, Baguio City, Philippines;
ASEAN IPM Knowledge Network, SEARCA, College, Laguna, Philippines; *and*
SEAMEO SEARCA, College, Laguna, Philippines;
Printed in the Republic of the Philippines
First Printing, January 2002

Compiled and edited by
Damaso P. Callo, Jr., Landis B. Teofilo, *and* **Harriet A. Tauli**
Style editing by
Claudia S.Z. Cabrera *and* **Nova A. Ramos**
Cover design and layout by
Romulo T. Yambao

ISSN No. 1606-8637

Table of Contents

Section 4

Acknowledgment

We are very pleased to acknowledge all vegetable IPM farmers and facilitators of farmer field schools (FFSs), training of trainers (TOT) and vegetable specialist training (VST) for their commendable efforts in advancing KASAKALIKASAN, the PHILIPPINE NATIONAL IPM PROGRAM thrust and objectives as enabling tools of people empowerment. Experiences they shared in various FFS endeavors formed the bases of exercises compiled in this field guide.

Our sincere gratitude goes to the staff of CHARM, headed by Dr. Cameron P. Odsey; KASAKALIKASAN National Program Office and ASEAN IPM Knowledge Network Center, headed by Dr. Jesus S. Binamira; SEAMEO SEARCA Consulting Services Unit, headed by Dr. Francisco P. Fellizar, Jr.; and Media Lab of Knowledge Management Program, headed by Ms. Nova A. Ramos, for the generous assistance they had extended, without which this field guide may not have been completed.

Special thanks are also given to Dr. Jose R. Medina, Dr. Eulogio V. Cardona, Jr.,Dr. Edwin T. Balaki and Dr. Sergia P. Milagrosa; Professor Silvestre L. Kudan, Mr. Freddie T. Langpaoen, Mr. Roland A. Carpio, Mr. Inocencio B. Bernard, Mr. Charles C. Sagudan and Mr. Alvin S. Fajardo, and Ms. Teresita K. Mangili, Ms. Araceli B. Pedro and Ms. Luz M. Palengleng for their very useful comments, suggestions, facilitation, and extensive technical inputs. Our gratefulness are likewise extended to Mr. Alvin G. Tallada, Mr. Ronald P. Salazar, Mr. Reden R. Cabantac, Mr. Nonoy B. Alegre and Mr. Ding S.J. Austria, and Ms. Maria A. Austria, and Ms. Adelfa B. Bellen for their constant support and assistance.

Furthermore, this field guide may not have been published without concurrence and financial support extended by the Philippine Department of Agriculture (DA) and SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA).

Preface

The ultimate goal of ASEAN IPM Knowledge Network (ASEAN IPM) is to help national government and nongovernment organizations within the ASEAN region to improve effectiveness of program implementation by making knowledge sharing easy among national IPM programs and ensuring that information held is accurate, relevant, and up-to-date.

A critical function of ASEAN IPM in this direction is knowledge management. This includes gathering and updating of available integrated pest management (IPM) information, as well as related practices and experiences in growing healthy crops from the national IPM or crop production programs of the ASEAN countries and synthesis of these information to create knowledge capital appropriate for each specific country.

One concrete output in this regard is *Field Guide of Discovery-based Exercises for Vegetable IPM (Volume II)*, which is copublished by the Philippine National IPM Program (KASAKALIKASAN), the Cordillera Highland Agricultural Resources Management (CHARM) Project, the ASEAN IPM Knowledge Network (ASEAN IPM), and the SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA).

This field guide is a compilation of supplemental and additional discovery-based exercises in integrated crop, soil, pest, and disease management as well as in seed production, harvest and postharvest management topics enriched by technical experts from Benguet State University (BSU) and specialists from CHARM, KASAKALIKASAN, and ASEAN IPM.

We are hopeful that this practical training tool will be used, adapted, or modified by FFS field trainers in conducting season-long vegetable IPM training not only in the Philippines but in other ASEAN countries as well, when and where they judge them to be helpful.

RUBEN L. VILLAREAL
Director, SEARCA

Acronyms and Abbreviations

ADB	Asian Development Bank
AESA	Agroecosystem Analysis
Ammophos	Ammonium phosphate
Ammosul	Ammonium sulfate
ASEAN	Association of Southeast Asian Nations
ASEAN IPM	ASEAN IPM Knowledge Network
AT	Agricultural Technologist (or Technician)
ATI-NTC	Agricultural Training Institute-National Training Center
BCA	Biological Control Agent
BIOACT	*Paecilomyces lilacinus* (soil fungus' commercial preparation)
BOT	Bacterial Oozing Technique
BPI	Bureau of Plant Industry
BPI-BNRDC	BPI-Baguio National Research and Development Center
Bt	*Bacillus thuringiensis* (bacterium)
BSF	Baseline Survey Form
BSU	Benguet State University
Ca	Calcium
CAR	Cordillera Administrative Region
CHARM	Cordillera Highland Agricultural Resources Management Project
CO_2	Carbon dioxide
CSF	Contour Strip Farming
CRA	Cost and Return Analysis
DA	Department of Agriculture
DA-CARFU	DA-Cordillera Administrative Regional Field Unit
DA-CECAP	DA-Central Cordillera Agricultural Project
DBM	Diamondback Moth
Diadegma	*Diadegma semiclausum* wasp
ECM	Evaporative Cooling Method

FARM	Farmer-centered Agricultural Resources Management Project
FAO	Food and Agriculture Organization (of the United Nations)
FCP	Farmers' Crop Protection
FFS	Farmer Field School
GLM	Green Leaf Manuring
GOP	Government of the Philippines
GR	Gross Return
HARRDEC	Highland Agricultural Resources Research and Development Consortium
HWT	Hot Water Treatment
ICM	Integrated Crop Management
IIBC	International Institute for Biological Control
IFAD	International Funds for Agricultural Development
INM	Integrated Nutrient Management
ISM	Integrated Soil Management
IPM	Integrated Pest Management
KASAKALIKASAN	Kasaganaan ng Sakahan at Kalikasan
LGU	Local Government Unit
Limestone	Calcium or Magnesium Carbonate
MAD	Man-Animal-Days
MAO	Municipal Agricultural Office (or Officer)
MD	Man-Days
Mg	Magnesium
MI	Maturity Index
MMD	Man-Machine-Days
NAFC	National Agricultural and Fishery Council
NE	Natural Enemies
NFE	Nonformal Education
NGO	Nongovernment Organization
NPO	National Program Office (or Officer)
NPRCRTC	Northern Philippines Root Crop Research and Training Center
NPV	Nucleo-polyhedrosis Virus
NR	Net Return
OPA	Office of the Provincial Agriculturist
O_2	Oxygen
P	Phosphorus
PA	Provincial Agriculturist

PCARRD	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development
pH	Negative logarithm of hydrogen ion concentration in soil solution (log 1/[H])
PHM	Post-Harvest Management
PTD	Participatory Technology Development
Quicklime	Calcium or Magnesium Oxide
RCT	Refresher Course for Trainers
ROI	Return on Investment
S	Sulfur
SALT	Sloping Agricultural Land Technology
SEAMEO	Southeast Asian Ministers of Education Organization
SEARCA	SEAMEO Regional Center for Graduate Study and Research in Agriculture
Slaked Lime	Calcium or Magnesium Hydroxide
STT	Sap Transmission Technique
TLC	Total Labor Cost
TMC	Total Material Cost
TOS	Training of Specialists
TOT	Training of Trainers
Trichoderma	*Trichoderma harzianum* fungus
TVD	Tymo Virus Disease
UPLB	University of the Philippines Los Baños
VST	Vegetable Specialist Training
WFT	Water Floating Technique
WHC	Water Holding Capacity
YST	Yellow Sticky Trap

Section 1

Introduction

Section 1 Introduction

ABOUT THIS FIELD GUIDE

This *Field Guide of Discovery-based Exercises for Vegetable IPM (Volume II)* is designed for use in vegetable IPM farmer field schools (FFSs). The exercises in this field guide were based on experiences shared by vegetable FFS facilitators and farmer-graduates from the Cordilleras and resource persons from Benguet State University (BSU), ASEAN IPM Knowledge Network (ASEAN IPM) Regional Center , Philippine National IPM Program (KASAKALIKASAN) and Cordillera Highland Agricultural Resources Management (CHARM) Project in three interrelated workshops. These were: (a) *Technical and Program Administration Review of IPM in the Cordilleras* held on 03-06 August 1998[1] ; (b) *Curriculum Development for the Refresher Course for Trainers and FFSs in IPM on Crucifers and Other Vegetables in the Cordilleras* held on 10-14 August 1998[2] , and (c) *Refresher Course for Trainers of Integrated Pest Management (RCT-IPM) in Crucifers and Other Vegetables* held from 27 September to 27 October 1998[3] .

In said workshops, participants (see *Annexes A-E*) shared experiences from FFSs that have been conducted since the 1992 pilot project on IPM in the Cordilleras. These series of activities allowed participants to critique

1 Binamira, J.S. 1998. A Consultant's Report: An Evaluation of Impact of the IPM in Crucifers in the Cordilleras. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Regional Field Unit, Baguio City, Philippines. pp1-18.

2 Binamira, J.S. 1998. A Consultant's Report: Curriculum Development for Refresher Course for Trainers and Farmer Field Schools on IPM in Crucifers and Other Highland Vegetable Crops. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Regional Field Unit, Baguio City, Philippines. pp1-23.

3 Binamira, J.S. 1998. A Consultant's Report: Refresher Course for Trainers of IPM in Crucifers and Other Highland Vegetable Crops. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Regional Field Unit, Baguio City, Philippines. pp1-30.

exercises in the previous volume and determine supplemental and additional discovery-based exercises for FFS for this new volume (Volume II) that will enhance better understanding of some topics discussed in Volume I. The additional exercises will also supplement new topics suggested for inclusion in Volume II. Some of these exercises are updated versions of exercises that we feel work well already while others are totally new.

This field guide is a collection of discovery-based exercises that facilitators like us can use and adapt, when and where we judge them useful. We involved as many FFS stakeholders as was possible in compiling or redesigning these field exercises. Although these exercises belong to us, this field guide will achieve nothing until we start to put the ideas into action.

As in the first volume, discovery-based exercises contained in this field guide are divided into several sections consisting of supplementary and additional exercises on: (i) introductory; (ii) general; (iii) agronomy, integrated crop and soil management; (iv) pest and disease management; and (v) seed production, harvest and post-harvest management topics.

With ownership comes responsibility. It is *our* responsibility to update and modify this field guide as new experiences and ideas come out of our own FFSs. Some additions have to be made to these exercises, because we did not have time to fill all gaps and refine all steps. This means that we might need to revise and redesign what is written here, based on *future* experiences and feedback.

What is a discovery-based exercise?

During our previous workshops we returned repeatedly to these questions, 'What do we really mean by a discovery-based exercise?' and 'How can we make this exercise more discovery-based?'

There are no *ultimate* answers to these questions, but a number of patterns and ideas did emerge from our design sessions. These are described below. We hope that they will give you some ideas of what we are aiming for.

Go to the field

The field provides main learning material for FFS and other fields in the village (barangay) provide us with an extra resource when needed. Any exercise that we design should have its roots in the fields. This means that we need to go out to the fields and observe *before* we start any discussions or activities.

What is happening in the field today?

If activities are rooted in the field, they are also based on what is happening in the field at *the moment*. We cannot discover something happening *now* if it already happened in the past, or will happen in the future. Therefore, activities described in this field guide are designed to be used in response to what is happening in the field NOW!

Share our experiences

We must never forget that farmers may already have plenty of experience on a particular topic. We need to listen to and learn about farmers' experiences. We will gain new ideas and insights from local practices, as well as having a better idea of areas where farmers are lacking in technical information or understanding.

What do farmers want and need?

The people who are discovering in FFS are primarily FARMERS.

People remember[5]: **20% of what they HEAR**
40% of what they SEE
80% of what they DISCOVER FOR THEMSELVES.

4 Hope, A. and Timmel, S. 1994. Training for Transformation 1: A Handbook for Community Workers. Mambo Press, Gweru, Zimbabwe. pp99-120.

Some of the things that FFS group discovers are also new to us. Nevertheless, 'discovery-based' exercises aim to help participants remember more of what they are learning. Therefore, we must choose exercises based on what FARMERS want and need to discover for themselves!

Discover, evaluate, and understand!

We do not want to start any exercise with the assumption that there will be a *correct* answer or outcome. If we do this, then we cannot expect participants to learn from what they have observed. Instead, they will just tell us what they think we want to hear, based on what we told them to say!

An example: If we want to run a session on 'Record Keeping,' we cannot start the session by saying, "*Record keeping is important*, so what records do you think we should keep?" Even if this seems participatory, it is not discovery-based, because we have started by instructing farmers that record keeping is important! Instead, we need to guide farmers to *discover* that record keeping may be useful to them.

By discovering information ourselves and then evaluating *if* and *how* it could be useful, we can start to look at what we observe or hear more critically.

By discovering information ourselves and then evaluating *if* and *how* it could be useful to us, we can start to be more critical with what we observe and hear.

By thinking *critically we* are not being NEGATIVE, we are being *POSITIVE*. We do not just think what people *tell* us to think anymore. We are starting to build skills in *analyzing* what we observe. We can then base our decisions on our *own experiences* and *understanding*.

These skills of critical *questioning*, *discovery*, *analysis,* and *evaluation* are what farmers take away from FFS to use in tackling new problems in their own farms.

Thus, building farmers' *DISCOVERY-BASED* skills
WITH farmers' *DECISION-MAKING* skills
is what makes IPM farmers field school *SUSTAINABLE*!

General guidelines for discovery-based exercises!

In consideration of the above, participants in the recently concluded IPM refresher course[5] agreed on some general guidelines in conducting discovery-based exercises for FFS on crucifers and other vegetables, namely: (a) exercise should be preceded by a field activity (e.g., field walk, field observation, field visit, etc.); (b) procedure should enhance participatory, discovery-based, and experiential learning; (c) exercise should be designed to facilitate regular FFS activities, such as agroecosystem analysis (AESA), field studies, cultural management practices, and special topics; (d) exercise should encourage use of biological control and discourage indiscriminate use of pesticides; and (e) exercise should use appropriate nonformal education (NFE) techniques as learning tools.

Format for exercises

Each exercise in this field guide has been arranged in a standard format of sections and subsections. We hope that this will make it easier for you to find specific information that you want to use. The various exercises under each section or subsection are further divided into subheadings as listed below with a short description of content:

Background and rationale

- This section gives a short description of exercise, which we hope you can easily grasp.

When is this exercise most appropriate?

- Some guidelines as to what might be happening in the learning field, and what experience the FFS group needs to have before starting an exercise.

How long will this exercise take?

- An estimate of the length of time between the start and end of an exercise. In addition, how much time an exercise will take during FFS meetings and what extra time inputs are needed outside FFS meetings.

Learning objectives

- What we aim to discover from an exercise.

[5] Binamira, J.S. 1998. A Consultant's Report: Refresher Course for Trainers of IPM in Crucifers and Other Highland Vegetable Crops. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Regional Field Unit, Baguio City, Philippines. pp1-30.

Materials

- What equipment, supplies, and materials you will need to collect or prepare in advance.

Methodology

- A list of nonformal education methods or approaches used to facilitate an exercise, e.g., field walks and observations, sharing of experiences, brainstorming, participatory discussions in small or big groups, role-playing, hands-on or simulation exercise, and others.

Steps

1. A numbered list of steps that you will take to complete an exercise.

Some suggested questions for processing discussion

- ❑ Every exercise needs a processing discussion to evaluate observations and results and to draw out a common agreement on what has been discovered. This section gives some suggestions for questions and ideas that your group may like to explore during your processing.

- ❑ If an exercise is based on a guided discussion, processing may already be included in the STEPS section.

Section 2

Supplementary and Additional General Topics

Section 2 Supplementary and Additional General Topics

In a previous volume (Volume I), a section of general topics dealt on KASAKALIKASAN and FFS orientation. That section consisted of five sub-sections, namely: (a) approach and concept; (b) some useful training tools; (c) ecosystem; (d) hazards of pesticides to humans and environment; and (e) record keeping. Thus, discovery-based exercises under each subsection were compiled to help participants better understand and apply KASAKALIKASAN principles through FFSs[6].

Under this new volume, supplemental and additional general topics were compiled based from experiences shared by FFS facilitators in implementing local vegetable IPM programs since the previous volume was published in 1997[7]. Included in this section are exercises tried by our FFS facilitators and proven to be effective in enhancing participants' understanding of IPM concepts and principles, such as:

- *What is in a box: Nonformal versus formal education.* This exercise was designed to supplement 'Approach and Concept of KASAKALIKASAN and Farmer Field School.'

---

[6] Philippine National IPM Program. 1997. Field Guide of Discovery-based Exercises for Vegetable IPM. National Agricultural and Fishery Council, Department of Agriculture, Diliman, Quezon City, Philippines. pp2-1 to 2-124.

[7] Binamira, J.S. 1998. A Consultant's Report: Refresher Course for Trainers of IPM in Crucifers and Other Highland Vegetable Crops. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Regional Field Unit, Baguio City, Philippines. pp1-30.

- *Gathering and using baseline data.* This exercise was designed to supplement previous exercises on 'Groundworking for Farmer Field Schools' and 'Barangay Immersion: How Do We Identify Needs of Farmers in FFS.'

- *Facilitating problems of absenteeism.* This exercise will supplement previous exercises on 'Managing Farmer Field Schools' and 'How to Establish IPM Participatory Norms.'

- *'Ballot box' for farmer field schools of other vegetables: Developing functional questionnaires for pre- and post-evaluation.* This exercise is a supplement to the 'Ballot Box Exercise: Evaluating Knowledge and Skills in IPM.'

- *Agroecosystem analysis for farmer field schools of other vegetables: Establishing minimum data for decision-making.* This exercise is a supplement to the 'Agroecosystem Analysis: Making a Crop Management Decision.'

- *Field layout and agroecosystem analysis format for farmer field schools of crucifers and other vegetables.* This is an additional supplement to the exercise on 'Agroecosystem Analysis: Making a Crop Management Decision.'

- *Cost and return analysis of vegetable production.* This activity was designed to supplement the exercise on 'Guided Discussion and Sharing on *Why* and *What* to Record: Keeping Record of Farm Activities.'

Exercise No. 2.01

What is in the box: Nonformal education versus formal education

Background and rationale

NFE methods and approaches, as knowledge management strategies, bring about sharing of knowledge and creation of new knowledge, and in this process empowers participants. Activities allow participants to observe, discuss, interact, brainstorm; as well as perform analysis, make decisions, and solve problems[8] .

Essentially, NFE is a participatory educational process based on assumptions on adult learning. When adult learners decide to participate in any learning activity, they bring along a wealth of experience, knowledge, and skills. They are armed with their own beliefs, values, and convictions. They have their own perceptions, biases, and feelings. With such a background, an adult learner is the richest resource in a learning process[9] .

NFE methods and approaches encourage participants to see themselves as source of information and knowledge about the real world. When they are encouraged to work with knowledge they have from their own experience, they can develop strategies together to change their immediate situations. This learning experience takes place in several ways as described below[10] :

- *Existing popular knowledge is recognized and valued.* The learning process starts with an assumption that participants already possess some knowledge. Participants do not start with a clean slate. In this approach, synthesis of popular knowledge with existing scientific knowledge strengthens learning experience of participants.

- *New knowledge is built on existing knowledge.* In the learning process, the starting point for creating new knowledge is on the existing knowledge that people have, particularly, authentic elements of it. As people begin to

[8] Callo, Jr. D.P., W.R. Cuaterno, and H.A. Tauli (eds.). 1999. Handbook of Non-Formal Education and Team Building Exercises for Integrated Pest Management. SEAMEO Regional Center for Graduate Study and Research in Agriculture, College, Laguna, Philippines. pp5-7.

[9] Ortigas, C.D. 1997. Training for Empowerment. Office of Research and Publication, Ateneo de Manila University, Loyola Heights, Quezon City. p13-26.

[10] Society for Participatory Research in Asia. 1987. Participatory Training for Adult Educators. Society for Participatory Research in Asia Publication, New Delhi, India. p7-9.

appreciate what they already know, they are more open to seek new information. This desire to seek new information and knowledge enhances learning process.

- *Participants learn to exercise control.* A learning process puts emphasis on active participation of participants in generating their own knowledge. This encourages them to take responsibility for their own learning. It is this active posture which constitutes a powerful impetus for learning and for learners to exercise control over their learning.

- *Learning becomes a collective process.* One of the elements of NFE is a promotion of collective responsibility for seeking new knowledge. As a result, participants learn to get together, collectively seeking and analyzing information.

- *Learning creates informed options.* The very process of collectively analyzing a given situation presents various alternatives. As part of the process of analysis, options are debated based on concrete information. As a result, participants are able to accept and reject options on an informed basis. This creates a sense of empowerment, which is based on confidence that information has been understood and interpreted.

- *Actions emerge out of this analysis.* The very act of involvement in a process of analyzing a given reality creates a sense of ownership of that knowledge and willingness to transform that situation. Participants are then able to take concrete actions.

Thus, where possible, facilitators should create a learning situation where adults can discover answers and solutions for themselves. People remember things they have said themselves best, so facilitators should not speak too much. They need to give participants a chance to find solutions before adding important points a group has not mentioned. Likewise, it was mentioned earlier that people remember 20 percent of what they hear, 40 percent of what they see, and 80 percent of what they discover for themselves[11] .

[11] Hope, A. and Timmel, S. 1994. Training for Transformation 1: A Handbook for Community Workers. Mambo Press, Gweru, Zimbabwe. pp99-120.

This exercise was designed to supplement Exercise No. 2.01 (Mental Map Exercise: Approach and Concept of KASAKALIKASAN and Farmer Field School) and Exercise No. 2.02 (Nine Dot Game: Approach and Concept of KASAKALIKASAN and Farmer Field School), Field Guide of Discovery-based Exercises for Vegetable IPM, Volume I.

When is this exercise most approriate?

- In TOT and VST sessions, when supplemental or additional exercise is needed to further enhance participants' understanding of concepts and principles of nonformal education

How long will this exercise take?

- At least 30 minutes for simulation game
- At least 30 minutes for brainstorming and sharing of experiences

Learning objectives

- To differentiate nonformal education from formal education techniques.
- To further enhance participants' understanding of concepts and principles of nonformal education.

Materials

- Manila paper, marking pens, notebooks, and ball pens

Methodology

- Simulation game, brainstorming, and sharing of experiences

Steps

1. The facilitator fills a box with 10 different objects and asks each small group to choose three representatives from among themselves.

2. The first set of representatives (one from each group) is asked to stand in front and beside a facilitator who then shakes the box for about two minutes while each representative listens. Representatives are then requested to take their seats, then try to list down the contents of above box based on what they heard while the box was being shaken, without conferring with each other.

3. The second set of representatives (one from each group) is again asked to stand in front and beside the facilitator who again shakes the box for about two minutes while each representative listens. Afterwards, each representative is asked to touch the contents of the box, one after the

other, without looking at the inside. Representatives then take their seats and try to come up with their own list of contents of the box, without conferring with each other.

4. A third set of representatives (one from each group) is again asked to stand in front and beside a facilitator who again shakes the box for about two minutes while each representative listens. Afterwards, each representative is asked to touch and see the contents of the box, one after the other. Representatives then take their seats and try to come up with their own list of contents of the box, without conferring with each other.

5. Remaining participants are instructed to observe ongoing activities.

6. A facilitator will then request each set of representatives from each small group to read their lists before the big group. A facilitator compares the lists made by each set of representatives and process the activity.

Some suggested questions for processing discussion

- ❏ Which set of representatives listed more objects? Why?
- ❏ What learning principles characterize each game as exemplified by each set of representatives?
- ❏ Which learning principles can we adopt in the farmer field school?
- ❏ What is nonformal education? How do you differentiate it from formal education?
- ❏ Which form of education is more relevant to farmers? Why?

Exercise No. 2.02

Gathering and using baseline data for impact evaluation of Farmer Field Schools

Background and rationale

As mentioned in a previous volume, the local IPM team as a pre-FFS activity carries out the task of groundworking. Groundworking determines actual needs in an area, which will ultimately be used as basis in developing local IPM programs. Thus, largely, the success of a local IPM program is directly related to the quality of groundworking activities conducted.

One very useful component activity of groundworking is gathering of baseline data from FFS farmer-participants. Baseline data are important for comparison with current data when stakeholders review and assess impact of local IPM programs on farmer-participants and their communities. The formulation of appropriate recommendations, which will form courses of actions or interventions, will depend on the accurateness of baseline data gathered.

Hence, usefulness of baseline data is contingent on accurate gathering of the same data. FFS facilitators must regularly share their experiences in gathering and using baseline data to continuously evolve better FFS approaches. This exercise was designed as a supplement for Exercise No. 2.03 (Role-play: Groundworking for Farmer Field Schools) and Exercise No 2.04 (Brainstorming and Participatory Discussions: Barangay Immersion; How Do We Identify Needs of Farmers in FFS), Field Guide of Discovery-based Exercises for Vegetable IPM, Volume I.

When is this exercise most approriate?

- In TOT and VST sessions, or by local IPM team, on or before an FFS session.
- After a barangay soil map has already been prepared.

How long will this exercise take?

- One to two hours for field walks and farmers' interviews one week before starting an FFS session.
- Thirty minutes to one hour for brainstorming session in processing area.
- Thirty minutes to an hour of additional farmers' interviews on first week of an FFS session.

Learning objectives

- To make participants aware of and understand the importance of proper gathering and using baseline data for designing and evaluating local IPM programs.
- To learn innovative approaches and experience hands-on the gathering and using of baseline data for designing local IPM programs.

Materials

- Barangay spot or soil map indicating farm sites of prospective FFS farmer-participants
- Farmer-validated baseline survey form for crucifers and other vegetables (see Form A)[12]
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)

Methodology

- Field walks, farmers' interviews, and brainstorming.

Steps

1. Review farm sites of prospective FFS farmer-participants from a barangay spot or soil map earlier developed by TOT and VST participants, or by IPM training team members;

2. Divide participants into smaller groups and ask each group to secure 25-30 copies of farmer-validated baseline survey forms for crucifers and other vegetables;

3. Using a barangay spot or soil map, go to prospective FFS farmer-participants, explain objective of survey, interview as many farmers as possible, and fill up baseline survey forms (personal information, farm profile, farm management, and production data);

4. Return to processing area and brainstorm in small groups on initial data gathered and methods used in data gathering. Present observations and experiences of small groups in the big group on the following:

   ✓ Who and how many additional farmers to interview;
   ✓ Items to exclude, include, or clarify in succeeding surveys;

[12] Binamira, J.S. 1998. A Consultant's Report: Refresher Course for Trainers of IPM in Crucifers and Other Highland Vegetable Crops. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Regional Field Unit, Baguio City, Philippines. pp56-59.

- ✓ Approaches and methods to use in gathering additional data; and
- ✓ How and when to use all baseline data gathered.

5. Complete baseline data gathering from at least 25-30 actual FFS farmer-participants during first week session;

6. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from the exercise.

7. Use output exercise on baseline data gathering in planning local IPM program in community, such as:

   - ✓ Crops and pest problems to be addressed;
   - ✓ Number and schedule of FFS to be conducted; and
   - ✓ Type and schedule of follow up activities to sustain local IPM program.

Some suggested questions for processing discussion

- ❏ What is a baseline survey? What is a baseline survey form?
- ❏ Why do we need to conduct baseline surveys? Who are the respondents of baseline surveys? What data do we need to gather in a baseline survey?
- ❏ What method or approach is most appropriate for gathering baseline data in FFSs?
- ❏ Can we use baseline data to plan present and future FFS activities? How?
- ❏ When do we gather baseline data in farmer field schools? How often do we gather baseline data for local IPM program implementation?

Form A

KASAKALIKASAN BASELINE SURVEY FORM FOR CRUCIFERS AND OTHER VEGETABLES

A. PERSONAL INFORMATION

1. **Name of Farmer:** ____________________
2. **Address:** ____________________
____
3. **Age:** ______ 4. **Sex:** [ ] Male [ ] Female
5. **Status:** [ ] Single [ ] Married [ ] Widow/Widower
6. **Education:** [ ] Elementary [ ] High School [ ] College
[ ] Others: ____________________
7. **Name of Spouse:** ____________________
8. **Tenural Status:** [ ] Owner/Cultivator [ ] Leaseholder
[ ] Tenant [ ] Others (please specify): __________
9. **No. of household members involved in farming:** ____________________
10. **Membership in community organizations:**

Organization	Position

11. **Last two trainings attended:**

	Sponsored by:	When

B. FARM PROFILE

1. **Farm Area (ha):** (a) major crop: __________ (b) other crops: __________
area: __________ area: __________

2. **Soil Type:** ____________________

3. **Irrigation:** [ ] NIA [ ] Communal [ ] Pump [ ] Rainfed
[ ] Others (Specify):

4. **Sources of income other than vegetable farming:** ____________________

5. **Sources of Capital:**

	Dry Season	Wet Season
a. Credit		
Production Loan (Pesos)	______	______
Percent per annum	______	______
Source	______	______
b. Self-financed (Pesos)	______	______

6. **Vegetable Crop Combination (arranged from largest area planted):**

DRY SEASON	AREA (ha)	WET SEASON	AREA (ha)
1.			
2.			
3.			
4.			
5.			

C. FARM MANAGEMENT

1. **Vegetable Crop Planted (Season: __________)**

CROPS	AREA (ha)	VARIETY	SEED CLASS	RATE/HA	COST/HA
1.					
2.					
3.					
4.					
5.					

2. Cost of Land Preparation and Weeding:

	LAND PREPARATION		WEEDING				
CROPS	PLOWING	HARROWING	FIRST	SECOND	THIRD	FOURTH	FIFTH
1.							
2.							
3.							
4.							
5.							

3. Seedbed Preparation, Planting and Fertilization:

	COST (INCLUDING LABOR)		FERTILIZER USE			
CROPS	SEEDBED	PLANTING	QUANTITY	KIND/BRAND	UNIT COST	APPL'N COST
1.	1.	1a.	1a.	1a.	1a.	1.
		1b.	1b.	1b.		
		1c.	1c.	1c.		

2.	2.	2a.	2a.	2a.	2a.	2.
		2b.	2b.	2b.		
		2c.	2c.	2c.		

3.	3.	3a.	3a.	3a.	3a.	3.
		3b.	3b.	3b.		
		3c.	3c.	3c.		

	COST (INCLUDING LABOR)		FERTILIZER USE			
CROPS	SEEDBED	PLANTING	QUANTITY	KIND/BRAND	UNIT COST	APPL'N COST
4.	4.	4a.	4a.	4a.	4a.	4.
		4b	4b.	4b.		
		4c.	4c.	4c.		

5.	5.	5a.	5a.	5a.	5a.	5.
		5b.	5b.	5b.		
		5c.	5c.	5c.		

Have you been using noncommercial fertilizers (e.g., animal manure, rice straw, compost, azolla, etc.) in your farm? [ ] Yes [ ] No If yes, since when? ________________

4. Pesticide Use

CROPS	HERBICIDE			INSECTICIDE			FUNGICIDE			OTHERS		
	QTY	KIND	UNIT PRICE	QTY	BRAND	UNIT PRICE	QTY	BRAND	UNIT PRICE	QTY	BRAND	UNIT PRICE
1.												
2.												
3.												
4.												
5.												

How many times did you spray your crop with pesticide? What was the cost of application?

CROPS	HERBICIDE		INSECTICIDE		FUNGICIDE		OTHERS	
	NO. OF TIMES	COST OF APPL'N	NO. OF TIMES	COST OF APPL'N	NO. OF TIMES	COST OF APPL'N	NO. OF TIMES	COST OF APPL'N
1.								
2.								
3.								
4.								
5.								

What was your basis for spraying? Please check.

[ ] Farmer friend told me to do so

[ ] Technicians/pesticide dealer told me to do so

[ ] Following the calendar spraying

[ ] Others (please specify) ____________

What were the common pest problems you have encountered ?

VEGETABLE CROPS	PEST PROBLEMS ENCOUNTERED
1.	
2.	
3.	
4.	
5.	

What insects/animals would you consider as friend or enemy of the farmer in his field ?

FARMER'S FRIEND	ENEMIES

D. PRODUCTION (Season : ___________):

CROPS	COST (PESOS)		YIELD PER HECTARE	
	HARVESTING	HAULING	KILOGRAMS	AMOUNT (P)
1.				
2.				
3.				
4.				
5.				

DATE INTERVIEWED: ________________________ INTERVIEWER: ______________________

BALLOT BOX SCORE: PRE-TEST _____________ POST-TEST _____________

Exercise No. 2.03

Facilitating sessions regarding absenteeism in Farmer Field Schools

Background and rationale

In a recently concluded refresher course for trainers (RCT) of IPM in the Cordilleras[13], some positive experiences and lessons learned were shared by participants in facilitating and managing FFSs. The most notable observations shared were: (1) protocols conducted by facilitators to involve local government unit (LGU) officials, consultation with farmers right at beginning, and continuous feedback activities to enhance local IPM program sustainability; and (2) facilitators' skills and perseverance contributed largely to FFS successes as farmer-participants try to replicate what facilitators practice.

However, one of the recurring problems experienced by facilitators is still absenteeism. The most common reason mentioned for absenteeism was attendance in community occasions and meetings. A number of recommendations were offered by FFS facilitators to solve absenteeism, such as: (1) proper orientation at the start of FFS activity must be done right at the beginning; (2) facilitators should make weekly topics interesting; (3) absenting farmer-participants should be required to send advance notice of their absences; sending of proxies should not be allowed; (4) absenting farmer-participants should be given importance by doing follow up on them and avoiding overemphasis on processing of absenteeism; and (5) FFS farmer-participants should be facilitated to organize themselves so that they can apply peer pressure to absenting farmer-participants.

The FFS facilitators can regularly share their learning experiences in solving problems of absenteeism among farmer-participants to further improve their individual facilitating skills and thus ensure sustained local IPM implementation. The forgoing exercise was designed as a supplement for Exercise No. 2.05 (Brainstorming and Participatory Discussions: Managing Farmer Field Schools) and Exercise No. 2.07 (Participatory Discussions: How to Establish IPM Participatory Norms), Field Guide of Discovery-based Exercises for Vegetable IPM, Volume I.

---

[13] Binamira, J.S. 1998. A Consultant's Report: Refresher Course for Trainers of IPM in Crucifers and Other Highland Vegetable Crops. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Regional Field Unit, Baguio City, Philippines. pp1-30.

When is this exercise most approriate?

- In TOT and VST sessions, or by local IPM team, when absenteeism among farmer-participants of an on-going FFS is a problem.

How long will this exercise take?

- One to two hours for field walks to visit absenting FFS farmer-participants anytime during a scheduled FFS follow up session.
- Thirty minutes for brainstorming session.
- Another one to two hours for the field walk to visit absenting FFS farmer-participants in succeeding FFS follow up session.

Learning objectives

- To make participants aware and understand the importance of facilitating sessions regarding absenteeism among farmer-participants of FFS to ensure sustained local IPM program implementation.
- To learn innovative approaches from other facilitators and do hands-on facilitating of a session on absenteeism among FFS farmer-participants.

Materials

- Barangay spot or soil map showing farm sites of farmer-participants of an ongoing FFS.
- Office supplies (Manila papers, notebooks, ball pens, and marking pens).

Methodology

- Field walks, farmers' interviews, and brainstorming.

Steps

1. Review farm sites of ongoing FFS farmer-participants from a barangay spot or soil map earlier developed by TOT and VST participants, or by IPM training team members;

2. Divide big group into smaller groups and let each small group design their own strategy to solve absenteeism. Using a barangay spot or soil map as a guide, each small group goes to absentee FFS farmer-participants and implements designed strategy on how to:

   ✓ Show absentee farmer-participants that they are important in the success of ongoing FFS;
   ✓ Make absentee farmer-participants share their own problems in vegetable production;
   ✓ Convince absentee farmer-participants that regularly attending FFS will help them solve or better understand their problems in vegetable production; and

- ✓ Get assurance from absentee farmer-participants to continue attending succeeding FFS sessions.

3. Return to processing area and brainstorm in small groups on initial experiences in using designed strategy to solve absenteeism. Present observations and experiences of small groups to the big group.

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from exercise.

5. Use output of exercise to facilitate succeeding FFS follow up sessions on absenteeism.

6. Repeat steps 3-5.

Some suggested questions for processing discussion

- ❑ What were the most common causes of absenteeism among FFS farmer-participants?
- ❑ What strategies did you employ to facilitate solving of absenteeism among FFS farmer-participants? Which of the strategies employed worked best?
- ❑ What pre-FFS activities should be undertaken by an IPM training team to ensure regular attendance of farmer participants in an FFS?
- ❑ How can a facilitator ensure that topics are interesting in every FFS session?
- ❑ Did following up of absentee farmer-participants help solve problems of absenteeism in an on-going FFS?
- ❑ How did you show absentee farmer-participants that they are important in the success of the ongoing FFS?
- ❑ How did you make absentee farmer-participants share their own problems in vegetable production? How did you convince absentee farmer-participants that regularly attending FFS will help them solve or better understand their problems in vegetable production?
- ❑ How did you get assurance from absentee farmer-participants to continue attending succeeding FFS sessions?

Exercise No. 2.04

'Ballot box' for Farmer Field Schools of other vegetables: Developing functional questionnaires for pre- and post-evaluation

Background and rationale

'Ballot Box' test is a field-based test administered to participants without using pen and paper. It uses specimens (e.g., materials, objects, plants, or animals) in vegetable fields. Questions in a 'Ballot Box' evaluation dealt mainly on knowledge and skills in identifying pest damages, disease symptoms, arthropod pests and their natural enemies, fertilizers and chemicals, as well as soil, irrigation, and environmental stresses in vegetable fields[14] .

For each questions, there are three 'ballot boxes' representing possible correct answers. Participants put replicates of their numbers in the box corresponding to the correct answer. A question may refer to a plant with strings attached to three specimens in a vegetable field as possible answers. In another instance, a question may refer to a specimen with strings attached to three plants in a vegetable field as possible answers[15] .

Past experiences showed that for a 'Ballot Box' test to be effective, the questions should focus on functions of organisms or specimens rather than on their technical definitions. In the previous volume of this field guide, function-based questions on crucifers for the 'Ballot Box' had been developed. For this new volume, this exercise was designed to develop functional 'Ballot Box' questionnaires for farmer field schools of other vegetables. This exercise is a supplement for Exercise No. 2.08 ('Ballot Box' Exercise: Evaluating Knowledge and Skills in IPM), Field Guide of Discovery-based Exercises for Vegetable IPM, Volume I.

14 Callo, Jr. D.P., W.R. Cuaterno, and H.A. Tauli (eds.). 1999. Handbook of Non-Formal Education and Team Building Exercises for Integrated Pest Management. SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA), College, Laguna, Philippines. pp179-180.

15 Philippine National IPM Program. 1997. Field Guide of Discovery-based Exercises for Vegetable IPM (Volume I). National Agricultural and Fishery Council, Department of Agriculture, Diliman, Quezon City, Philippines. pp2-23 to 2-26.

When is this exercise most approriate?

- In TOT and VST, before pre- and post-FFS evaluations of participants' IPM knowledge and skills in vegetables
- When other vegetables, in addition to crucifers, will also be addressed in a season-long IPM training activity

How long will this exercise take?

- At least 30 minutes for field walks and observations
- At least 30 minutes for brainstorming and participatory development of questionnaires in small groups
- At least one hour for presentation and participatory discussions in big group

Learning objectives

- To familiarize participants with the most common field problems of vegetables other than crucifers.
- To improve participants' knowledge and skills in identifying field problems of vegetables other than crucifers.
- To improve participants' skills in developing appropriate and function-based 'Ballot Box' questions for FFS evaluation of farmers' IPM knowledge and skills in other vegetables.

Materials

- Fields of vegetables other than crucifers at different stages near each other where the most common field problems can be observed
- Cartolina cardboard or folders
- Vials, rubber bands, marking pens, masking and scotch tapes, ball pens, threads or plastic straws, thumb tacks
- Bamboo sticks, glue, fertilizer samples
- Actual, live or preserved specimens

Methodology

- Field walks and observations, brainstorming or participatory discussions

Steps

1. Divide the big group into four smaller groups. Assign each small group to a specific group of vegetables, a field of which they are to visit:

   ✓ Legumes (e.g., snap bean and garden pea)
   ✓ Solanaceous vegetables (e.g., potato, bell pepper, and tomato)
   ✓ Parsley (e.g., carrot and celery)
   ✓ Cucurbits (e.g., cucumber, chayote, and zucchini)

2. Conduct field walks to identify, observe, and record the common field problems of vegetables other than crucifers in vegetable fields, such as:

   ✓ Pests and diseases
   ✓ Deficiencies and toxicities
   ✓ Environmental stresses and other physiological disorders

3. Collect specimens of pests and their natural enemies, pest and disease damages, other abnormalities and physiological disorders of vegetables other than crucifers.

4. Go back to processing area or session hall to further observe and characterize collected specimens.

5. With guidance from a facilitator, brainstorm in small groups to develop functional 'Ballot Box' questions to identifying the most common field problems of vegetables other than crucifers based on field activities conducted by:

   ✓ Focusing on functions of organisms or nonorganisms in an ecosystem
   ✓ Avoiding questions requiring technical definition of specimens (e.g., organisms or nonorganisms)

6. Present output of small groups to the big group and conduct participatory discussions to improve questionnaires developed for each group of vegetables. A sample shopping list of validated functional 'ballot box' questionnaires for pre- and post-evaluation of FFS on some important vegetables (*Note: Correct specimens are indicated by bold, underlined words.*) are shown below[16]:

   Legumes (Snap Bean and Garden Pea):

   ✓ Which is a sucking insect pest? (specimens: **<u>aphids</u>**, cutworm, semi-looper)

[16] Binamira, J.S. 1998. A Consultant's Report: Refresher Course for Trainers of IPM in Crucifers and Other Highland Vegetable Crops. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Regional Field Unit, Baguio City, Philippines. pp42-47.

- ✓ This insect pest (specimen: pod borer) attacks this crop (legumes) at what stage? (specimens of three crop stages: flowering stage, **fruit setting stage**, seedling stage)
- ✓ Which of these specimens is considered a legume pest? (specimens: hover fly, **pod borer**, ladybird beetle)
- ✓ What caused this damage (show a specimen with leaf-miner damage)? (specimens: **leaf miner**, aphids, mites)
- ✓ What caused this damage (show a specimen with bean seeds damaged by seed weevils)? (specimens: **seed weevil**, aphids, mites)
- ✓ Which of these specimens is infected by bean rust? (specimens infected by: **bean rust**, fusarium wilt, anthracnose)
- ✓ Identify which of these specimens is infected by fusarium wilt? (specimens infected by: damping-off, **fusarium wilt**, powdery mildew)
- ✓ Which of these specimens is infected by anthracnose? (specimens infected by: bean rust, leaf spot, **anthracnose**)
- ✓ Which of these diseases can be controlled by leaf removal and proper disposal? (specimen infected by: bacterial wilt, **bean rust**, virus)
- ✓ Wind can spread the causal organism of which of these diseases? (specimen infected by: **bean rust**, bacterial wilt, virus)
- ✓ Which of these specimens is an organic fertilizer? (specimens: complete fertilizer, **compost**, sandy soil)
- ✓ This plant (show a nitrogen-deficient plant) needs which of these fertilizers? (specimens: muriate of potash, **urea**, solophos)
- ✓ Which of these specimens is a complete fertilizer? (specimens: **14-14-14**, 46-0-0, 0-17-0)
- ✓ Which of these soils is fertile? (specimens: **black loamy soil**, red clayey soil, sandy soil)
- ✓ This physiological disorder (specimens: abscessed flowers) is due to lack of which of these fertilizers? (specimens: 46-0-0, 14-14-14, **0-18-0**)
- ✓ Which of these specimens is a farmer's friend? (specimens: **spider**, pod borer, aphids)
- ✓ Which of these specimens is a legume pest? (specimens: lady beetle, hover fly, **mites**)
- ✓ This (show a hover fly) is a natural enemy of which of these pests? (specimens: **aphids**, leaf miner, pod borer)
- ✓ Which of these specimens is a predator? (specimens: **preying mantis**, diamondback moth, *Diadegma sp.*)

- ✓ Identify which of these specimens is a natural enemy. (specimens: **ladybird beetle**, white fly, aphids)

Solanaceous Vegetables (Potato, Bell Pepper, and Tomato):

- ✓ Which of these specimen is a vector of this disease (show a virus-infected plant) ? (specimens: **aphids**, semi-looper, cutworm)
- ✓ What caused this damage (show a pinhole damage on bell pepper fruit)? (specimens: pod borer, **fruit fly**, leaf miner)
- ✓ What caused this damage (show a tomato leaf damaged by cutworm)? (specimens: **cutworm**, aphids, thrips)
- ✓ This hole (show a tomato fruit with a hole caused by fruit worm) indicates the presence of what pest? (specimens: pod borer, aphids, **fruit worm**)
- ✓ Which of these specimens causes this damage (show dried branches or twigs of potato)? (specimens: cutworm, **twig borer**, mole cricket)
- ✓ What disease does this pest transmit (show a specimen of aphids)? (specimens: bacteria, **virus**, fungus)
- ✓ Which of these diseases is not enhanced by humid weather conditions? (specimens: potato late blight, **virus**, damping off)
- ✓ Soil treatment and crop rotation can control which of these diseases? (blossom end rot, **fusarium wilt**, virus)
- ✓ Which of these diseases are cuased by bacteria? (specimens: **potato plant infected with bacterial wilt**, bell pepper plant infected by fusarium wilt, tomato plant infected by mosaic)
- ✓ Which of these diseases does a fungus cause? (specimens: potato plant infected with bacterial wilt, **bell pepper plant infected by fusarium wilt**, tomato plant infected by mosaic)
- ✓ Which of these fertilizer materials enhances faster vegetative growth? (specimens: solophos, **urea**, muriate of potash)
- ✓ These symptoms (show a tomato plant with weak stems and underdeveloped roots) indicate that the plant needs which of these fertilizers? (specimens: muriate of potash, **solophos**, ammonium sulfate)

- ✓ This disease (show a plant with symptoms of potato scab) is caused by excessive application of which of these fertilizers? (specimens: muriate of potash, solophos, **urea**)
- ✓ Which of these soils is acidic? (specimens: **red clayey soil**, black loamy soil, sandy soil)
- ✓ Which of these materials improves soil texture? (specimens: **compost**, plain garden soil, commercial inorganic fertilizer)
- ✓ Which of these specimens is a predator of aphids? (specimens: ants, **hover fly**, thrips)
- ✓ What is the most voracious stage of this predator? (show these) (specimens: egg, **larva**, adult of ladybird beetle)
- ✓ Which of these animals is a farmer's friend? (specimens: cutworm, **frog**, aphids)
- ✓ Which of these animals is a natural enemy of aphids? (specimens: white fly, cutworm, **syrphid fly**)
- ✓ Which of these stages is the best time to do weeding? (specimens of potato plants at: flowering stage, seedling stage, **vegetative stage**)

Parsley (Carrots and Celery):

- ✓ Which among these pests damaged this crop (specimen: carrot at vegetative stage damage by cutworm) at this stage? (specimens: aphids, **cutworm**, leaf miner)
- ✓ Which among these animals caused this damage? (show a carrot modified root damaged by rodent) (specimens: **rodent**, aphids, flies)
- ✓ Which of the following insects damaged the crop? (celery plant damaged at basal portion by a mole cricket) (specimens: **mole cricket**, aphids, cutworm)
- ✓ Which among these animals is a farmer's friend? (specimens: leafhopper, cutworm, **hover fly**)
- ✓ Which of these insects is considered as beneficial? (specimens: **ladybird beetle**, semi-looper, cutworms)
- ✓ Which of these soils is suited for this crop? (show a healthy carrot plant)) (specimen: clayey, sandy, **sandy loam**)

- ✓ At what stage of crop is it best to conduct hand weeding? (specimens showing carrot plant at: three weeks after sowing, **one month after sowing**, two months after sowing)
- ✓ Which of these fertilizers contains nitrogen, phosphorus, and potassium? (specimens: 16-20-0, **14-14-14**, 17-0-17)
- ✓ Which among these materials corrects soil acidity? (specimens: **lime**, chalk (powdered), urea)
- ✓ Which of these soil samples is a clay loam? (specimens: clay, **clay loam**, sand)
- ✓ Which of these materials is an inorganic fertilizer? (specimens: ash, **ammonium sulfate**, chicken dung)
- ✓ Which of these damages is caused by fungus? (show specimens of carrot plants with symptoms of: **powdery mildew**, root-forking, stem cracking)
- ✓ Which of these specimens is a physiological disorder? (show specimens of carrot plants with symptoms of: powdery mildew, **root-forking**, soft rot)
- ✓ Which of these damages is caused by nematodes? (specimens of carrot plants with symptoms of: **root knot nematodes**, powdery mildew, stem cracking)
- ✓ Which of these disorders is caused by water stress and boron deficiency? (show specimens with symptoms of: soft rot, **stem cracking**, root knot nematodes)
- ✓ This animal (specimen: preying mantis) is a predator of what insect pest? (specimens: flea beetles, **mole cricket**, aphids)
- ✓ Which of these parsley crops cannot be transplanted? (specimens: **carrot**, celery, parsley)
- ✓ In which of these soils will you normally have root-forking problem? (specimens: **gravely soil**, clay loam soil, sandy loam soils)
- ✓ Which of these specimens does not belong to the parsley family? (specimens: carrot, celery, **green onion**)
- ✓ Which of these soils contains high organic matter? (specimens: clayey soil, **clay loam soil**, sandy soil)

Cucurbits (Cucumber, Chayote and Zucchini):

- ✓ Which of these pests caused this damage (show a cucumber plant with cut leaves)? (specimens: mites, leaf miner, **cutworm**)
- ✓ Which of these pests caused this damage (show a cucumber plant showing dried vines)? (specimens: **vine borer**, cutworm, caterpillar)
- ✓ Which of these is a major pest of cucumber at this stage of crop (show a cucumber plant at early vegetative stage)? (specimens: **flea beetle**, thrips, fruit worm)
- ✓ Which of these pests caused this damage (show a fruit fly damaged fruit of cucumber)? (specimens: caterpillar, flea beetle, **fruit fly**)
- ✓ Which of these pests caused this damage (show a fruit worm damaged fruit of cucumber)? (specimens: caterpillar, flea beetle, **fruit worm**)
- ✓ Which of these animals is a friend of farmers? (specimens: cutworm, aphids, **coccinilid beetle**)
- ✓ Which of these pests can be controlled by overhead irrigation? (specimens: cutworm, **aphids**, semi-looper)
- ✓ Which of these disorders is aggravated by infertile soils? (specimens showing symptoms of: **flower abscission in cucumber**, fruit rot, virus-infected plant)
- ✓ This disease (show a cucumber plant with symptoms of a virus disease) is transmitted by which pest? (specimens: cutworm, **aphids**, rodent)
- ✓ Which of these pests can be controlled by flooding? (specimens: **cutworm**, aphids, semi-looper)
- ✓ Which of these disorders can be minimized by crop rotation? (specimens of cucumber showing symptoms of: flower abscission, **damping off**, nitrogen deficiency)
- ✓ This fertilizer is needed for flowering and fruit setting in cucumber. (specimens: urea, ammonium sulfate, **solophos**)
- ✓ Which of these fertilizer materials contains only nitrogen and phosphorus elements? (specimens: **ammonium phosphate**, ammonium sulfate, complete fertilizer)

- ✓ Which of these plants is suffering from lack of nitrogen? (specimens of cucumber plants showing: **general yellowing**, curling of leaves, leaf spots)
- ✓ Which of these cucurbits is more resistant to diseases? (specimens: cucumber, **chayote**, zucchini)
- ✓ Which of these disorders is best controlled by uprooting and proper disposal? (specimens: **virus infected chayote plant**, abscised flower of zucchini, and aborted fruit of cucumber)
- ✓ Which of these cucurbits can be grown without trellis? (specimen seedlings of: **zucchini**, cucumber, and chayote)
- ✓ Which of these bugs is a predator? (specimens: true bug, **assassin bug**, and green soldier bug)
- ✓ Which of these is a symptom of virus disease? (specimens: **rosetting of chayote leaves**, presence of powdery substance on cucumber leaves, and zucchini fruit damaged by fruit fly)
- ✓ Which of these materials contains high organic matter? (specimens: urea, solophos, and **compost**)

Some suggested questions for processing discussion

- ❏ What are some of the most common field problems of vegetables other than crucifers observed in vegetable fields?
- ❏ What problems are common to crucifers and other vegetables?
- ❏ What do we mean by functional questions? Why do we need functional questions for 'Ballot Box' evaluation?
- ❏ What do we mean by technical definition of specimens? Why should we avoid questions requiring technical definitions of specimen in "Ballot Box' evaluation?
- ❏ What are some other considerations in developing effective 'Ballot Box' evaluation questions?

Exercise No. 2.05

Agroecosystem analysis for Farmer Field Schools of crucifers and other vegetables: Establishing minimum data for decison-making

Background and rationale

Agroecosystem analysis (AESA) is a way of assembling what participants are studying and placing into a process useful for decision-making based on many factors[17]. An AESA, therefore, must look into various elements of a crop ecosystem, how these elements, in one way or another, affect a crop and what are those elements that work interdependently or separately for a particular crop. This exercise, therefore, provides a holistic approach in monitoring the crop in question.

In a previous volume, minimum data necessary for decision-making had been established in FFS of crucifers. For this volume, minimum data necessary for decision-making in FFS of other vegetables (e.g., legumes, solanaceous vegetables, parsley, and cucurbits) will likewise be established through this exercise. Thus, this activity will be undertaken as a supplement to Exercise No. 2.24 (Agroecosystem Analysis: Making a Crop Management Decision), Field Guide of Discovery-based Exercises for Vegetable IPM, Volume I.

When is this exercise most approriate?

- In TOT and VST, before conducting first AESA in FFS of crucifers and other vegetables
- When other vegetables, in addition to crucifers, will also be addressed in a season-long IPM training activity

How long will this exercise take?

- At least 30 minutes for field walks and observations
- At least 30 minutes for brainstorming in small groups to determine minimum data necessary for decision-making in farmer field schools of other vegetables
- At least one hour for presentation and participatory discussions in big group to fine-tune minimum data necessary for decision-making in farmer field schools of other vegetables

[17] Callo, Jr. D.P., W.R. Cuaterno, and H.A. Tauli (eds.). 1999. Handbook of Non-Formal Education and Team Building Exercises for Integrated Pest Management. SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA), College, Laguna, Philippines. pp190-191.

Learning objectives

- To familiarize participants with the most common vegetables in an FFS area other than crucifers.
- To improve participants' knowledge and skills in identifying morphological characteristics at different growth stages of other vegetables.
- To establish minimum data necessary for decision-making in farmer field schools of the most common vegetables in the area other than crucifers.

Materials

- Fields of vegetables other than crucifers near each other where morphological characteristics at different growth stages can be observed
- Manila paper, notebook, pencil, crayon, and ball pen
- Actual or live plant or plant parts

Methodology

- Field walks and observations, brainstorming or participatory discussions

Steps

1. Divide big group into four smaller groups, assign each small group to a specific group of vegetables. Go to vegetable fields, as shown below:

   ✓ Legumes (e.g., snap bean and garden pea)
   ✓ Solanaceous vegetables (e.g., potato, bell pepper, and tomato)
   ✓ Parsley (e.g., carrot and celery)
   ✓ Cucurbits (e.g., cucumber, chayote, and zucchini)

2. Conduct field walks to identify, observe, and record morphological characteristics of most common vegetables other than crucifers in an FFS area, such as:

   ✓ Adaptability to local conditions
   ✓ Morphological structures at various growth stages
   ✓ Resistance to pests and diseases
   ✓ Tolerance to deficiencies, toxicities, and other environmental stresses

3. Collect plants or plant parts at various growth stages showing morphological characteristics and reactions to pests, diseases, and environmental stresses of vegetables other than crucifers.

4. Go back to processing area or session hall to further observe and characterize collected specimens.

5. With guidance from a facilitator, brainstorm in small groups to establish minimum data necessary for decision-making in farmer field schools of the most common vegetables in an area other than crucifers, such as:

    ✓ For all vegetable crops (e.g., general data needed)
    ✓ For specific crops (e.g., additional data needed)

6. Present output of small groups to the big group and conduct participatory discussions to fine-tune established minimum data necessary for decision-making in farmer field schools for each group of vegetables. A sample of minimum data required for decision-making in agroecosystem analysis (AESA) for farmer field schools (FFSs) on other vegetables is shown below[18] :

    For All Crops (Legumes, Solanaceous, Parsley and Cucurbits):

    ✓ Insects, other pests, and their natural enemies (e.g., numbers on a weekly basis)
    ✓ Diseases and physiological disorders (e.g., percentage incidence of total area)
    ✓ Weather conditions (e.g., sunny, cloudy, or rainy day)
    ✓ Background information (e.g., variety, sowing or planting date, seeding rate, soil type, planting distance, fertilizer rate, etc.)
    ✓ Agronomic data (e.g., plant height, number of leaves, and total yield)
    ✓ General observations (e.g., water, weed, and cultural management practices)

[18] Binamira, J.S. 1998. A Consultant's Report: Refresher Course for Trainers of IPM in Crucifers and Other Highland Vegetable Crops. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Regional Field Unit, Baguio City, Philippines. pp48-49.

For Specific Crops (Additional Data):

Legumes (Garden Pea and Snap Bean)

✓ Number of leaves (e.g., until tendril initiation only)
✓ Number of nodes (e.g., additional nodes every week)
✓ Plant height (e.g., until tendril initiation only)
✓ Number of flowers or pods developed or aborted
✓ Others (e.g., date of tendril initiation, flowering, pod setting, pod maturity, frequency of pod priming)

Solanaceous (Potato, Bell Pepper, and Tomato)

✓ Number of branches (e.g., potato, bell pepper, and tomato)
✓ Number of fruits (e.g., bell pepper and tomato)
✓ Number of flowers or fruits developed or aborted (e.g., bell pepper and tomato)
✓ Others (e.g., date to flower, fruit setting, fruit maturity, frequency of fruit priming)

Parsley (Carrot and Celery)

✓ Methods of sowing (e.g., celery and carrot), planting (e.g., celery and carrot), or pricking-off (e.g., celery)
✓ Root elongation and development (e.g., quantitative and qualitative observations for carrot)

Cucurbits (Cucumber, Chayote, and Zucchini)

✓ Number of leaves (e.g., until tendril initiation only)
✓ Number of nodes (e.g., additional nodes every week)
✓ Number of branches (e.g., additional branches every week)
✓ Number of flowers or fruits developed or aborted
✓ Others (e.g., date of tendril initiation, flowering, fruit setting, fruit maturity, frequency of fruit priming)

Some suggested questions for processing discussions

- ❑ What are some of the most common vegetables observed in an FFS area other than crucifers? In what group do these vegetables belong?
- ❑ Are there common morphological characteristics, which distinguish each group of vegetables?
- ❑ What are the minimum data required for decision-making in agroecosystem analysis (AESA) for farmer field schools (FFSs) on other vegetables?

Exercise No. 2.06

Field layout and agroecosystem analysis format for Farmer Field Schools of crucifers and other vegetables

Background and rationale

In previous vegetable IPM FFSs in the Cordilleras, field layout and AESA format considered only one crucifer crop. Such format had been modified in current FFSs, which now involve IPM studies of more than one type of vegetables in addition to crucifers. Depending upon elevation, types of crucifers planted may not vary but types of other vegetables grown may vary considerably.

This particular exercise will be undertaken to develop a field layout and AESA format for vegetable FFSs where crucifers and other vegetables are simultaneously addressed. This activity is an additional supplement to Exercise No. 2.24 (Agroecosystem Analysis: Making a Crop management Decision), Field Guide of Discovery-based Exercises for Vegetable IPM, Volume I.

When is this exercise most approriate?

- In TOT and VST, before layouting of crucifers and other vegetables in FFS learning field
- When other vegetables, in addition to crucifers, will also be addressed in a season-long IPM training activity

How long will this exercise take?

- At least 30 minutes for field walks and observations
- At least 30 minutes for brainstorming in small groups to design layout and reporting format for AESA of crucifers and other vegetables in FFS learning field
- At least one hour for presentation and participatory discussions in big group to finalize layout design and reporting format for AESA of crucifers and other vegetables in FFS learning field

Learning objectives

- To determine what type of crucifers and other vegetables will be addressed in high and middle elevation FFS learning fields.
- To design field layout for AESA of crucifers and other vegetables in high and middle elevation FFS learning fields.
- To develop reporting format for AESA of crucifers and other vegetables in high and middle elevation FFS learning fields.

Materials

- Learning field ready for planting of crucifers and other vegetables
- Manila paper, notebook, marking pens, and ball pen
- Meter stick or tape, plastic twine, bamboo sticks, and labeling materials

Methodology

- Field walks and observations, brainstorming, or participatory discussions

Steps

1. Divide big group into two smaller groups, assign each small group to a specific situation or option, as shown below:

   ✓ First option, where a group of farmers observes and compares two different crop protection practices (e.g., both IPM and Farmers' Crop Protection [FCP] practices)
   ✓ Second option, where a group of farmers observes only one distinct crop protection practice (eg. IPM or FCP)

2. Go to the learning field, conduct field walks, observe and design field layout for AESA of crucifers and other vegetables in high and middle elevation, such as:

   ✓ Field layout for first and second options showing plots of first (e.g., cabbage) and second (e.g., other than crucifers) major crops
   ✓ AESA reporting format for first and second options showing general observations and recommendations

3. Go back to processing area or session hall and with guidance from a facilitator, brainstorm in small groups to develop field layout and reporting format for AESA of crucifers and other vegetables in high and middle elevation FFS learning fields, such as:

   ✓ Field layout for first and second options showing plots of first (e.g., cabbage) and second (e.g., other than crucifers) major crops
   ✓ AESA reporting format for first and second options showing general observations and recommendations

4. Present output of small groups to the big group and conduct participatory discussions to finalize field layout and reporting format for AESA of crucifers and other vegetables in high and middle elevation FFS learning fields. A sample field layout and AESA format for FFSs on crucifers and other vegetables is shown below[19] :

   Crops to be addressed. The FFS activities will cater to needs of farmers planting crucifers and other vegetables in high and middle elevations, as follows:

   ✓ *High Elevation.* In high elevation, problems on crucifers (e.g., cabbage, Chinese cabbage [wongbok], broccoli, cauliflower, and pechay) and other vegetables belonging to solanaceous (e.g., potato), parsley (e.g., carrots), and legume (e.g., snap bean and garden pea) families will be addressed in FFS. Farmer-participants will select their first two major vegetable crops for FFS field studies.

   ✓ *Middle Elevation.* In middle elevation, problems on crucifers (e.g., cabbage, Chinese cabbage [wongbok], broccoli, cauliflower, and pechay) and other vegetables belonging to solanaceous (e.g., bell pepper, tomato and potato), parsley (e.g., carrots and celery), legume (e.g., snap bean and garden pea), and cucurbit (e.g., chayote, cucumber and zucchini) families will be addressed in FFS. Similarly, farmer-participants will select their first two major vegetable crops for FFS field studies.

   Area, field layout, and group assignments. A minimum of 1,000-sqm area from a portion of a farmer-participant's farm, representing average field condition of FFS community, should be selected. The area may be increased depending upon the availability and willingness of farmer-participants. The farmer-participants, through an appropriate participatory process or sharing of experiences, should select two major crops. The area will be divided into five plots and crops will be assigned in plots as follows:

[19] Binamira, J.S. 1998. A Consultant's Report: Refresher Course for Trainers of IPM in Crucifers and Other Highland Vegetable Crops. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Regional Field Unit, Baguio City, Philippines. pp50-55.

First Option

- ✓ The first major crop (Crop A) is usually assigned to three plots (Plots I, II, and III) while the second major crop (Crop B) is usually assigned to remaining plots (Plots IV and V). This arrangement may be changed depending upon needs or priorities of farmer-participants.
- ✓ The plots (Plots I, II, III, IV and V) are further subdivided into sub-plots where farmers' crop protection (FCP sub-plot) and integrated pest management (IPM sub-plot) practices are compared.
- ✓ The 25-30 farmer-participants are then divided into five small groups of 5-6 members and are assigned to conduct AESA in one of plots (e.g., Group I is assigned to Plot I, Group II to Plot II, Group III to Plot III, Group IV to Plot IV and Group V to Plot V). Plot assignment may be changed depending upon needs or priorities of farmer-participants.

Field layout in conducting AESA for FFS on crucifers and other vegetable (First option)

CROP A (CABBAGE)			CROP B (OTHER VEGETABLE)	
PLOT I	PLOT II	PLOT III	PLOT IV	PLOT V
GROUP I	GROUP II	GROUP III	GROUP IV	GROUP V

IPM	**IPM**	**IPM**	**IPM**	**IPM**
FCP	**FCP**	**FCP**	**FCP**	**FCP**

Second Option

✓ The first major crop (Crop A) is usually assigned to three plots (Plots I, II, and III) while the second major crop (Crop B) is usually assigned to remaining plots (Plots IV and V). This arrangement may be changed depending upon needs or priorities of farmer-participants.

✓ Two of three Crop A plots are assigned as IPM plots (e.g., Plots I and III) and one is assigned as FCP plot (e.g., Plot II) while one of two Crop B plots is assigned as IPM plot (e.g., Plots IV) and another one as FCP plot (e.g., Plot V). The plot assignment may be changed depending upon needs or priorities of farmer-participants.

✓ The 25-30 farmer-participants are then divided into five small groups of 5-6 members and are assigned to conduct AESA in one of the plots (e.g., Group I is assigned to Plot I, Group II to Plot II and Group III to Plot III of Crop A plots while Group IV is assigned to Plot IV and Group V to Plot V of Crop B plots). Plot assignment may be changed depending upon needs or priorities of farmer-participants.

Field layout in conducting AESA for FFS on crucifers and other vegetable (Second option)

CROP A (CABBAGE)			CROP B (OTHER VEGETABLE)	
PLOT I	PLOT II	PLOT III	PLOT IV	PLOT V
GROUP I	GROUP II	GROUP III	GROUP IV	GROUP V
FCP	**IPM**	**FCP**	**IPM**	**FCP**

Format of presentation. The AESA presentation will depend on layout option selected above and minimum data required per crop to be studied in FFS sites. This is described as follows:

✓ *First Option*. In the first option, each group of farmer-participants conducts AESA in two subplots (e.g., IPM and FCP subplots). This means that two separate sets of observations will be gathered in each of the subplots. This will give an opportunity for each group to directly compare IPM with FCP treatments. However, this will require additional time for processing in small groups. The suggested reporting format is shown below in *AESA Reporting Format for First Option*.

AESA reporting format for first option

BACKGROUND INFORMATION NATURAL ENEMIES  PESTS **IPM**	AGRONOMIC AND WEATHER DATA NATURAL ENEMIES  PESTS **FCP**
GENERAL OBSERVATIONS	RECOMMENDATIONS

✓ *Second Option*. In the second option, each group of farmer-participants conducts AESA only in either an IPM or FCP plot. This means that only one set of observation is required per group. Each group's set of observation is compared with other groups' set of observation. This option will require lesser time for processing in small groups but will not allow direct comparison of IPM and FCP treatments per group. The suggested reporting format is shown in *AESA Reporting Format for Second Option*.

AESA reporting format for second option

BACKGROUND INFORMATION

AGRONOMIC AND WEATHER DATA

NATURAL ENEMIES

PESTS

IPM or FCP

GENERAL OBSERVATIONS	RECOMMENDATIONS

Some suggested questions for processing discussion

- What elevations will be addressed in FFS? What vegetables other than crucifers will be addressed in those elevations? Why?
- What options are available? What were some considerations in designing field layout for AESA of crucifers and other vegetables in FFS learning fields for each options?
- What were some considerations in designing AESA reporting format for crucifers and other vegetables in FFS learning fields for each options?
- Are there advantages and disadvantages in using each option?

Exercise No. 2.07 Cost and return analysis of vegetable production

Background and rationale

Finding a market for produce is one of the most important activities of a vegetable farmer. Always remember that no price should be considered fixed. A price is simply an offer or a suggestion to test prevailing market rate. If the buyer accept an offer, it is fine. If he or she rejects it, the price usually may be changed as quickly as possible. But one should see to it that there is a profit. Farmers should understand the meaning and importance of pricing. The price offered to a buyer depends largely on the quality of the product[20].

After farmers had successfully learned and understood what records would be useful to keep, a guided discussion and sharing on cost and return analysis of their vegetable production can be undertaken. Data obtained from an earlier exercise on 'why' and 'what' to record will be very useful for this next activity.

In this exercise we will try to start with a question 'What profit farmers will make now?' This will allow them to share useful records they keep for this current season. This sharing discussion will allow farmers to find out whether they will now make profit or not. This activity was designed to supplement Exercise No. 2.30 (Guided Discussion and Sharing on 'Why' and 'What' to Record: Keeping Record of Farm Activities), Field Guide of Discovery-Based Exercises for Vegetable IPM, Volume I.

When is this exercise most approriate?

- This exercise is most appropriate toward the end of an FFS season
- When farmers want to learn and understand how the records of their production and labor costs in learning field experiments and in their own fields can be used for cost and return analysis of their vegetable production

How long will this exercise take?

- One to two hours of an FFS meeting

[20] Tabinga, G.A. and A.O. Gagni. 1985. Corn Production in the Philippines. Department of Development Communication, University of the Philippines Los Baños, College, Laguna, Philippines. pp94-102.

Learning objectives

- To build awareness on the value of cost and return analysis for understanding profit or loss in vegetable production.
- To learn and understand how records of production and labor costs can be used for cost and return analysis of vegetable production.

Materials

- Records kept by farmer-participants (Note: Ask farmers to bring in all current records that they keep for learning field and their own vegetable fields)
- Manila paper
- Pens and masking or Scotch tapes

Methodology

- Guided discussion and sharing of experiences

Steps

1. Arrange participants in a circle for sharing.

2. Start a discussion by asking some volunteer-farmers to share their records on production and labor costs of their own vegetable fields for this current season. Here are some records needed:

   ✓ Records of production
   ✓ Records of man and animal labor
   ✓ Records of equipment used in vegetable farming enterprise
   ✓ Costs and return

3. Guide a discussion to obtain accurate figures of production and labor costs of volunteer-farmers' own vegetable fields and those in learning field. Here are some suggested guides:

   ✓ Production records (indicate date, kind, amount and value of each product and by-product of vegetables)
   ✓ Labor records (labor used in enterprise including man, animal and implement hours for each farm operation plus all expenses for hired work animals, implements, and all 'bayani' labor)
   ✓ Cash receipts records (cash accounts of all receipts from vegetable enterprise indicating date items were received and their value)

- ✓ Cash return records (subtract from cash account all expenses incurred aside from labor such as seed, fertilizer, insecticide, etc.)
- ✓ Equipment records (equipment is not used for vegetable enterprise alone, hence, charge only a certain percentage of depreciation to vegetable)

4. Guide a discussion so that accurate figures of total expenses, expected yield (e.g., per hectare basis), gross income (e.g., based on current price per kg), and net income to compare profits that is gained from IPM and FCP practice plots.

5. Make a list of all information that the big group wants to record.

6. Calculate costs and returns for vegetable enterprise and for the whole farm. The following is a procedure you may want to consider in analyzing costs and returns[21] :

- ✓ *Labor and Power Costs*. The amount of labor and power spent in each operation for every enterprise should be expressed in man-days (MD), man-animal days (MAD), or man-machine days (MMD). Calculate total power cost for each enterprise and then for the whole farm. This is calculated using the formula below:

Total Labor Cost = Total labor (MD) x Wage rate + Total power (MAD/MD/MMD) x rate

- ✓ *Material Input Cost*. Total cost of all materials used in each enterprise (e.g. seeds, fertilizers, herbicides, etc). This is calculated as:

Total Material Cost = (Quantity material 1 x Price of material 1 + ... + Quantity of material N x Price of material N)

[21] Binamira, J.S. 2000. The Search for the National Filipino Corn Farmer Award (Draft Guidelines). National Agricultural and Fishery Council, Department of Agriculture, Diliman Quezon City, Philippines. pp7-9.

✓ *Gross Return.* The product type, production volume, and product price are important components in calculating gross returns. Calculate gross returns using this formula:

Gross Return = (Volume of product x Price of product)

✓ *Net Return.* Calculate net return of vegetable enterprise and for the whole farm, if applicable. This is computed as:

Net Return = Gross Return - [Total Labor Cost + Total Material Cost]

✓ *Return on Investment (ROI).* This is a measure of return for every monetary unit in a farm. A higher ROI indicates a better economic performance of an enterprise. This ratio is calculated as:

$$\text{ROI} = \frac{\text{Net Income}}{\text{Total Costs}}$$

Some suggested questions for processing discussion

- ❑ If you have a big profit, would you say then that you have been successful in your endeavor?
- ❑ What would you do so that cost of production of your vegetable enterprise will give good returns?
- ❑ How much do you have to sell your produce? How much profit can you get?

Section 3

Supplementary and Additional Agronomy, Integrated Crop and Soil Management Topics

Section 3 Supplementary and Additional Agronomy, Integrated Crop and Soil Management Topics

In a previous volume (Volume I)[22] , a section on 'Soils and Agronomy Topics' was included. That section consisted of five subsections, namely: (a) seedbed and land preparation; (b) integrated nutrient management; (c) morphology and growth stages; (d) varietal selection and seed production; and (e) weeds and weed management. Although specific discovery-based exercises on soils and agronomy were covered in each subsection, only selected and very limited topics were included in that aforesaid section.

Under this new volume, supplemental as well as additional soils and agronomy topics were compiled based on new experiences shared by FFS facilitators in local vegetable IPM implementation since the publication of a previous volume in 1997. Likewise, modifications were made to enhance better understanding of topics under this section. First, a more comprehensive coverage of topics on agronomy, integrated crop and soil management are included under this section. Second, this section now consists only of two but more condensed subsections, namely: (a) integrated soil management or ISM; and (b) agronomy and integrated crop management or ICM.

Under the ISM subsection, topics on seedbed and land preparation, integrated nutrient management (INM), as well as weeds and weed management became integral parts of an expanded ISM concept. However, some ISM-related pest and disease management topics in this new volume, are deemed more

[22] Philippine National IPM Program. 1997. Field Guide of Discovery-based Exercises for Vegetable IPM. National Agricultural and Fishery Council, Department of Agriculture, Diliman, Quezon City, Philippines. pp2-1 to 2-124.

appropriately categorized under Section 4 (Supplemental and Additional Pest and Disease Management Topics). A subsection on agronomy and ICM, on the other hand, include a wide range of cultural management practices related to specific vegetable crops at their various growth stages, in addition to those already addressed in a previous volume. Likewise, some ISM-related cultural management topics in this new volume are categorized under the said subsection.

Integrated Soil Management

People are dependent on soils, and to a certain extent, good soils are dependent upon people and the use they make of them. Soils are natural bodies on which plants grow. Society enjoys and uses these plants because of their beauty and because of their ability to supply fiber and food for humans and for animals. Standards of living are often determined by quality of soils and kinds and quality of plants and animals grown on them. Farmers, along with homeowners, look upon soil as a habitat for plants. A farmer makes a living from soil and is thereby forced to pay attention to its characteristics. To a farmer, soil is more than useful - it is indispensable[23] .

Effective conservation and management of soils require an understanding of these natural bodies and of processes going on with them. These processes, which are vital to production of plants, also influence many other uses of soils. With only a few exceptions, agricultural crops depend upon soil for anchorage, water, and nutrients. Very little can be done to alter climatic factors, but much can be done with soil for benefit of a crop[24] . Consequently, soil management aims to allow a grower to produce optimum yield and sustained long-term returns.

One of the basic principles in integrated pest management (IPM) is growing a healthy crop[25] . Among others, this principle is attained through integrated soil management (ISM), which include efficient nutrient, water, and weed management. In addition, ISM also includes effective soil-borne pest and disease management as well as effective use of beneficial soil microorganisms for better crop productivity. Sound soil management must provide a suitable medium in which seeds can germinate and roots can grow. It must supply nutrients necessary for crop growth. Weeds must be kept in check

23 Brady, N.C. 1985. The nature and properties of soils. 9th Edition. Macmillan Publishing Company, Inc., 866 Third Avenue, New York, New York, USA. pp 1-33.

24 Bautista, O.K. (Ed.) 1994. Introduction to tropical horticulture. 2nd Edition. SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp 279-316.

25 Philippine National IPM Program. 1993. Kasaganaan ng Sakahan at Kalikasan (KASAKALIKASAN), The National IPM Program Document. National Agricultural and Fishery Council (NAFC), Department of Agriculture, Elliptical Road, Diliman, Quezon City, Philippines. pp 1-12.

and necessary build-up of pests and diseases prevented[26] . The soils harbor a varied population of living organisms. The whole range in size from larger rodents through worms and insects to tiniest bacteria commonly occurs in normal soils. The quantity of living organic matter, including plant roots, is sufficient to influence profoundly many physical and chemical trend of soil changes. Virtually all-natural soil reactions are directly or indirectly biochemical in nature.

In the context of IPM, therefore, ISM will require provision of environment-friendly soil management options for improvement of some important interrelated soil properties (e.g., physical, biological and chemical), which will result to better crop productivity and higher farmer income[27] .

In this new volume, most of the discovery-based exercises compiled in 'Integrated Soil Management' subsection are additional exercises identified by participants in a recently concluded intensive one-month *Refresher Course for Trainers of IPM in Crucifers and Other Highland Vegetable Crops*[28]. However, Exercise No. 3.01 (Barangay Soil Mapping: Determining Soil Types and Their Farm Locations as Management Guide for Improving Vegetable Productivity) is a supplement to Exercise No. 2.04 (Barangay Immersion: How Do We Identify the Needs of Farmers in the FFS), Section 2, Field Guide of Discovery-based Exercises for Vegetable IPM, Volume I.

---

[26] Davies, D.V., D.J. Eagle and J.B. Finney. 1972. Soil Management. Farming Press Limited, Fenton House, Wharfedale Road, Ipswich, Suffolk, Great Britain. pp 15-25.

[27] Settle, W. 1999. Living soil: A source book for IPM training. United Nations-Food and Agriculture Organization (UN-FAO) Programme for Community IPM in Asia, Jl. Jati Padang, Pasar Minggu, Jakarta, Indonesia. pp 5.

[28] Binamira, J.S. 1998. A Consultant's Report: Refresher Course for Trainers of IPM in Crucifers and Other Highland Vegetable Crops. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Regional Field Unit, Baguio City, Philippines. pp15-22.

Exercise No. 3.01

Barangay soil mapping: Determining soil types and their farm locations as a management guide for improving vegetable productivity

Background and rationale

For practical purposes, soil types can be determined by examining soil layers and soil textures. The most important criterion in separating layers is soil texture. If two sections of profile differ in their soil texture, then these can be classified as separate layers. If there is no difference in soil texture, layers can be separated based on a change in color, structure, or consistency.

In absence of these distinguishing characteristics, layers are simply defined by depth, with top 20-cm being designated as upper layer. Soil texture, on the other hand, can be classified either as sandy, loamy, or clayey. Sandy soil is a soil type composed of more than 70 percent sand and less than 15 percent clay. Loamy soil is a soil type containing less than 35 percent clay but does not have a sandy texture described above. Clayey soil is a soil type consisting of more than 35 percent clay.

The characteristics of any soil are a result of parent material it developed from and external conditions such as weather, slope, vegetation, and farming practices. Parent materials and external conditions are often location specific and may differ within a short distance in a farming area of the same community[29] .

In FFSs, a barangay soil map can be developed to indicate not only soil types but also the location of farmer's individual farms. This information will be very useful in determining appropriate soil management strategies for each soil type by actual field examination and sharing of experiences among farmers. This particular exercise was designed to address this concern.

[29] FARM. 1998. Facilitator's Manual: Farmer Field School on Integrated Soil Management. Farmer-centered Agricultural Resource Management (FARM) Programme, Food and Agriculture Organization Regional Office for Asia-Pacific, Bangkok, Thailand. pp34-35.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, as component of topic on 'Soil Conservation and Management' or 'Barangay Soil Mapping'
- When farmers want to learn more improved soil management practices from other farmers by studying soil types of their individual farms

How long will this exercise take?

- Thirty minutes to one hour for field walks and observations of different soil types of individual farmers in adjoining and learning fields
- Thirty minutes to one hour soil mapping and brainstorming session in processing area

Learning objectives

- To make participants understand that different soil types have different soil management requirements to improve crop productivity.
- To learn how to do a barangay soil map showing different soil types of farmers' individual farms.
- To learn from each other appropriate soil management practices for different soil types.

Materials

- Individual farms in adjoining and learning fields where different soil types can be observed visually
- Office supplies (Manila paper, notebooks, ball pens, and marking pens)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups in accordance with the closeness of their farms. Briefly explain to them the objective of the exercise and ask them to conduct field walks and observe soil types of their individual farms as follows:

   ✓ describe physical characteristics (soil layers and texture) of soil in their individual farms

   ✓ take note in a piece of paper description of physical characteristics of soils in their individual farms

2. Go back to processing area. Brainstorm in small groups to integrate all observations in individual farms.

3. Present output of small groups to the big group. Conduct participatory discussions to allow sharing of experiences among participants on characteristics of each soil type identified. Relate effects on crop growth and soil management practices. Perform the following activities:

   - ✓ Draw a simple map of the area on a Manila paper indicating roads, rivers, settlements, slopes (for mountain areas), etc.
   - ✓ Mark farm location of individual farmers on map
   - ✓ Identify soil type boundary on map
   - ✓ Place each group's soil type descriptions close to their site on map

4. Synthesize and summarize outputs of small groups into one big group output. Draw up conclusions and recommendation from this exercise.

Some suggested questions for processing discussion

- ❏ What do we mean by barangay soil mapping? What is the importance of making a barangay soil map?
- ❏ Were there differences observed in the soil characteristics of farmers' individual farm? Were there differences in soil layers and textures?
- ❏ How did soil type and farm location influence selection of crops planted and soil-water management practices employed?
- ❏ Did farmers use different soil management practices because of different soil types and farm locations? Why?
- ❏ Do you think there will be differences in crop performance (i.e., in terms of plant growth, development, and yield) among farms exhibiting different soil types? Why?
- ❏ Did you learn any important soil management practices from other farmers related to differences in soil types? What are they?

Exercise No. 3.02

Soil profile analysis: A guide in understanding soil fertility and productivity

Background and rationale

Examination of a vertical section of a soil in a field reveals presence of more or less distinct horizontal layers. Such a section is called a *soil profile*, and individual layers are regarded as *soil horizons*. Every well-developed, undisturbed soil has its own distinctive profile characteristics, which are used in soil classification and are of great practical importance in judging soil fertility and productivity[30]. *Soil fertility* refers to inherent capacity of a soil to supply nutrients to plants in adequate amounts and in suitable proportions. *Soil productivity*, on other hand, is related to ability of a soil to yield crops and is a broader term since soil fertility is only one of factors that determine magnitude of crop yields.

The topsoil, being near surface, is major zone of root development. It carries much of the nutrients available to plants, and it supplies a large share of water used by crops. In addition, as a layer that is plowed and cultivated, it is subject to manipulation and management. Proper cultivation and incorporation of organic residues may modify its physical condition. It can be treated easily with chemical fertilizers and limestone, and it can be drained. In short, its fertility and, to a lesser degree, its productivity, may be raised, lowered, or satisfactorily stabilized at levels consistent with economic crop production.

An analysis, therefore, of a soil profile is important in deciding appropriate cultural management practices that will enhance crop productivity. Farmers, through years of experience, had evolved their own way of assessing soil profile. In FFSs, these experiences must be shared among farmers and facilitators to gain new knowledge in improving soil fertility and productivity. This exercise was designed to achieve this particular objective.

[30] Brady, N.C. 1985. The nature and properties of soils. 9th Edition. Macmillan Publishing Co., 866 3rd Ave., New York, New York, U.S.A. pp1-33.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, before land preparation as component of 'Integrated Nutrient Management' and 'Soil Biodiversity' topics
- When farmers want to learn from other innovative soil management practices and do hands-on of soil profile analysis

How long will this exercise take?

- Thirty minutes to one hour for field walks, observations, and hands-on of soil profiles in adjoining and learning fields
- Thirty minutes to one hour for brainstorming session in processing area

Learning objectives

- To make participants aware of and understand how soil profile analysis can be used in deciding appropriate cultural management practices to improve soil fertility and productivity.
- To learn innovative soil management practices from other farmers and do hands-on of soil profile analysis.

Materials

- Soil profiles in adjoining and learning fields used in 'Soil Biodiversity' exercise
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)
- Other supplies (plastic bags, ruler, meter stick or steel tape, shovel, crowbars, magnifying lens, and bolo)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe different soil profiles in adjoining fields of learning field so that different soil types could be described. The following suggestions may be tried, thus:

   ✓ Group I to observe rolling forest soil profile (e.g., undisturbed forest trees are grown)
   ✓ Group II to observe rolling brush land soil profile (e.g., plants grow as tall as 1-2 meters)
   ✓ Group III to observe stiff grassland soil profile (e.g., plants grow less than 1 meter tall)

- ✓ Group IV to observe flat crop land soil profile (e.g., vegetable crops are grown)
- ✓ Group V to observe plain barren land soil (e.g., no crop or other plant is grown)

2. Each group marks a 1 sqm quadrant of soil surface with use of pegs and nylon twine to secure corners of quadrant and perform activities below:

   - ✓ Pull out and 'de-soil' (e.g., *ipagpag* or shake to retain soil in roots) weeds inside quadrant.
   - ✓ Collect soil litters and organisms (e.g., rove beetles, ants, millipede, earthworms, etc.) found in soil surface and place separately in plastic bags.
   - ✓ Scrape soil within two inches depth of quadrant and place in separate plastic bag.
   - ✓ Dig a pit one meter deep and one meter wide to show soil profile.
   - ✓ Let participants determine layers in soil profile by describing color, texture, presence of stones, parent materials, etc.
   - ✓ Observe crop development, root depth, presence of soil organisms, etc.
   - ✓ Observe possible indication of management practices, nutrients, fertility level, organic matter content, erosion hazards, etc.
   - ✓ Take soil samples from different layers.
   - ✓ List down all pertinent observations.

3. Go back to processing area. Brainstorm in small groups to design a suitable matrix to record observations and do following activities:

   - ✓ Summarize all observations made in soil profile.
   - ✓ Draw and color soil profiles as observed or construct a mini-soil profile using soil samples collected from soil layers.
   - ✓ List down all pertinent observations on soil and water management practices.

4. Present output of small groups to the big group. Conduct participatory discussions to allow sharing of experiences among participants. Relate soil profile characteristics to abundance of soil organisms, soil organic matter content, soil water holding capacity, soil nutrient availability, and crop productivity.

5. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendation from this exercise.

Some suggested questions for processing discussion

- ❑ What is a soil profile? Did you observe different soil layers and textures in a soil profile? Did you see variations in color and textures in different soil layers? What did these variations suggest?
- ❑ Did you observe differences in kind and number of organisms and litters found in different layers of a soil profile?
- ❑ Do you think there will be differences in performance (e.g., plant growth, development, and yield) of crops to be grown in soils with varying soil profiles?
- ❑ What factors do you think influenced the number and kind of organisms and litters found in different soil layers of a soil profile?
- ❑ What do you think is the influence of varying soil layers and textures of a soil profile on abundance of soil organisms, soil organic matter content, soil water holding capacity, soil nutrient availability, and crop productivity?
- ❑ What characteristics should we observe in a soil profile to suggest abundance of soil organisms, soil organic matter content, soil water holding capacity, soil nutrient availability, and crop productivity.

Exercise No. 3.03

The 'Feel method': Classifying soil textures for vegetable production

Background and rationale

The common field method of classifying a soil is by its feel[31]. Much can be judged about texture and class of a soil merely by rubbing it between thumb and fingers than by any other superficial means. Usually, it is helpful to wet sample in order to estimate plasticity more accurately. The way a wet soil 'slick out' (e.g., develops a continuous ribbon when pressed between thumb and fingers) gives a good idea of the amount of clay present. The slicker a wet soil, the higher its clay content. Sand particles are gritty; silt has a floury or talcum powder-feel when dry and is only slightly plastic and sticky when wet. Silt and clay generally impart persistent cloddiness. Soil textures are not subject to easy modification in farmers' field.

For some garden and vegetable crops with high economic value, large quantities of sand may be added to a fine-textured soil to improve its tillage properties. In greenhouses, mixtures of different soils and organic materials are commonly used and a textural class of mixtures may be varied. One factor to consider in raising healthy and vigorous vegetable crops is soil texture. Soils that are coarse or stony have low water holding capacities and organic matter contents, while crumbly and friable soils are richer in organic matter, easier to work on, and more suited for growing vegetables.

Many vegetable farmers had accumulated vast experiences in dealing with different soil textures. These experiences must be shared with others in FFSs to further improve current practices in managing soils with varying soil textures. This exercise was designed to address this particular concern.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, as component of 'Integrated Nutrient Management' topic
- When farmers want to learn from others some soil texture management practices for vegetable productions

[31] Brady, N.C. 1985. The nature and properties of soils. 9th Edition. Macmillan Publishing Co., 866 3rd Ave., New York, New York, U.S.A. pp36-71.

How long will this exercise take?

- Thirty minutes to one-hour for field walks and observations of soil texture management practices for vegetables grown at adjoining fields of learning field
- Thirty minutes to one-hour for hands-on and brainstorming session in processing area

Learning objectives

- To make participants aware of and understand how proper soil texture management can improve productivity and profitability in growing vegetables.
- To learn from other farmers and experience hands-on proper soil texture management that will improve productivity and profitability in vegetable production.

Materials

- Vegetable crops grown in soils of different soil textures in adjoining fields of learning field
- Soils obtained in 'Soil Biodiversity' exercise, if conducted already
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)
- Other supplies (empty one-litter capacity plastic bottles, cutter, alaskin (tulle), rubber bands, water, and weighing scale)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe different soil textures in adjoining fields of learning field, as follows:

   ✓ Group I to visually observe soil texture of forest soil (e.g., undisturbed forest trees are grown)
   ✓ Group II to visually observe soil texture of brush land (e.g., plants grow as tall as 1-2 meters)
   ✓ Group III to visually observe soil texture of grassland (e.g., plants grow less than 1 meter tall)
   ✓ Group IV to visually observe soil texture of crop land (e.g., vegetable crops are grown)
   ✓ Group V to visually observe soil texture of barren land (e.g., no crop or other plant is grown)

2. Each group should mark a 1 sqm quadrant of soil surface with use of pegs and nylon twine to secure corners of quadrant and perform following activities:

    ✓ Pull out and 'de-soil' (e.g., *ipagpag* or shake to retain soil from roots) weeds inside quadrant.
    ✓ Remove soil litters and organisms (e.g., rove beetles, ants, millipede, earthworms, etc.) found in soil surface.
    ✓ Scrape soil within two inches depth of quadrant and place in separate plastic bag.
    ✓ List down all pertinent observations.

3. Go back to processing area. Brainstorm in small groups to modify, improve, if necessary, or implement as the procedure suggested below:

    ✓ Get air-dried soil samples from respective quadrants, pulverize, and weigh 1 kg soil.
    ✓ Take soil sample sufficient to fit comfortably into palm.
    ✓ Remove foreign bodies (e.g., roots, seeds, insects, etc.) and soil materials greater than 2 mm (e.g., gravel, etc,).
    ✓ Moisten sample uniformly, a little at a time; knead soil until it just begins to stick to fingers (e.g., so-called sticky point).
    ✓ Break down soil into its individual particles so that no aggregates remain; some soils need much working.
    ✓ Work soil in hand and squeeze soil between thumb and forefinger to determine if it is one of the following:

    Sandy soil has nil to very little coherence. It can be formed into a rough ball which will break easily when squeezed lightly between thumb and fingers. Alternatively, a rough cylinder (about 5-cm long, 1.5-cm diameter) can also be formed out of the soil but the cylinder is not smooth and cracks form. It has a sandy feel, which predominates and is not very sticky.

    Loamy soil forms a smooth ball or cylinder that is coherent. Alternatively, ball or cylinder can be rolled into a thread (about 13-cm long, 0.6-cm diameter) and soil can be easily worked between thumb and forefinger. Meanwhile, the thread can be formed into 'U' or ring but cracks are formed. Alternatively, 'I' formed sticks on fingers with a silky-soapy feel that predominates but may sometimes also have a slightly sandy feel.

Clayey soil can be formed into a ball, which is smooth and plastic, and soil is stiff to work between thumb and forefinger. Alternatively, soil can be rolled into a ribbon, which forms a ring without cracking. It also takes on polish when moist and is very sticky when wet. It has a silky-soapy feel that predominates but sometimes a few sand grains may also be felt.

4. Present output of small groups to the big group. Conduct participatory discussions to allow sharing of experiences among participants. Relate soil texture to water holding capacity, abundance of soil organisms, soil organic matter content, soil nutrient availability, and crop productivity.

5. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendation from this exercise.

Some suggested questions for processing discussions

- ❑ What do we mean by soil texture?
- ❑ Which soil sample had sandy texture? Which soil sample had loamy texture? Which soil sample had clayey texture?
- ❑ Which soil texture exhibited higher water holding capacity? Which soil texture exhibited lower water holding capacity?
- ❑ What physical, chemical, and biological soil characteristics were related to sandy, loamy, and clayey soil textures?
- ❑ Did you observe differences in the kind and number of organisms in soils exhibiting different textures?
- ❑ Do you think there will be differences in performance (e.g., plant growth, development, and yield) of crops to be grown in soils of different textures?
- ❑ What do you think is the role of soil texture on water holding capacity, abundance of soil organisms, soil organic matter content, soil nutrient availability, and crop productivity?
- ❑ How do you change or improve soil textures? Did you learn from other farmers their innovative practices for improving different soil textures?

Exercise No. 3.04

Soil water holding capacity determination: A soil management guide for improving productivity in growing vegetables

Background and rationale

Organic matter functions as a 'granulator' of mineral particles, being largely responsible for loose, easily managed condition of productive soils. Through its effect on physical condition of soils, organic matter also increases the amount of water a soil can hold or *water holding capacity* and proportion of this water available for plant growth. Soils high in organic matter are darker in color and have greater water holding capacities than soils low in organic matter[11] .

Two major concepts concerning soil water emphasize significance of this component of soil in relation to plant growth, namely: (1) water is held within soil spaces (pores) with varying degrees of attraction (tenacity) depending on amount of water present and size of pores; and (2) together with its dissolved nutrients (salts), soil water makes up *soil solution*, which is very important as a medium for supplying nutrients to growing plants.

In FFSs, relevant experiences on water holding capacities of different soils can be shared freely among farmers and facilitators in order to improve current soil management practices in vegetable production. This particular exercise was designed to address this concern.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, as component of topic on 'Soil Conservation and Management' or 'Soil Biodiversity'
- When farmers want to learn more improved soil management practices from other farmers that will increase water-holding capacities of their soils

How long will this exercise take?

- Thirty minutes to one hour for field walks and observations of water holding capacities of soils in adjoining and learning fields
- Thirty minutes to one hour hands-on and brainstorming session in processing area

---

[32] Brady, N.C. 1985. The nature and properties of soils. 9th Edition. Macmillan Publishing Co., 866 3rd Ave., New York, New York, U.S.A. pp14-16.

Learning objectives

- To make participants aware of and understand the factors contributing to higher soil water holding capacity and its role in improving crop productivity.
- To learn the current best practices from other farmers that will increase soil water holding capacity.

Materials

- Adjoining and learning fields where different soil water holding capacities can be observed visually
- Soils obtained in 'Soil Biodiversity' exercise
- Office supplies (Manila papers, notebooks, ball pens, and marking pens).
- Other supplies (empty 1 liter capacity plastic bottles, cutter, alaskin (tulle), rubber bands, water, and weighing scale)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe different soil water holding capacities (WHC) in adjoining and learning fields as follows:

   ✓ Group I to visually observe WHC of forest soil (e.g., undisturbed forest trees are grown)
   ✓ Group II to visually observe WHC of brush land (e.g., plants grow as tall as 1-2 meters)
   ✓ Group III to visually observe WHC of grassland (e.g., plants grow less than 1 meter tall)
   ✓ Group IV to visually observe WHC of crop land (e.g., vegetable crops are grown)
   ✓ Group V to visually observe WHC of barren land (e.g., no crop or other plant is grown)

2. Each group should mark a 1 sqm quadrant of soil surface with use of pegs and nylon twine to secure corners of quadrant and perform the activities below:

   ✓ Pull out and 'de-soil' (e.g., *ipagpag* or shake to retain soil from the roots) weeds inside quadrant.

- ✓ Remove soil litters and organisms (e.g., rove beetles, ants, millipede, earthworms, etc.) found in soil surface.
- ✓ Scrape soil within two inches depth of quadrant and place in separate plastic bag.
- ✓ List down all pertinent observations.

4. Go back to processing area. Brainstorm in small groups to modify, improve, if necessary, or implement as the procedure suggested below:

   - ✓ Get air-dried soil samples from respective quadrants, pulverize, and weigh 1 kg soil.
   - ✓ Get two empty plastic bottles, cut bottom of one (Container A) and neck of another (Container B).
   - ✓ Put tulle on mouth of Container A, secure with a rubber band, invert and place pulverized soil in it.
   - ✓ Place Container A over Container B, pour one liter of water slowly into soil in Container A and wait for water to drop into Container B.
   - ✓ Record time when you observed first and last drops of water in Container B.
   - ✓ Measure amount of water collected in Container B.
   - ✓ List down all pertinent observations.

4. Present output of small groups to the big group. Conduct participatory discussions to allow sharing of experiences among participants. Relate soil water holding capacity to abundance of soil organisms, soil organic matter content, soil nutrient availability, and crop productivity.

5. Synthesize and summarize output of the small groups into one big group output. Draw up conclusions and recommendation from this exercise.

Some suggested questions for processing discussion

- ❑ What do we mean by soil water holding capacity?
- ❑ Which soil sample drained faster? Which soil sample drained more water?
- ❑ Which soil samples exhibited the highest water holding capacity? Which soil samples exhibited the lowest water holding capacity?
- ❑ What physical, chemical, and biological soil characteristics were related to high water holding capacity?
- ❑ Did you observe differences in the kind and number of organisms in soils exhibiting different water holding capacities?
- ❑ Do you think there will be differences in performance (e.g., plant growth, development, and yield) of crops to be grown in soils of different water holding capacities?
- ❑ What do you think is the role of soil water holding capacity on the abundance of soil organisms, soil organic matter content, soil nutrient availability, and crop productivity?
- ❑ How do you maintain or increase soil water holding capacity?

Exercise No. 3.05

Composting[33] as a soil and weed management strategy in vegetable production

Background and rationale

Many farmers believe that weeds are more of a problem in vegetable production. This is so because weeds do not only compete with crops for nutrient uptake but also harbor some pests. This is also one reason why farmers, during land clearing and preparation, will either throw or burn weeds. Unknown to most of them is the many benefits that can be derived when weeds are used or managed properly. Using and managing weeds properly will ease burden on lack of fertilizers, improving soil structure, and encouraging soil microbial activity, which will eventually lead to improved soil fertility and productivity.

One way of doing this is by weed composting. The composting process involves decomposition of organic materials to form small bits of organic matter called *compost*. The whole process is done by decomposers that use organic matter as source of energy for their growth and reproduction. A majority of decomposers are microorganisms. Macroorganisms such as earthworm, termite, and other insects also contribute in breaking down organic materials. Therefore, two requirements for process to occur are: (1) composting materials, and (2) decomposers. Microorganisms prefer materials that are high in nitrogen (N), such as weeds and crop residues. Materials high in N are also easier to break down. The more decomposers present, the faster is the decomposition process.

The soil-borne fungus *Trichoderma harzianum* is now locally available. If applied to compost materials, it can shorten composting process from four months to only 3-5 weeks. This microorganism is now mass-cultured and mass distributed to farmers. Such innovative strategies can be shared and enriched by farmers and facilitators in FFSs to improve current practices through participatory, discovery-based, and experiential learning approaches, hence this exercise.

[33] Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition, SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp284-294.

When is this exercise most approriate?
- In FFS, TOT, and VST sessions, before or immediately after weeding operations in the learning field
- When farmers want to learn from other farmers some innovative composting process for weeds and other crop residues

How long will this exercise take?
- Thirty minutes to one hour for field walks, observations, interaction with farmers, and hands-on in learning field
- Thirty minutes for brainstorming session in processing area

Learning objectives
- To create awareness and understanding among participants about the role of composting as a soil and weed management strategy in vegetable production.
- To learn from others and do hands-on of proper composting of weeds and other crop residues.

Materials
- Office supplies (Manila papers, notebooks, ball pens, marking pens, and crayons)
- Vegetable crops that are newly weeded or ready for weeding operations in learning and adjoining fields
- Other supplies (weeds, animal manure, *Trichoderma harzianum* fungus, complete and urea fertilizers, black polyethylene sheets, bamboo poles, banana trunks, shovel or spading fork, top soil, tape measure, bolo, or scythe)

Methodology
- Field walks, hands-on, and brainstorming

Steps
1. Divide participants into smaller groups and ask them to conduct field walks and observe weeding and post-weeding practices of vegetables in learning and adjoining fields. Take note of cultural practices employed. Interview other farmers if necessary. List down all observations related to:

   ✓ Kind of crops planted and crop stand;
   ✓ Prevalent weeds, pests, and diseases; and
   ✓ Weeding and post-weeding practices, etc.

2. Go back to processing area; brainstorm in small groups and present output to big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. Motivate farmers to share their best experiences in composting of weeds and other crop residues.

3. Develop an improved procedure of composting as a soil and weed management strategy in vegetable production.

4. Facilitate each farmer to do hands-on of composting of weeds and other crop residues in learning field every after weeding operation by improving the procedure below:

   ✓ After weeding operation, collect at least 100 kg composting materials (e.g., weeds, and other crop residues);
   ✓ Soak collected composting materials in water overnight;
   ✓ Dig a pit with an area of 2 m x 2 m and a depth of one foot to pile composting materials;
   ✓ Place banana trunks as walling to hold composting materials;
   ✓ Pile composting materials into pit to a height of about one foot;
   ✓ Spread uniformly a thin coating of *Trichoderma harzianum* fungus (optional) over composting materials;
   ✓ Spread also uniformly one-foot thick animal manure and 200 grams each of complete (14-14-14) and urea (46-0-0) fertilizers over composting materials;
   ✓ Cover pile with one-inch topsoil;
   ✓ Repeat procedure until at least five layers are formed;
   ✓ Cover compost pile with black polyethylene sheet;
   ✓ Insert a bamboo pole with joints bored at the side into pile to serve as ventilation vent; or after two weeks, mix thoroughly compost pile then cover again with black polyethylene sheet;
   ✓ Compost process is complete in one (with *Trichoderma*) to four (without *Trichoderma)* months (100 kg composted weeds and other crop residues is equivalent to one sack pure organic fertilizer); and
   ✓ Take note of all relevant observations and experiences during this activity.

5. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❏ Did you observe different weeding and post-weeding practices on vegetables and other plants in learning and adjoining fields?
- ❏ Did you observe farmers preparing composts in their fields? Did they use weeds and other crop residues as composting materials?
- ❏ Did you observe farmers using other composting materials? What are these composting materials?
- ❏ Is composting effective as a soil and weed management strategy in vegetable production? When is the best time to do composting as a soil and weed management strategy in vegetable production?
- ❏ Did you observe any innovative composting procedures used by farmers as a soil and weed management strategy in vegetable production? What benefits did farmers derive in composting weeds and other crop residues?
- ❏ What other cultural management options can you use to complement composting as a soil and weed management strategy in vegetable production?

Exercise No. 3.06 Green leaf manuring as a soil and weed management strategy in vegetable production

Background and rationale

If the source of organic matter comes from plants grown at site where it is needed and then plowed under before flowering and allowed to decompose, the practice is called *green manuring*. If plant to be incorporated is not grown at site where it is needed, the practice is called *green leaf manuring*. Examples of the latter are wild sunflower and 'kakawate' (*Gliricidia sepium*)[34] leaves cut from plants or indigenous azolla (*Azolla pinnata*)[35] collected and brought to field for incorporation.

The more common practice in the Cordilleras is green leaf manuring. However, except for source of green manure, processes of green manuring and green leaf manuring are the same. An ideal green leaf manure is fast-growing, produces large amounts of organic matter even on poor soils, contain high amount of nitrogen (N), is easily decomposed, disease-resistant, and has an extensive root system. All fast-growing weeds when incorporated before flowering at land preparation and hilling-up operations may also be classified as green manures. Weeds gathered on side of terraces such as wild sunflowers when incorporated in vegetable fields are also classified as green leaf manures.

The practice of green leaf manuring is a strategy to manage weeds and soils. Many vegetable farmers had innovative green leaf manuring practices. These innovations can be shared to others in FFSs to continuously improve their existing best practices, through participatory, discovery-based, and experiential learning approaches, hence this exercise.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, before land preparation, weeding or hilling-up operations in learning field
- When farmers want to learn innovative practices in green leaf manuring using weeds and other crops from other farmers

---

34 Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition, SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp295-296.

35 Callo, Jr. D.P. 1989. Azolla adaptability and utilization on farmers' fields. In Azolla: Its Culture, Management and Utilization in the Philippines. National Azolla Action Program (NAAP), University of the Philippines Los Baños, College, Laguna, Philippines. pp109-128.

How long will this exercise take?

- Thirty minutes to one hour for field walks, observations, interaction with farmers, and hands-on in learning field
- Thirty minutes for brainstorming session in processing area

Learning objectives

- To create awareness and understanding among participants on the role of green leaf manuring as a weed and soil management strategy in vegetable production.
- To learn from others and do hands-on of proper green leaf manuring using weeds and other crops.

Materials

- Office supplies (Manila papers, notebooks, ball pens, marking pens, and crayons)
- Vegetable fields ready for land preparation, weeding, and hilling-up operations in learning and adjoining fields
- Other supplies (green leaf manures composed of weeds and other crops, shovel or spading fork, top soil, tape measure, bolo, or scythe)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe weeding and post-weeding practices of vegetables in learning and adjoining fields. Take note of cultural practices employed. Interview other farmers, if necessary. List down all observations related to:

   ✓ Kind of crops planted and crop stand;
   ✓ Prevalent weeds, plants in side of terraces, and hedgerows grown; and
   ✓ Weeding and post-weeding practices, etc.

2. Go back to processing area; brainstorm in small groups and present output to big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. Motivate farmers to share their best experiences in green leaf manuring using weeds and other crops.

3. Develop an improved procedure of green leaf manuring as a soil and weed management strategy in vegetable production.

4. Facilitate each farmer to do hands-on of green leaf manuring using weeds and other crops in learning field during land preparation, weeding, and hilling-up operations by improving procedure below:

   ✓ Before land preparation, weeding or hilling-up operations in learning field, collect all possible green leaf manure materials (e.g., weeds and other crops) from other fields;
   ✓ Cut or remove all weeds before land preparation or hilling-up operations in learning field;
   ✓ Gather other weeds and trim hedges or plants growing on sides of terraces and bring from adjoining field to learning field;
   ✓ Incorporate in the soil all weeds gathered, plants and hedges trimmed during land preparation or hilling-up operations;
   ✓ Take note of all relevant observations and experiences during this activity.

6. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendation from this exercise.

Some suggested questions for processing discussion

❑ Did you observe different weeding and post-weeding practices on vegetables and other plants in learning and adjoining fields?
❑ Did you observe farmers green leaf manuring in their fields? Did they use weeds and other crops for green leaf manuring?
❑ Did you observe farmers using other green leaf manuring materials? What are these green leaf manuring materials?
❑ Is green leaf manuring effective as a soil and weed management strategy in vegetable production? When is the best time to do green leaf manuring as a soil and weed management strategy in vegetable production?
❑ Did you observe any innovative green leaf manuring procedures used by farmers as a soil and weed management strategy in vegetable production? What benefits did farmers derive in green leaf manuring weeds and other crops?
❑ What other cultural management options can you use to complement green leaf manuring as a soil and weed management strategy in vegetable production?

Exercise No. 3.07 Maintaining soil biodiversityas a soil management option for improving vegetable productivity

Background and rationale

The soil harbors a varied population of living organisms. Both animals and plants are abundant in soils. Moreover, most organisms vary so much both in number and in amount as to make precise statements impossible. This condition is known as *soil biodiversity*. In any case, the quantity of living organism including plant roots is sufficient to influence profoundly physical and chemical trend in soil changes.

Activities of soil organism range from largely physical disintegration of plant residues by insects and earthworms to eventual complete decomposition of these residues by smaller organisms such as bacteria and fungi. Accompanying these decaying processes is the release of several nutrient elements, including nitrogen, phosphorus, and sulfur from the decomposed organic matters. By contrast, conditions in nature are such that organisms need these elements for their growth and for a reversal to occur (elements are converted again into organic forms not available to higher plants).

Thus, soil biodiversity is important so that the above process, known as *biocycling*, can proceed in a faster pace. Through this process, residues and wastes are incorporated into soils, disintegrated and decomposed, and pertinent product of organic matters are then taken up by plants to stimulate further biomass production and thus, improve crop productivity[36]. In FFSs, farmers and facilitators can learn from each other many appropriate cultural practices that will enhance soil biodiversity through participatory, discovery-based, and experiential approaches; hence this exercise.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, as component of the topic on 'Ecosystem'
- When farmers want to learn more about the role of soil organisms in further sustaining productivity in growing vegetables

[36] Brady, N.C. 1985. The nature and properties of soils. 9th Edition. Macmillan Publishing Company, 866 3rd Avenue, New York, New York, USA. pp1-33.

How long will this exercise take?

- Thirty minutes to one hour for field walks and observations of soil biodiversity for different soil ecosystems in adjoining fields of learning field
- Thirty minutes to one hour brainstorming session in processing area

Learning objectives

- To make participants aware of and understand the contribution of soil biodiversity in improving productivity in vegetable growing.
- To learn from other farmers some innovative cultural management practices that will enhance soil biodiversity to further sustain productivity in growing vegetables.

Materials

- Adjoining fields of learning field where different soil ecosystems can be observed
- Field supplies (meter stick, pegs, nylon twine, plastic bags, weighing scale, magnifying lens, bolo, and spade)
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)

Methodology

- Field walks and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe different soil ecosystems in adjoining fields of learning field as follows:

   ✓ Group I to observe forest soil (e.g., undisturbed forest trees are grown)
   ✓ Group II to observe brush land (e.g., plants grow as tall as 1-2 m)
   ✓ Group III to observe grassland (e.g., plants grow less than 1 m tall)
   ✓ Group IV to observe crop land (e.g., vegetable crops are grown)
   ✓ Group V to observe barren land (e.g., no crop or other plant is grown)

2. Each group marks a one-sqm quadrant of soil surface with use of pegs and nylon twine to secure corners of quadrant and perform the activities below:

   ✓ Pull out and 'de-soil' (e.g., *ipagpag* or shake to remove soil in roots) weeds inside the quadrant.

- ✓ Collect soil litters and organisms (e.g., rove beetles, ants, millipede, earthworms, etc.) found in soil surface and place separately in plastic bags.
- ✓ Scrape soil within two inches depth of quadrant and place in separate plastic bag.
- ✓ List down all pertinent observations.

3. Go back to processing area. Brainstorm in small groups to design a suitable matrix to record observations and do following activities:

   - ✓ For soil organisms, spread soil collected from quadrant in a Manila paper, count number of organisms and add to initial collections made. The abundance of minute organisms, such as mites, can be described quantitatively, namely: too many (numbers more than 100); many (numbers from 50-100); or few (numbers less than 50).

   - ✓ For soil litters, spread, segregate, and weigh separately all dried or decaying grasses and leaves, branches and twigs, dead insects and other animals, etc. The presence of mycelia bodies or foul odor on decaying plant and animal debris should be noted also to indicate probable presence of fungi and bacteria in soil.

   - ✓ List down all pertinent observations.

4. Present output of small groups to the big group. Conduct participatory discussions to allow sharing of experiences among participants. Relate soil biodiversity to abundance of soil organisms, soil organic matter content, soil water holding capacity, soil nutrient availability, and crop productivity.

5. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendation from this exercise.

Some suggested questions for processing discussion

- ❑ What do we mean by soil biodiversity?
- ❑ Did you observe differences in the kind and number of organisms and litters found in different soil ecosystems?
- ❑ Do you think there will be differences in the performance (e.g., plant growth, development, and yield) of crops to be grown in different soil ecosystems observed? Why?
- ❑ What factors do you think influenced number and kind of organisms and litters found in different soil ecosystems?
- ❑ What do you think is the role of soil biodiversity on abundance of soil organisms, soil organic matter content, soil water holding capacity, soil nutrient availability, and crop productivity?
- ❑ How do we maintain or enhance soil biodiversity?

Exercise No. 3.08 Methods of applying fertilizer as a key factor in improving vegetable productivity in the highlands

Background and rationale

Fertilizer application is important and must not be overlooked. Fertilizer should be applied as close as possible to but not touching roots and seeds so as not to adversely affect physically root growth or germination. It should be applied when nutrients are most needed, usually at early vegetative stage and at flowering or fruiting time. For rainfed areas, application of fertilizer is done when there is still moisture in the soil.

The usual practice in applying chemical fertilizer at planting time for direct-seeded vegetables is to place half or one-third of fertilizer at bottom of furrows, cover slightly with soil, and then plant seed. During growing stage of crop, fertilizer can be applied on surface of soil between rows with shallow cultivation. The rest of the fertilizer can be applied during vegetative growth, before flowering, or during fruit development. The area must be free from weeds to limit crop-weed competition for nutrients[37] .

For transplanted crops, a starter solution will enable plant to be established quickly. However, many vegetable farmers in the Cordilleras do not follow appropriate methods of application. Hence, use of very high organic and inorganic fertilizer rates is common. This practice had resulted in inefficient fertilizer usage and high production cost. On the other hand, a number of enterprising farmers have evolved, through time, sound fertilizer application practices that must be shared with others in FFSs, to further improve their existing best fertilizer application practices. This exercise was specifically designed for this purpose.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, before plot and furrow preparations or before planting vegetable crops in learning field
- When farmers want to learn the best fertilizer application practices for vegetables from other farmers

[37] Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition, SEAMEO Regional Center for Graduate Study and Research in Agriculture and University of the Philippines Los Baños, College, Laguna, Philippines. pp290-293.

How long will this exercise take?

- Thirty minutes to one hour for field walks and observations of best fertilizer application practices for vegetables in adjoining fields of learning field
- Thirty minutes to one hour brainstorming session in processing area

Learning objectives

- To make participants aware of and understand how proper fertilizer application methods can improve productivity and profitability in vegetable production.
- To learn proper fertilizer application methods from other farmers.

Materials

- Adjoining fields of learning field where plots and furrows are about to be prepared or planted with vegetable crops
- Office supplies (e.g., Manila papers, notebooks, ball pens, and marking pens)

Methodology

- Field walks and brainstorming

Steps

1. Divide participants in small groups and ask them to conduct field walks and observe fertilizer application practices in adjoining vegetable fields of learning field. Interview other farmers, if necessary. List down all observations related to fertilizer application practices, kind of fertilizer materials used, crops planted, crop stand, etc.

2. Go back to processing area. Brainstorm in small groups and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. List down important observations shared by farmers, as follows:

   ✓ Frequency and timing of fertilizer application for different crops;
   ✓ Placement and method of fertilizer application for different crops; and
   ✓ Kind and amount of fertilizer applied for different crops.

3. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❑ Did you observe different fertilizer application practices for vegetable crops planted in farmers' fields?
- ❑ When and why did farmers apply basal fertilizer? When and why did farmers apply side or top dress fertilizer? When and why did farmers apply foliar fertilizer?
- ❑ What growth stages of vegetable crops are critical to fertilizer application?
- ❑ Did you observe differences in crop stand with different fertilizer application practices for vegetable crops?
- ❑ What vegetable pests and diseases were prevalent on crops observed in farmers' fields in relation to fertilizer application practices?
- ❑ Did you learn from other farmers their best experiences regarding the methods of fertilizer application for different vegetable crops? How did they do it?
- ❑ What other cultural management practices can complement proper fertilizer application to improve productivity and profitability in vegetable production?

Exercise No. 3.09

Applying fertilizers before hilling-up operations to improve vegetable productivity in the highlands

Background and rationale

One cultural management practice undertaken after field establishment of vegetable crops is proper fertilizer application before hilling-up. Vegetable crops are usually fertilized in hill or row at second and succeeding fertilizations after planting or transplanting. If placed in a hill, fertilizer may be deposited on one side, or better, on both sides of plant. When applied to row, fertilizer usually is placed in a narrow band on one or both sides of row, 5-8 cm away a plant.

For more cost efficient practice, applying fertilizer is timed just before hilling-up operations. Such practice promotes good healthy crop development, as well as better weed, pest, and disease control. Ultimately, such practice results in improved productivity and profitability in growing vegetables. Many farmers in the Cordilleras had evolved more efficient fertilizer application practices before hilling-up operations through years of experience in vegetable farming. These experiences must be shared with others in FFSs to further improve their existing practices, hence, this exercise.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, before hilling-up operations at second and succeeding fertilizations of vegetable crops in learning field
- When farmers want to learn from each other better fertilizer application practices before hilling-up operations in vegetable productions

How long will this exercise take?

- Thirty minutes to one hour field walks and observations of fertilizer application practices before hilling-up operations in vegetables at adjoining fields of learning field
- Thirty minutes to one hour for brainstorming session in processing area

Learning objectives

- To make participants aware of and understand how proper fertilization before hilling-up operations can improve productivity and profitability in vegetable production.
- To learn from other farmers proper fertilization techniques before hilling-up operations that will improve productivity and profitability in vegetable production.

Materials

- Vegetable crops in adjoining fields of the learning field where hilling-up operations and second or succeeding fertilization will be undertaken
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)

Methodology

- Field walks and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe fertilizer application practices before hilling-up operations in adjoining vegetable fields of learning field. Interview other farmers, if necessary. List down all observations related to fertilizer application practices before hilling-up operations, kind of fertilizer materials used, crops planted, crop stand, etc.

2. Go back to processing area. Brainstorm in small groups and present output to big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. List down important observations shared by farmers, as follows:

   ✓ Frequency and timing of fertilizer application and hilling-up operation for different crops;
   ✓ Placement and method of fertilizer application for different crops; and
   ✓ Kind and amount of fertilizer applied before hilling-up operation for different crops.

3. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

❑ Did you observe different fertilizer application practices before hilling-up operations of vegetable crops planted in farmers' fields?
❑ When and why did farmers apply fertilizer in hills? When and why do we apply fertilizer in rows?
❑ What growth stages of vegetable crops are critical to hilling-up operations?
❑ Did you observe differences in crop stand among vegetables with different fertilization practices before hilling-up operations?

- ❑ What pests and diseases were prevalent in crops observed in farmers' fields related to fertilizer application practices before hilling-up operations?
- ❑ Did you learn from other farmers their best experiences on fertilization before hilling-up operations for different vegetable crops? How did they do it?
- ❑ What other cultural management practices can complement proper fertilization before hilling-up operations to improve productivity and profitability in vegetable production?

Exercise No. 3.10 Liming as a cultural management strategy for improving vegetable productivity

Background and rationale

The problem of soil acidity is common in areas where precipitation is high enough to leach appreciable amount of calcium (Ca) and magnesium (Mg) from soil surface. In addition, acidity arises from a variety of factors such as type of clay, presence of iron and aluminum oxides and free acids from continuous application of large amounts of acid-forming fertilizers such as ammonium sulfate, ammonium phosphate, and ammonium nitrate. To decrease acidity, iron, aluminum, and hydrogen must be replaced by Ca and Mg bases through liming. This is commonly done by adding agricultural lime, such as *quicklime* (calcium or magnesium oxide), *slaked lime* (calcium or magnesium hydroxide), or *limestone* (calcium or magnesium carbonate)[38].

The agricultural lime available in the Cordilleras is calcitic limestone or calcium carbonate. Limestone must be pulverized when applied to soil. The finer it is, the faster is its rate of neutralizing soil acidity. As soil pH approaches neutrality, most soil nutrients become available for plant use. Indirectly, improved structure is also encouraged when an acid soil is limed. Lime stimulates activities of many soil organisms favoring formation of humus and encouraging elimination of by-products that are toxic to higher plants. Liming likewise encourages most of the favorable soil organisms[39].

Some vegetable farmers have more innovative liming practices than others do, which resulted in more sustained productivity in their own farms. In FFSs, these experiences must be shared among farmers to improve their current best liming practices through participatory, discovery-based, and experiential learning approaches, hence, this exercise.

[38] Brady, N.C. 1985. The nature and properties of soils. 9th Edition. Macmillan Publishing Co., 866 3rd Ave., New York, New York, U.S.A. pp572-588.

[39] Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition, SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp314-316.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, as component of the topic on 'Integrated Nutrient Management'
- When farmers want to learn some innovative liming practices from other farmers to improve vegetable productivity

How long will this exercise take?

- Thirty minutes to one hour field walks, farmer interviews, and observations of vegetable field where different liming practices were employed
- Thirty minutes to one-hour simulation exercise and brainstorming session in processing area

Learning objectives

- To make participants aware of and understand the role of liming in improving vegetable productivity.
- To learn from other farmers some innovative liming practices that resulted in improved vegetable productivity.

Materials

- Adjoining vegetable fields of learning field where different liming practices were employed
- Office supplies (Manila papers, notebooks, ball pens, and marking pens).
- Supplies for simulation exercise, Option 1 (two lemon fruits, table sugar, three drinking glasses, clean water and spoons)
- Supplies for simulation exercise,Option 2 (one ripe plus two green 'carabao' mango fruits, table salt or sugar, three saucers, and knife)

Methodology

- Field walks, brainstorming, and simulation exercise

Steps

1. Divide participants into smaller groups and ask them to conduct field walks, and observe vegetable fields where different liming practices were employed. Interview other farmers, if necessary. List down all observations related with pest and disease occurrence, kind of crops planted, crop stand, etc.

2. Go back to processing area, brainstorm in small groups, and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. As a wrap-up session following simulation exercises, the following options may be undertaken:

Option 1:

- ✓ Request one volunteer to half-fill three drinking glasses with clean water.
- ✓ Request another volunteer to add lemon fruit juice in two of three glasses of water.
- ✓ Request another volunteer to add and stir enough sugar in one of two glasses of water with lemon fruit juice.
- ✓ Request three other volunteers, one to taste plain water (to represent Neutral soil medium), another one to taste water with lemon fruit juice (to represent Acidic soil medium), and a last one to taste water with lemon fruit juice and sugar (to represent Limed acidic soil medium).
- ✓ Let each small group observe, discuss, and relate what were learned from field walks to what were depicted in simulation exercise; and
- ✓ Process activity in big group.

Option 2:

- ✓ Request one volunteer to peel, slice, and serve green mango fruits in two of three saucers.
- ✓ Request another volunteer to peel, slice, and serve a ripe mango fruit in another saucer.
- ✓ Request three other volunteers, one to taste ripe mango fruit (to represent Neutral soil medium), another one to taste green mango fruit (to represent Acidic soil medium), and a last one to taste green mango fruit with either salt or sugar (to represent Limed acidic soil medium).
- ✓ Let each small group observe, discuss, and relate what were learned from field walks to what were depicted in simulation exercise; and
- ✓ Process activity in big group.

3. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendation from this exercise.

Some suggested questions for processing discussion

- ❑ What is liming? What were the commonly used liming materials? How do we apply lime in soil?
- ❑ Did you observe different liming practices in different vegetable fields?
- ❑ Did you observe differences in crop stand, pest and disease occurrence, etc.?
- ❑ What benefits did farmers derive from the liming practices they employed in their farms?
- ❑ What vegetable diseases can be managed by liming? When is the most appropriate time to lime vegetable fields?
- ❑ What innovations did you learn from other farmers in their liming practices that resulted in better vegetable productivity?
- ❑ How did you feel about doing a simulation exercise? Did it help you understand the topic better? How?
- ❑ What improvement was made when we put sugar in water with lemon fruit juice or in green carabao mango fruit? What did this exercise depict?
- ❑ What other cultural management practices can complement liming as a strategy to improve vegetable productivity? What other practices can we employ to increase soil pH?

Exercise No. 3.11 Contour planting as a soil conservation strategy for highland vegetable production

Background and rationale

When land is cultivated up and down a slope, furrows act as fabricated channels or rills. Each time it rains, water runs down furrows and enlarges them, becoming gullies, if not checked. The solution is to plow across slope following contour lines rather than up and down, a method called contour farming or *contour planting*. Contours are areas around a field having same elevation.

In contour planting, a row of plants is planted on a contour and the next rows of plants on the next contour. Each furrow in contour serves as a small dam to check flows of water. Eventually water seeps into the ground. If one to four contours of cultivated crops are followed by either a row (also called *strip*) of a perennial crop that will not shade vegetable crops, such practice is called *contour strip farming*. If hedges are used along contour lines, such hedges are more aptly called contour hedgerows and such cropping system is known as alley cropping system or *sloping agricultural land technology* (SALT)[40]. The strips slow and spread water movement, thus reducing likelihood of serious erosion in cultivated areas. The SALT is gaining wide acceptance among small vegetable farmers in sloping areas. The rows or strips are closer in steeper slopes and wider in moderate slopes.

When growing vegetable crops, planting one permanent crop out of four would help greatly in conserving soil. In planting several kinds of vegetable crops, plant tall crops at lower strips and shorter ones at higher strips. Farmers in the Cordilleras are continuously adapting more innovative contour farming practices, which when shared with others in FFSs will further improve existing best practices. This exercise was so designed to enhance such sharing of experiences.

[40] Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition, SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp301-304.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, before land preparation and layouting in learning field
- When farmers want to learn from other farmers some innovative contour farming practices for vegetable production in sloping areas

How long will this exercise take?

- Thirty minutes to one hour for field walks, observations, interaction with farmers, and hands-on in learning field
- Thirty minutes for brainstorming session in processing area

Learning objectives

- To create awareness and understanding among participants on the role of contour farming as a soil conservation strategy for vegetable production in sloping areas.
- To learn from others and do hands-on of proper contour farming practices for vegetable production in sloping areas.

Materials

- Office supplies (Manila papers, notebooks, ball pens, marking pens, and crayons)
- Other materials (marking, leveling and staking materials, grab hoe, shovel or spading fork, tape measure, and bolo or scythe)
- Sloping vegetable fields ready for land preparation in learning and adjoining fields

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe different contour farming practices for vegetables grown in sloping areas. Take note of cultural management practices employed. Interview other farmers, if necessary. List down all observations related to the following:

   ✓ Kind of crops (e.g., vegetable and perennial crops) planted and crop stand;
   ✓ Row orientation of crops grown in relation to topography; and
   ✓ Cultural management practices employed, etc.

2. Go back to processing area; brainstorm in small groups and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. Motivate farmers to share their best experiences in contour farming practices for vegetables grown in sloping areas.

3. Develop an improved procedure of contour farming for vegetable production in sloping areas.

4. Facilitate each small group to do hands-on of contour farming for vegetables grown in sloping areas of learning field during land preparation and layouting by improving procedure below:

   - ✓ Prepare land properly. Soil-incorporate all weeds and crop residues.
   - ✓ Determine which areas are same elevation in contour planting using a leveling triangle.
   - ✓ Determine and layout rows or strips in learning field starting from highest elevation.
   - ✓ Determine which rows or strips will be planted with vegetable and hedgerow crops.
   - ✓ Prepare rows or strips to be planted with vegetable and hedgerow crops.
   - ✓ Plant rows or strips with vegetables and hedgerow crops; and
   - ✓ Take note of all relevant observations and experiences during this activity.

5. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❑ Did you observe farmers practicing contour farming for vegetables grown in slopes?
- ❑ Did you observe different contour farming practices for different crops grown in slopes?
- ❑ Did you observe farmers using different hedgerow crops grown for contour farming? What are these hedgerow crops?

- ❑ Is contour farming an effective soil conservation strategy for vegetable production in sloping areas? What contour farming practice is best for a particular topography for vegetable production in sloping areas?
- ❑ Did you observe any innovative contour farming practices used by farmers as a soil conservation strategy in vegetable production? What benefits did farmers derive by practicing contour farming for vegetable production in sloping areas?
- ❑ What other cultural management options can you use to complement contour farming as a soil conservation strategy for vegetable production in sloping areas?

Exercise No. 3.12 Bench terracing as a soil conservation strategy for highland vegetable production

Background and rationale

Terracing is a most effective erosion control measure practiced in the Cordilleras. If properly designed and constructed, terraces can reduce soil losses to about one-eight of what it would be with no erosion control measure. Land that is moderately sloping and subject to moderate or severe erosion would require use of terraces such as those in Ifugao and Mountain Province. Forming a series of banks breaks down a long slope. Drainage ditch at base of each bank conduct water around slopes. Such areas may have slopes of 20 percent or more. Of the different types of terracing that can be done, bench terracing is the most intensive form and is applicable to small vegetable areas.

Bench terracing consists of creating a series of level strips running across slope. Viewed from a distance, it looks like a stairway. Each terrace is separated by an almost vertical retaining wall of earth, rock, or concrete protected by vegetation. Bench terraces are sometimes provided with silt pits or soil traps, which are actually short canals, constructed after every few rows of vegetable crops to slow flow of water and catch soil washed downhill. Soil that accumulates in pit is regularly removed and thrown up to form a dike, especially before the rainy season[41] .

Farmers in highlands are continuously adapting more innovative bench terracing practices for long sloping areas, which when shared with others in FFSs will further improve existing best practices. This exercise was designed to enhance such sharing of experiences.

[41] Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition, SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp310-312.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, before land preparation and layouting in learning field
- When farmers want to learn from other farmers some innovative bench terracing practices for vegetable production in long sloping areas

How long will this exercise take?

- Thirty minutes to one-hour for field walks, observations, and interaction with farmers in adjoining fields of learning field
- Thirty minutes for brainstorming session in processing area
- As needed for hands-on in farmers' own fields

Learning objectives

- To create awareness and understanding among participants on the role of bench terracing as a soil conservation strategy for vegetable production in long sloping areas.
- To learn from others and do hands-on of proper bench terracing practices for vegetable production in long sloping areas.

Materials

- Office supplies (Manila papers, notebooks, ball pens, marking pens, and crayons)
- Other materials (marking, leveling and staking materials, grab hoe, shovel or spading fork, tape measure, and bolo or scythe)
- Long sloping vegetable fields ready for land preparation in learning and adjoining fields

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe different bench terracing practices for vegetables grown in long sloping areas. Take note of cultural management practices employed. Interview other farmers, if necessary. List down all observations related with the following:

   ✓ Kinds of crop planted and crop stand in bench terraces;
   ✓ Kind of vegetation established in vertical retaining walls; and
   ✓ Cultural management practices employed, etc.

2. Go back to processing area; brainstorm in small groups and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. Motivate farmers to share their best experiences in bench terracing for vegetables grown in long sloping areas.

3. Develop an improved procedure of bench terracing for vegetable production in long sloping areas.

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

5. During land preparation, facilitate each farmer in the hands-on exercise of bench terracing for vegetables grown in long sloping areas in their individual fields by improving the procedure below:

   ✓ Determine which areas in their field will require bench terracing (long sloping areas);
   ✓ Determine and mark minimum vertical intervals between terraces wide enough to be cultivated once bench terrace is constructed;
   ✓ Dig out upper portion to fill up lower portion of slope, making sure area to be dug out equals area to be filled;
   ✓ Prepare bench terrace sloped from front to back so that surplus water drains slowly along back of each terrace, which is back of next wall;
   ✓ Construct a side drain in such a way that surface water will run off to other drain at end of each terrace;
   ✓ Construct silt pits or soil traps at desired intervals to catch soil washed downhill during heavy rainfall;
   ✓ Encourage grasses and dense vegetation to grow on front edge and retaining wall of a terrace; and
   ✓ Take note of all relevant observations and experiences during this activity.

Some suggested questions for processing discussion

- ❑ Did you observe farmers practicing bench terracing for vegetables grown in long slopes?
- ❑ Did you observe different bench terracing practices for different crops grown in long slopes?
- ❑ Did you observe farmers maintaining different grasses and vegetation on vertical retaining walls of bench terraces? What are these grasses and vegetation? What materials are vertical retaining walls made of?
- ❑ Is bench terracing an effective soil conservation strategy for vegetable production in long sloping areas? What bench terracing practice is best for a particular topography for vegetable production?
- ❑ Did you observe any innovative bench terracing practices used by farmers as a soil conservation strategy in vegetable production? What benefits did farmers derive by practicing bench terracing in sloping areas for vegetable production?
- o What other cultural management options can you use to complement bench terracing as a soil conservation strategy in sloping areas for vegetable production?

Agronomy and Integrated Crop Management

In this new volume, most of the discovery-based exercises compiled under 'Agronomy and Integrated Crop Management' subsection are additional exercises identified by participants in a recently concluded intensive one-month *Refresher Course for Trainers and Farmer Field Schools in IPM for Crucifers and Other Highland Vegetable Crops*[42]. Some of the discovery-based exercises in this subsection are supplements to previous exercises under Section 3, Field Guide of Discovery-based Exercises for Vegetable IPM, Volume I, such as:

- *Vernalization of radish seeds for seed production purposes*; *Stratification of snap bean and garden pea seeds for better production*; *Hydroization of tomato and carrot seeds for better drought tolerance*; and *Breaking seed dormancy of potato seed tubers as a cultural management strategy for improving productivity*. These discovery-based exercises were designed to supplement 'Exercise on Seed Treatment: Last Alternative for Control of Seed- and Soil-Borne Diseases in Vegetables.'

- *Cultural management practices in relation to morphology and growth stages of leafy vegetables*; *Cultural management practices in relation to morphology and growth stages of head- and curd-forming vegetables*; *Cultural management practices in relation to morphology and growth stages of self-pollinated vegetables*; *Cultural management practices in relation to morphology and growth stages of cross-pollinated vegetables*; and *Cultural management practices in relation to morphology and growth stages of root, bulb, and tuber vegetables*. These discovery-based exercises were designed to supplement 'Developing a Production Guide: Morphology, Growth Stages and Related Cultural Management Practices for Vegetables.'

[42] Binamira, J.S. 1998. A Consultant's Report: Refresher Course for Trainers of IPM in Crucifers and Other Highland Vegetable Crops. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Regional Field Unit, Baguio City, Philippines. pp15-22.

Exercise No. 3.13 Vernalization of radish seeds for seed production purposes

Background and rationale

Vernalization is a process by which seeds are subjected to cold temperature treatment before germination to trigger process of flowering later. Some vegetable seeds (e.g., cabbage, carrots, celery, onion, and radish) need vernalization either to deactivate inhibitory substances or activate stimulating hormones necessary for their flowering. Cabbage will flower if plants that have formed heads are exposed to a temperature of 4.4^{0}C for 6-8 weeks. Celery will form seedstalk if exposed to a mean temperature of 4.4-10^{0}C for 10 days or longer[43] .

In the Cordilleras, farmers usually vernalize their radish seeds if they intend to use them for seed production. Some farmers had tried different vernalization techniques to suit their location specific conditions. If these learning experiences are shared among farmers in FFSs, then in this process, their current techniques can still be further improved. This particular exercise was designed to realize this objective.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, before sowing radish seeds in learning field
- When farmers want to learn improved vernalization techniques for radish seeds from other farmers

How long will this exercise take?

- Thirty minutes for field walks, farmer interviews, and observations of fields planted to vernalized radish seeds
- Thirty minutes to one hour for hands-on and brainstorming session in processing area

Learning objectives

- To make participants aware and understand that some vegetable seeds need vernalization if they will be used for seed production.
- To learn and do hands-on of improved techniques shared by farmers in vernalizing radish seeds for seed production.

[43] Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition, SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp381-402.

Materials

- Vegetable fields planted to vernalized and nonvernalized radish seeds
- Field supplies (radish seeds, filter papers, and plastic boxes)
- Refrigerator (temperature of 5^0C should be maintained regularly)
- Office supplies (Manila papers or blackboard and chalks, notebooks, staplers, crayons, ball pens, and marking pens)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks, interview farmers, and observe vegetable fields planted to either vernalized or nonvernalized radish seeds. List down all observations and experiences shared by farmers interviewed.

2. Go back to processing area. Brainstorm in small groups on how to improve standard procedure provided below:

   ✓ Line bottom of plastic boxes with filter papers;
   ✓ Broadcast thinly radish seeds on filter papers;
   ✓ Moisten filter papers and seeds;
   ✓ Keep seeds in boxes at room temperature until radicles break off seed coat;
   ✓ Place pregerminated seeds in a refrigerator section where temperature can be maintained at 5^0C for 14 days; and
   ✓ Sow vernalized seeds in seedbeds prepared with 30 x 30-cm spacing.

3. Present output of small groups to big group. Conduct participatory discussions and sharing of experiences among participants and facilitators.

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❑ What do we mean by vernalization?
- ❑ Did you observe radish planted in farmers' field whose seeds were vernalized? How were they compared with radish whose seeds were not vernalized?
- ❑ Why do we need to vernalize radish seeds if intended for seed production?
- ❑ Do you know of a better vernalization technique for radish seeds? How will you do it?
- ❑ What other vegetable seeds need vernalization? How are they vernalized?
- ❑ What changes in appearance of seeds did you observe after vernalization?
- ❑ Were there differences in plant growth and development between vernalized and nonvernalized seeds?
- ❑ Were there differences in yields between vernalized and nonvernalized seeds?

Exercise No. 3.14 Stratification of snap bean and garden pea seeds for better production

Background and rationale

Stratification is placement of seeds between layers of moist sand, soil, or sawdust at high and low temperatures so that action of water and high and low temperatures will soften seed coat[44] . For some vegetable seeds, stratification can be accomplished by filing and rearranging seeds packed in plastic bags in the vegetable section of a refrigerator for a predetermined period. This practice was reported to increase seed viability as well as yield in snap beans and garden peas.

In FFSs, very few farmers had shared their experiences about stratification despite known benefits that can be derived from this practice. This exercise was designed to allow farmers and facilitators to share their more innovative experiences in stratification as a strategy to improve productivity in snap beans and garden peas production.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, before sowing snap bean or garden pea seeds in learning field
- When farmers want to learn improved stratification techniques for snap bean and garden pea seeds from other farmers and facilitators

How long will this exercise take?

- Thirty minutes for field walks, farmer interviews, and observations of fields planted to stratified and nonstratified snap bean and garden pea seeds
- Thirty minutes to one hour hands-on and brainstorming session in processing area

Learning objectives

- To make participants aware and understand that some vegetable seeds can be stratified to improve their productivity.
- To learn and do hands-on of improved techniques shared by farmers and facilitators in stratifying snap bean and garden pea seeds.

[44] Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition, SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp155-182.

Materials

- Vegetable fields planted to stratified and nonstratified snap beans and garden pea seeds
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)
- Field supplies (snap bean and garden pea seeds, rubber bands, and plastic bags)
- Refrigerator (temperature may vary from time to time)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks, interview farmers, and observe vegetable fields planted to either vernalized or nonvernalized radish seeds. List down all observations and experiences shared by farmers interviewed.

2. Go back to processing area. Brainstorm in small groups on how to improve standard procedure provided below:

   ✓ Place seeds in undamaged plastic bags and carefully tie bags with rubber bands;
   ✓ Place bags of seeds in vegetable section of a refrigerator for 45-60 days;
   ✓ When field is ready for planting, bring out stratified seeds from refrigerator and plant; and
   ✓ Follow all required cultural management practices for growing snap beans or garden peas.

3. Present output of small groups to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators.

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❏ What do we mean by stratification?
- ❏ Did you observe snap beans and garden peas planted in farmers' field whose seeds were stratified? How were they compared with snap beans or garden peas whose seeds were not stratified?
- ❏ Why do we need to stratify snap bean or garden pea seeds?
- ❏ Did you learn from farmers interviewed of a better stratification technique for snap bean and green pea seeds? How did they do it?
- ❏ What other vegetable seeds need stratification? How are they stratified?
- ❏ What changes in appearance of seeds did you observe after stratification?
- ❏ Were there differences in plant growth and development between stratified and nonstratified seeds?
- ❏ Were there differences in yields between stratified and nonstratified seeds?

Exercise No. 3.15 Hydroization of tomato and carrot seeds for better drought tolerance

Background and rationale

Hardening could either be done before sowing (presowing hardening or *hydroization*) or a week or two before transplanting (seedling hardening). Presowing hardening or *hydroization* consists of soaking seeds in water for 1-48 hours depending on seeds, and then air drying to their original moisture content before sowing. This is generally practiced for vegetable seeds. For tomato and carrot, this usually takes 24-48 hours[45] .

Hydroization is a good cultural practice, where drought is foreseen, as it is expected to induce drought resistance. Researchers reported that hydroization can increase yield by about 25 percent in tomato and carrot[46] . As in stratification, very few farmers in FFSs had shared their experiences about hydroization despite known benefits that can be derived from this practice. This exercise was designed to allow farmers and facilitators to share their more innovative experiences in hydroization as a strategy to improve drought tolerance of tomato and carrot.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, before sowing tomato or carrot seeds in learning field
- When farmers want to learn improved presowing hardening or hydroization techniques for tomato and carrot seeds from other farmers and facilitators

How long will this exercise take?

- Thirty minutes for field walks, farmer interviews, and observations of fields planted to hydroized and nonhydroized tomato and carrot seeds
- Thirty minutes to one hour hands-on and brainstorming session in processing area

45 Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition, SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp295-296.
46 Kudan, S.L. 1998. Personal communications.

Learning objectives

- To make participants understand that some vegetable seeds can be hardened by hydroization to improve their drought tolerance.
- To learn and do hands-on of improved techniques shared by farmers and facilitators in hydroization of tomato and carrot seeds.

Materials

- Vegetable fields planted to hydroized and nonhydroized tomato or carrot seeds
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)
- Field supplies (tomato or carrot seeds, clean water, plastic boxes, and plates)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks, interview farmers, and observe vegetable fields planted to hydroized and nonhydroized tomato or carrot seeds. List down all observations and experiences shared by farmers interviewed.

2. Go back to processing area. Brainstorm in small groups on how to improve standard procedure provided below:

   ✓ Weigh seeds and add water equivalent to 75 percent of seed weight;
   ✓ Stir properly until all seeds are wet;
   ✓ Keep wet seeds at room temperature for 24 hours;
   ✓ Dry wet seeds under diffuse light for three days or until they return to their original moisture content; and
   ✓ Repeat procedure once or twice before sowing seeds.

3. Present output of small groups to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators.

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendation from this exercise.

Some suggested questions for processing discussion

- ❑ What do we mean by pre-sowing hardening or hydroization?
- ❑ Did you observe tomato and carrot planted in farmers' field whose seeds were hydroized? How were they compared with tomato or carrot whose seeds were not hydroized?
- ❑ Why do we need to harden tomato or carrot seeds by hydroization?
- ❑ Did you learn from farmers interviewed of a better hydroization technique for tomato and carrot seeds? How did they do it?
- ❑ What other vegetable seeds need hydroization? How are they hydroized?
- ❑ What changes in appearance of seeds did you observe after hydroization?
- ❑ Were there differences in plant growth and development between hydroized and nonhydroized seeds?
- ❑ Were there differences in yields between hydroized and nonhydroized seeds?

Exercise No. 3.16 Breaking dormancy of potato seed tubers as a cultural management strategy for improving productivity

Background and rationale

The scarcity of quality potato seed pieces in Benguet and Mountain Province limits farmers' ability to expand potato production in their respective areas. In addition, disease-free potato seed pieces cannot be guaranteed if these intended-planting materials would come from unregistered farmer-seed growers. To ensure that a relatively high quality planting materials is immediately available, farmers may use disease-free seed pieces from his latest harvest. In this case, a need to break potato seed tuber dormancy will be necessary to meet requirements for succeeding planting operations.

The most practical technique used by farmers to break seed tuber dormancy is with the use of calcium carbide, a procedure that allows rapid potato eye emergence[47]. Farmers have their own innovations to ensure rapid production of quality seed tubers. In FFSs, these experiences must be shared among farmers to improve their current best practices in breaking potato seed tuber dormancy. This particular exercise is intended for this purpose.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, before harvesting potato and when there is scarcity of planting materials for succeeding planting operations
- When farmers want to learn innovative practices of breaking seed tuber dormancy from other farmers

How long will this exercise take?

- Thirty minutes to one hour for field walks and observations of potato crops two weeks before harvesting in learning and adjoining fields
- Thirty minutes to one hour hands-on and brainstorming session

Learning objectives

- To make participants aware of and understand the process of breaking seed tuber dormancy in potato.
- To learn from other farmers and do hands-on of innovative practices of breaking potato seed tuber dormancy.

[47] Kudan, S.L. 1998. Personal communication.

Materials

- Fields planted to potato crops to be harvested two weeks later in learning and adjoining fields
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)
- Other supplies (calcium carbide, cartoons, newsprint, plastic bags, and ramie sacks)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe potato crops two weeks before harvesting in learning and adjoining fields. Observe and choose relatively healthy potato crops. Take a few representative sample plants and tubers. List down all observations related to pest and disease incidence, crop stand, etc.

2. Go back to processing area, cut tubers, and assess plant and tuber health. Determine if tubers can be used as source of seed materials. Brainstorm in small groups and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. Decide on a better procedure of breaking seed tuber dormancy.

3. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

4. Two weeks before harvest, determine if there is scarcity of seed materials for next planting operations. If seed materials will be scarce, do hands-on at harvest time by improving the procedure below:

   ✓ Prepare appropriate containers (cartons, plastic bags, and ramie sacks) and other materials (newsprint and calcium carbide);
   ✓ Select healthy potato seed pieces from farmers' early harvest or from sample seed tubers in learning field;
   ✓ Spread plastic bags wide enough to accommodate seed pieces inside carton;
   ✓ Place ramie sacks over plastic bags and keep moist as necessary;

- ✓ Wrap at least 50g of calcium carbide in newsprint and place at bottom of carton;
- ✓ Place potato seed pieces on top of wrapped calcium carbide until carton is full; and
- ✓ Cover for 14-21 days, keeping ramie sacks moist until potato eyes emerge from seed tubers.

Some suggested questions for processing discussion

- ❑ What do you mean by potato seed tuber dormancy? What causes potato seed tuber dormancy?
- ❑ How do we break potato seed tuber dormancy? Did you find farmers breaking potato seed tuber dormancy?
- ❑ Did you learn more innovative practices from farmers in breaking seed tuber dormancy? How was it done?
- ❑ When is breaking seed tuber dormancy most practical?
- ❑ What seed tuber characteristics do we consider if we are to break its dormancy? How do we select tubers for seed purposes in farmers' field?

Exercise No. 3.17

Pricking-off to hasten hardening of celery and lettuce seedlings prior to transplanting

Background and rationale

If root disturbance cannot be avoided, such as when seeds are sown in seedbeds or seed boxes, it becomes necessary to prepare them for adverse environmental conditions in farmers' field and minimize transplanting shock. *Transplanting shock* refers to a temporary setback in growth after transplanting. Such preparation hardens them and this process is called *hardening*. It involves a checking of growth. Hardening results in making protoplasm less hydrated, thus, plants can resist longer periods of low water absorption.

If seedlings were closely spaced initially, transferring some of them to new containers or spacing them wider would facilitate growth. Transplanting to give seedlings greater space in which to grow before transplanting in farmers' field is called *pricking-off*[48] . Pricking-off is an old practice by farmers in the Cordilleras, particularly for celery and lettuce seedlings.

Through the years, some farmers had made innovations, which led to better hardening process, resulting in better crop productivity. These experiences must be shared with other farmers in FFSs to continuously evolve better practices, which will further improve productivity, hence, this exercise.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, at seedling stage of celery and lettuce in seedbed of learning field
- When farmers want to learn improved pricking-off practices from other farmers for hardening of celery and lettuce seedlings

[48] Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition, SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp179-180.

How long will this exercise take?

- Thirty minutes for field walks, farmer interviews, and observations of celery and lettuce seedbeds where pricking-off were practiced in adjoining fields of learning field
- Thirty minutes hands-on for pricking-off of celery and lettuce seedlings from seedbed
- One hour brainstorming session in processing area after one month

Learning objectives

- To make participants aware and understand that some vegetable seedlings can be better hardened by pricking-off to improve their tolerance to adverse environment.
- To learn and do hands-on of improved pricking-off techniques shared by farmers for celery and lettuce seedlings.

Materials

- Seedbeds of celery and lettuce seedlings ready for hardening by pricking-off
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)
- Field materials (cleaning tools, digging tools, and compost)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks, interview farmers, and observe vegetable seedlings hardened by pricking-off. List down all observations and experiences shared by farmers interviewed.

2. Go back to processing area. Brainstorm in small groups on how to improve standard procedure provided below:

   ✓ Grow celery or lettuce seedlings to about 2-3 inches tall;
   ✓ Select a suitable area near seedbed for pricking-off of seedlings;
   ✓ Clean and cultivate area properly;
   ✓ Apply and incorporate compost or any organic matter to soil and level;
   ✓ Uproot seedlings from seedbed and sort them according to sizes;
   ✓ Prick-off seedlings at a distance of 7-8 cm between plants; and
   ✓ Transplant seedlings in main field after one month.

3. Present output of small groups to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators.

4. Synthesize and summarize the output of the small groups into one big group output. Draw up conclusions and recommendations from the exercise.

Some suggested questions for processing discussion

- ❑ What do we mean by seedling hardening by pricking-off?
- ❑ Did you observe transplanted celery and lettuce seedlings in farmer's fields that were hardened by pricking-off? How were they compared with transplanted celery or lettuce seedlings that were not hardened by pricking-off?
- ❑ Why do we need to harden celery and lettuce seedlings before transplanting in main field?
- ❑ Did you learn from farmers interviewed of a better pricking-off technique for celery and lettuce seedlings? How did they do it?
- ❑ What other vegetable seedlings need hardening by pricking-off? How are they done?
- ❑ What changes in appearance of celery and lettuce seedlings did you observe one, two, three, and four weeks after pricking-off?
- ❑ Were there differences in plant growth and development between pricked-off and not pricked-off celery and lettuce seedlings?
- ❑ Were there differences in yields between pricked-off and not pricked-off celery and lettuce seedlings?

Exercise No. 3.18 Varietal adaptability to different elevation as a key factor for improving productivity in the highlands

Background and rationale

Yield potential is usually a reflection of plant's ability to use and adapt to its environment in terms of its morphology, anatomy, or biochemical nature. In the Cordilleras, vegetable crops, to be more productive, must adapt to unfavorable environmental conditions, which include presence of harmful insects and diseases, water logging, drought, too high or too low temperature, too much or too little light or nutrients.

Varietal adaptability of crops in highlands differs relative to elevations mainly because of temperature as well as pest and disease prevalence. At high elevation, potato and cabbage are predominant crops because of their tolerance to relatively cooler temperatures. Whereas, snap bean, green pea and cucumber, which can tolerate slightly warmer temperatures, are more adapted in middle elevation. The beneficial parasitoid *Diadegma sp.* and harmful microorganism cyst nematode are more adapted to cooler temperatures. Hence, diamondback moth (DBM) is easier checked in high elevation, where its parasitoid *Diadegma sp.* adapts very well, than at middle elevation. Similarly, cyst nematode does not thrive well at warmer temperatures and is never a problem of potato grown in middle elevation[49].

Every vegetable farmer knows which crop is most adaptable to his specific environment. His experiences, when shared with others in FFSs, will allow them to acquire additional knowledge and understanding to improve their current practices, which may result to better crop productivity. This exercise was designed to address this concern.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, before planting vegetable crops in learning field
- When farmers want to learn more on varietal adaptability of vegetable crops in their area from other farmers

[49] Kudan, S.L. 1998. Personal communication.

How long will this exercise take?

- Thirty minutes to one hour for field walks and observations of vegetable crops most adapted in adjoining vegetable fields of learning field
- Thirty minutes to one hour brainstorming session in processing area

Learning objectives

- To make participants aware and understand how adaptability of their vegetable crops to different elevation can improve productivity and profitability.
- To learn from other farmers the adaptability of different vegetable crops to their local environments.

Materials

- Fields planted to vegetable crops that are most adapted to prevailing conditions in adjoining vegetable fields of learning field
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)

Methodology

- Field walks and brainstorming

Steps

1. Divide participants in small groups and ask them to conduct field walks and observe as many vegetable crops planted in adjoining fields of learning field. Interview other farmers, if necessary. List down all observations related to pest and disease occurrence, kind of popular and introduced crops planted, crop adaptability, crop stand, etc.

2. Go back to processing area; brainstorm in small groups and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. List down important observations shared by farmers, as follows:

    ✓ Vegetable crop species or varieties most adapted to their local environments;
    ✓ Vegetable crop species or varieties less adapted to their local environments;
    ✓ Introduced vegetable crop species or varieties from higher or lower elevations most adapted to their local environments; and
    ✓ Introduced vegetable crop species or varieties from higher or lower elevations less adapted to their local environments.

3. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❑ Did you observe differences in adaptability among crop species and varieties planted in farmers' fields? Did you observe crops introduced from different elevations that were adapted in farmers' fields?
- ❑ What pests and diseases were prevalent on crop species and varieties observed in farmers' fields?
- ❑ Did you learn from other farmers their experiences on adaptability of other crop species and varieties planted in an area? Which of the crop species and varieties they tried were more adapted to their area? Why?
- ❑ Did you learn from other farmers some crop species and varieties that were adapted to all elevations? What were these crops? Why did these crops have wider range of adaptability?
- ❑ What good characteristics were observed among crop species and varieties adaptable to a locality?
- ❑ What other cultural management practices can complement crop adaptability in improving productivity and profitability?

Exercise No. 3.19 Growing in east-west row orientation as a cultural management strategy for improving vegetable productivity

Background and rationale

Vegetable growing in east-west row orientation refers to sowing, planting, or transplanting of vegetables in east-west row direction or in relation to rising-setting direction of sun. This cultural management practice enhances efficient use of sunlight by vegetable crop by reducing shading effects among plants leading to decrease in photosynthetic rate and to favorable environmental conditions for pest and disease development. Research results indicate that this practice can increase productivity of some vegetables grown in highlands. However, many farmers in the Cordilleras are still unaware of the benefits that can be derived from such practice.

On the other hand, a few innovative farmers have tried and benefited from this practice in benched terraced farms and in relatively flat terrain of valley floors. In FFSs, there is a need to share among farmers their best experiences in using different row orientations to further sustain productivity in growing vegetables. There is also a need to learn alternative approaches and understand nonadoption by farmers of this practice in some sloping areas. The foregoing exercise was designed as an attempt to address this particular concern.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, before deciding on plot and row orientations of vegetables to be grown in learning field
- When farmers want to learn best experiences from other farmers in using different row orientations to further sustain productivity in growing vegetables

How long will this exercise take?

- Thirty minutes for field walks, farmer interviews, and observations of different row orientations practiced for growing vegetables in adjoining fields of learning field
- Thirty minutes to one hour brainstorming session in processing area

Learning objectives

- To make participants understand that proper row orientation in growing vegetables contributes to better crop productivity.
- To learn from other farmers their best experiences in using different row orientations to further sustain productivity in growing vegetables.

Materials

- Adjoining fields of learning field grown to any vegetable where different row orientations were practiced
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks, interview farmers, and observe vegetables grown in different row orientations. List down all observations and experiences shared by farmers interviewed.

2. Go back to processing area. Brainstorm in small groups on the best row orientation to use. Present output of small groups to the big group. Conduct participatory discussions to allow sharing of experiences among participants. Agree on the best row orientation to be followed.

3. Do hands-on using best row orientation for growing vegetables in learning field as agreed upon by the big group.

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❏ What do we mean by growing vegetables in east-west row orientation? Did you observe different row orientations for different vegetables grown in farmers' field?
- ❏ Were there differences in crop performance (e.g., plant growth, development, and yield) between vegetables grown in east-west row direction and vegetables grown using different row orientations?
- ❏ Is the use of east-west orientation applicable in growing all vegetables?
- ❏ Did you learn from farmers interviewed of better row orientation for growing different vegetables? How did they do it?

Exercise No. 3.20

Proper timing of planting to improve productivity and profitability in vegetable production

Background and rationale

Many farmers in the Cordilleras learned by experience the best time to plant their vegetable crops. In proper timing of planting, farmers usually consider pest and disease occurrence, weather condition, crop adaptability, and market demands in an area. Some farmers, particularly when dealing with introduced crops, may not know the best time to plant such crops to attain better productivity and profitability.

Through field walks, observations, and brainstorming sessions in FFSs, farmers can share their best practices to other farmers, including proper timing of planting, in growing vegetable crops in their respective areas. This approach will allow comparison of best learning experiences among farmers and in this process further improve their individual best practices. Thus, this exercise was designed to address this specific concern.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, before planting vegetable crops in learning field
- When farmers want to learn more on proper timing of planting vegetable crops in their area from other farmers

How long will this exercise take?

- Thirty minutes to one hour for field walks and observations of vegetable crops planted at different time during same cropping season
- Thirty minutes to one hour brainstorming session in processing area

Learning objectives

- To make participants aware and understand how proper timing of planting their vegetable crops can improve productivity and profitability.
- To learn the best practices on timing of planting vegetable crops from other farmers.

Materials

- Fields planted with vegetable crops at different planting time
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)

Methodology

- Field walks and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe as many vegetable crops planted in fields at different times during the same cropping season. Interview other farmers and collect specimens, if necessary. List down all observations related to pest and disease occurrence, kinds of crop planted, crop stand, weed growth, quality of products, etc.

2. Go back to processing area, brainstorm in small groups and present output to big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators.

3. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from the exercise.

Some suggested questions for processing discussion

- ❏ Did you observe different crops planted at different time during the same cropping season? What are your observations on crops planted?
- ❏ What pests and diseases are prevalent on crops planted at different times during the same cropping season?
- ❏ When is best time during cropping season to plant different kind of crops? Why?
- ❏ Did planting at proper time during the same cropping season improve productivity and profitability? Can we reduce pest and disease occurrence by proper timing of planting? How? Why?
- ❏ What other cultural management practices can you suggest that will complement proper timing of planting to improve productivity and profitability in vegetable production?

Exercise No. 3.21

Proper planting distance as a strategy to maximize crop productivity in vegetables

Background and rationale

One important cultural management practice in growing vegetables is the use of proper planting distance. Some of the benefits derived from using this practice are optimized seeding rate, minimized pest (including weed) and disease incidence, and maximized crop productivity. Through years of experience in farming, farmers had adapted the most appropriate planting distance for various crops in their localities.

In FFSs, these best practices can be shared and learned among farmers through field walks and brainstorming. These learning experiences can be further enhanced by role-playing, hence this exercise.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, before sowing in seedbed and before planting or transplanting in learning field
- When farmers want to learn the best experiences from other farmers on proper planting distance in growing vegetables

How long will this exercise take?

- Thirty minutes to one hour for field walks and observations of different sowing, planting, and transplanting distances in adjoining vegetable farms of learning field
- Thirty minutes to one hour brainstorming session in processing area

Learning objectives

- To make participants aware of and understand the role of proper planting distance in maximizing crop productivity in vegetable production.
- To learn the best experiences from other farmers on proper planting distance in growing vegetables.

Materials

- Seedbeds and fields sown, planted or transplanted with vegetable crops at varying planting distances
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)

Methodology

- Field walks, role-playing, and brainstorming.

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe as many seedbeds in adjoining farms sown, planted, or transplanted with vegetable crops at varying planting distances. List down all observations related to planting distance, seeding rate, percentage germination, pest and disease occurrence, kind of crops planted, crop stand, etc.

2. Go back to processing area and do a role-play. Divide big group in two small groups. Make sure there are equal number of participants in each group. Excess group members will act as observers. Each group will form a column as follows:

   ✓ Group A participants will have wider distances between them (e.g., participants should not be touching other persons when their arms are raised sideward);
   ✓ Group B participants will have closer distances between them (e.g., participants should be touching other persons when their arms are raised sideward); and
   ✓ Let participants in each group turn twice (clockwise and counter-clockwise) with their arms extending sideward and record all experiences. Relate all experiences to the topic.

3. Brainstorm in small groups and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators.

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❏ Did you observe different sowing, planting, and transplanting distances used in vegetable seedbeds and fields?
- ❏ Did you observe differences in seeding rates, percentage germination, plant vigor, crop stand, pest and disease occurrence, etc. in vegetable seedbeds and main fields, which used different sowing, planting, and transplanting distances?
- ❏ What benefits will you get when you use proper planting distances?
- ❏ What were the proper sowing, planting, and transplanting distances used for various vegetable crops?
- ❏ What are the negative effects of too close and too wide sowing, planting, or transplanting distances in growing vegetables?
- ❏ Will proper sowing, planting, or transplanting distances in growing vegetables reduce pest and diseases occurrence? Why?
- ❏ What other cultural management practices will complement proper sowing, planting, or transplanting distances in growing vegetables to improve productivity?

Exercise No. 3.22 Thinning as a cultural management strategy in improving carrot production

Background and rationale

Carrot (*Daucus carota*) is among the top high-valued crops that grow well in high elevations, ranging from 1,200-7,400 m above sea level. In the Cordilleras, carrot is directly seeded in beds either by furrow or drill method. In some areas, carrot seeds are broadcasted in newly harrowed fields. Optimum yield is achieved when crop is planted in sandy loam soils where appropriate cultural management practices are followed throughout its growing period.

One popular cultural management practice employed in growing carrot is thinning.[50] Thinning out of undesirable plant ease out overcrowding of seedlings, which allows better penetration of sunlight, permits proper aeration or more rapid drying of dew or rain on foliage after a downpour, and minimizes nutrient competition. For better results, thinning operation is done in two to three stages depending on sowing density. In carrots, proper timing and methods are as important as frequency of thinning operations. The decision of whether to do one-time or staggered thinning operations is often dictated by seedling density and crop stand. Improper thinning often results to poor quality carrot roots due to forking and cracking, significant yield loss, and consequently lower profit.

Through years of experiences, some farmers had made innovations, which led to better thinning practices, resulting in better crop productivity. These experiences must be shared with other FFSs to continuously evolve better practices, which will further improve productivity, hence, this exercise.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, during weeding operations at early seedling stages of carrots in learning field
- When farmers want to learn improved thinning practices from other farmers for carrot seedlings

[50] Kudan, S.L. 1998. Personal communication.

How long will this exercise take?

- Thirty minutes for field walks, farmer interviews, and observations of thinning practices of carrot seedlings in learning and adjoining fields
- Thirty minutes hands-on exercise for thinning of carrot seedlings in learning field
- One hour brainstorming session in processing area after two to three thinning operations

Learning objectives

- To make farmers aware and understand that carrot seedlings need proper thinning to improve their productivity.
- To learn and do hands-on of improved thinning techniques or practices shared by farmers for carrot seedlings.

Materials

- Carrot seedlings ready for thinning and weeding operations in learning and adjoining fields
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)
- Field materials (cleaning or digging tools, bolo, or scythe)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks, interview farmers, and observe thinning operations conducted on carrot seedlings in adjoining fields of learning field. List down all observations and experiences shared by farmers interviewed, as follows:

   ✓ Seeding rates used;
   ✓ Age of carrot seedlings every thinning and weeding operations;
   ✓ Number of thinning and weeding operations normally conducted;
   ✓ Size, weight, and quality of carrot roots harvested; and
   ✓ Incidence of forking, cracking and other maladies.

2. Go back to processing area. Brainstorm in small groups on how to improve standard procedure provided below:

   ✓ Grow carrot seedlings to about 2-3 inches tall;
   ✓ Based on crop stand, decide on when and how many thinning and weeding operations will be conducted;

- ✓ Conduct simultaneous thinning and weeding operations;
- ✓ Repeat thinning and weeding operations as earlier decided upon;
- ✓ Dispose thinned diseased seedlings properly or soil incorporate thinned uninfected seedlings; and
- ✓ Take note of all relevant observations and experiences during this activity.

3. Present output of small groups to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators.

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❑ What do we mean by thinning in vegetable production? What are the reasons for thinning of vegetable seedlings?
- ❑ Did you observe transplanted carrot seedlings in vegetable fields? If there were any, how were they compared with direct seeded carrot seedlings?
- ❑ Why do we need to do thinning of carrot seedlings in the main field? How many thinning and weeding operations are needed for carrot seedlings? When are they conducted? Why are they conducted at those times?
- ❑ Did you learn from farmers interviewed some better thinning techniques or practices for carrot seedlings? How did they do it?
- ❑ What other vegetable seedlings need thinning operations? How are they done? Why are they done?
- ❑ Were there differences in plant growth (e.g., size and weight of roots) and development (e.g., forking and cracking incidences) between thinned and not thinned carrot seedlings?
- ❑ Were there differences in yields (e.g., marketable and unmarketable roots) between thinned and not thinned carrot seedlings?

Exercise No. 3.23

Trellising[51] for quality produce in legumes, tomato, and cucurbits

Background and rationale

Trellising is an important cultural management practice of vegetable farmers in the Cordilleras. Such practice improves quality of products and avoids rotting of fruits associated with soil-borne pathogens. Several types of trellises are used. Stalks of *rono* (talahib) are used as poles for cucurbits and legumes. The usual trellis for vegetable gardens and small farms is an arbor or overhead type, locally called *bangsal* (balag), where a platform is constructed out of interwoven bamboo or hog wire.

A fence-type trellis is also used in small and large vegetable farms, made of crisscrossing stalks or constructed with posts at each end of a row with horizontally strung wires, resembling a fence. In plastic sheds, indeterminate tomato (that which bear fruits on leaf axis) is trained on string trellises, where strings are hanged from wires in ceiling.

On the other hand, determinate tomato (that which bears fruit at end of branches), is trained on a T-trellis with two wires strung horizontally to produce high quality fruits and to avoid rotting of fruits in contact with soil. For better results, farmers often modify these types of trellises. In FFSs, these experiences can be shared and learned by other farmers through field walks and brainstorming session, hence this exercise.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when vegetable crops in learning field is ready for trellising
- When farmers want to learn better trellising techniques from other farmers

How long will this exercise take?

- Thirty minutes to one hour for field walks and observations in vegetable fields with different types of trellises
- Thirty minutes to one hour brainstorming session in processing area

Learning objectives

- To make participants aware of and understand how proper trellising techniques can improve quality of vegetable products.
- To learn better trellising techniques from other farmers to further improve quality of vegetable products.

[51] Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition, SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp382-385.

Materials

- Fields planted with vegetable crops using different types of trellises
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)

Methodology

- Field walks and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe as many trellised and nontrellised vegetable crops in the fields. Take note of types of trellises and techniques in trellising. Interview other farmers, if necessary. List down all observations related to pest and disease occurrence, distance of planting, types of trellises, techniques used, crop stand, weed growth, quality of products, etc.

2. Go back to processing area, brainstorm in small groups and present output to big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators.

3. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❏ What types of trellises did you observe in the field? When were different types of trellises used? Were there different types of trellises used per crop? Why?
- ❏ Did you observe differences in crop performance with different types of trellises? Did trellised crops perform better than nontrellised crops?
- ❏ Did trellising improve quality of vegetables grown? How?
- ❏ Did trellising control or reduce disease incidence? What particular diseases were controlled or reduced with trellising?
- ❏ When is the best time to install trellis in legumes, tomato, and cucurbits? What type of trellis was most appropriate for legumes, tomato, and cucurbits?
- ❏ What other cultural management practices can complement use of trellises to improve quality of legumes, tomato, and cucurbits?

Exercise No. 3.24

Crop sequencing as a cultural management strategy for improving vegetable productivity

Background and rationale

Crop sequencing refers to proper arrangement of crops planted in succession to maximize production. It is important to use a cropping sequence that will conserve or improve nutritional status of soil, add organic matter, improve soil structure, protect land from erosion and, ultimately, give high yield. A good cropping sequence also make more efficient use of environment, considering that space, light, moisture, and nutrients are available most of the time. An alternate planting of leguminous and nonleguminous vegetables is an example of a good cropping sequence[52] .

If leguminous vegetables are not used in a cropping sequence, larger amount of nitrogenous fertilizers will be needed to maintain soil productivity. The current practice of monocropping by farmers, not only in the Cordilleras, may result in higher yields, but higher inputs are also needed for crop protection, irrigation, and fertilization, among others. It also concentrates risk of loss or price fluctuation on one crop. For small farmer, taking such a risk may not be appropriate, especially when vegetable farming is his sole source of income.

It is interesting to note that many farmers, through the years, have designed more appropriate crop sequencing scheme that better suit their prevailing local conditions. These experiences must be shared among farmers in FFSs, so that their current best practices can be further improved, hence this exercise.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, during discussions on cultural management practices as a component of IPM in vegetable production
- When farmers want to learn from other farmers their best crop sequencing schemes for improving vegetable productivity

[52] Balaki, E.T. 1998. Personal communication.

How long will this exercise take?

- Thirty minutes for field walks and observation of different crop sequencing schemes in adjoining vegetable fields of the learning field
- Thirty minutes to one hour brainstorming session in processing area

Learning objectives

- To make participants aware and understand how crop sequencing can be used as a cultural management strategy to improve vegetable productivity.
- To enhance farmers' learning experiences of proper crop sequencing to improve vegetable productivity.

Materials

- Vegetable fields where different crop sequencing schemes can be observed
- Office supplies (Manila papers or blackboard and chalks, notebooks, ball pens, and marking pens)

Methodology

- Field walks and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe as many possible crop sequencing schemes in adjoining farms of learning field. List down all observations related to crop sequencing schemes, degree of pest and disease infestation, kind of crops planted, crop productivity, etc.

2. Go back to processing area. Brainstorm in small groups and present output to big group. Each group should share knowledge on possible effects and reactions of crops on different factors contributing to development or occurrence of pest and diseases, crop productivity, etc.

3. Conduct participatory discussions to allow sharing of experiences among participants and facilitators.

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❏ What is crop sequencing? How do you differentiate crop succession from crop sequencing?
- ❏ Did you observe different crop sequencing scheme in farmers' field? What were these crop-sequencing schemes commonly practiced by farmers?
- ❏ Which was the best crop-sequencing scheme practiced by farmers? Why? What were the important characteristics of a good crop-sequencing scheme?
- ❏ Do you think crop sequencing will solve pest and disease problems in your area? Will crop sequencing result to better crop productivity? How?
- ❏ What benefits can you derive by proper crop sequencing?
- ❏ What other cultural practices can complement crop sequencing to improve vegetable productivity?

Exercise No. 3.25 Rejuvenating snap bean, cucumber and bell pepper by pruning to sustain productivity

Background and rationale

The productivity of plants declines after some time. In some vegetable crops that have grown old, pruning is necessary to make them as productive as before. Pruning of shoots always results in lessened photosynthetic area and, therefore, lesser food manufactured. However, since roots are undisturbed at the time of pruning, more nutrients and water are available to remaining shoots and, soon afterwards, there is increased vegetative growth. If shoot pruning is extensive, an explosion of vegetative growth frequently occurs. This is a basis of pruning to rejuvenate plants[53].

Some farmers producing snap bean, cucumber, and bell pepper claimed that life span of their crops decreased nowadays. This enabled them to harvest or prime marketable fruits or pods for six to seven times only per cropping season. For snap beans, farmers before can have as many as 12 priming or harvesting of pods per cropping season. Many farmers in the Cordilleras had reported that priming or harvesting of marketable pods could be increased by at least five times after rejuvenation of snap beans.

In FFSs, these notable experiences must be shared among farmers to further improve their existing best practices in rejuvenation to improve productivity. This exercise was designed to attain this particular objective.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, after a significantly reduced number of snap bean pods or cucumber and bell pepper fruits are primed or harvested in learning field
- When farmers want to learn better ways to rejuvenate snap bean, cucumber, and bell pepper from others

[53] Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition, SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp389-399.

How long will this exercise take?

- Thirty minutes to one hour for field walks and observations of snap bean, cucumber, and bell pepper ready for rejuvenation in adjoining and learning fields
- Thirty minutes to one hour for hands-on in learning field and brainstorming session in processing area

Learning objectives

- To make participants aware and understand how rejuvenation of snap bean, cucumber, and bell pepper can improve productivity and profitability.
- To learn better experiences from other farmers and do hands-on of proper rejuvenation practices for snap beans, cucumbers, and bell peppers.

Materials

- Snap beans, cucumbers, or bell peppers ready for rejuvenation in adjoining and learning fields
- Office supplies (Manila papers, notebooks, ball pens, masking tape, and marking pens)
- Other supplies (Japanese hoe, pruning shear, trowel, and fertilizers)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe snap beans, cucumbers, and bell peppers ready for rejuvenation in adjoining and learning fields. Interview other farmers, if necessary. List down all observations related to rejuvenation practices, time of harvesting, crops rejuvenated, crop stand, etc.

2. Go back to processing area. Brainstorm in small groups and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators.

3. Conduct hands-on exercise of rejuvenating snap bean, cucumber, or bell pepper when the need arises in learning field. Determine if there is a need to improve the procedure suggested below:

   ✓ Remove at least 70-80 percent old, matured and yellowing leaves, leaving about 20 percent green, healthy leaves in upper portion of plants;

- ✓ Recultivate soils, allowing minimum disturbance of plant's lateral roots;
- ✓ Apply fertilizer (based on results of STK analysis) between rows, not very close to plant's base to cause burning of plant parts;
- ✓ Hill-up soils near plant's base to cover fertilizer;
- ✓ Observe and gather pertinent data every week until last pod or fruit priming or harvesting is conducted; and
- ✓ Take note of all pertinent learning experiences from this exercise.

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❏ Did you observe farmers rejuvenating their vegetable crops in the fields? What vegetable crops do farmers commonly rejuvenate?
- ❏ Why do farmers rejuvenate their vegetable crops? When do they normally rejuvenate their vegetable crops?
- ❏ Did productivity improve after rejuvenating their vegetable crops?
- ❏ How many pod or fruit priming or harvesting did farmers undertake after rejuvenating their vegetable crops?
- ❏ Did farmers observe reduced pest and disease occurrence of their rejuvenated vegetable crops?
- ❏ Did you learn from other farmers their best experiences on rejuvenating their snap beans, cucumbers, and bell peppers? How did they do it?
- ❏ In your hands-on exercise, what did you observe on snap beans, cucumbers, and bell peppers after one, two, three, four weeks, and so on after rejuvenation?
- ❏ What benefit can you derive from rejuvenating your vegetable crops?
- ❏ What other cultural management practices can complement proper rejuvenation of vegetable crops to improve productivity and profitability?

Exercise No. 3.26

Cultural management practices in relation to morphology and growth stages of leafy vegetables

Background and rationale

Vegetable crops grown mainly for their leaves are classified as leafy vegetables[54]. Some examples of leafy vegetables are pechay, mustard, lettuce, green onion, leek, and celery. The most important product of a home garden, for instance, is leafy vegetable. In a home garden, leafy vegetables are easy to grow and do not need much attention or labor, yet they give highest rate of edible products. In highlands, leafy vegetables are grown commercially by farmers. Commercial growing of leafy vegetables requires intensive labor and capital investments.

Thus, appropriate and location-specific cultural management practices employed at different growth stages of crops are necessary for more productive and profitable venture. Through years of experiences, farmers in the Cordilleras had evolved innovative cultural management practices that are more adapted to various stages of growing leafy vegetables in their localities. These unique experiences can be regularly shared among farmers in FFSs to further improve current practices. The foregoing exercise was designed to address this particular concern.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when participants decided to grow leafy vegetables in learning field or leafy vegetables are grown in adjoining fields
- When farmers want to learn innovative cultural management practices in relation with growth stages of leafy vegetables from other farmers

How long will this exercise take?

- Thirty minutes to one hour for field walks and observations of appropriate cultural management practices in relation to growth stages of leafy vegetables in learning and adjoining fields
- Thirty minutes to one hour for brainstorming session in processing area

[54] Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition. SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp12-52.

Learning objectives

- To make participants aware and understand how appropriate cultural management practices in relation to growth stages of leafy vegetables can improve productivity and profitability.
- To learn innovative cultural management practices in relation to growth stages of leafy vegetables from other farmers.

Materials

- Leafy vegetables grown in learning and adjoining fields
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)

Methodology

- Field walks and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe different stages of leafy vegetables grown in learning and adjoining fields. Interview other farmers, if necessary. List down all observations related to:

   ✓ Kinds, varieties, or cultivars of leafy vegetables planted;
   ✓ Different growth stages of leafy vegetables planted; and
   ✓ Cultural management practices employed at different growth stages.

2. Go back to processing area; brainstorm in small groups and present output to the big group.

3. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. Motivate farmers to share their best cultural management practices employed in relation to morphology and growth stages of different leafy vegetables in their own farm, such as:

   ✓ Pre-planting operations (e.g., land preparation, seedbed preparation, seedbed treatment, sowing, care of seedling, roguing of diseased plants, cultural control of pests, pricking off, raised bed preparation, furrowing, liming, organic and inorganic fertilizer application, pulling of seedlings, monitoring, etc.);
   ✓ Planting or transplanting operations (e.g., direct seeding or transplanting, mulching, irrigation, etc.);

- ✓ Recovery and early vegetative stages (e.g., replanting, roguing of diseased plants, leaf removal of infected leaves, cultural control of pests, spot weeding, side dressing of fertilizer, irrigation, monitoring, etc.);
- ✓ Active vegetative stage (e.g., roguing of diseased plants, leaf removal of infected leaves, cultural control of pests, spot weeding, side dressing of fertilizer, hilling up, irrigation, monitoring, etc.);
- ✓ Late vegetative stage (e.g., roguing of diseased plants, leaf removal of infected leaves, cultural control of pests, spot weeding, side dressing of fertilizer, hilling up, irrigation, monitoring, etc.); and
- ✓ Harvest and postharvest stages (e.g., harvesting, sorting, grading, packaging, etc.).

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise. Design appropriate matrix, as shown below:

SPECIES, VARIETY OR CULTIVAR	GROWTH STAGE	DESCRIPTION OF DISTINCT MORPHOLOGY	CULTURAL MANAGEMENT PRACTICE	PURPOSE OF MANAGEMENT PRACTICE
PECHAY, MUSTARD, GREEK ONION, LEEK, AND CELERY	Preplanting			
	Planting or transplanting			
	Recovery and early vegetative			
	Active vegetative			
	Late vegetative			
	Harvest and postharvest			

Some suggested questions for processing discussion

- ❏ Did you observe different kinds, varieties, or cultivars of leafy vegetables grown in adjoining fields of the learning field?
- ❏ What kinds, varieties, or cultivars of leafy vegetables did farmers commonly grow? Why did farmers prefer these kinds, varieties, or cultivars of leafy vegetables to others?
- ❏ What cultural management practices did farmers employ to the different kinds, varieties, or cultivars of leafy vegetable at different growth stages? Why did farmers employ these cultural management practices?
- ❏ Did you observe distinct changes in morphological structures of different kinds, varieties, or cultivars of leafy vegetables at different growth stages? What are these distinct changes in morphological structures?
- ❏ Did farmers use this knowledge in morphological structures as basis for employing different cultural management practices? How?
- ❏ Did you learn innovative cultural management practices from other farmers at different growth stages of leafy vegetables? What are these innovative cultural management practices?

Exercise No. 3.27

Cultural management practices in relation to morphology and growth stages of head- and curd-forming vegetables

Background and rationale

Head- and curd-forming vegetables are grown for their terminal buds or flowers technically known as heads or curds, respectively. Some of these vegetables are Chinese cabbage, head cabbage, head lettuce, cauliflower, and broccoli. Actually, an edible part of a cabbage is an exaggerated terminal bud termed as head. This is also true of heading type of lettuce called head lettuce. Some vegetable crops grown for their curds are cauliflower and broccoli. The curds are floral initials and not fully developed flowers, which are fibrous and tougher[55] .

Unlike leafy vegetables that are usually grown in home gardens, head- and curd-forming vegetables are high-valued crops normally grown by farmers in commercial scale. Just like any commercially grown vegetables, appropriate and location-specific cultural management practices employed at different growth stages of crops are necessary for more productive and profitable undertaking.

Through years of experiences, farmers in the Cordilleras had evolved innovative cultural management practices that are more adapted to various stages of growing head- and curd-forming vegetables in their localities. These unique experiences can be regularly shared among farmers in FFSs to further improve current practices. The foregoing exercise was designed to achieve this particular objective.

[55] Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition. SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp90-94.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when participants decide to grow head- and curd-forming vegetables in learning field or in the adjoining fields
- When farmers want to learn innovative cultural management practices in relation to growth stages of head- and curd-forming vegetables from other farmers

How long will this exercise take?

- Thirty minutes to one hour for field walks and observations of appropriate cultural management practices in relation to growth stages of head- and curd-forming vegetables in learning and adjoining fields
- Thirty minutes to one hour for brainstorming session in processing area

Learning objectives

- To make participants aware of and understand how appropriate cultural management practices in relation to growth stages of head- and curd-forming vegetables can improve productivity and profitability.
- To learn innovative cultural management practices in relation to growth stages of head- and curd-forming vegetables from other farmers.

Materials

- Head- and curd-forming vegetables grown in learning and adjoining fields
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)

Methodology

- Field walks and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe different stages of head- and curd-forming vegetables grown in learning and adjoining fields. Interview other farmers, if necessary. List down all observations related to:

   ✓ Kinds, varieties, or cultivars of head- and curd-forming vegetables planted;
   ✓ Different growth stages of head- and curd-forming vegetables planted; and
   ✓ Cultural management practices employed at different growth stages.

2. Go back to processing area; brainstorm in small groups and present output to the big group.

3. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. Motivate farmers to share their best cultural management practices employed in relation to morphology and growth stages of head- and curd-forming vegetables in their own farm, as follows:

   - ✓ Preplanting operations (e.g., land preparation, seedbed preparation, seedbed treatment, sowing, care of seedling, roguing of diseased plants, cultural control of pests, land preparation, raised bed preparation, furrowing, liming, organic and inorganic fertilizer application, pulling of seedlings, monitoring, etc.);
   - ✓ Planting or transplanting operations (e.g., transplanting, mulching, irrigation, etc.);
   - ✓ Recovery and early vegetative stages (e.g., replanting, roguing of diseased plants, leaf removal of infected leaves, cultural control of pests, spot weeding, side dressing of fertilizer, irrigation, monitoring, etc.);
   - ✓ Active vegetative stage (e.g., roguing of diseased plants, leaf removal of infected leaves, cultural control of pests, spot weeding, side dressing of fertilizer, hilling up, irrigation, monitoring, etc.);
   - ✓ Late vegetative stage (e.g., roguing of diseased plants, leaf removal of infected leaves, cultural control of pests, spot weeding, side dressing of fertilizer, hilling up, irrigation, monitoring, etc.);
   - ✓ Head- or curd-forming stage (e.g., roguing of diseased plants, leaf removal of infected leaves, cultural control of pests, spot weeding, side dressing of fertilizer, hilling up, irrigation, monitoring, etc.); and
   - ✓ Harvest and postharvest stages (e.g., harvesting, sorting, grading, packaging, etc.).

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise. Design appropriate matrix as shown at the succeeding page:

SPECIES, VARIETY OR CULTIVAR	GROWTH STAGE	DESCRIPTION OF DISTINCT MORPHOLOGY	CULTURAL MANAGEMENT PRACTICE	PURPOSE OF MANAGEMENT PRACTICE
HEAD CABBAGE, HEAD LETTUCE, CAULIFLOWER, AND BROCOLLI	Preplanting			
	Planting or transplanting			
	Recovery and early vegetative			
	Active vegetative			
	Late vegetative			
	Head- and curd-forming			
	Harvest and postharvest			

Some suggested questions for processing discussion

- ❑ Did you observe different kinds, varieties, or cultivars of head- and curd-forming vegetables grown in adjoining fields of learning field?
- ❑ What kinds, varieties, or cultivars of head- and curd-forming vegetables did farmers commonly grow? Why did farmers prefer these kinds, varieties, or cultivars of head- and curd-forming vegetables to others?
- ❑ What cultural management practices did farmers employ to the different kinds, varieties, or cultivars of head- and curd-forming vegetable at different growth stages? Why did farmers employ these cultural management practices?

- ❑ Did you observe distinct changes in morphological structures of different kinds, varieties, or cultivars of head- and curd-forming vegetables at different growth stages? What are these distinct changes in morphological structures?
- ❑ Did farmers use this knowledge in morphological structures as basis for employing different cultural management practices? How?
- ❑ Did you learn innovative cultural management practices from other farmers at different growth stages of head- and curd-forming vegetables? What are these innovative cultural management practices?

Exercise No. 3.28

Cultural management practices in relation to morphology and growth stages of self-pollinated vegetables

Background and rationale

Self-pollinated vegetables are vegetables wherein pod or fruit setting results from union of female (ovule) and male (pollen) reproductive cells of same plant, variety, or cultivar. The most common self-pollinated vegetables are those belonging to legumes and solanaceous crops. Populations of self-pollinated plants usually consist of mixture of many closely related homozygous lines, which, although they exist side by side, remain more or less independent of one another in reproduction. Individual plants are likely to be homozygotes. Within these species, a goal of most breeding programs is to produce a pure line[56] .

Some examples of legume vegetables are snap bean and garden pea while those of solanaceous vegetables are tomato, bell pepper, and eggplant. Just like leafy vegetables, some self-pollinated vegetables such as eggplant and tomato are usually grown in home gardens to effectively use land and family labor. However, several self-pollinated vegetables such as snap beans and green pea are considered high-valued crops and are normally grown by farmers in commercial scale.

In commercial growing of vegetables, appropriate and location-specific cultural management practices must be employed at different growth stages of crops to ensure more productive and profitable undertakings. Through years of experiences, farmers in the Cordilleras have evolved innovative cultural management practices that are more adapted to various stages of growing self-pollinated vegetables in their localities. These unique experiences can be regularly shared among farmers in FFSs to further improve current practices. The foregoing exercise was designed to achieve this particular objective.

[56] Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition. SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp133-141.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when participants decided to grow self-pollinated vegetables (e.g., snap bean, garden pea, tomato, bell pepper, and eggplant) in learning field or in adjoining fields
- When farmers want to learn innovative cultural management practices in relation to growth stages of self-pollinated vegetables from other farmers

How long will this exercise take?

- Thirty minutes to one hour for field walks and observations of appropriate cultural management practices in relation to growth stages of self-pollinated vegetables (e.g., snap bean, garden pea, tomato, bell pepper, and eggplant) in learning and adjoining fields
- Thirty minutes to one hour for brainstorming session in processing area

Learning objectives

- To make participants aware and understand how appropriate cultural management practices in relation to growth stages of self-pollinated vegetables can improve productivity and profitability.
- To learn innovative cultural management practices in relation to growth stages of self-pollinated vegetables from other farmers.

Materials

- Self-pollinated vegetables (snap bean, garden pea, tomato, bell pepper, and eggplant) grown in learning and adjoining fields
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)

Methodology

- Field walks and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe different stages of self-pollinated vegetables grown in learning and adjoining fields. Interview other farmers, if necessary. List down all observations related to:

   ✓ Kinds, varieties, or cultivars of self-pollinated vegetables (e.g., snap bean, garden pea, tomato, bell pepper, and eggplant) planted;
   ✓ Different growth stages of self-pollinated vegetables (e.g., snap bean, garden pea, tomato, bell pepper, and eggplant) planted; and
   ✓ Cultural management practices employed at different growth stages.

2. Go back to processing area; brainstorm in small groups and present output to big group.

3. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. Motivate farmers to share their best cultural management practices in relation to morphology and growth stages of different self-pollinated vegetables (e.g., snap bean, garden pea, tomato, bell pepper, and eggplant) they use in their own farms, as follows:

   ✓ Preplanting operations (e.g., stratification, hydroization, land preparation, seedbed preparation, seedbed treatment, sowing, care of seedling, roguing of diseased plants, cultural control of pests, land preparation, raised bed preparation, furrowing, liming, organic and inorganic fertilizer application, pulling of seedlings, monitoring, etc.);
   ✓ Planting or transplanting operations (e.g., transplanting, mulching, irrigation, etc.);
   ✓ Recovery and early vegetative stages (e.g., replanting, roguing of diseased plants, leaf removal of infected leaves, cultural control of pests, spot weeding, side dressing of fertilizer, irrigation, monitoring, etc.);
   ✓ Active vegetative stage (e.g., staking, trellising, roguing of diseased plants, leaf removal of infected leaves, cultural control of pests, spot weeding, side dressing of fertilizer, hilling up, irrigation, monitoring, etc.);
   ✓ Late vegetative stage (e.g., roguing of diseased plants, leaf removal of infected leaves, twigs or vines, cultural control of pests, spot weeding, side dressing of fertilizer, hilling up, irrigation, monitoring, etc.);
   ✓ Bud formation and flowering stages (e.g., hand pollination, roguing of diseased plants, leaf removal of infected leaves, twigs, vines or flowers, cultural control of pests, spot weeding, side dressing of fertilizer, hilling up, irrigation, monitoring, etc.);
   ✓ Pod or fruit setting and development stages (e.g., roguing of diseased plants, leaf removal of infected leaves, twigs or vines, thinning of undesirable pods and fruits, cultural control of pests, spot weeding, side dressing of fertilizer, hilling up, irrigation, monitoring, etc.); and

✓ Harvest and postharvest stages (e.g., 1st to nth pod or fruit priming or harvesting, sorting, grading, packaging, etc.).

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise. Design appropriate matrix as shown below:

SPECIES, VARIETY OR CULTIVAR	GROWTH STAGE	DESCRIPTION OF DISTINCT MORPHOLOGY	CULTURAL MANAGEMENT PRACTICE	PURPOSE OF MANAGEMENT PRACTICE
SNAP BEAN, GARDEN PEA, TOMATO, BELL PEPPER, AND EGGPLANT	Preplanting			
	Planting or transplanting			
	Recovery and early vegetative			
	Active vegetative			
	Late vegetative			
	Bud and flower-initiation			
	Pod or fruit setting and development			
	Harvest and postharvest			

Some suggested questions for processing discussion

- ❏ What do we mean by self-pollinated vegetables? Did you observe different kinds, varieties, or cultivars of self-pollinated vegetables (e.g., snap bean, garden pea, tomato, bell pepper, and eggplant) grown in adjoining fields of learning field?
- ❏ What kinds, varieties, or cultivars of self-pollinated vegetables did farmers commonly grow? Why did farmers prefer these vegetables to others?
- ❏ Which kinds, varieties, or cultivars of self-pollinated vegetables initiated buds and flowered first? How many pod or fruit priming or harvesting did farmer conduct?
- ❏ In what cultural management practices did farmers employ different kinds, varieties, or cultivars of self-pollinated vegetable at different growth stages? Why did farmers employ these cultural management practices?
- ❏ Do we need insect pollinators for self-pollinated vegetables? Do we need to hand-pollinate self-pollinated vegetables? Why? Why not?
- ❏ Did you observe distinct changes in morphological structures of different kinds, varieties, or cultivars of self-pollinated vegetables at different growth stages? What are these distinct changes in morphological structures?
- ❏ Did farmers use this knowledge in morphological structures as basis for employing different cultural management practices? How?
- ❏ Did you learn innovative cultural management practices from other farmers at different growth stages of self-pollinated vegetables (e.g., snap bean, garden pea, tomato, bell pepper, and eggplant)? What are these innovative cultural management practices?

Exercise No. 3.29 Cultural management practices in relation to morphology and growth stages of cross-pollinated vegetables

Background and rationale

Cross-pollinated vegetables are vegetables wherein pod or fruit setting results from union of female (ovule) and male (pollen) reproductive cells of two different plants, varieties, or cultivars. The most common cross-pollinated vegetables are those belonging to cucurbits. All plants in populations of cross-pollinated species are highly heterozygous and enforced inbreeding (continuous self-pollination) results in deterioration of their vigor and other adverse effects. Heterozygosity is an essential feature of commercial varieties of these species and it must be either maintained during a breeding program or restored as a final step of a program[57].

Some examples of cucurbits are chayote, cucumber, and zucchini. Unlike some self-pollinated vegetables that are grown in home gardens, cross-pollinated vegetables (including chayote) are considered high-valued crops and are normally grown by farmers in commercial scale. Just like any commercially grown vegetables, appropriate and location-specific cultural management practices must be employed at different growth stages of crops to ensure more productive and profitable ventures.

Through years of experiences, farmers in the Cordilleras had evolved innovative cultural management practices that are more adapted to various stages of growing cross-pollinated vegetables in their localities. These unique experiences can be regularly shared among farmers in FFSs to further improve current practices. The foregoing exercise was designed to achieve this particular objective through participatory, discovery-based and experiential learning approaches.

---

[57] Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition. SEAMEO Regional Center for Graduate Study and Research in Agriculture and University of the Philippines Los Baños, College, Laguna, Philippines. pp133-144.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when participants decided to grow cross-pollinated vegetables (e.g., chayote, cucumber, and zucchini) in learning field or these vegetables are grown in adjoining fields
- When farmers want to learn innovative cultural management practices in relation to growth stages of cross-pollinated vegetables from other farmers

How long will this exercise take?

- Thirty minutes to one hour for field walks and observations of appropriate cultural management practices in relation to growth stages of cross-pollinated vegetables in learning and adjoining fields
- Thirty minutes to one hour for brainstorming session in processing area

Learning objectives

- To make participants aware and understand how appropriate cultural management practices in relation to growth stages of cross-pollinated vegetables can improve productivity and profitability.
- To learn innovative cultural management practices in relation to growth stages of cross-pollinated vegetables from other farmers.

Materials

- Cross-pollinated vegetables (chayote, cucumber and zucchini) grown in learning and adjoining fields
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)

Methodology

- Field walks and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe different stages of cross-pollinated vegetables grown in learning and adjoining fields. Interview other farmers, if necessary. List down all observations related to:

   ✓ Kinds, varieties, or cultivars of cross-pollinated vegetables (e.g., chayote, cucumber, and zucchini) planted;
   ✓ Different growth stages of cross-pollinated vegetables (e.g., chayote, cucumber, and zucchini) planted; and
   ✓ Cultural management practices employed at different growth stages.

2. Go back to processing area; brainstorm in small groups and present output to big group.

3. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. Motivate farmers to share their best cultural management practices employed in relation to morphology and growth stages of different cross-pollinated vegetables (e.g., chayote, cucumber, and zucchini) in their own farm, as follows:

   ✓ Preplanting operations (e.g., stratification, hydroization, land preparation, seedbed preparation, seedbed treatment, sowing, care of seedling, roguing of diseased plants, cultural control of pests, land preparation, raised bed preparation, furrowing, liming, organic and inorganic fertilizer application, pulling of seedlings, monitoring, etc.);
   ✓ Planting operations (e.g., transplanting, mulching, irrigation, etc.);
   ✓ Recovery and early vegetative stages (e.g., replanting, roguing of diseased plants, leaf removal of infected leaves, cultural control of pests, spot weeding, side dressing of fertilizer, irrigation, monitoring, etc.);
   ✓ Active vegetative stage (e.g., staking, trellising, roguing of diseased plants, leaf removal of infected leaves, cultural control of pests, spot weeding, side dressing of fertilizer, hilling up, irrigation, monitoring, etc.);
   ✓ Late vegetative and tendril initiation stages (e.g., roguing of diseased plants, leaf removal of infected leaves or vines, cultural control of pests, spot weeding, side dressing of fertilizer, hilling up, irrigation, monitoring, etc.);
   ✓ Bud formation and flowering stages (e.g., hand pollination, enhancing population of insect pollinators, roguing of diseased plants, leaf removal of infected leaves and flowers, cultural control of pests, spot weeding, side dressing of fertilizer, hilling up, irrigation, monitoring, etc.);
   ✓ Fruit setting and development stages (e.g., roguing of diseased plants, leaf removal of infected leaves or vines, thinning of undesirable fruits, fruit bagging, cultural control of pests, spot weeding, side dressing of fertilizer, hilling up, irrigation, monitoring, etc.); and

✓ Harvest and postharvest stages (e.g., 1st to nth fruit priming or harvesting, sorting, grading, packaging, etc.).

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise. Design appropriate matrix as shown below:

SPECIES, VARIETY OR CULTIVAR	GROWTH STAGE	DESCRIPTION OF DISTINCT MORPHOLOGY	CULTURAL MANAGEMENT PRACTICE	PURPOSE OF MANAGEMENT PRACTICE
CHAYOTE, CUCUMBER, AND ZUCCHINI	Preplanting			
	Planting or transplanting			
	Recovery and early vegetative			
	Active vegetative			
	Late vegetative			
	Bud and flower-initiation			
	Fruit setting and development			
	Harvest and postharvest			

Some suggested questions for processing discussion

- ❑ What do we mean by cross-pollinated vegetables? Did you observe different kinds, varieties, or cultivars of cross-pollinated vegetables (e.g., chayote, cucumber and zucchini) grown in adjoining fields of learning field?
- ❑ What kinds, varieties, or cultivars of cross-pollinated vegetables did farmers commonly grow? Why did farmers prefer these vegetables to others?
- ❑ Which kinds, varieties, or cultivars of cross-pollinated vegetables initiated buds and flowered first? How many fruit priming or harvesting did farmer conduct?
- ❑ What cultural management practices did farmers employ different kinds, varieties, or cultivars of cross-pollinated vegetable at different growth stages? Why did farmers employ these cultural management practices?
- ❑ Do we need insect pollinators for cross-pollinated vegetables? Do we need to hand-pollinate cross-pollinated vegetables? Why? Why not?
- ❑ Did you observe distinct changes in morphological structures of different kinds, varieties, or cultivars of cross-pollinated vegetables at different growth stages? What are these distinct changes in morphological structures?
- ❑ Did farmers use this knowledge in morphological structures as basis for employing different cultural management practices? How?
- ❑ Did you learn innovative cultural management practices from other farmers at different growth stages of cross-pollinated vegetables? What are these innovative cultural management practices?

Exercise No. 3.30 Cultural management practices in relation to morphology and growth stages of root, bulb, and tuber vegetables

Background and rationale

Root, bulb, and tuber vegetables are grown for their swollen underground edible stems or roots. Some of these vegetables are carrots, potato, radish, and bulb onions. These vegetables are shallow rooted crops with depth of rooting ranging from 90 to 100 cm. The attainments of their maximum vegetative and reproductive development depend largely on the kind of soil preparation and soil moisture condition[58] .

Unlike other vegetables that are grown for their leaves, curds, pods, or fruits, such that cultural management practices are largely concentrated on above-ground parts, root, bulb, and tuber vegetables need more special attention on their underground parts. Just like any high-valued crops normally grown by farmers in commercial scale, appropriate and location-specific cultural management practices must be employed at different growth stages of crops for more productive and profitable production.

Through years of experiences, farmers in the Cordilleras had evolved innovative cultural management practices that are more adapted to various stages of growing root, bulb, and tuber vegetables in their localities. These unique experiences can be regularly shared among farmers in FFSs to further improve current practices. The foregoing exercise was designed to achieve this particular objective.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when participants decided to grow root, bulb, and tuber vegetables in learning field or these vegetables are grown in adjoining fields
- When farmers want to learn innovative cultural management practices in relation to growth stages of root, bulb, and tuber vegetables from other farmers

[58] Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition. SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp94-98.

How long will this exercise take?

- Thirty minutes to one hour for field walks and observations of appropriate cultural management practices in relation to growth stages of root, bulb, and tuber vegetables in learning and adjoining fields
- Thirty minutes to one hour for brainstorming session in processing area

Learning objectives

- To make participants aware and understand how appropriate cultural management practices in relation to growth stages of root, tuber, and tuber vegetables can improve productivity and profitability.
- To learn innovative cultural management practices in relation to growth stages of root, tuber, and tuber vegetables from other farmers.

Materials

- Root and tuber vegetables grown in learning and adjoining fields
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)

Methodology

- Field walks and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe different stages of root and tuber vegetables grown in learning and adjoining fields. Interview other farmers, if necessary. List down all observations related to:

   ✓ Kinds, varieties, or cultivars of root, bulb, and tuber vegetables planted;
   ✓ Different growth stages of root, bulb, and tuber vegetables planted; and
   ✓ Cultural management practices employed at different growth stages.

2. Go back to processing area; brainstorm in small groups and present output to the big group.

3. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. Motivate farmers to share their best cultural management practices employed in relation to morphology and growth stages of different root, bulb, and tuber vegetables in their own farm, as follows:

- ✓ Preplanting operations (e.g., land and raised bed preparation, seed tuber selection and dormancy breaking, vernalization, seedbed preparation and treatment, sowing, care of seedling, roguing of diseased plants, cultural control of pests, furrowing and holing, liming, organic and inorganic fertilizer application, pulling of seedlings, monitoring, etc.);
- ✓ Planting or transplanting operations (e.g., direct seeding, transplanting, mulching, irrigation, etc.);
- ✓ Recovery and early vegetative stages (e.g., thinning, replanting, roguing of diseased plants, leaf removal of infected leaves, cultural control of pests, spot weeding, side dressing of fertilizer, irrigation, monitoring, etc.);
- ✓ Active vegetative stage (e.g., roguing of diseased plants, leaf removal of infected leaves, cultural control of pests, spot weeding, side dressing of fertilizer, hilling up, irrigation, monitoring, etc.);
- ✓ Early root, bulb and tuber development stages (e.g., roguing of diseased plants, leaf removal of infected leaves, cultural control of pests, spot weeding, side dressing of fertilizer, hilling up, irrigation, monitoring, etc.)
- ✓ Maximum root, bulb and tuber development stages (e.g., roguing of diseased plants, leaf removal of infected leaves, cultural control of pests, spot weeding, side dressing of fertilizer, hilling up, irrigation, monitoring, dehaulming, etc.); and
- ✓ Harvest and postharvest stages (e.g., harvesting, sorting, grading, packaging, etc.).

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise. Design appropriate matrix as shown in the next page:

SPECIES, VARIETY OR CULTIVAR	GROWTH STAGE	DESCRIPTION OF DISTINCT MORPHOLOGY	CULTURAL MANAGEMENT PRACTICE	PURPOSE OF MANAGEMENT PRACTICE
CARROT, POTATO, RADISH, AND BULB ONION	Preplanting			
	Planting or transplanting			
	Recovery and early vegetative			
	Active vegetative			
	Early root, bulb, and tuber development			
	Maximum root and tuber development			
	Harvest and postharvest			

Some suggested questions for processing discussion

- ❏ Did you observe different kinds, varieties, or cultivars of root, bulb, and tuber vegetables grown in adjoining fields of learning field?
- ❏ What kinds, varieties, or cultivars of root, bulb, and tuber vegetables did farmers commonly grow? Why did farmers prefer these root, bulb, and tuber vegetables to others?
- ❏ Which kinds, varieties, or cultivars of root, bulb, and tuber vegetables developed enlarged root, bulb, and tuber first? How long did it take for enlarged root, bulb, and tuber to fully develop?
- ❏ In what cultural management practices did farmers employ different kinds, varieties, or cultivars of root, bulb, and tuber vegetable at different growth stages? Why did farmers employ these cultural management practices?
- ❏ Is hilling up operation necessary in root, bulb, and tuber vegetable production? When did farmers conduct hilling up operations? Why?
- ❏ Did you observe distinct changes in morphological structures of different kinds, varieties, or cultivars of root, bulb, and tuber vegetables at different growth stages? What are these distinct changes in morphological structures?
- ❏ Did farmers use this knowledge in morphological structures as basis for employing different cultural management practices? How?
- ❏ Did you learn innovative cultural management practices from other farmers at different growth stages of root, bulb, and tuber vegetables? What are these innovative cultural management practices?

Section 4

Supplementary and Additional Pest and Disease Management Topics

Section 4 Supplementary and Additional Pest and Disease Management Topics

In a recently concluded intensive one-month *Refresher Course for Trainers of IPM in Crucifers and Other Highland Vegetable Crops*[59], design of discovery-based exercises on insects and other pests and natural enemies was started with field walks, observations, and collection of live specimens (including plants exhibiting damages) in vegetable fields. Sorting and identification of collected insects, other pests and their natural enemies by participants were then conducted in small groups. Validation of output in big group with assistance of technical experts followed. The participants, together with technical experts, summarized the activity by classifying collected specimens as follows[60]:

- *Destructive insects.* A group of insects that feeds on vegetable crops specifically on leaves, stems, flowers, and fruits. The feeding of these insects causes damage to crop, which affects yield or quality of produce. Destructive insects are grouped based on the kind of feeding they inflict on vegetable crops:

  Sucking insects. These insects are normally represented by plant bugs, which have piercing-sucking mouthparts. As sap feeders, majority of these insects have toxic saliva, which when injected into plant produces curling, necrosis and drying of tissues, resulting sometimes in death of shoots and branches. Some bugs transmit virus diseases in cucurbits and solanaceous vegetables. Some examples are true bugs, aphids, thrips, and mites.

[59] Binamira, J.S. 1998. A Consultant's Report: Refresher Course for Trainers of IPM in Crucifers and Other Highland Vegetable Crops. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Regional Field Unit, Baguio City, Philippines. pp22-28.

[60] Medina, J.R. 1998. Personal communication.

Chewing insects. These are insects whose destructive stages have a mandibulate or chewing mouthparts. They feed mostly on leaves, flowers, and fruits. During severe infestation, insects may defoliate whole plants. Other damages are folding of leaves, pinholes, and huge holes and feeding on undersurface of leaves. On flowers and fruits, scraped surface is a sign of damage done by insects. Some common examples are diamondback moth (DBM), cutworm, leaffolder, and flea beetle.

Borer insects. The immature stages of these insects bore or tunnel fruit or stem of plant. In severe infestation, many fruits drop prematurely. Stems heavily affected dry up leading to death of crop. A few examples are shoot borer, pod borer, melon fruit fly, and fruit worm.

Miner insects. Immature stages of insects puncture and mine on leaves down to petiole and stem. On leaves, damage is characterized by transparent mine extending over surface. Heavily infested leaves may dry up but remain attached to plant. Seriously infested plants are stunted and produce injuries on flowers and fruits. Some examples are sweet pea miner and bean fly.

Root feeders. Immature stages and some adults of insects feed on living roots or base of plants, causing stunted growth or death of plants. Yellowing of leaves or plants in patches is the first indication of damage by these insects. Some result in complete cutting of aerial portions from roots. A few examples are crickets, mole cricket, and grubs.

- *Beneficial Insects.* Refer to insect groups that give benefit to farmers in terms of insect pest reduction and improvement of yield or quality of product.

  Biological control agents. This refers to any living organism used in reducing pest population in vegetable farms. The employment of sound agricultural practices will help conserve and encourage reproduction of naturally occurring enemies of vegetable pests. The kind of living organism identified can be one of following:

  ✓ *Predators.* A group of organisms that are free-living throughout their entire life cycle. Each predator consumes a number of pests, called preys, in its lifetime. In vegetable areas, spiders, predatory bugs, ants, wasps and some ladybird beetles are organisms identified eating both larval and adult stages of insect pests.

✓ *Parasitoids.* These are insects, mostly wasps and flies, that lay eggs on or near insect pests of vegetables. Upon hatching, parasitoid larvae feed on hosts, either internally or externally and kill hosts during their development. Adult parasitoids feed mostly on flowers. Some examples are *Diadegma sp., Cotesia sp., Diadromus sp.,* and *Trichogramma sp.*

✓ *Pathogens.* These are parasitic microorganisms used to control insect pests of vegetables. Some insect pathogens infecting various insect pests are viruses, bacteria, and fungi. Both viruses and bacteria infect their host when eaten. Fungal pathogens can infect their hosts by penetrating directly through surfaces of host's body. A few examples are *nucleo-polyhedrosis virus* (NPV), *Nomurea sp., Beauverea sp.*, and *Cordecyps sp.*

Pollinators. These insects pollinate flowers of some vegetable crops like cucumber, chayote, snap bean, green pea, bell pepper, and tomato. Wild bees and honeybees are most predominant pollinators of vegetables.

In that same refresher course[61], field walks, observations and collection of diseases and physiological disorders of crucifers (e.g., cabbage and cauliflower), parsley (e.g., carrot and celery), legumes (e.g., snap bean and garden pea), cucurbits (e.g., cucumber, chayote, and zucchini), and solanaceous vegetables (e.g., potato, tomato and bell pepper) were similarly conducted. Sorting and identification of collected specimens by participants in small groups and validation with technical experts in a big group session followed. Again, participants together with technical experts, summarized output of said session by coming up with a list of the most distinguishing characteristics for field identification of vegetable diseases[62] and physiological disorders[63] as follows:

---

61 Binamira, J.S. 1998. A Consultant's Report: Refresher Course for Trainers of IPM in Crucifers and Other Highland Vegetable Crops. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Regional Field Unit, Baguio City, Philippines. pp15-22.

62 Milagrosa, S.P. 1998. Personal communication.

63 Balaki, E.T. 1998. Personal communication.

- *Virus Diseases.* The general symptoms are: (a) leaf discoloration, (b) stunting, (c) leaf rolling or twisting, and (d) vein clearing;

- *Bacterial Diseases.* The most common symptoms are: (a) maceration or disintegration of tissues, (b) 'water-soaked' appearance, and (c) 'foul' odor;

- *Fungal Diseases.* The general symptoms are presence of: (a) 'cotton-like' and (b) 'dry' appearances (e.g., leaf spots) of infected plant parts;

- *Nematodes (or the 'unseen enemy').* The general symptoms are: (a) gall formation in root system, (b) root necrosis (e.g., branching), and (c) gall formation within root system (in contrast to nodules which are formed outside root system); and

- *Physiological Disorders.* The usual symptoms are malformations caused by: (a) noninfectious organisms, (b) nutrient deficiencies or toxicities, and (c) chemical injuries or toxic residues.

Through participatory discussions, the participants, facilitators, and technical resource persons in aforesaid refresher course identified additional and supplementary discovery-based exercises to a previous volume (Volume I)[64]. These exercises were focused on management of vegetable pests, diseases, physiological disorders and cultural management problems identified in the first two IPM workshops[65], which were validated by participants in aforesaid refresher course for inclusion in this new volume (Volume II).

[64] Philippine National IPM Program. 1997. Field Guide of Discovery-based Exercises for Vegetable IPM (Volume I). National Agricultural and Fishery Council, Department of Agriculture, Diliman, Quezon City, Philippines. pp1-1/6-40.

[65] Binamira, J.S. 1998. A Consultant's Report: An Evaluation of the Impact of the IPM in Crucifers in the Cordilleras. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Field Unit, Baguio City, Philippines. pp1-62.

Pest Management

In this new volume, most discovery-based exercises compiled under 'Pest Management' sub-section are additional exercises identified in a previous curriculum development workshop[66], which were validated by participants in a recently concluded intensive one-month *Refresher Course for Trainers of IPM in Crucifers and Other Highland Vegetable Crops*[67]. However, some discovery-based exercises in this subsection are supplements to previous exercises under Sections 4 and 5, Field Guide of Discovery-based Exercises for Vegetable IPM, Volume I, such as:

- *'Pulling the guts' technique: Measuring degree of parasitism by Diadegma on diamondback moth of crucifers.* This discovery-based exercise was designed to supplement several exercises, such as: 'Parasitic Wasps: Why Are They Farmers' Friends?'; 'Field Releases of Diadegma Parasites'; and 'Field Exercise for Diamondback Moth of Crucifers'.

- *Enhancing natural enemy populations by using Bacillus thuringiensis against lepidopterous pests of vegetables.* This discovery-based exercise was designed to supplement some exercises, such as: 'Mapping Exercises: Encouraging Natural Enemies in the Farm (What Environments Do Natural Enemies Prefer?)'; and 'Natural Enemies Preferred Environments and Cultural Practices: Can We Increase Natural Enemies By Employing Suitable Cultural Practices'.

- *Using cage traps and scaring materials as management strategies against rats in vegetable production.* This discovery-based exercise was designed to supplement 'Hands-On and Participatory Discussion: Rodent Management'.

[66] Binamira, J.S. 1998. A Consultant's Report: Curriculum Development for Trainers and Farmer Field Schools on IPM in Crucifers and Other Highland Vegetable Crops. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Regional Field Unit, Baguio City, Philippines. pp6-23.

[67] Binamira, J.S. 1998. A Consultant's Report: Refresher Course for Trainers of IPM in Crucifers and Other Highland Vegetable Crops. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Regional Field Unit, Baguio City, Philippines. pp15-22.

Exercise No. 4.01

'Pulling the guts' technique: Measuring the degree of parasitism by *Diadegma* on DBM of crucifers

Background and rationale

The standard approach in DBM population is the use of biological control with parasitoid *Diadegma.* Augmentation release of parasitoid early at onset of dry season is usually practiced so that future DBM populations are effectively held in check. In some areas, augmentation releases may not be necessary where parasitoid is already well established.

The establishment of *Diadegma* can be determined by knowing the degree of DBM parasitism in a field. Insect parasitism is a process of how an insect parasitoid kills a host as it undergoes its life cycle. One effective method of monitoring larval parasitism of DBM in farmers' field is by *pulling the guts* technique[68]. 'Pulling the guts' will also show farmers how a DBM larva is killed by *Diadegma* parasitoid present inside it. Simply hold a DBM larva on both ends between thumb and index finger and slowly pull until gut or *bituka* breaks to show a developing larva of *Diadegma* inside.

In FFSs, this practical tool will improve farmers' decision-making skills and will help them analyze and find out if there is a need to release or augment *Diadegma* in a field.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when there are early infestations of DBM in learning and adjoining crucifer fields
- When farmers want to learn a practical tool of determining degree of DBM larval parasitism by *Diadegma* in their field

How long will this exercise take?

- Thirty minutes field walks observations, hands-on, and interaction with farmers
- Thirty minutes brainstorming session in processing area

[68] IIBC. 1996. Integrated Pest Management for Highland Vegetables, Volume 4: Training Guide for Participatory Action Towards Discovery Learning. International Institute for Biological Control, BPI Compound, Baguio City, Philippines. pp63-64.

Learning objectives

- To create awareness and understanding among participants on role of *Diadegma* parasitoid in managing population of DBM in crucifers.
- To learn and do hands-on of 'pulling the guts' technique in determining degree of DBM larval parasitism by *Diadegma* in farmers' field.

Materials

- Office supplies (Manila papers notebooks, ball pens, marking pens, and crayons)
- Other supplies (hand lenses, soft brush for collecting specimens, plastic jars, syringe, vials, and denatured alcohol)
- Crucifers grown in learning and adjoining field showing early infestations of third and fourth instar DBM larvae

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks, observe crucifer crops showing early infestations of DBM in learning and adjoining fields. Take note of feeding characteristics of pest. Interview other farmers, if necessary. List down all observations related to pest occurrence, degree of parasitism and characteristic of pest damage, etc.

2. Facilitate each farmer to do hands-on of 'pulling the guts' (limit to one larva per farmer or 25-30 larvae per FFS to avoid too destructive sampling) to determine degree of DBM larval parasitism by *Diadegma* in learning and adjoining crucifer fields, as follow:

   ✓ Collect and record number of third and fourth instar DBM larvae collected;
   ✓ Take one larva, hold on both ends between thumb and index finger, slowly pull, and carefully observe *Diadegma* larva coming out a gut or *bituka* of DBM larva with aid of a magnifying lens;
   ✓ Count and record number of DBM larvae with *Diadegma* larval parasitoid inside;
   ✓ Count and record number of DBM larvae without *Diadegma* larval parasitoid inside; and
   ✓ Determine percent parasitism following formula on the next page:

$$\text{Percent parasitism} = \frac{\text{total number of parasitized larvae}}{\text{total number of collected DBM larvae subjected to } \textit{pulling the guts}} \times 100$$

3. Go back to processing area, brainstorm in small groups and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators.

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendation from exercise.

Some suggested questions for processing discussion

- ❑ Why is this exercise called pulling the guts?
- ❑ Did you observe DBM infestations on crucifers in farmers' field?
- ❑ Did you identify the difference between *Diadegma* parasitized and non-parasitized DBM larvae? What were the differences between these two?
- ❑ Did you try pulling the guts to estimate the percentage DBM larval parasitism by *Diadegma*? Is it a practical technique for farmers?
- ❑ Can you detect a parasitized DBM larva without pulling the guts? How?
- ❑ Did you see adult *Diadegma* parasitoids in farmers' field? How did they survive in field?
- ❑ Did you see adult *Diadegma* parasitoids actually parasitizing DBM larvae?
- ❑ What farmers' practices do you think can be destructive for *Diadegma* parasitoids?
- ❑ What cultural practices do you think can enhance or conserve population of *Diadegma* parasitoids in farmers' field?
- ❑ What other cultural management strategies can complement the use of *Diadegma* parasitoids to manage DBM population in farmers' field?

Exercise No. 4.02 Brushing or scraping as control strategy against scale insects of vegetables

Background and rationale

Some farmers in the Cordilleras practice brushing or scraping as a control strategy against scale insects of vegetables. Brushing or scraping is particularly helpful as a control measure in smaller farms where scale insect population is relatively low and when there are localized pest infestations in vegetable fields[69]. The practice minimizes production cost, as farmers are able to avoid indiscriminate use of pesticides. Likewise, this strategy favors increase in population of pests' natural enemies and reduces human health and environmental hazards as well.

A number of enterprising farmers initially spray scale insects with chili-detergent solution to weaken pests for easier brushing or scraping. Other innovative practices can be shared among farmers in FFSs and allow them to further improve their current best practices. The foregoing exercise was designed to ensure such learning process to happen.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when there is a relatively moderate scale insect infestation on vegetables in learning field
- When farmers want to learn when is it more practical to use brushing or scraping as a control strategy against scale insects of vegetables

How long will this exercise take?

- Thirty minutes field walks, observations, hands-on, and interaction with farmers
- Thirty minutes brainstorming session in processing area

Learning objectives

- To create awareness and understanding among participants that brushing and scraping can be a practical control strategy against moderate scale insect infestations.
- To learn and do hands-on of brushing and scraping scale insects when moderate infestation is observed in learning field.

69 Cardona, Jr. E.V. 1998. Personal communication.

Materials

- Office supplies (Manila papers, notebooks, ball pens, marking pens, and crayons)
- Vegetable crops grown in learning and adjoining fields showing moderate scale insect infestations
- Other supplies (medium soft brush, spatula or knife, and plastic jars)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe vegetable crops showing moderate scale insect infestations in learning and adjoining fields. Take note of feeding characteristics of pests. Interview other farmers, if necessary. List down all observations related to pest occurrence, crops or weeds infested, degree and characteristic of damage.

2. Guide each farmer to conduct hands-on exercise of brushing or scraping scale insects when moderate infestation is observed on vegetables grown in learning field, as follow:

   ✓ Look for localized areas where scale insects are concentrated;
   ✓ Take note of characteristic damage, plant part damaged, relative density, etc. of pests;
   ✓ If possible, estimate degree of pest infestation per plot;
   ✓ Perform brushing or scraping of scale insects making sure that injury to crop is avoided; and
   ✓ Take note of all relevant observations and experiences during this activity.

3. Go back to processing area; brainstorm in small groups and present output to big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. Motivate farmers to share their best experiences in controlling scale insects at moderate infestation levels.

4. Synthesize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❑ Which areas in plots were most concentrated with scale insects?
- ❑ Which vegetable crops were more and less infested by scale insects? What were the most distinguishing characteristics of scale insect damage? Which parts of plant were damaged by scale insects?
- ❑ How much time did you spend in brushing or scraping scale insects? Do you think it is a practical approach?
- ❑ Did you observe farmers who practiced brushing or scraping to control scale insects? Did farmers practice other innovative strategies to control scale insects? What are these strategies?
- ❑ Do farmers consider scale insects destructive pests of vegetables?
- ❑ What other cultural management strategies can you use to complement brushing or scraping of scale insects at moderate and high infestation levels?

Exercise No. 4.03

Cultivation as a management strategy for crop residue- and soil-inhabiting pests of vegetables

Background and rationale

Cultivation to control weeds is normal farming practice, but it also destroys pest pupating in soil and exposes them to predation. Cultivation affects a variety of pests that have at least part in their development in soil. This includes cutworms, white grubs, and grasshoppers. Effectiveness of cultivation often depends upon soil types and local conditions. General application is also limited because operations that reduce numbers of one pest may benefit other pests. Crop rotation and cultivation are most widely used cultural practices for pest control, although some vegetable farmers do not always recognize these benefits[70].

In the case of cutworm, larvae stay below soil surface at daytime, and become very active at night. They inflict damage by cutting base of seedlings, as well as eating leaves of older plants. The larval stage varies from 2-5 weeks, and pupae stay several inches below soil surface from 1-8 weeks. The larvae are most abundant in moist areas; thus, thorough cultivation is one of the most practical approaches to minimize cutworm infestation.

Many pests remain in seeds, stalks, or other crop residues after harvest. For example, removal or incorporation of these residues into soil by cultivation is essential in controlling twig borer in solanaceous vegetables and vine borer in cucurbits.

In the Cordilleras, many farmers had evolved a number of cultivation practices that effectively manage soil-inhabiting pests. In FFSs, these unique experiences must be shared among farmers to continuously adapt better cultivation practices to manage crop residue- and soil-inhabiting pests. This exercise was designed to achieve this objective.

70 Medina, J.R. 1998. Personal communications.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when infestations of crop residue- and soil inhabiting pests are observed on vegetable crops in learning field
- When farmers want to learn proper cultivation practices from other farmers to manage crop residue-and-soil-inhabiting vegetable pests

How long will this exercise take?

- Thirty minutes to one hour for field walks and observations of vegetable crops showing infestations of crop residue-and-soil-inhabiting pests in learning and adjoining fields
- Thirty minutes to one hour for brainstorming session in processing area

Learning objectives

- To make participants aware and understand how proper cultivation can contribute to better management of crop residue-and-soil-inhabiting pests of vegetables.
- To learn some cultivation practices from other farmers that resulted to better management of crop residue-and-soil-inhabiting pests of vegetables.

Materials

- Vegetable crops showing infestations of crop residue-and soil-inhabiting pests in learning and adjoining fields
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)

Methodology

- Field walks and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe cultivation practices that resulted to better management of crop residue- and soil-inhabiting pests of vegetables in learning and adjoining fields. Interview other farmers and collect specimens, if necessary. List down all observations related to:

   ✓ Kind of crops planted and crop stand;
   ✓ Prevalent weeds, pests, and diseases; and
   ✓ Quality of products, etc.

2. Go back to processing area; brainstorm in small groups and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators.

3. List down important observations shared by farmers, such as:

   ✓ Reasons for choice of crop species, cultivars, or varieties planted;
   ✓ Unique cultivation practices employed for crops planted; and
   ✓ Specific crop residue-and- soil-inhabiting pest problems managed by specific cultivation practices.

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussions

- ❑ Did you observe different crop species, cultivars, or varieties planted in farmers' fields? What was the farmers' reason for choice of crops planted?
- ❑ What crop residue- and- soil-inhabiting pests and diseases were prevalent on crops planted? What cultivation practices were employed by farmers to help manage these pests?
- ❑ Did you learn some unique cultivation practices from other farmers to help manage crop residue- and- soil-inhabiting vegetable pests?
- ❑ When is the best time during cropping season to plant different crop species, cultivars, or varieties? Why?
- ❑ Did proper cultivation improve productivity and profitability? Can we really reduce crop residue- and- soil-inhabiting pest and disease occurrence by proper cultivation? How? Why?
- ❑ What other cultural management practices can complement proper cultivation to control crop residue- and- soil-inhabiting pests in vegetable production?

Exercise No. 4.04 Hand picking as a control strategy for black and common cutworms at low to moderate infestation levels

Background and rationale

Hand picking of pests is probably one of the earliest methods of pest control and is still a profitable method for removal of some vegetable pests. Hand picking could be used to limit an attack when first the few insects are detected on time. The black and common cutworms, for example, can be effectively controlled by hand picking at relatively low to moderate infestation levels[71].

In cabbage, when parasitoid Diadegma puts population of diamondback moth in check by high degree of larval parasitism, hand picking at low to moderate cutworm infestations will avoid indiscriminate insecticide application. In parsley and legumes, hand picking of cutworm pupae may be instituted when they are exposed in field because of land preparation and hilling-up operations. Hand picking and using trap materials can complement each other for better control of black and common cutworms in vegetables even at moderate infestation.

Farmers in the Cordilleras had evolved some unique practices employed to supplement hand picking as a control strategy against cutworms. These experiences must be shared with others in FFSs to further improve their current control strategies against cutworms. This exercise was designed to address this concern.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when there is a relatively low to moderate cutworm infestations on vegetables in learning field
- When farmers want to learn when is it more practical to use hand picking as a control strategy against cutworms of vegetables

How long will this exercise take?

- Thirty minutes field walks, observations, hands-on, and interaction with farmers
- Thirty minutes brainstorming session in processing area

[71] Medina, J.R. 1998. Personal communication.

Learning objectives

- To create awareness and understanding among farmers that hand picking can be a practical control strategy against relatively low to moderate cutworm infestations.
- To learn andexperience hands-on hand picking cutworms when relatively low to moderate infestations are observed in learning field.

Materials

- Office supplies (notebooks, ball pens, marking pens, crayons, Manila papers)
- Vegetable crops grown in learning and adjoining fields showing relatively low to moderate cutworm infestations

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe vegetable crops showing low to moderate cutworm infestations in learning and adjoining fields. Take note of feeding characteristics of pests. Interview other farmers, if necessary. List down all observations related to pest occurrence, crops or weeds infested, degree and characteristic of damage, etc.

2. Facilitate each farmer to do hands-on of hand picking cutworms when relatively low to moderate infestations are observed on vegetables grown in learning field, as follow:

   ✓ Look for localized areas where cutworms are concentrated;
   ✓ Take note of characteristic damage, plant part damaged, relative density, etc., of pests;
   ✓ If possible, estimate degree of pest infestation per plot;
   ✓ Perform direct hand picking of cutworms at relatively low infestation levels;
   ✓ Use trap materials to complement handpicking of cutworms at moderate infestation levels; and
   ✓ Take note of all relevant observations and experiences during the activity.

3. Go back to processing area; brainstorm in small groups and present output to big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. Motivate farmers to share their best experiences in controlling cutworms at relatively low to moderate infestation levels.

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❑ Which areas in plots were most concentrated with cutworms?
- ❑ Which vegetable crop was more and less infested by cutworms? What were the most distinguishing characteristics of cutworm damage? Which parts of plant did cutworm damage?
- ❑ How much time did you spend in hand picking cutworms? Do you think it is a practical approach?
- ❑ Did you observe farmers who practiced hand picking to control cutworms? Did farmers practice other innovative strategies to control cutworms? What are these strategies?
- ❑ Do farmers consider cutworms destructive pests of vegetables?
- ❑ What other cultural management strategies can you use to complement hand picking of cutworms at relatively low to moderate infestation levels?

Exercise No. 4.05

Spraying chili (hot pepper) solution to control webworms at low to moderate infestation levels

Background and rationale

Some indigenous plants that are safe to humans are now being exploited for their insecticidal properties. For example, extract from marigold has been found effective against DBM of crucifers. In the Cordilleras, farmers are using chili or hot pepper solution to control webworms at low to moderate infestation levels in cabbage. The use of chili may be supplemented by hand picking to be more effective. Some farmers claim that adding detergent as a sticker improves effectiveness of chili solution in controlling moderate to severe webworm infestations.

Considering that webworm infestation can start as early as seedling stage and may continue almost up to maturity of cabbage, using safe and effective indigenous materials like chili to control the pest will surely avoid indiscriminate use of insecticide, reduce production cost, and improve profitability. Many farmers had unique experiences in using chili as a control strategy in combination with other techniques that gave results that are more outstanding. These experiences must be shared among farmers in FFSs to further improve current control strategies against webworms in cabbage.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when there is a relatively low to moderate webworm infestations on crucifers in learning field
- When farmers want to learn when is it more practical to spray chili solution to control webworm of crucifers

How long will this exercise take?

- Thirty minutes field walks, observations, hands-on, and interaction with farmers
- Thirty minutes brainstorming session in processing area

Learning objectives

- To create awareness and understanding among participants that spraying with chili can be a practical control strategy against relatively low to moderate webworm infestations in crucifers.
- To learn and experience hands-on spraying chili solution against webworms when relatively low to moderate infestations in crucifers are observed in learning field.

Materials

- Office supplies (notebooks, ball pens, marking pens, crayons, sheets of Manila papers)
- Other supplies (chili or hot peppers, measuring cup, sprayer, detergent, and water)
- Crucifers grown in learning and adjoining fields showing relatively low to moderate webworm infestations

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe crucifers showing low to moderate webworm infestations in learning and adjoining fields. Take note of feeding characteristics of pests. Interview other farmers, if necessary. List down all observations related to pest occurrence, crops or weeds infested, degree and characteristic of damage, etc.

2. Facilitate each farmer to do hands-on of spraying chili against webworms when relatively low to moderate infestations are observed on crucifers grown in learning field, as follows:

   ✓ Look for localized areas where webworms are concentrated;
   ✓ Take note of characteristic damage, plant part damaged, relative density, etc., of pests;
   ✓ If possible, estimate degree of pest infestation per plot;
   ✓ Prepare chili solution by pounding and diluting 20 ripe chili fruits per liter of water. Add one spoonful of detergent per litter of chili solution;
   ✓ Perform localized spraying of chili solution at relatively low to moderate webworm infestation levels;
   ✓ Use handpicking to complement spraying of chili solution at moderate webworm infestation levels, and
   ✓ Take note of all relevant observations and experiences during this activity.

3. Go back to processing area; brainstorm in small groups and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. Motivate farmers to share their best experiences in controlling cutworms at relatively low to moderate infestation levels.

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❑ Which areas in plots were most concentrated with webworms?
- ❑ Which crucifer vegetables were more and less infested by webworms? What were the most distinguishing characteristics of webworm damage? Which parts of plant did webworm damage?
- ❑ How much time did you spend in spraying webworms with chili solution? Do you think it is a practical approach?
- ❑ Did you observe farmers who sprayed chili solution against webworms? Did farmers practice other innovative strategies to control webworms? What are these strategies?
- ❑ Do farmers consider webworms as destructive pests of vegetables?
- ❑ What other cultural management strategies can you use to complement spraying chili solution to control webworms at relatively low to moderate infestation levels?

Exercise No. 4.06

Using repellent and trap crops as a pest management strategy in vegetable production

Background and rationale

The use of repellent and trap crops, when properly implemented as a cultural management strategy can effectively reduce pest populations in vegetables without resorting to pesticide application. A popular repellent crop in highlands is marigold, which is used against diamondback moth (DBM). Trap crops, on the other hand, may include susceptible crops (e.g., marigold) or alternate hosts (e.g., *Galinzoga parviflora* and *Bidens pilosa*) of destructive pests (e.g., root knot nematodes) that are strategically planted in field to evade attacks by altering their food preference and migration from main vegetable crop to trap crop[72].

Chinese cabbage (locally known as *wongkok*) seems to be preferred by flea beetles and this could be used as a trap crop of this pest. For cutworm caterpillars, a simple and effective trap crop is use of large senescing cabbage leaves, which are placed on ground around plants in late afternoon. The caterpillars seek refuge under these leaves where they can be easily collected when the sun rises the following day. This trap crop is also effective for garden snails and slugs.

Many farmers in the Cordilleras had their own innovations in using repellent and trap crops. These experiences can be effectively shared and learned among farmers in FFSs through field walks, observations, and brainstorming. These learning experiences can be enhanced further by role-playing, hence this exercise.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, during discussions on cultural management practices as a component of IPM in vegetable production
- When farmers want to learn the best practices from other farmers on the use of repellent and trap crops as a pest management strategy in vegetable production

[72] Medina, J.R. 1998. Personal communication.

How long will this exercise take?

- Thirty minutes for field walks, observations, and collection of suspected repellent, trap, and main vegetable crops in learning and adjoining fields
- Thirty minutes to one hour role-playing and brainstorming session in processing area

Learning objectives

- To make participants aware of and understand the role of repellent and trap crops for pest management in their own vegetable farms.
- To enhance farmers' learning experiences by role-playing how repellent and trap crops work as a management strategy for vegetable pests.

Materials

- Vegetable fields where pest infestations or noninfestation can be observed on possible trap or repellent crops
- Other office supplies (sheets of Manila paper, notebooks, ball pens, and marking pens)

Methodology

- Field walks, role-playing, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe as many possible repellent and trap crops in adjoining farms of learning field. Interview other farmers, if necessary. List down all observations related to degree of pest infestations, kinds of repellent, trap or main crops planted, crop stand, etc.

2. Go back to processing area and prepare for a role-play. A facilitator explains mechanics of play to the big group and assigns two groups to different repellent or trap crops, one group to a main crop and two groups to different pests as shown below:

   ✓ Group 1 to repellent-trap crops A (Marigold)
   ✓ Group 2 to trap crops B (*Galinzoga parviflora*)
   ✓ Group 3 to main crops C (Carrot)
   ✓ Group 4 to pests A (half the group as root knot nematodes; half as diamondback moths)
   ✓ Group 5 to pests B (cutworms)

3. Each small group selects volunteers, discusses, and prepares for their roles. The role-play is then conducted by the big group to depict the following scenes:

- ✓ The pests shall migrate and pass by different repellent or trap crops;
- ✓ Half of pests A (root knot nematodes) shall be attracted to repellent-trap crops A while another half (diamondback moths) shall shy away and die;
- ✓ On the other hand, pests B shall be attracted to trap crops B;
- ✓ One or two of pests A and B shall not notice trap crops A and B and shall land instead on main crops C;
- ✓ These few pests shall survive on main crops C but shall be weak and sluggish;
- ✓ Most pests shall be strong, active, and cling to trap crops A and B; and
- ✓ Main crops C shall exhibit minimal damage while trap crops A and B shall be totally destroyed.

4. Brainstorm in a big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. Relate lessons learned in field walks to those learned in role-play.

5. Synthesize and summarize output in brainstorming session into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❏ Did you observe any weeds or crops in field, which can be used as repellent or trap crops?
- ❏ Did you observe varying degrees of pest damage among crops?
- ❏ What pests did these repellent or trap crop repel or trap?
- ❏ What is the economic importance of repellent and trap crops?
- ❏ Can we effectively manage pests by using repellent or trap crops? How?
- ❏ How do we layout repellent or trap crops in field?
- ❏ Did you learn from other farmers some innovations in using repellent or trap crops as a management strategy for vegetable pests?
- ❏ In this role-play, what were portrayed as characteristics of a good repellent or trap crop?
- ❏ What other cultural practices can complement the use of repellent or trap crops to manage vegetable pests?

Exercise No. 4.07

Trapping as a management strategy for soil-inhabiting vegetable pests

Background and rationale

Attracting insects to a trap has been a successful concept for insect control. The trap may contain nonpesticide baits such as sex attractant or an attractive food source for insect pest. In some cases, traps also serve as mating and egg laying (oviposition) sites[73]. Farmers in the Cordilleras, to collect some soil-inhabiting vegetable pests, commonly use trap materials. For cutworm caterpillar, a simple and effective method is using traps in the form of light slabs of wood, plywood boards, or even large leaves which are placed on ground around plants in late afternoon. Cutworms seek refuge under these slabs where they can be easily collected when the sun rises the following day. These traps are also effective for garden snails and slugs.

Many innovative vegetable farmers had tried other trap materials that are more readily available in their areas. In FFSs, these experiences must be shared among farmers to improve their current best practices in using trap materials. To enhance the learning process, this participatory, experiential, and discovery-based exercise was designed.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when there are early infestation signs of soil-inhabiting pests in learning field
- When farmers want to learn from other farmers their innovative practices in using trap materials for soil-inhabiting pests of vegetables

How long will this exercise take?

- Thirty minutes to one-hour for field walks, observations, and interaction with farmers
- Thirty minutes to one-hour for hands-on and brainstorming session

Learning objectives

- To create awareness and understanding among participants on the role of trap materials in management of soil-inhabiting vegetable pests.
- To learn from other farmers their innovative practices in using different trap materials for management of soil-inhabiting vegetable pests.

73 Cardona, Jr. E.V. 1998. Personal communications.

Materials

- Office supplies (Manila papers, hand lenses, notebooks, ball pens, marking pens, crayons)
- Vegetable crops grown in learning and adjoining fields showing early infestations of soil-inhabiting pests
- Different trap materials (large senescing cabbage leaves, light slabs of wood, plywood boards, etc.)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe as many vegetable crops with early infestations of cutworms, slugs, and snails in farmers' fields. Take note of feeding characteristics of pests. Interview other farmers, if necessary. List down all observations related to pest occurrence, crops or weeds infested, degree and characteristic of damage, etc.

2. Go back to processing area, brainstorm in small groups, and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. Motivate farmers to share their best experiences in controlling soil-inhabiting pests using different trap materials.

3. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

4. Facilitate farmers to do hands-on to compare effectiveness of trap materials as early as first infestations of soil-inhabiting pests is observed, as follows:

   ✓ Install suitable trap materials (e.g., large senescing cabbage leaves, light slabs of wood, plywood boards, etc.) during the afternoon at a distance of one meter in rows within plots;
   ✓ Gather installed trap materials and collect trapped pests in succeeding morning;
   ✓ Record pest numbers and species collected in each trap material and feed collected pests to chickens; and

- ✓ Repeat process daily until necessary; determine best trap materials and common pests usually trapped.

Some suggested questions for processing discussion

- ❑ What were the most common soil-inhabiting vegetable pests you observed in learning and adjoining fields?
- ❑ Did you observe farmers using trap materials for soil-inhabiting vegetable pests in their fields? What were the most common trap materials used for these soil-inhabiting pests? Why?
- ❑ Did you observe any differences in effectiveness among different trap materials used for soil-inhabiting vegetable pests? What soil-inhabiting vegetable pests were attracted to different trap materials used?
- ❑ Were there differences in crop stand and severity of pest damage between vegetable fields which used and did not use trap materials for soil-inhabiting vegetable pests?
- ❑ What other innovative practices in the use of trap materials did you learn from other farmers?
- ❑ Which trap materials will you use if soil-inhabiting vegetable pests attack your own farm? Why?
- ❑ What other cultural management strategies can you use to complement trap materials to manage soil-inhabiting vegetable pests?

Exercise No. 4.08 Use of yellow sticky traps as a management strategy for potato leafminers

Background and rationale

The potato leafminer, *Liriomyza huedobrensis*, has only recently invaded Southeast Asia. The first leafminer infestations in potato were reported in Indonesia in 1994. Farmers there said that they had not seen the pest before, although it was probably there for several years earlier. It is likely that it came in from cut flowers or other ornamental foliage that is frequently moving into that country. Interestingly, this pest has fairly recently been found in several other countries (Sri Lanka, Israel, Madagascar, Indonesia, Malaysia, and Thailand), and is spreading all over areas where it was not found before. Other vegetable crops are attacked but damage is usually not severe[74]. In the Philippines, the Department of Agriculture's Cordillera Administrative Regional Field Unit reported a major infestation of leafminers in potatoes in Buguias, Benguet. A validation conducted with field facilitators in September 1999 indicated that leafminers were not a major pest, but it seems that in this municipality, the build-up of this pest is reaching alarming proportions[75].

Several yellow traps (made of different materials and shades of yellow colors) were seen installed in many infested areas. Substantial numbers of adult leafminer catches were also observed on these trap materials, with more catches, as shades of yellow color became deeper. Interaction with farmers showed that, so far, only yellow traps worked among nonpesticide control strategies introduced in those areas.

It was also interesting to note a number of innovations shared on the use of yellow traps during interactions with farmers. For instance, some claimed that better result was obtained when each plant was installed with yellow soft drink straw dipped in grease oil. Others confirmed effectiveness of using yellow flaglets with grease oil to sweep adults as we have observed in some fields, which they said complemented these installed yellow traps.

[74] Shepard, B.M., Carner, G.R., Barrion, A.T., Ooi, P.A.C, and van den Berg, H. 1999. Insects and Their Natural Enemies Associated with Vegetables and Soybean in Southeast Asia. Quality Printing Company, Orangeburn, South Carolina, U.S.A. pp57.

[75] Callo, Jr., D.P. 2000. Travel report of leafminer infestation in Buguias, Benguet from 05-08 January 2000. ASEAN IPM Knowledge Network Center, SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA), College, Laguna, Philippines. pp2-5.

Many innovative vegetable farmers had tried other yellow trap materials that are more readily available in their areas. In FFSs, these experiences must be shared among farmers to improve their current best practices in using yellow trap materials. To enhance learning process, this participatory, experiential, and discovery-based exercise was designed.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when there are early infestation signs of potato leafminers in learning field
- When farmers want to learn from other farmers their innovative practices in using yellow sticky trap materials potato leafminers

How long will this exercise take?

- Thirty minutes to one-hour for field walks, observations, and interaction with farmers
- Thirty minutes to one-hour for hands-on and brainstorming session

Learning objectives

- To create awareness and understanding among participants about the role of yellow sticky trap materials in the management of potato leafminers.
- To learn from other farmers their innovative practices in using different yellow sticky trap materials for management of potato leaf miners.

Materials

- Office supplies (Manila papers, hand lenses, notebooks, ball pens, marking pens, crayons)
- Potato crops grown in learning and adjoining fields showing early infestations of potato leaf miners
- Different yellow sticky trap materials (made of different materials and shades of yellow colors)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe as many potato crops with early infestations of potato leafminers in farmers' fields. Take note of feeding characteristics of leafminers. Interview other farmers, if necessary. List down all observations related to pest occurrence, crops or weeds infested, degree and characteristic of damage, etc. For instance, in a recent field

observations and interactions with officials and farmers in Buguias, Benguet, several important concerns were noted, such as[76]:

✓ Majority of areas visited was planted with potato at varying growth stages (early, mid-vegetative and later stages). Other vegetable crops (e.g., carrot, Chinese cabbage or wongbok, cabbage, sweet and garden peas) were also planted. The effect of leafminer was observed to be less serious, as exhibited by punctured but still appearing green leaves, at earlier stages and becoming more serious, as exhibited by drying of leaves or dying of whole potato plants, at later stages. Heavily infested potato plant debris, alternate host crops, and weeds are left undisturbed in all areas visited;

✓ Interactions with farmers and extension workers suggested practice of continuous planting of potato in those areas, without any fallow period, year in and year out. Likewise, they indicated that this leafminer problem was first observed in Sitios Magmagaling, Lusong and Salingao, Barangay Buyakawan, Buguias, Benguet and later in Sitios Mudayan and Loo Proper, Barangay Loo, Buguias, Benguet. Farmers also said they observed that other vegetable crops are also infested by leafminers. They said some crops were, however, more susceptible (e.g., wongbok, celery and peas) than others (e.g., carrots and cabbage);

✓ Extensive and indiscriminate spraying of pesticides were practiced throughout those areas as evidenced by farmers spraying at the time of field visit and by smell of pesticides everywhere in areas planted to potato;

✓ Interaction with farmers and extension workers indicated that many farmers have increased their frequency of spraying against leafminer from every four days to every other day. Likewise, they said some farmers have again cocktailed or mixed several pesticides as spray

76 Callo, Jr., D.P. 2000. Travel report of leafminer infestation in Buguias, Benguet from 05-08 January 2000. ASEAN IPM Knowledge Network Center, SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA), College, Laguna, Philippines. pp2-5.

materials against leafminer. However, farmers themselves confirmed that such practice did not help contain this problem. In fact, they observed that leafminer was unaffected by most of pesticides they have tried. There were also reports from them that some farmers had started to use cyanide and formalin again but these did not help contain this problem as well;

- ✓ Several yellow sticky traps (e.g., made of different materials and shades of yellow colors) were seen installed in many infested areas. Substantial number of adult leafminer catches were also observed on these trap materials, with more catches, as shades of yellow became deeper; and

- ✓ Interaction with farmers showed that, so far, only these yellow sticky traps worked among several non-pesticide control strategies introduced in those areas. It was also interesting to note a number of innovations shared on use of yellow sticky traps during interaction with farmers. For instance, some claimed that better result was obtained when each plant was installed with yellow soft drink straw dipped in grease oil. Others confirmed effectiveness of using yellow flaglets with grease oil to sweep adults as we have observed in potato field, which they said complemented these installed yellow traps.

2. Go back to processing area, brainstorm in small groups, and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. Motivate farmers to share their best experiences in controlling potato leafminers using different yellow sticky trap materials.

3. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendation from this exercise. For example, based on field observations and interactions with officials and farmers in Buguias, Benguet, the following conclusions and recommendations were made[77]:

[77] Callo, Jr., D.P. 2000. Travel report of leafminer infestation in Buguias, Benguet from 05-08 January 2000. ASEAN IPM Knowledge Network Center, SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA), College, Laguna, Philippines. pp2-5.

✓ The leafminer infesting Barangays of Buyakawan and Loo, Buguias, Benguet belongs to a fly family (Diptera), probably *Liriomyza huedobrensis*, which was also reported infesting potato in other Southeast Asian countries (e.g., Indonesia, Malaysia, and Thailand).

✓ Based on progressing appearance and severity of symptoms observed in the field, it appears that an adult leafminer (smaller than a rice whorl maggot adult) will choose a younger potato plant for oviposition. Thus, newly hatched larvae will be too small to see with naked eyes at earlier crop stage and a progressing severity of damage will be more visible together with larger larvae as the crop grows older.

✓ The indiscriminate use of pesticides had apparently resulted in the development of pesticide resistance by this pest as shown by the absence of dead leafminers in field after pesticide spraying were conducted. It likewise resulted to elimination of natural enemies, particularly predators and parasites, as shown by their absence in the field.

✓ The practice of continuous and asynchronous planting of potato as well as planting of alternate host crops, such as Chinese cabbage and celery, by farmers provided year-round host and uninterrupted life cycles for leafminer. This is aggravated by the improper disposal of infested potato plant debris as well as alternate host crops and weeds.

✓ While the use of yellow sticky traps is more effective than spraying pesticides and is well accepted as a non-pesticide control strategy against leafminer, its sustainability hinged on how fast we can facilitate FFS farmer-graduates and facilitators to establish participatory technology development (PTD) activities to get answers on the following questions: (1) What size and number of yellow traps are required per unit area? (2) Where and when do we install the yellow traps in potato fields? (3) What shades of yellow and materials do we use for yellow sticky traps? (4) What complementary activities do we need for yellow sticky traps to be more effective?

- ✓ There is a need to drastically bring down existing leafminer population in these infested areas to sustain effectiveness of yellow sticky traps. This will require a moratorium in planting potato and other alternate host crops, like Chinese cabbage and celery, and planting instead of less preferred or nonhost crops, such as cabbage and carrots, in these areas for at least two months to break the life cycle of leaf miner. Appropriate sanitation practices (e.g., proper disposal of infested potato plant debris, alternate host crops and weeds) should also be employed to bring down further leafminer population in those areas. The Sangguniang Bayan of Buguias or Sanguniang Barangays of Buyakawan and Loo can pass a municipal or barangay resolution to this effect.

- ✓ In succeeding seasons, once leafminer population is already low, synchronous planting of potato can be done together with early installation of yellow sticky traps in those areas to: (1) maintain pest population at low level, (2) discourage use of pesticides, and (3) encourage build-up of natural enemy populations. Follow-up planting of nonhost crops should also be done to break life cycle of this pest before planting potato again in these same areas. These strategies can be well articulated in FFS follow-up and local multi-media awareness campaign activities in leafminer infested and adjoining areas.

- ✓ In coordination with LGUs, through the Office of Provincial Agriculturist (OPA) of Benguet and Municipal Agricultural Office (MAO) of Buguias, Benguet, the government technical staff should design, plan, and implement a crash FFS follow-up activities in all infested areas as soon as possible.

4. Facilitate farmers to do hands-on to compare the effectiveness of yellow sticky trap materials as early as first infestations of leafminers is observed, as follows:

   - ✓ Install suitable yellow sticky trap materials (made of different materials and shades of yellow colors) in early morning or late afternoon at varying distances and locations in rows within plots;

- ✓ Gather installed yellow sticky trap materials and collect trapped potato leafminers in succeeding morning or afternoon;
- ✓ Record pest numbers and species collected in each trap material; and
- ✓ Repeat process daily until necessary; determine best yellow sticky trap materials and common pests usually trapped.

Some suggested questions for processing discussion

- ❏ What were the most common leafminer species you observed in learning and adjoining potato fields?
- ❏ Did you observe farmers using yellow sticky trap materials for potato leafminers in their fields? What were the most common yellow sticky trap materials used for these pests? Why?
- ❏ Did you observe any differences in effectiveness among different yellow sticky trap materials used against potato leafminers? What leafminer species were attracted to different yellow sticky trap materials used?
- ❏ Were there differences in crop stand and severity of pest damage between potato fields, which used and did not use yellow sticky trap materials against leafminers?
- ❏ What other innovative practices in using yellow sticky trap materials did you learn from other farmers?
- ❏ Which yellow sticky trap materials will you use if potato leafminers attack your own farm? Why?
- ❏ What other cultural management strategies can you use to complement yellow sticky trap materials to manage potato leafminers?

Exercise No.4.09

Timing of planting and harvesting as a pest management strategy in vegetable production

Background and rationale

Seasonal abundance of pests affects performance and yield of vegetable crops. Likewise, the degree of infestation may be high or low depending on cropping season. Pest occurs also almost throughout the year, depending on availability of host plants. Hence, proper timing of planting and harvesting is one practical strategy to manage vegetable pests. Pest attack can be avoided or minimized by altering planting dates to avoid time when insect pests are laying eggs (i.e., ovipositing), or to allow crop to be beyond susceptible stage when attack begins.

Similarly, harvest dates can be altered (e.g., early harvesting may be employed) to reduce attack by late season pests. For instance, early planting of crucifers for dry season cropping (September-October) will reduce infestation of DBM. The shift to young carrot or 'baby carrot' production as market demand permits will allow early harvesting of carrots and consequently reduce occurrence of forking and cracking maladies. Prompt harvesting of potato will avoid potato tuber moth infestations.

Through many years of experience, some enterprising farmers in the Cordilleras had determined proper timing of planting and harvesting their vegetable crops to evade severe pest infestations. These notable experiences must be shared among farmers in FFSs to improve their current pest management strategies. This particular exercise was designed to address this concern.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, before planting vegetable crops in learning field
- When farmers want to learn proper timing of planting and harvesting vegetable crops from other farmers to evade pest infestations

How long will this exercise take?

- Thirty minutes to one hour for field walks and observations of vegetable crops planted and harvested at different time during same cropping season
- Thirty minutes to one hour for brainstorming session in processing area

Learning objectives

- To make participants aware and understand how proper timing of planting and harvesting their vegetable crops can contribute to better pest management.
- To learn from other farmers their best practices on timing of planting and harvesting vegetable crops to evade severe pest infestations.

Materials

- Vegetable crops at different planting and harvesting time in adjoining fields of learning field
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)

Methodology

- Field walks and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe as many vegetable crops planted and harvested at different time during same cropping season. Interview other farmers and collect specimens, if necessary. List down all observations related to:

   ✓ Kinds of crop planted and crop stand;
   ✓ Prevalent weeds, pests, and diseases; and
   ✓ Quality of products, etc.

2. Go back to processing area, brainstorm in small groups and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. List down important observations shared by farmers, such as:

   ✓ Reason for choice of crops planted early during cropping season and specific pest problem managed;
   ✓ Reason for choice of crops harvested early during cropping season and specific pest problem managed;
   ✓ Reason for choice of crops planted later during cropping season and specific pest problem managed; and
   ✓ Reason for choice of crops harvested later during cropping season and specific pest problem managed.

3. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❏ Did you observe different crops planted and harvested at different times during same cropping season?
- ❏ What pests and diseases were prevalent on crops planted and harvested at different time during same cropping season?
- ❏ What pests and diseases were managed by planting and harvesting vegetable crops at different times during same cropping season?
- ❏ When is the best time during cropping season to plant and harvest different crop species, cultivars, and varieties? Why?
- ❏ Did planting and harvesting at proper time during same cropping season improve productivity and profitability? Can we really reduce pest and disease occurrence by proper timing of planting and harvesting? How? Why?
- ❏ What other cultural management practices can complement proper timing of planting and harvesting to control pests in vegetable production?

Exercise No. 4.10 Sanitation practices for management of pod borers, leafminers, and leaf folders in vegetables

Background and rationale

One of the most practical approaches to pest management is good cultural control, specifically sanitation. Sanitation is aimed at reducing exposure of crops to pest infestation. Sanitation excludes use of biological control. For some vegetable pests, such as pod borers, leaf miners, and leaf folders, a primary objective of sanitation is prevention of pest build-up and not total destruction of existing or damaging pest populations[78]. Proper disposal of crop residues, which may serve as breeding places for pests, is a good way of preventing build-up of these pests. Elimination of crop residues after harvest destroys pests and prevents carry-over to next crop.

There are several sanitation practices commonly employed to control pod borers, leafminers, and leaf folders in vegetable production. These are: (1) roguing of host weeds and plants at earlier stages of growth; (2) removal of infested leaves and fruits at later growth stages; (3) proper disposal of rogued plants, removed leaves or fruits and other crop residues by burying, burning, etc.; and (4) plowing under of infested crop residues immediately after harvest[79].

Many farmers in the Cordilleras have adapted better sanitation practices to control pod borers, leafminers, and leaf folders in vegetables, through time, which when shared with others in FFSs will result in much improved sanitation practices. The foregoing exercise was designed primarily to address this concern.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when there are infestations of pod borers, leafminers, and leaf folders on vegetables grown in learning field
- When farmers want to learn innovative sanitation practices from others to control pod borers, leafminers, and leaf folders of vegetables

[78] Cardona, Jr. E.V. 1998. Personal communication.

[79] Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition, SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp369-371.

How long will this exercise take?

- Thirty minutes to one-hour for field walks, observations, interaction with farmers, and hands-on in learning field
- Thirty minutes for brainstorming session in processing area

Learning objectives

- To create awareness and understanding among participants on the role of sanitation to control pod borers, leafminers, and leaf folders of vegetables.
- To learn from others and do hands-on of proper sanitation to control pod borers, leafminers and leaf folders of vegetables.

Materials

- Office supplies (Manila papers, notebooks, ball pens, marking pens, and crayons)
- Vegetable crops showing infestations of pod borers, leafminers, and leaf folders in learning and adjoining fields
- Other supplies (pruning shear, knife, or scythe)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe sanitation practices to control pod borers, leafminers, and leaf folders of vegetables in learning and adjoining fields. Take note of cultural practices employed. Interview other farmers, if necessary. List down all observations related to:

   ✓ Kind of crops planted and crop stand;
   ✓ Prevalent weeds, pests, and diseases; and
   ✓ Quality of products, etc.

2. Go back to processing area; brainstorm in small groups and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. Motivate farmers to share their best experiences in sanitation practices to control pod borers, leafminers, and leaf folders of vegetables.

3. Develop an improved procedure of sanitation as a management strategy against pod borers, leafminers, and leaf folders of vegetables.

4. Facilitate each farmer to do hands-on of sanitation practices to control pod borers, leafminers, and leaf folders on vegetables and other plants observed in learning field at all growth stages by improving the procedure below:

   - ✓ Determine if there are infestations of pod borers, leafminers, and leaf folders on vegetables and other plants;
   - ✓ Rogue host weeds or plants at earlier stages of growth;
   - ✓ Remove infested leaves and fruits at later growth stages;
   - ✓ Dispose properly rogued plants, removed leaves or fruits and other crop residues by burying, burning, etc.;
   - ✓ Plow under infested crop residues immediately after harvest; and
   - ✓ Take note of all relevant observations and experiences during this activity.

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❏ Did you observe infestations of pod borers, leafminers, and leaf folders on vegetables and other plants in learning and adjoining fields?
- ❏ Did you observe any farmer practicing sanitation to control pod borers, leafminers, and leaf folders on vegetables and other plants in farmers' field?
- ❏ What other pests can be effectively controlled by sanitation practices? Is sanitation applicable as a control strategy for all pests of vegetables? When is the best time to do sanitation as a control strategy for pod borers, leafminers, and leaf folders of vegetables?
- ❏ Did you observe any innovative sanitation practices by farmers as a control strategy for pod borers, leafminers, and leaf folders of vegetables?
- ❏ What other cultural management options can you use to complement sanitation as a control strategy for pod borers, leafminers, and leaf folders of vegetables?

Exercise No. 4.11

Enhancing natural enemy populations by using *Bacillus thuringiensis* against lepidopterous pests of vegetables

Background and rationale

Bacillus thuringiensis or *Bt* is already widely used in the control of lepidopterous larvae in vegetables in the Philippines. As a microbial insecticide[80], *Bt* protein is usually used in formulations containing spores and crystalline inclusions that are released upon metabolism of *Bt* during its growth. *B. thuringiensis* is a gram-positive bacterium naturally occurring in soil. It kills larvae by disrupting larvae's digestive system leading to slow growth and ultimately death. When dose is high, sudden death can usually occur. *Bt*-based pesticides are marketed under various trade names. Because of its specificity, it is being used as a complementary control strategy to *Diadegma* parasitoid against DBM and other lepidopterous larvae.

In the Cordilleras, *Diadegma* is used as an egg parasitoid. In cases where eggs escaped and developed into larvae, *Bt* is used as a follow-up treatment to specifically kill pest larvae but not *Diadegma*. *Bt* has been found very effective against intended pests but not harmful to their natural enemies. Despite these positive features, use of *Bt*-based pesticides also has its own limitation. They are expensive; they require several applications as sunlight breaks down toxin and rain removes active ingredient from plant.

However, many vegetable farmers, through years of experience, have evolved some practical approaches for effectively using *Bt* to control pests and enhancing natural enemy populations as well. These experiences must be shared among farmers in FFSs to further improve current approaches in enhancing natural enemy populations. This exercise was designed to attain this particular objective.

80 IIBC. 1990. Manual on Biological Control and Biological Methods for Insect Pests in the Tropics. FAO/IRRI/IIBC Training Course on Biological Control in Rice-based Cropping Systems, International Institute of Biological Control, Kuala Lumpur, Malaysia. pp2.3/1-3.2/4 (Part 1), pp1.3/2-1.3/10 (Part 2) and pp2.6/1-2.6/8 (Part 3).

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when there is a relatively moderate to serious lepidopterous pest infestations on vegetables in learning field
- When farmers want to learn when is it more practical to spray *Bt* to control lepidopterous pests of vegetables

How long will this exercise take?

- Thirty minutes field walks, observations, and interaction with farmers
- Thirty minutes brainstorming session in processing area

Learning objectives

- To create awareness and understanding among participants that spraying Bt can effectively control lepidopterous pests and enhance natural enemy populations in vegetables.
- To learn from other farmers and do hands-on of innovative approaches on how Bt can effectively control lepidopterous pests and enhance natural enemy populations in vegetables.

Materials

- Office supplies (notebooks, ball pens, marking pens, crayons, Manila papers)
- Other supplies (locally available *Bt* biological pesticide, measuring cup, sprayer, detergent, and water)
- Vegetables grown in learning and adjoining fields showing relatively moderate to serious infestations of lepidopterous pests

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe vegetable crops showing relatively moderate to serious lepidopterous pest infestations sprayed with *Bt* and chemical pesticides in learning and adjoining fields. Take note of presence and number of pests and natural enemies. Interview other farmers, if necessary. List down all observations related to pest and natural enemy activity and occurrence, crops infested, degree, and characteristic of damage, etc.

2. Facilitate each to do hands-on of spraying *Bt* against lepidopterous pests when relatively moderate to serious infestations are observed on vegetables grown in learning field, as follows:

- ✓ Look for localized areas where lepidopterous pests are concentrated;
- ✓ Take note of characteristic damage, plant part damaged, relative density of pests, etc.;
- ✓ If possible, estimate degree of pest infestation per plot;
- ✓ Take note of presence, number, and activity of natural enemies before spraying; compare to plots to be sprayed with chemical insecticides;
- ✓ Perform localized spraying of *Bt* solution (recommended dosage and application method) on infested vegetable areas of learning field;
- ✓ Take note again of presence, number and activity of natural enemies after spraying; compare to plots sprayed with chemical insecticides; and
- ✓ Take note of all relevant observations and experiences during this activity.

3. Go back to processing area; brainstorm in small groups and present output to big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. Motivate farmers to share their best experiences in using *Bt* to control lepidopterous pests at relatively moderate to serious infestation levels. Relate shared experiences to effect of *Bt* on natural enemy populations.

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❑ Which areas in plots were most concentrated with lepidopterous pests?
- ❑ Which vegetable crop was more and less infested by lepidopterous pests? What were the most distinguishing characteristics of lepidopterous pest damage? Which parts of plant did lepidopterous pests damage?
- ❑ Did you observe farmers spraying *Bt* and chemical insecticides to control lepidopterous pests? Did you observe differences in the presence, number, and activity of pests and natural enemies in vegetable crops sprayed with *Bt* and chemical insecticides?
- ❑ Did you observe farmers who sprayed *Bt* alone to control lepidopterous pests? Did farmers practice other innovative strategies to control lepidopterous pests? What are these strategies?

- ❑ Do farmers consider lepidopterous pests destructive to vegetables?
- ❑ What other cultural management strategies can you use to complement spraying *Bt* to control lepidopterous pests and enhance natural enemy populations even at relatively moderate to serious infestation levels?

Exercise No. 4.12

Using cage traps and scaring materials as management strategies against rats in vegetable production

Background and rationale

Rats are among the most serious pests of vegetables in highlands. Signs of gnawing, nibbling, cut seedlings, and damaged plant parts (e.g., flowers, pods, fruits, roots tubers, etc.) and presence of runways and burrows in field suggest their occupancy. Rats are nocturnal animals, which can cause heavy damage on vegetables and other crops at nighttime. Rats readily multiply in areas where food is abundant. Under field conditions, rats can live for one year or longer. A female rat can reproduce up to four times a year with an average of six offsprings per litter.

Often, success of rat campaign is determined by how many rats are killed. This is not so. A large file of dead rats means that there are lots more rats out in field ready to feed on vegetable crops. This also means that the number of dead rats is not as important as the number of live rats eating vegetable crops in field. Therefore, for rat management to be effective, farmers must learn how to identify the presence of rats, understand rat barrow structures and runways, and suggest practical rat management strategies.

Some enterprising farmers in the Cordilleras have evolved more practical and effective management strategies against rats. For example, using cage traps and scaring materials are reportedly effective and now common in the Mountain Province. Similar effective strategies can be more regularly shared among farmers in FFSs and, in the process, evolve much improved approaches. This exercise was designed to achieve this purpose.

When is this exercise most approriate?

- In FFS, TOT and VST sessions, when there are early infestation signs of rats in learning field
- When farmers want to learn from other farmers their innovative practices in using traps and scaring materials against rats in vegetable fields

How long will this exercise take?

- Thirty minutes to one hour of field walks, observations, and interaction with farmers
- Thirty minutes to one hour of hands-on and brainstorming session

Learning objectives

- To create awareness and understanding among participants on role of cage traps and scaring materials as management strategies against rats in vegetable production.
- To learn from other farmers their innovative practices in using different traps and scaring materials as management strategies against rats in vegetable production.

Materials

- Office supplies (Manila papers, notebooks, ball pens, marking pens, and crayons)
- Vegetable crops grown in learning and adjoining fields showing early infestation signs of rats
- Different trap and scaring materials (e.g., cage traps, used cassette tapes, used plastic bags or cellophane, wire, etc.)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe as many vegetable crops with early infestation signs of rats in learning and adjoining fields. Take note of the signs of gnawing, nibbling, cut seedlings, and damaged plant parts (e.g., flowers, pods, fruits, roots, tubers, etc.) and presence of runways and burrows in field. Interview other farmers, if necessary. List down all observations related to the following:

   ✓ Crops grown and crop stand;
   ✓ Signs of rat damages on plants and plant parts;
   ✓ Presence of runways, burrows, footprints, and feces; and
   ✓ Management strategies employed by farmers, if any.

2. Go back to processing area; brainstorm in small groups and present output to the big group.

3. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. Motivate farmers to share their best experiences in using different traps and scaring materials against rats.

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

5. Facilitate farmers to do hands-on of installing cage traps and scaring materials when early infestation signs of rats are observed in learning field by improving procedures given below:

Option 1 (Using Cage Traps)

- ✓ Acquire or fabricate and install at least five cage traps with appropriate baits in strategic places (e.g., runways and burrows) of learning field before nighttime;
- ✓ Inspect and gather cage traps with rat catches in the succeeding morning;
- ✓ Record and dispose rat catches promptly;
- ✓ Reinstall cage traps in the same area before nighttime;
- ✓ Gather and reinstall cage traps without rat catch near reinstalled cage traps with previous rat catches; if possible, estimate percent rat damage;
- ✓ Repeat process daily until necessary; and
- ✓ Take note of all relevant observations and experiences during this activity.

Option 2 (Using Scaring Materials)

- ✓ Install scaring materials (e.g., used cassette tapes, used plastic bags or cellophane, etc.) at a distance of one-meter in rows within plots;
- ✓ Inspect and record presence of runways, burrows, footprints, and feces in the succeeding morning;
- ✓ Inspect and also record signs of rat damages on plants and plant parts in the succeeding morning; if possible, estimate percent rat damage;
- ✓ Repeat process daily until necessary;
- ✓ If different scaring materials were used, determine best scaring material; and

✓ Take note of all relevant observations and experiences during this activity.

Some suggested questions for processing discussion

- ❏ Did you observe farmers using cage traps against rats in their fields? Did you observe farmers using scaring materials against rats in their fields?
- ❏ What traps and scaring materials against rats were commonly used by farmers?
- ❏ Did you observe any differences in effectiveness among different traps and scaring materials used against rats? When is it practical to use cage traps against rats? When are scaring materials more practical to use against rats?
- ❏ What stages of crops are most susceptible to rats? Were there differences in crop stand and severity of rat damage between vegetable fields, which used and did not use traps and scaring materials against rats?
- ❏ What other innovations did you learn from other farmers in using different traps and scaring materials against rats?
- ❏ What other cultural management practices can you use to complement cage trapping and using scaring materials as management strategies against rats in vegetable production?

Disease Management

Many discovery-based exercises compiled under 'Disease Management' sub-section in this new volume are additional exercises identified in a previous curriculum development workshop[81] which were validated by participants in a recently concluded intensive one-month Refresher Course for Trainers of IPM in Crucifers and Other Highland Vegetable Crops[82]. However, some discovery-based exercises in this subsection are supplements to previous exercises under Section 6, Field Guide of Discovery-based Exercises for Vegetable IPM, Volume I, such as:

- *Bacterial oozing technique: Identifying bacterial wilt disease of solanaceous vegetables in farmers' fields.* This discovery-based exercise was designed to supplement 'Disease Culture: Recognizing Disease Symptoms of Potato Blights and Wilts' and 'Field Experiment for Bacterial Wilt of Potatoes: How Do Bacteria Spread?'.

- *Water floating technique: Determining presence of golden cyst nematodes in potato fields.* This discovery-based exercise was designed to supplement 'Field Walks and Brainstorming: Potato Cyst Nematodes'.

- *Simulation exercise: Understanding disease transport in vegetables.* This discovery-based exercise was designed to supplement 'Disease Culture: How To Learn More About Vegetable Diseases'.

- *Sap transmission technique: Understanding how virus diseases are transmitted in vegetable fields;* and *Uprooting and proper disposal as a management strategy against tymo virus disease of chayote.* These discovery-based exercises were designed to supplement 'Field Walks and Sharing of Ideas: Virus Diseases of Vegetables'.

---

81 Binamira, J.S. 1998. A Consultant's Report: Curriculum Development for Trainers and Farmer Field Schools on IPM in Crucifers and Other Highland Vegetable Crops. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Regional Field Unit, Baguio City, Philippines. pp6-23.

82 Binamira, J.S. 1998. A Consultant's Report: Refresher Course for Trainers of IPM in Crucifers and Other Highland Vegetable Crops. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Regional Field Unit, Baguio City, Philippines. pp15-22.

- *Leaf removal and proper disposal as disease management strategy against leaf diseases of vegetables.* This discovery-based exercise was designed to supplement 'Field Experiment: Will Leaf Removal Work For Leaf Spots of Cabbage?'.

Exercise No. 4.13 Simulation exercise: Understanding disease transport in vegetables

Background and rationale

Plant pathogens are very minute disease-causing microorganisms that reduce the aesthetic value, quality, and yield of infected vegetable crops. Unlike insect pests, which normally moves using their appendages (e.g., wings, legs, etc.), microorganisms are transported mainly through mechanical means from one place to another. Thus, disease transport can be accomplished by any of the following means: (a) carried from source by wind or water, (b) transported from source by clinging to anything it came in contact with, or (c) transferred by man and animals directly from source to another point either intentionally or accidentally.

Clearly, diseases do not just occur. They consist of a sequence of various stages during the course of their development, a succession of events or modifications, one usually leading to another. These living and nonliving things play an important role in the dissemination of diseases. However, these agents have their own way of transporting a disease[83].

In FFSs, farmers can better understand mechanisms of disease transport through field walks, observations, simulation exercise and participatory sharing of experiences among them and facilitators. This exercise was developed to serve this purpose.

When is this exercise most approriate?

- During FFS, TOT, and VST sessions as component of 'Integrated Disease Management' topic
- When farmers want to learn how vegetable diseases are transported from one place to another

How long will this exercise take?

- Thirty minutes to one hour field walk observation and simulation exercise
- Thirty minutes to one hour brainstorming session

[83] IIBC. 1996. Integrated Pest Management for Highland Vegetables, Volume 4: Training Guide for Participatory Action Towards Discovery Learning. International Institute for Biological Control, BPI Compound, Baguio City, Philippines. pp113.

Learning objectives

- To create awareness and appreciation among participants of different disease transport mechanisms in vegetable fields.
- To improve farmers' decision-making skills through better understanding of these different disease transport mechanisms.

Materials

- Vegetable fields with standing crops that are infected with diseases
- Flour, rice bran, lime or any nontoxic white powder substance that is cheap and locally available
- Barren field (preferably dry and not so weedy)

Methodology

- Field walks, simulation exercise, and brainstorming

Steps

1. Start exercise by conducting field walks and observations in vegetable fields with standing crops that are infected with diseases. List down all observations related to spread of diseases among plants within a field and between vegetable fields.

2. Ask participants to go to a barren field and request for one volunteer to broadcast any available powder material evenly on soil surface of a barren field. Ask other participants to observe how powder material is distributed in a barren field. Let all participants walk over an area and observe what happened to applied powder material as they walk around.

3. Parallel simulation exercise with disease transport mechanisms in vegetable field observed with standing crops that are infected with diseases, such as:

   ✓ Bacteria that get around by water;
   ✓ Fungi that get around by wind;
   ✓ Virusesthat get around by insects; and
   ✓ Nematodes that get around by dirt.

4. Process activity by brainstorming and participatory sharing of experiences among participants and facilitators.

5. Summarize and synthesize all learning experiences shared. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❏ What part of your body was contaminated with white powder material when you walked over the field? How did white powder material contaminate your body?
- ❏ Did the white powder material applied in the field move to other areas? How?
- ❏ Did the white powder material that contaminated your body move to other bodies or areas as you walked in the field? How?
- ❏ Were there still white powder materials left in your body after leaving the field? Where did the white powder material go? How?
- ❏ Do you think vegetable diseases can be transported in the same way? What made you think so?
- ❏ Can farm tools transport vegetable diseases to other areas? Do you know of other means by which vegetable diseases can be transported to other places?
- ❏ Can we manage vegetable diseases by knowing how they are transported to other places? How?
- ❏ What practical cultural management practices can you suggest that will avoid transport of vegetable diseases from one place to another?

Exercise No. 4.14

Water floating technique: Determining the presence of golden cyst nematodes in potato fields

Background and rationale

Golden cyst nematode is one of the most destructive pests of potato. At high population, cyst nematodes can inflict serious damage to vegetable crops. Symptoms on above ground plant parts resemble that of drought injury or nutrient deficiency. Most farmers are not aware that their fields are infested by cyst nematodes. A practical and appropriate tool should be available for them to determine presence of these harmful organisms in their fields.

Thus, water-floating technique is a very useful tool for farmers in assessing golden cyst nematode infestation in their own fields. In this foregoing exercise, living and squirming nematodes will be impressive to see, particularly for farmers who do not even know they exist[84].

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when existing farmer's fields are possibly infested by golden cyst nematodes
- When farmers want to experience how live cyst nematodes look like and learn how other farmers manage them in their fields

How long will this exercise take?

- One hour and 30 minutes for field walks, and observations in learning field and hands-on exercise in processing area
- Thirty minutes to one hour brainstorming session

Learning objectives

- To make participants aware and understand how proper identification of golden cyst nematodes contribute to better management of the problem in vegetable fields.
- To learn how to identify golden cyst nematode infested fields and experience how living nematodes look like.

---

84 IIBC. 1996. Integrated Pest Management for Highland Vegetables, Volume 4: Training Guide for Participatory Action Towards Discovery Learning. International Institute for Biological Control, BPI Compound, Baguio City, Philippines. pp110.

Materials

- Vegetable field suspected to be infested with golden cyst nematodes
- Field supplies (fine mess nets or sieves # 10, 20, and 30, magnifying lens [10x], plastic bags for specimens, farming tools, bowl and water)
- Office supplies (Manila paper, marking pens, and masking tapes)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide big group into five smaller groups. Go to the field and observe plants showing symptoms of golden cyst nematode infestation. In suspected nematode infested field, gather soil samples with plant. With aid of fine mess nets or sieves # 10, 20 and 30, wash soil samples until semi-clear water solution is obtained. With the finest sieve, collect water solution and place in clean and transparent glass vial.

2. Have water in vial settle down for 20 minutes or wait until particles are already settled. With the aid of 10x-magnifying lens, observe squirming pechay seed-like golden cyst nematodes. List down observations in small groups.

3. After observations, conduct participatory discussions in a big group to allow sharing of experiences among participants and facilitators. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❑ Have you seen any squirming pechay seed-like structures?
- ❑ Can you explain or describe (e.g., color, structure, appearance, size, etc.) what you saw to the group?
- ❑ What symptoms were expressed in plant by golden cyst nematode infestation?
- ❑ What were the possible sources of pest infestations? How are they transmitted?
- ❑ How can we avoid infestation of golden cyst nematodes in our vegetable fields?
- ❑ What cultural management practices can be undertaken to prevent golden cyst nematode infestation in potato fields?

Exercise No. 4.15

Bacterial oozing technique: Identifying bacterial wilt disease of solanaceous vegetables in farmers' fields

Background and rationale

Diseases of vegetable crops are caused by plant pathogens such as virus, fungus, bacteria, and nematodes. For solanaceous vegetables, the most destructive disease caused by bacteria is bacterial wilt, commonly known as *kuyos*. The disease initially causes partial wilting of plants. The vascular tissue of main stem turns brown. The infected tubers ooze through eyes or stolon end of tubers from vascular ring of cut tubers. This bacterium is soil-borne and can persist for many years. High soil temperature and high soil moisture favor the disease. Unless farmers know how to determine which plant pathogen causes disease, they cannot employ appropriate control or management approaches.

For farmers to determine if their fields are infected by bacterial wilt or other bacterial diseases, they can adopt the bacterial oozing technique[85]. This technique can be used also to determine if other bacterial diseases infect a vegetable field. In FFSs, this technique will be a useful tool to aid farmers in their decision-making process, hence this exercise.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions when there are different vegetable diseases that can be found in learning and adjoining fields
- When farmers want to learn practical tools to identify bacterial diseases in their own vegetable fields

How long will this exercise take?

- Thirty minutes to one hour for field walks and observations of different solanaceous vegetable diseases in learning field and adjoining vegetable farms
- Thirty minutes to one hour brainstorming session in processing area

[85] IIBC. 1996. Integrated Pest Management for Highland Vegetables, Volume 4: Training Guide for Participatory Action Towards Discovery Learning. International Institute for Biological Control, BPI Compound, Baguio City, Philippines. pp106-107.

Learning objectives

- To make participants aware of and understand that different solanaceous vegetable diseases are caused by different plant pathogens.
- To learn a practical method in identifying bacterial diseases of solanaceous vegetables.

Materials

- Fields planted to different solanaceous vegetable crops infected with different diseases
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe as many solanaceous crops in learning and adjoining fields infected with different diseases. Search for partially wilting plants, observe symptoms, pull plants, and bring them to processing area. List down all observations related to pest and disease occurrence, kind of crops planted, crop stand, etc.

2. Go back to processing area, cut roots of plants, and observe them. Cut a part of stem above ground level to about 5-cm length. Insert toothpick into stem part and hang it in a glass of water. Leave glass for a few minutes. Do the same process using tubers, roots, and different parts of stem. Observe ooze coming out of stem-base (bacterial wilt). Compare different set-up.

3. Brainstorm in small groups and present output to big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators.

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❑ What happened to the color of water? Have you seen milky liquid from the stem?
- ❑ Do you believe this is causing wilting of solanaceous crop you tested? Why? How can we confirm this?
- ❑ Does healthy crop produce or have this milky liquid coming from stem or tuber? What were the symptoms of infected plants before soaking?
- ❑ What will you do in your farm if you confirmed that there is bacterial wilt infection of solanaceous vegetable you planted?
- ❑ Do you know of other practical ways of determining the presence of bacterial wilt in your vegetable farm? How do we do it?

Exercise No. 4.16

Sap transmission technique: Understanding how virus diseases are transmitted in vegetable fields

Background and rationale

Virus diseases are most difficult to manage in vegetable production. Either one or a combination of the following usually transmits them: (a) direct mechanical contact, (b) aid of insect victors, or (c) other carriers. Strong winds and rains, as well as action of man who tends his vegetable crops regularly and other animals harboring around these crops may cause direct mechanical transmission of virus diseases. Symptoms of some virus diseases may also appear similar to those suffering from physiological and nutritional disorders.

In FFSs, farmers will need practical techniques that will ensure accurate disease identification and understanding of virus disease transmission in their own fields. Thus, this simple exercise was designed to enable participants to address this particular concern.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when first signs or symptoms of virus disease infection are observed in learning and adjoining fields
- When farmers want to learn practical techniques to accurately identify and understand virus disease transmission in their vegetable fields

How long will this exercise take?

- Thirty minutes to one hour for field walks, observations, and collection of suspected virus-infected vegetables in learning and adjoining field
- Thirty minutes to one hour brainstorming session and setting-up of exercise in processing area
- Fifteen to 30 minutes consecutive weekly observations and processing after setting-up this exercise

Learning objectives

- To make participants aware and understand how accurate virus disease identification and transmission lead to its better management in their own farms.
- To learn through hands-on and direct observations how virus diseases are transmitted in vegetables by mechanical means.

Materials

- Vegetable fields where signs and symptoms of virus infections can be observed
- Mortar and pestle (can be improvised), suspected virus-infected and healthy test-plants, hand-sprayer and sandpaper)
- Other office supplies (e.g., Manila papers, notebooks, ball pens, and marking pens)

Methodology

- Field walks, hands-on and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe and collect healthy and suspected virus-infected plants or plant parts in learning and adjoining vegetable fields. Interview other farmers, if necessary. List down all observations related to signs and symptoms (e.g., rosetting, curling, mosaic appearance, etc.), pest and disease occurrence, kind of crops planted, crop stand, etc.

2. Go back to processing area and set-up this exercise by performing the following activities:

   ✓ Pound suspected virus-infected plants and extract juice or sap;
   ✓ Create artificial mechanical damage by rubbing sandpaper on leaves of healthy test-plants (e.g., same crop species, or any seedlings of other crop species);
   ✓ Spray or rub extracted sap or juice on damaged and undamaged leaves of healthy test-plants; and
   ✓ Observe and take note of physical changes on test-plants after 14-21 days.

3. Brainstorm in small groups and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators.

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❏ What vegetable crops did you observe showing symptoms of virus infections?
- ❏ Were there differences in symptoms exhibited by different crops you observed?
- ❏ Did you observe same symptoms in test-plants after one week, two weeks, and three weeks? Were you convinced that virus diseases could be transmitted through mechanical means?
- ❏ What are the other means by which virus diseases can be transmitted in vegetable crops?
- ❏ What is the importance of knowing how virus diseases are transmitted in vegetable crops?
- ❏ What practical management strategies can you design after knowing virus diseases transmission mechanism?

Exercise No. 4.17

Hot water treatment as a control strategy against soil-borne diseases of vegetables

Background and rationale

Many farmers believe that use of certified seeds will ensure production of healthy and vigorous seedlings. This is not so. In vegetable areas, where soil-borne plant pathogens are prevalent, proper seedbed care is of paramount importance. This includes using appropriate soil media, proper seed bed preparation, and soil sterilization. Hot water treatment is a practical soil sterilization method, which when done properly will safeguard seedlings from fungal and bacterial disease infections and will promote better seedling growth and development[86].

Some farmers constantly make modifications to improve effectiveness of hot water treatment as a soil sterilization method. In FFSs, these innovations should be shared among farmers to further improve current best practices of soil sterilization using hot water treatment. This exercise was so designed to allow farmers to freely share these experiences.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when soil-borne vegetable diseases are prevalent in farmer's fields
- When farmers want to learn more about other farmers' best practices in using hot water treatment to control soil-borne vegetable diseases in seedbed

How long will this exercise take?

- One hour and 30 minutes for field walks, observations, and hands-on exercise in learning field
- Thirty minutes to one hour brainstorming session

Learning objectives

- To make participants aware of and understand the importance of soil sterilization in the control of soil-borne vegetable diseases in seedbeds.
- To learn current innovations made by farmers and further improve their skills in using hot water treatment as a soil sterilization method.

86 Milagrosa, S.P. 1998. Personal communication.

Materials

- Office supplies (notebooks, ball pens, marking pens, crayons, Manila papers)
- Field supplies (kerosene can, fire wood, black plastic sheets, mat or jute sacks, sprinkle cans, etc.)
- Vegetable field ready for seedbed preparation (vegetable seedbed to be used as the learning field)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide the big group into five smaller groups. Before sterilizing seedbeds by hot water treatment, each group should observe already established seedbeds in adjoining farms and record estimated percentage germination, seedling vigor, weeds present, pest and disease occurrence, etc.

2. Each small group will then sterilize their seedbeds using hot water treatment. The groups may opt to leave a portion of their seedbed untreated for comparison. The procedure below is an option that participants can brainstorm in big group for possible modification:

   ✓ Stir soil several times and expose to sunlight;
   ✓ Pour boiling water (70-90%) on to seedbed until water penetrates soil to at least four inches deep;
   ✓ Cover treated seedbed with black plastic sheets for at least 30 minutes; and
   ✓ After one to two days, incorporate appropriate soil media and sow required amount of seeds.

3. Every week thereafter, each group will record same observations they made in their seedbed before hot water treatment. After every observation, participants should brainstorm in small groups to summarize their observations but present same to the big group every other week until seedlings are ready for transplanting. The summary of weekly observations should be printed in Manila paper.

4. After final observations, conduct participatory discussions in a big group to allow sharing of experiences among participants and facilitators. Synthesize and summarize output of small groups into one big group output.

5. Draw up conclusions and recommendation from this exercise.

Some suggested questions for processing discussion

- ❏ When is the best time to prepare and sterilize seedbed by hot water treatment? Why?
- ❏ Did you observe differences in percentage seed germination, seedling vigor, pest and disease occurrence, etc., in hot water treated and untreated seedbeds?
- ❏ Were there variations or modifications made by each group to common procedures used in sterilizing seedbed by hot water treatment? Why? Did variations or modifications improve effectiveness of method?
- ❏ Did sterilizing seedbed by hot water treatment reduce occurrence of soil-borne vegetable diseases? Was it cost efficient? Was it practical? What other benefits can you derive from soil sterilization?
- ❏ What other management strategies can you use, which will complement seedbed sterilization by hot water treatment, to reduce disease occurrence?

Exercise No. 4.18 Using resistant varieties as a management strategy against bean rust disease of legumes

Background and rationale

The development of resistant or tolerant varieties through selection and breeding is one of the best approaches to pest management[87]. Sometimes, growing cultivars resistant to a particular disease is the only way in which diseases can be controlled. Overhead irrigation during dry season, right timing of planting, and general field sanitation are known to reduce incidence of bean rust. However, using bean rust resistant varieties is a more practical and economical disease management approach.

In the Cordilleras, farmers themselves through their experiences select outstanding varieties most suitable to local growing conditions. Vegetable varieties that are high yielding, tolerant to diseases and environmental stresses are selected for seed production. In the case of bean rust, farmers had identified which among the legume vegetables are more resistant or tolerant to the disease during a particular season. These experiences must be regularly shared among farmers in FFSs to update their knowledge on local adaptability of these legume varieties. This exercise was designed to achieve this purpose.

When is this exercise most approriate?

- In FFS, TOT, and VST session, before planting leguminous vegetables in learning field
- When farmers want to learn varietal adaptability of leguminous vegetables to bean rust and other stresses from other farmers

How long will this exercise take?

- Thirty minutes to one hour for field walks and observations of leguminous vegetables most adapted to bean rust and other stresses in learning and adjoining fields
- Thirty minutes to one hour for brainstorming session in processing area

87 Bautista, O.K. (Ed.) 1994. Introduction to tropical horticulture. 2nd Edition. SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños (UPLB), College, Laguna, Philippines. pp366-379.

Learning objectives

- To make farmers aware and understand how adaptability of leguminous vegetables to bean rust and other stresses can improve productivity.
- To learn adaptability of leguminous vegetables to bean rust and other stresses from other farmers.

Materials

- Fields planted to leguminous vegetables showing different adaptability to bean rust and other stresses in adjoining fields of learning field
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)

Methodology

- Field walks and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe as many leguminous vegetables planted in adjoining fields of learning field. Interview other farmers, if necessary. List down all observations related to:

   ✓ Kind and variety of leguminous vegetables planted;
   ✓ Degree of bean rust infection and pest infestation;
   ✓ Crop adaptability to other stresses; and
   ✓ Farmer's reasons for choosing particular leguminous vegetables.

2. Go back to processing area. Brainstorm in small groups and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. Classify leguminous vegetables observed and shared by farmers according to:

   ✓ Varieties or cultivars most resistant or tolerant to bean rust;
   ✓ Varieties or cultivars most resistant or tolerant to other stresses;
   ✓ Varieties or cultivars with highest yield potential;
   ✓ Varieties or cultivars most adapted to local conditions during dry and wet seasons; and
   ✓ Varieties or cultivars most preferred by farmers and consumers.

3. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❑ Did you observe differences in adaptability of leguminous vegetables to bean rust and other stresses in farmers' fields?
- ❑ Did you observe crops introduced from different elevations that were adapted to bean rust and other stresses in farmers' fields?
- ❑ What pests and diseases were prevalent on crops observed in farmers' fields?
- ❑ Did you learn from other farmers their experiences on adaptability of leguminous vegetables planted in the area to bean rust and other stresses? Which of the leguminous vegetables they tried were more adapted to bean rust and other stresses in an area? Why?
- ❑ Did you learn from other farmers some leguminous vegetables that were more adapted to bean rust and other stresses in the area? What were these leguminous vegetables? Why did these leguminous vegetables have wider range of adaptability?
- ❑ Which of these leguminous vegetables were more adapted to bean rust and other stresses during the wet season? Which of these leguminous vegetables were more adapted to bean rust and other stresses during the wet season?
- ❑ What were the good characteristics of leguminous vegetables that were observed adaptable to bean rust and other stresses in the locality?
- ❑ What other cultural management practices can complement adaptability of leguminous vegetables to bean rust and other stresses in improving productivity and profitability?

Exercise No. 4.19

Using proper medium for seedbed preparation to control soil-borne diseases of vegetables

Background and rationale

Many vegetable farmers still produce their seedlings in seedbeds without using appropriate seedbed medium. This practice usually results in production of small and weak seedlings that are susceptible to attack by pests and diseases. Poor seedling growth and development in seedbeds is often associated with use of infertile and pathogen infected soils. Infertile soil medium cannot provide the right amount and kind of nutrient elements that are necessary at earlier stage of seedling development.

On the other hand, use of pathogen contaminated soil medium may lead to early development of soil-borne diseases in vegetable plants, which may eventually result in low yield and poor quality product[88]. It is therefore important for farmers to understand and become aware of the advantages in using appropriate medium for seedbed preparation. Through field walks, observations and participatory sharing of experiences among farmers in FFSs, their skills, and understanding of this cultural management practice can be further enriched, hence this exercise.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, two weeks before seedbed preparation in learning field
- When farmers want to learn better practices from other farmers regarding the use of appropriate medium for seedbed preparation

How long will this exercise take?

- One hour and thirty minutes for field walks, observations, and hands-on exercise in learning field
- Thirty minutes to one hour of brainstorming session

Learning objectives

- To make farmers aware of and understand the importance of using appropriate seedbed medium to control soil-borne vegetable diseases.
- To learn better practices of other farmers and further improve their skills in using appropriate medium for seedbed preparation.

[88] Milagrosa, S.P. 1998. Personal communication.

Materials

- Office supplies (Manila papers, notebooks, ball pens, marking pens, and crayons)
- Field supplies (garden soil free from soil-borne pathogens, river sand, measuring cans, dried crushed alnus leaves or other leguminous leaves, ash, sprinkle cans, etc.)
- Vegetable fields ready for seedbed preparation (vegetable seedbed in learning field)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide the big group into five smaller groups. Before seedbed preparation, each group should observe already established seedbeds in adjoining farms and record materials used, estimated percentage germination, seedling vigor, weeds present, pest and disease occurrence, etc. Interview some farmers to gather other relevant information.

2. Each small group will then gather appropriate seedbed medium and prepare seedbed for their assigned vegetable crops. The participants in each small group should brainstorm also for possible modification of procedure and materials to use. The groups may opt to leave a portion of their seedbed untreated for comparison.

3. Every week thereafter, each group will record the same observations they made before seedbed preparation. After every observation, participants in each small group should brainstorm and summarize their observations but present the same to big group every other week until seedlings are ready for transplanting. The summary of weekly observations should be written in Manila paper.

4. After final observations, conduct participatory discussions in big group to allow sharing of experiences among participants and facilitators. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❏ When is the best time to gather medium and prepare seedbeds for vegetable growing? Why?
- ❏ Did you observe differences in percentage seed germination, seedling vigor, pest and disease occurrence, etc., in treated and untreated seedbeds which you prepared, and seedbeds you observed in adjoining farms of learning field?
- ❏ Were there variations or modifications made by each group to common procedures and medium used in preparing seedbeds? Why? Did variations or modifications improve effectiveness of method?
- ❏ Did use of appropriate medium for seedbed preparation reduce occurrence of soil-borne vegetable diseases? Was it cost efficient? Was it practical? What other benefits can you derive by using appropriate medium for seedbed preparation?
- ❏ What other management strategies can you use to reduce disease occurrence, which will complement the use of appropriate medium for seedbed preparation?

Exercise No. 4.20

Using raised beds as a management strategy against vegetable diseases

Background and rationale

Raised beds or plots are usually constructed depending on the preference of farmers and prevailing field conditions. However, an ideal raised bed is about 1-m wide, 10-m long, and 30-cm high. Raised beds are preferred over flat beds in areas with heavy rainfall and in lower elevation areas where drainage is poor. It is also advisable in stony areas where topsoil is shallow and had to be strapped always to establish right soil depth before planting for better crop growth.

Raised beds are also easier to work on, neater and less subject to trampling because spaces in between beds serve as pathways as well. Properly prepared raised beds promote good root development, conserve soil moisture better, and make drainage more effective, thus minimizing infection of fungal and bacterial diseases in vegetable production[89].

Farmers through field walks, observations, and participatory discussions in FFSs can share the best practices in raised bed preparation. This approach will allow them to learn from experiences shared by co-farmers and enable them to further improve effectiveness of raised beds as a management strategy against vegetable diseases. This exercise was designed to address this particular concern.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when bed and plot preparation is about to start in adjoining and learning fields
- When farmers want to learn more from cofarmers about their improved practices in raised bed preparation

How long will this exercise take?

- Thirty minutes to one hour field walks, observations, and interaction with farmers
- Thirty minutes to one hour hands-on and brainstorming session

[89] Milagrosa, S.P. 1998. Personal communication.

Learning objectives

- To create awareness and appreciation among participants on the role of raised beds in management of vegetable diseases.
- To learn and understand the best practices of co-farmers in using raised beds or plot as a disease management strategy in vegetable production.
- To learn from others and understand other benefits derived by farmers from using raised beds in vegetable production.

Materials

- Office supplies (hand lenses, notebooks, ball pens, marking pens, crayons, Manila papers)
- Vegetable crops grown in raised beds and flat beds (e.g., vegetable crops are more or less at same growth stages)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe as many vegetable crops grown in raised and flat beds in fields. Take note of different activities in raised and flat bed preparations. Interview other farmers, if necessary. List down all observations related to pest and disease occurrence, crop stand, weed growth, soil moisture, drainage conditions, etc.

2. Go back to processing area, brainstorm in small groups and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. Motivate farmers to share their best experiences in raised and flat bed preparations.

3. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise. Facilitate farmers to do hands-on during actual bed preparations in their learning fields of the best experiences they shared.

Some suggested questions for processing discussion

- ❏ What was the most common dimensions (width, length, and height) of raised beds you observed in farmers' field?
- ❏ When is the proper time to prepare raised beds? Why? What crops need to be grown in raised beds? Why?
- ❏ Did you observe any differences in pest and disease occurrence on vegetable crops grown in raised and flat beds? What pests and diseases were more prevalent?
- ❏ Were there differences in crop stand, weed growth, soil moisture, and drainage conditions between vegetable crops grown in raised and flat beds or plots?
- ❏ Did you observe variation in raised bed preparations? Were there differences in pest and disease occurrence among variations? Were there differences in crop stand, weed growth, soil moisture, and drainage conditions among variations?
- ❏ Were there variations in other cultural management practices employed when using different variations of raised bed or plot preparations?
- ❏ Which of the raised bed variation was most cost efficient? Which of the raised bed variation was most practical?
- ❏ Was vegetable growing in raised beds effective in reducing disease occurrence?
- ❏ What other management strategies can you use to reduce disease occurrence which will complement growing of vegetable crops in raised beds?
- ❏ What other benefits can you derive by growing vegetables in raised beds?

Exercise No. 4.21

Proper method of sowing in seedbed to control soil-borne diseases of vegetables

Background and rationale

There are different sowing techniques used in vegetable production. Some techniques used by vegetable farmers were very appropriate while some were less appropriate to their prevailing local conditions. These inappropriate sowing practices often lead to wastage of seed materials, high incidence of seedbed diseases, poor quality seedlings and consequently, to very low productivity[90]. On the other hand, use of appropriate sowing methods can result in production of healthy seedlings, reduction in cost of production, and increase in productivity and profitability.

In FFSs, best sowing techniques practiced by some farmers can only be shared among and learned by most of them to enrich their current practices through participatory, experiential, and discovery-based learning approaches. Thus, the foregoing exercise was designed primarily for this purpose.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, during seed sowing in seedbed of learning field
- When farmers want to learn better practices from other farmers on proper seed sowing techniques in seedbed

How long will this exercise take?

- One hour and 30 minutes for field walks, observations, and hands-on exercise in learning and adjoining fields
- Thirty minutes to one hour brainstorming session

Learning objectives

- To make participants aware and understand how proper seed sowing techniques in seedbed can help control soil-borne vegetable diseases.
- To learn better practices from other farmers and further improve their skills in proper seed sowing techniques in seedbed.

[90] Milagrosa, S.P. 1998. Personal communication.

Materials

- Office supplies (Manila papers, ruler, notebooks, ball pens, marking pens, and crayons)
- Field supplies (seeds, watering cans, measuring cans, bamboo sticks, etc.)
- Vegetable seedbed ready for sowing (vegetable seedbed in learning field)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide the big group into five smaller groups. Before sowing seeds in seedbed, each group should observe already established seedbeds in adjoining farms and record sowing method, seeding density, estimated percentage germination, seedling vigor, pest and disease occurrence, etc. Interview some farmers to gather other relevant information.

2. The participants in each small group should brainstorm for possible modification of sowing method to use. Each small group will then sow seeds in seedbed (e.g., hands-on) prepared for their assigned vegetable crops. The groups may opt to use conventional sowing method to a small portion of their seedbed for comparison.

3. Every week thereafter, each group will record the same observations they made before sowing in their seedbed. After every observation, participants in each small group should brainstorm and summarize their observations but present the same to the big group every other week until seedlings are ready for transplanting. The summary of weekly observations should be printed in Manila paper.

4. After final observations, conduct participatory discussions in a big group to allow sharing of experiences among participants and facilitators. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendation from this exercise.

Some suggested questions for processing discussion

- ❑ When is the best time to sow seeds in seedbeds for vegetable growing? Why?
- ❑ What was the most appropriate seeding rate and distance between rows? Why?
- ❑ Did you observe differences in percentage seed germination, seedling vigor, pest and disease occurrence, etc. in seedbeds where you sow seeds and in seedbeds you observed in adjoining farms?
- ❑ Were there variations or modifications made by each group to common procedures for proper seed sowing in seedbed? Why? Did variations or modifications improve effectiveness of method?
- ❑ Did use of appropriate seed sowing method in seedbed reduce occurrence of soil-borne vegetable diseases? Was it cost efficient? Was it practical? What other benefits can you derive from appropriate seed sowing method in seedbed?
- ❑ What other management strategies can you use to reduce disease occurrence, which will complement appropriate seed sowing method in seedbed?

Exercise No. 4.22

Mulching as a means of disease prevention in vegetable production

Background and rationale

Mulching is a cultural management practice where plant residues (e.g., cogon grass, other weeds, rice straws or pine needles), plastic (e.g., polyethylene sheets) and other appropriate materials are laid out on vegetable plots or beds primarily to conserve soil moisture and suppress growth of weeds[91]. Mulching also minimizes splash soil erosion and soft rot or other soil-borne disease infections[92]. The purposes for and practices of mulching vary from farmer to farmer, from crop to crop, and from season to season.

In FFSs, these learning experiences can be shared among farmers and facilitators through field walks, observations, and participatory discussions to enrich everyone's experiences of said practice and thus contribute to better management of vegetable diseases in their own fields. This exercise was designed specifically to address this concern.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, as part of 'Other Cultural Management Practices in Vegetable Production' topic
- When farmers want to learn from other farmers some improved practices in mulching

How long will this exercise take?

- Thirty minutes to one hour field walks, observations, and interaction with farmers
- Thirty minutes to one hour brainstorming session in processing area

Learning objectives

- To create awareness and appreciation among participants on the role of mulching in management of vegetable pests and diseases.
- To learn and understand other benefits experienced by farmers from practice of mulching in growing vegetables.

---

91 Bautista, O.K. (Ed.) 1994. Introduction to tropical horticulture. 2nd Edition. SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños (UPLB), College, Laguna, Philippines. pp312-314.

92 Milagrosa, S.P. 1998. Personal communication.

Materials

- Office supplies (notebooks, ball pens, marking pens, crayons, Manila papers)
- Vegetable plots or beds mulched with plant residues (e.g., cogon grass, other weeds, rice straws or pine needles), plastic materials (polyethylene sheets) or other materials
- Non-mulched vegetable plots or beds (e.g., in the same area where you have mulched vegetable plots or beds)

Methodology

- Field walk and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe as many mulched and nonmulched vegetable plots or beds in the fields. Take note of different practices in mulching. List down all observations related to pest and disease occurrence, crop stand, weed growth, soil moisture conditions, etc.

2. Go back to processing area, brainstorm in small groups and present output to big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators.

3. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❏ Did you observe differences in pest and disease occurrence between mulched and nonmulched vegetable plots or beds? What pests and diseases were more prevalent?
- ❏ Were there differences in weed growth and soil moisture conditions between mulched and nonmulched vegetable plots or beds?
- ❏ Did you observe different mulching materials? Were there differences in pest and disease occurrence with different mulching materials? Were there differences in weed growth and soil moisture conditions with different mulching materials?
- ❏ Were there differences in cultural management practices employed when using different mulching materials?
- ❏ Which mulching material was most cost efficient? Which mulching material was most practical to use? Was mulching effective in reducing pest and disease occurrence?

- ❑ What other management strategies can you employ to complement mulching in reducing pest and disease occurrence? What other benefits can you derive from mulching in vegetables?

Exercise No. 4.23 Leaf removal and proper disposal as a disease management strategy against leaf diseases of vegetables

Background and rationale

In certain instances, removal of entire plants is unnecessary. Satisfactory control can be achieved by simply removing and disposing properly diseased foliage of vegetable crops[93]. For instance, lower leaves of snap bean and garden pea are removed and burned to control powdery mildew and bean rust. Potato foliage affected with late blight is dehaulmed and destroyed by burning to prevent inoculum from reaching tubers. Farmers, as an effective management approach against purple blotch disease, report removal and proper disposal of outermost fungus-infected leaves of green onion and leek.

In many FFSs conducted in Benguet and Mountain Province, leaf removal is normally shared as a common practice of farmers in managing moderate leaf disease infections in their vegetable farms. It is their experience that removal of infected leaves at earlier stage of disease development can effectively prevent spread of these diseases to other plants or plant parts. This exercise was designed so those farmers can share their best experiences in employing leaf removal and their proper disposal as a management strategy against leaf diseases of vegetables.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when there are early symptoms of leaf diseases on vegetables grown in learning and adjoining fields
- When farmers want to learn from each other innovative practices of leaf removal and disposal as a management strategy against leaf diseases of vegetables

How long will this exercise take?

- Thirty minutes to one hour field walks, observations, and interaction with farmers and hands-on in learning field
- Thirty minutes brainstorming session in processing area

93 Quebral, F.C. 1988. What one should know about plant diseases. University of the Philippines Los Baños, College, Laguna, Philippines. pp18-20.

Learning objectives

- To create awareness and understanding among participants about the role of early leaf removal and disposal as a management strategy against leaf diseases of vegetables.
- To learn and do hands-on of proper leaf removal and disposal as a management strategy against leaf diseases of vegetables.

Materials

- Office supplies (notebooks, ball pens, marking pens, crayons, Manila papers)
- Vegetable crops showing early symptoms of leaf diseases in learning and adjoining fields
- Other supplies (pruning shear, knife, or scythe)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe vegetable crops showing early symptoms of leaf diseases in learning and adjoining fields. Take note of cultural practices employed. Interview other farmers, if necessary. List down all observations related to disease occurrence, degree of infection, and characteristic symptoms, etc.

2. Go back to processing area. Brainstorm in small groups and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. Motivate farmers to share their best experiences in managing leaf diseases of vegetables. Develop an improved procedure of leaf removal and proper disposal as a management strategy for leaf diseases of:

   ✓ Powdery mildew and bean rust of legumes;
   ✓ Early and late blight of potato; and
   ✓ Purple blotch of green onion and leek.

3. Facilitate each farmer to do hands-on of leaf removal when early infection of leaf diseases is observed in learning field by improving the procedure as listed:

- ✓ Determine if there are early symptoms of leaf diseases in learning field;
- ✓ If there are early symptoms, remove all disease-infected leaves;
- ✓ Dispose of all foliage removed and other plant debris properly; and
- ✓ Take note of all relevant observations and experiences during the activity.

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❑ Did you observe vegetable crops showing early symptoms of leaf diseases in learning and adjoining fields?
- ❑ Did you observe any farmer practicing leaf removal to control early infection of leaf diseases in the field?
- ❑ What leaf diseases can be effectively controlled by leaf removal? Is leaf removal applicable to all vegetables with leaf diseases? When is the best time to do leaf removal to control leaf diseases?
- ❑ Did you observe any innovative practices by farmers in leaf removal to control leaf diseases of vegetables?
- ❑ Did you observe lesser degree of disease infection when leaf removal was practiced to control leaf diseases?
- ❑ What other cultural management options can you use to complement leaf removal as a control strategy against leaf diseases of vegetables?

Exercise No. 4.24 Uprooting and proper disposal as a management strategy againsy *tymo* virus disease of chayote

Background and rationale

The most common symptoms and effects exhibited by chayote plant with *tymo* virus disease are overgrowths, stunting, yellowing, curling, and mottling. Collectively, these symptoms are locally known as *agparparya or parparya*. The *tymo* virus disease is very infectious and can be transmitted easily from diseased to healthy plants by mere contact or by animals, men, and machines. It is also suspected that *tymo* virus can be spread by some insects.

Uprooting or removal of entire disease plant is one common control measure. Diseased plants are systematically removed from a plant population in order to reduce the amount of inoculum to which chayote crop will be exposed. Uprooting is a very sound practice in disease management, particularly when *tymo* virus disease is just starting to build up. In severe cases, complete destruction or uprooting of entire chayote population is an effective way of eradicating *tymo* virus disease[94]. In the highlands, some chayote farmers practice uprooting *tymo* virus-infected plants in their fields. Unfortunately, they lack knowledge on the proper disposal of uprooted infected plants. Many farmers, however, know that uprooting and proper disposal of virus-infected plants is the most practical and effective management strategy against *tymo* virus disease.

Through time, farmers that are more enterprising in the Cordilleras have evolved more effective strategies that can complement uprooting and proper disposal for better *tymo* virus disease management. Through participatory, discovery-based, and experiential learning approaches in FFSs, these strategies can be further improved. The foregoing exercise was designed to achieve this purpose.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when early symptoms of *tymo* virus disease are observed on chayote planted in learning and adjoining fields
- When farmers want to learn from other farmers proper uprooting and disposal of chayote plants infected with *tymo* virus disease

[94] Quebral, F.C. 1988. What one should know about plant diseases. University of the Philippines Los Baños, College, Laguna, Philippines. pp18-20.

How long will this exercise take?

- Thirty minutes to one hour for field walks and observations of proper uprooting and disposal of chayote plants infected with *tymo* virus disease in learning and adjoining fields
- Thirty minutes to one hour for brainstorming session in processing area

Learning objectives

- To make participants aware of and understand the role of proper uprooting and disposal in management of *tymo* virus disease of chayote.
- To learn from other farmers proper uprooting and disposal in management of tymo virus disease of chayote.

Materials

- Vegetable fields showing early symptoms of *tymo* virus disease on chayote planted in learning and adjoining fields
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)
- Other supplies (plastic bags, cutting, and digging tools, basket, match or lighter, etc.)

Methodology

- Field walks and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe *tymo* virus-infected chayote plants in learning and adjoining fields. Interview other farmers, if necessary. List down all observations related to:

   ✓ Varieties or cultivars of chayote planted;
   ✓ Degree of *tymo* virus disease infection of varieties or cultivars; and
   ✓ Cultural management practices employed (uprooting, pruning, leaf removal, disposal of crop residues, etc.)

2. Go back to processing area; brainstorm in small groups and present output to the big group.

3. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. Motivate farmers to share their best experiences in proper uprooting and disposal to manage the *tymo* virus disease of chayote.

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

5. Facilitate farmers to do hands-on of proper uprooting and disposal to manage *tymo* virus disease of chayote when early symptoms are observed in learning field by improving procedures given below:

   ✓ Look for *tymo* virus-infected vines and trace downward to base of plant;
   ✓ Dig and uproot plants with *tymo* virus-infected vines;
   ✓ Place uprooted plants in a plastic bag or any suitable container;
   ✓ Dispose and burn *tymo* virus-infected plants in a pit;
   ✓ Repeat process as often as necessary or as disease symptoms are observed in learning field; and
   ✓ Take note of all relevant observations and experiences during this activity.

Some suggested questions for processing discussion

❑ Did you observe *tymo* virus-infected chayote plants in farmers' field? What symptoms did you observe on chayote plants infected with *tymo* virus disease?
❑ What chayote varieties or cultivars were more resistant to *tymo* virus disease? What chayote varieties or cultivars were more susceptible to *tymo* virus disease?
❑ What sanitation practices did farmers commonly employ against *tymo* virus disease of chayote?
❑ Did farmers employ uprooting of *tymo* virus-infected chayote plants? Did farmers properly dispose uprooted *tymo* virus-infected chayote plants? How?
❑ Did you see different degrees of infections in chayote fields where uprooting and no uprooting of *tymo* virus-infected plants were done? Did you observe any innovative sanitation practices employed by farmers? What were these practices?
❑ What other cultural management practices can complement proper uprooting and disposal of *tymo* virus-infected chayote fields?

Exercise No. 4.25 Use of beneficial microorganisms in managing soil-borne vegetable diseases

Background and rationale

In soil, many microorganisms live in close proximity and they interact in a unique way. The use of beneficial soil microorganisms for biological control of soil-borne plant pathogens is possible only if such interactions between species as competition, amensalism, and parasitism or predation occur. *Competition* is a condition where there is a suppression of one organism as two species struggle for limiting quantities of nutrients, oxygen, or other common requirements. *Amensalism*, on the other hand, occurs when one species is suppressed while a second is not affected, typically a result of toxin production, while *parasitism* or *predation* refers to direct attack of one organism on another[95].

In vegetable production, use of a soil fungus, *Paecilomyces lilacinus* (commercially known as BIOACT) as parasite of *Meloidogyne incognita* (root knot nematode) or as competitor of another soil fungus, *Plasmodiophora brassica* (clubroot), is a typical example of a beneficial microorganism used to control a harmful microorganism[96]. Such practices as liming to increase soil pH and adding organic matters to soil will drastically reduce population of harmful soil microorganisms in favor of beneficial ones[97]. In FFSs, some innovative farmers can share their experiences in using useful soil microorganisms to improve current practices in managing soil-borne vegetable diseases. This exercise is meant to address this particular concern.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, as component of topic on 'Integrated Disease Management'
- When farmers want to learn from others some innovative practices in using beneficial soil microorganisms for management of vegetable diseases

95 Alexander, M. 1977. Introduction to soil microbiology. 2nd Edition. John Wiley and Sons, Inc., New York, USA. pp405-437.
96 Davide, R.G. 1990. Biological control of plant pathogens: progress and constraints in the Philippines. Phil. Phytopath. 26:pp1-7.
97 Callo, Jr. D.P. 1993. Recent Development on the Utilization of Soil Microorganisms for Biological Control of Plant Pathogens. Term paper submitted in partial fulfillment of the requirements for Advance Soil Microbiology, Institute of Graduate School, Gregorio Araneta University Foundation, Malabon City, Philippines. pp11-12.

How long will this exercise take?

- Thirty minutes to one hour field walks, farmer interviews, and observations of crops where beneficial soil microorganisms were used for management of vegetable diseases
- Thirty minutes to one hour role-playing and brainstorming session in processing area

Learning objectives

- To make participants aware of and understand the role of beneficial soil microorganisms for management of vegetable diseases.
- To learn from other farmers some innovative practices in using beneficial soil microorganisms for the management of vegetable diseases.

Materials

- Vegetable crops in adjoining fields of learning field where beneficial soil microorganisms are used to manage vegetable diseases
- Office supplies (e.g., Manila papers, notebooks, ball pens, and marking pens)

Methodology

- Field walks, role-playing, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe vegetable fields where beneficial soil microorganisms were used to manage vegetable diseases. Interview other farmers, if necessary. List down all observations related to pest and disease occurrence, kind of crops planted, crop stand, etc.

2. Go back to processing area, brainstorm in small groups and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. As a wrap-up session, the following activities may be undertaken as an option:

   ✓ Post in processing area an illustration showing some beneficial and harmful soil microorganisms;
   ✓ Ask each small group to examine and familiarize themselves with appearance of microorganisms in illustration;
   ✓ Let each small group discuss among themselves and relate what they learn from field walks to what was depicted in illustration;

- ✓ Request each small group to role-play their impression of a beneficial and harmful soil microorganisms; and
- ✓ Process activity in big group.

3. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❏ What beneficial soil microorganisms did farmers use to manage vegetable diseases? Did you observe differences in crop stand, pest and disease occurrence, etc.?
- ❏ What is the most common beneficial soil microorganism used in an area? Why is this beneficial soil microorganism preferred over others?
- ❏ What benefits were derived from using beneficial soil microorganisms to manage vegetable diseases? .
- ❏ What vegetable diseases can be managed by using beneficial soil microorganisms? When is the most appropriate time to use beneficial soil microorganisms to manage vegetable diseases?
- ❏ What innovations did you learn from other farmers in using beneficial soil microorganism to manage vegetable diseases?
- ❏ How did you feel doing a role-play? Did it help you understand the topic better? How?
- ❏ How can we conserve and enhance multiplication of beneficial soil microorganisms in our own farms?
- ❏ What other cultural management practices can complement the use of beneficial soil microorganisms for management of vegetable diseases?

Exercise No. 4.26

Dehaulming as a management strategy against late blight disease of potato

Background and rationale

Dehaulming is a cultural management strategy employed against late blight disease of potato. The practice consists of defoliating potato crop but leaving at least one foot of stem intact on tubers that are kept in field with rows well hilled-up to prevent late blight spores to get in contact with tubers. The tubers are not harvested for at least two weeks after diseased foliage had been cut off to allow time for spores to be washed off[98].

The importance and economic value of this activity is highly appreciated during and after harvesting of potatoes. It prevents spread of late blight disease from foliage to tubers and allows production of disease-free seed tubers for next planting season. Consequently, productivity is improved, production cost is reduced, and higher profitability is achieved. In FFSs, some innovative dehaulming practices must be shared among farmers to improve their current best practices. The foregoing exercise was designed to ensure participatory sharing of these best experiences.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when potato crop is ready for harvesting in learning field
- When farmers want to learn innovative dehaulming practices from other farmers as a management strategy against late blight disease of potato

How long will this exercise take?

- Thirty minutes to one hour field walks, observations, interaction with farmers, and hands-on in learning field
- Thirty minutes brainstorming session in processing area

Learning objectives

- To create awareness and understanding among participants on the role of dehaulming as a management strategy against late blight disease of potato.
- To learn and do hands-on of dehaulming potato when late blight is observed before harvesting in learning field.

98 Milagrosa, S.P. 1998. Personal communication.

Materials

- Office supplies (Manila paper, notebooks, ball pens, marking pens, and crayons)
- Potato crops ready for harvesting in learning and adjoining fields showing late blight infections
- Other supplies (bolo and scythe)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe late blight infected potato crops that are about to be harvested in learning and adjoining fields. Take note of cultural practices employed. Interview other farmers, if necessary. List down all observations related to the disease occurrence, degree of infection and characteristic symptoms, etc.

2. Go back to processing area. Brainstorm in small groups and present output to big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. Motivate farmers to share their best experiences in managing late blight disease of potato. Develop an improved procedure in dehaulming potato.

3. By improving the procedure below, facilitate each farmer to do hands-on of dehaulming when the potato crop ready for harvesting in learning field is infected with late blight :

   ✓ Get sample tubers, observe tuber skin, and determine if it is ready for harvesting;
   ✓ Determine if rows are properly hilled-up. Hill-up if necessary;
   ✓ Defoliate crop, leaving at least a one-foot stem intact on potato tubers;
   ✓ Dispose of all plant debris properly;
   ✓ Leave tubers in field for at least 10 days then harvest; and
   ✓ Take note of all relevant observations and experiences during this activity.

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❏ When do we employ dehaulming in potato? Is dehaulming applicable to other tuber and root crops? When is the best time to do dehaulming?
- ❏ Did you observe potato crops ready for harvesting that were infected with late blight in learning and adjoining fields?
- ❏ Did you observe any farmer dehaulming potato crops before harvesting?
- ❏ Did you observe any innovative practices by farmers in dehaulming potato crops before harvesting? When is the best time to harvest after dehaulming?
- ❏ Did you observe any difference in degree of late blight infection between dehaulmed and not dehaulmed potato tubers in learning and adjoining fields?
- ❏ What other cultural management options can you use to complement dehaulming of potato before harvesting as a control strategy against late blight disease?

Pest and DiseaseManagement

A 'Pest and Disease Management' sub-section is incorporated in this new volume to highlight several discovery-based exercises, which simultaneously address management of both pest and disease problems in vegetable production. All discovery-based exercises compiled under this sub-section are additional exercises identified in a previous curriculum development workshop[99], which were validated by participants in a recently concluded intensive one-month *Refresher Course for Trainers of IPM in Crucifers and Other Highland Vegetable Crops*[100]. These discovery-based exercises are therefore supplements to previous exercises under Sections 4, 5, and 6, Field Guide of Discovery-based Exercises for Vegetable IPM, Volume I. These exercises emphasize some fundamental principles of pest and disease management[101], such as:

- *Exclusion.* Exclusionary measures prevent a pest or pathogen from entering and becoming established in a non-infested or non-infected area. Measures include plant quarantine regulations, crop diversification, and use of certified pest- or disease-free seed materials.

- *Eradication.* This involves eliminating a pest or pathogen once it has become established on plant or in a cropping area. Non-chemical eradicative measures include removing and destroying pest-infested or disease-infected materials and plant trash, leaf removal, pruning and crop rotation with non-susceptible crops.

- *Protection.* This is achieved through interposing a protective barrier between pest or pathogen and susceptible plant. One environment-

99 Binamira, J.S. 1998. A Consultant's Report: Curriculum Development for Trainers and Farmer Field Schools on IPM in Crucifers and Other Highland Vegetable Crops. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Regional Field Unit, Baguio City, Philippines. pp6-23.

100 Binamira, J.S. 1998. A Consultant's Report: Refresher Course for Trainers of IPM in Crucifers and Other Highland Vegetable Crops. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Regional Field Unit, Baguio City, Philippines. pp15-22.

101 Quebral, F.C. 1988. What one should know about plant diseases. University of the Philippines Los Baños, College, Laguna, Philippines. pp11-20.

friendly barrier is spraying soap solution in vegetables to avoid infestation of scale insects or infection of sooty mold.

- *Resistance.* This refers to development and use of cultivars that can thwart or impede activity of a pest or pathogen. Generally, resistance can be categorized as vertical or specific resistance, and horizontal or nonspecific resistance. Vertical resistance is usually conferred by one or a few genes and is effective only against some biotypes of pests or physiologic races of a pathogen. Many genes control horizontal resistance and resistance is evenly spread against all biotypes of pests or races of a pathogen.

- *Therapy.* This refers to treatment of plants infested by a pest or infected by a pathogen. An example of nonchemical therapy is application of heat (hot or moist) to affected area or plant parts or materials. This inactivates or inhibits a pest in an infested area or a pathogen in an infected area or plant tissues.

- *Avoidance.* This tactic alters environment by making it less favorable to growth and development of a pest or pathogen. Examples include field sanitation measures such as leaf removal, and cultural practices, such as changing planting density, date of planting, date of harvesting, fertilization, liming and irrigation.

Exercise No. 4.27

Soil solarization as a pest and disease management strategy for vegetable production

Background and rationale

Soil solarization is a cultural management practice where soil under is exposed to sunlight for some time after cultivation to kill soil-borne pests and disease-causing pathogens in prepared seedbeds, beds, or plots intended for growing of vegetables. There are two common methods of soil solarization practiced by farmers in the Cordilleras. These are done by: (1) exposing prepared seedbeds, beds or plots to direct sunlight before planting, and (2) exposing prepared seedbeds, beds or plots covered with black polyethylene plastic to sunlight to accumulate heat then removing it before sowing, planting, or transplanting[102].

In continuous practice of soil solarization, some farmers had evolved more innovative approaches in their farms that contributed to better pest and disease management in vegetables. These learning experiences must be shared with other farmers in FFSs to further improve their current best soil solarization practices, hence this exercise.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, before sowing in seedbed and before planting or transplanting in learning field
- When farmers want to learn the best practices from other farmers on soil solarization for pest and disease management in vegetable production

How long will this exercise take?

- Thirty minutes to one hour for field walks, farmers' interview, and observations of soil solarization practices in seedbeds, beds or plots before sowing, planting, and transplanting in adjoining vegetable farms of learning field
- Thirty minutes to one hour role-playing and brainstorming session in processing area

Learning objectives

- To make participants aware of and understand the contribution of soil solarization in management of pests and diseases of vegetables.
- To learn best experiences on soil solarization from other farmers as a strategy for pest and disease management in vegetables.

[102] Milagrosa, S.P. 1998. Personal communication.

Materials

- Seedbeds, beds, or plots ready for sowing, planting or transplanting with vegetable crops
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)

Methodology

- Field walks, role-playing, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe as many seedbeds, beds or plots in adjoining farms where soil solarization were practiced before sowing, planting, or transplanting of vegetable crops. List down all observations related to soil solarization practices, kind of crops planted, crop stand, pest and disease occurrence, etc.

2. Go back to processing area and do a role-play. Divide the big group into five smaller groups. Request for a volunteer-participant from each small group. Other group members will act as observers. The volunteers and other group members will perform as follows:

   ✓ Group I volunteer will represent sunlight (e.g., by use of a flashlight, he or she flashes it to other volunteer-participants).
   ✓ Group II volunteer will represent a *clubroot* disease of cabbage (when light is flashed, he or she acts like succumbing to death and exits from scene).
   ✓ Group III volunteer will represent a *bacterial wilt* disease of potato (when light is flashed, he or she acts also like succumbing to death and exits from scene).
   ✓ Group IV volunteer will represent a *root knot nematode* of celery (when light is flashed he or she acts like resisting heat but eventually succumbs to death and exits from scene).
   ✓ Group V volunteer will represent a *cutworm larva* about to pupate in soil (when light is flashed, he or she acts like running away from heat but eventually succumbs to death and exits from scene).
   ✓ Let other members in each group observe reactions of volunteers (who is more resistant or susceptible to heat, etc.). Relate all experiences to this topic.

3. Brainstorm in small groups and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators.
4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❑ What is soil solarization? What benefits will you get from practicing soil solarization?
- ❑ Did you observe different soil solarization practices in seedbeds, beds, and plots before sowing, planting, and transplanting in vegetable fields?
- ❑ Did you observe differences in plant vigor, crop stand, pest and disease occurrence, etc., in vegetables grown from solarized seedbeds, beds, or plots before sowing, planting, and transplanting?
- ❑ Did you learn from farmers interviewed of better soil solarization practices for different vegetables? How did they do it?
- ❑ When do we need to practice soil solarization in vegetable production? Why?
- ❑ Were there differences in yields between vegetables grown in seedbeds, beds, or plots that were solarized and not solarized?
- ❑ What other cultural practices will complement soil solarization as a pest and disease management strategy in vegetable production?

Exercise No. 4.28

Hilling-up as a pest and disease management strategy in vegetable production

Background and rationale

Most vegetable farmers in the Cordilleras practice hilling-up. Hilling-up is a cultural management practice where soil is cultivated and raised at base of plant primarily to enhance better root development, improve anchorage, and suppress growth of weeds. For most vegetable crops, this operation is usually conducted a month after transplanting or immediately after application of top or side dress (e.g., second inorganic) fertilizers, thereby ensuring its proper soil incorporation and its more efficient use by plants. For tuber crops, hilling-up is done to suppress growth of aerial tubers and prevent infestation of potato tuber moth and other pests[103].

Hilling-up also disturbs development of other soil-borne pests and exposes to sunlight many soil-borne plant pathogens that thrive near base of plants. Hence, this practice contributes largely to better pest and disease management. Hilling-up operation is useful only as a pest and disease management strategy if done at proper time. In FFSs, best practices in hilling-up can be shared among farmers by conducting field walks, hands-on, simulation exercises, and participatory discussions. This exercise was designed to address this particular concern.

For field walk and brainstorming exercise:

When is this exercise most approriate?

- In FFS, TOT, and VST sessions as part of 'Other Cultural Management Practices in Vegetable Production' topic
- When farmers want to learn improved practices from other farmers in hilling-up
- When hilling-up operation is to be conducted in learning field

How long will this exercise take?

- Thirty minutes to one hour field walks, observations, and interaction with farmers
- Thirty minutes to one hour brainstorming session in processing area

[103] Balaki, E.T. 1998. Personal communication.

Learning objectives

- To create awareness and appreciation among participants regarding the role of hilling-up in management of vegetable pests and diseases.
- To learn from other farmers the proper ways and the best time to do hilling-up operations in vegetable production.
- To learn from other farmers other benefits derived from practicing hilling-up in vegetable production.

Materials

- Office supplies (notebooks, ball pens, marking pens, crayons, Manila papers)
- Hilled-up and not hilled-up vegetable plots or beds (vegetable crops should be more or less at same growth stages)

Methodology

- Field walks and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe as many hilled-up and unhilled-up vegetable plots or beds in a field. Take note of different practices in hilling-up. Interview other farmers, if necessary. List down all observations related to pest and disease occurrence, crop stand, weed growth, soil moisture conditions, etc.

2. Go back to processing area, brainstorm in small groups, and present output to big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators.

3. Synthesize and summarize outputs of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

<u>**For hands-on and brainstorming exercise:**</u>

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when crops are about a month after planting or transplanting in learning field
- When farmers want to learn and understand how hilling-up can be used as a pest and disease management strategy in vegetable production

How long will this exercise take?

- One hour and 30 minutes for field walks and observations in adjoining fields of learning field
- Thirty minutes to one hour hands-on and brainstorming session

Learning objectives

- To create awareness and understanding among participants regarding the role of hilling-up operation for pest and disease management in vegetables.
- To learn and share with cofarmers appropriate skills in hilling-up operations for pest and disease management in vegetables.

Materials

- Office supplies (notebooks, pencils, ball pens, and marking pens)
- Field supplies and tools (fertilizer materials and grab hoe)
- Adjoining and learning fields planted to one-month old vegetable crops and ready for hilling-up operations)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide the big group into five smaller groups. Before hilling-up operation, each group should observe and record the crop stand, plant vigor, weeds present, pest and disease occurrence, etc., in adjoining vegetable fields of learning field. Each small group will then do hilling-up operation (e.g., hands-on) in half of the plots assigned to them in learning field. The other half will not be hilled-up for comparison.

2. Every week thereafter, each group will record the same observations they made before hilling-up operations. After every observation, participants should brainstorm in small groups to summarize their observations but present the same to the big group every other week. The summary of weekly observations should be printed in Manila paper.

3. After final observation, conduct participatory discussions in the big group to allow sharing of experiences among participants and facilitators. Synthesize and summarize outputs of small groups into one big group output.

4. Draw up conclusions and recommendations from this exercise.

For the simulation and brainstorming exercise:

When is this exercise most approriate?
- In FFS, TOT, and VST sessions, when tuber crops are about a month after planting or transplanting
- When farmers want to learn and understand how hilling-up can be used as a management strategy for insect pests of tuber crops

How long will this exercise take?
- Thirty minutes to one hour for field walks and observations in tuber crop fields
- Thirty minutes to one hour simulation exercise and brainstorming session in processing area

Learning objectives
- To create awareness and understanding among participants regarding the role of hilling-up operations in the management of tuber crop pests.
- To learn and share with co-farmers appropriate skills in hilling-up operation for tuber crops.

Materials
- Office supplies (notebooks, pencils, ball pens, and marking pens)
- Field supplies (plastic trays and two spoon of sugar)
- Other materials (garden soil and at least 8 potato stem cuttings)

Methodology
- Field walks, simulation, and brainstorming

Steps
1. Divide big group into five smaller groups. Go to the field and observe potato crops that were hilled-up and not hilled-up. Record all observations on crop stand, plant vigor, weed growth, soil moisture condition, pest and disease occurrence, etc. Gather some garden soil and potato stem cuttings.

2. Proceed to processing area and do simulation exercise. Each small group fills-up two plastic trays with the same amount of soil. Cultivate soil and form two mini-plots per tray. Plant four stem-cuttings per tray. To simulate fertilizer application, apply one spoon of sugar to soil in both trays. Simulate hilling-up operation in one of the trays by using spoon as grab hoe. No hilling-up operation is done on the other tray. Put water to simulate irrigation in trays.

3. After the exercise, conduct participatory discussions in a big group to allow sharing of experiences among participants and facilitators. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❑ What is hilling-up? When is the best time to do hilling-up operation?
- ❑ In the simulation exercise, what happened when you applied irrigation in hilled-up and not hilled-up plots? Why? Can this happen in real field conditions?
- ❑ In a field, did you observe any differences in pest and disease occurrence between hilled-up and not hilled-up vegetable plots or beds? What pests and diseases were more prevalent?
- ❑ Were there differences in crop stand, weed growth, and other conditions between hilled-up and not hilled-up vegetable plots or beds?
- ❑ Did you observe variation in hilling-up practices? Were there differences in pest and disease occurrence among variations? Were there differences in crop stand, weed growth, and other conditions among variations?
- ❑ Were there variations in other cultural management practices employed when using different hilling-up operations?
- ❑ Which of the hilling-up variation was most cost-efficient? Which of hilling-up variation was the most practical to use? Was hilling-up effective in reducing pest and disease occurrence? What other management strategies can you employ to complement hilling-up in reducing pest and disease occurrence?
- ❑ What other benefits can you derive by practicing hilling-up in vegetable production?

Exercise No. 4.29 Surface irrigation or flooding as a pest and disease management strategy in vegetable production

Background and rationale

In surface irrigation, water flows on soil surface, then later seeps downward, or moves vertically (surface flooding), moves along a canal or horizontally (furrow flooding) in soil until it reaches roots of plants[104]. A modification of surface flooding is basin irrigation. Ridges are constructed around a plant or along contour lines and water is introduced into basin. A water hose could be brought to field and water is delivered plant by plant, when basin is on a plant-basis. In vegetable production, flooding is a very important cultural practice for pest and disease management.

Flooding kills eggs, larvae, and some adults of soil-inhabiting insect pests, helps control weeds, and reduces population of some soil-borne fungal pathogens, and nematodes but may hasten dispersal of some bacterial diseases. In FFSs, innovative farmers can share their best experiences in using flooding as a pest and disease management strategy in vegetable production. Through participatory, discovery-based, and experiential learning approaches, farmers can further adapt their best irrigation practices to improve crop productivity, hence this exercise.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, as component of topic on 'Integrated Water Management'
- When farmers want to learn from other farmers their innovative practices in flooding as a pest and disease management strategy in vegetable production

How long will this exercise take?

- Thirty minutes to one hour for field walks and observations of different practices in flooding by farmers in adjoining fields of the learning field
- Thirty minutes to one hour brainstorming session in processing area

[104] Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition. SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp326-330.

Learning objectives

- To make participants aware of and understand the role of flooding as a pest and disease management strategy in vegetable production.
- To learn from other farmers some innovative practices in flooding that can be used as a pest and disease management strategy in vegetable production.

Materials

- Adjoining fields of learning field where different practices in flooding can be observed
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)

Methodology

- Field walks and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe irrigation practices by flooding in as many adjoining vegetable fields of learning field. Interview other farmers, if necessary. List down all observations related to irrigation practices, pest and disease occurrence, kind of crops planted, crop stand, weed growth, etc.

2. Go back to processing area, brainstorm in small groups and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators.

3. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

❑ What different flooding practices did you observe in farmers' field?
❑ Did you observe differences in crop stand, weed growth, pest and disease occurrence, etc?
❑ What is the most common flooding practice used in an area? Why is this flooding practice preferred over others?
❑ What are the advantages and disadvantages of different flooding practices used for vegetables?
❑ When is the most appropriate time to do irrigation by flooding in vegetables? When is most appropriate time to do other irrigation practices?

- ❏ What other cultural management practices can complement the practice of irrigation by flooding, for management of pests and diseases in vegetables?

Exercise No. 4.30

Overhead irrigation as a pest and disease management strategy in vegetable production

Background and rationale

In overhead irrigation, water is applied either in the form of a fine mist (spraying) or spray simulating rain (sprinkling). Water may be manually applied using watering cans or mechanically applied under pressure and at pre-determined intervals[105]. Experiences shared by farmers in previous FFSs indicated that overhead irrigation is a cultural management practice that plays a significant role in pest and disease management in vegetable production.

Overhead irrigation is suitable to dispense spores of many fungus diseases (e.g., powdery mildew of garden pea, downy mildew of cabbage seedlings, rust of beans) from leaf surface of infected vegetable crops, thereby minimizing disease infections. Likewise, practice reduces population of aphids, spider mites, white flies, and thrips in crucifers, legumes, and solanaceous vegetables.

Many farmers reported also that irrigating the field for at least eight hours using Jetmatic sprinkler (a type of overhead irrigation equipment) disturbed and thus minimized egg-laying capacity of female adult DBM, a major insect pest of crucifers. These experiences and other farmer innovations can be better shared to other farmers in FFSs through field walks and brainstorming sessions, hence this exercise.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, before doing an overhead irrigation in learning field
- When farmers want to learn the best experiences from other farmers on how overhead irrigation minimize pest and disease occurrence in their vegetable fields

[105] Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition. SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp326-330.

How long will this exercise take?

- Thirty minutes to one hour for field walks and observations of different irrigation practices and equipment in adjoining vegetable farms of learning field
- Thirty minutes to one hour brainstorming session in processing area

Learning objectives

- To make participants aware of and understand the role of overhead irrigation in management of pests and diseases in vegetables.
- To learn the best experiences from other farmers on the use of overhead irrigation in minimizing pest and disease occurrence in vegetables.

Materials

- Vegetable fields where different irrigation practices and equipment can be observed
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)

Methodology

- Field walks and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe irrigation practices and equipment used in as many vegetable fields. Interview other farmers, if necessary. List down all observations related to irrigation practices and equipment used, pest and disease occurrence, kind of crops planted, crop stand, weed growth, etc.

2. Go back to processing area. Brainstorm in small groups and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators.

3. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❑ What irrigation practices and equipment used did you observe in the field?
- ❑ Did you observe differences in crop stand, weed growth, pest and disease occurrence, etc?
- ❑ What is the most common irrigation practice used in an area? Why is this irrigation practice preferred over others?
- ❑ What are the advantages and disadvantages of different irrigation practices and equipment used for vegetables?

- ❏ When is the most appropriate time to do overhead irrigation in vegetables? When is the most appropriate time to do other irrigation practices?
- ❏ What other cultural management practices can complement the practice of overhead irrigation in management of pests and diseases in vegetables?

Exercise No. 4.31

Sanitation as a pest and disease management strategy in vegetable production

Background and rationale

Sanitation is the most common and practical cultural management approach against most pests and diseases of vegetables. Sanitation starts with the use of clean seeds, seedlings, and other planting materials to prevent insect infestations and disease infections. On the other hand, pruning, roguing, and proper disposal of affected plants or plant parts are employed to reduce insect pest and disease incidence in field[106].

Sanitation practices varies with locations and among farmers depending upon their understanding of pest or disease problem, crops grown, and cropping season. In FFSs, these innovations and best sanitation practices can be shared and learned among farmers through field walks, observations and brainstorming. This exercise is designed to enhance learning experiences of farmers on proper sanitation practices.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when first signs or symptoms of pest infestation or disease infection are observed in learning field
- When farmers want to learn best sanitation practices from other farmers to minimize pest and disease occurrence in their vegetable fields

How long will this exercise take?

- Thirty minutes to one hour for field walks and observations of different sanitation practices in adjoining vegetable farms of learning field
- Thirty minutes to one hour brainstorming session in processing area

Learning objectives

- To make participants aware of and understand the role of proper sanitation practices in management of pests and diseases in vegetables.
- To learn the best sanitation practices from other farmers in minimizing pest and disease occurrence in vegetables.

106 Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition. SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp369-371.

Materials

- Vegetable fields where different sanitation and other cultural management practices can be observed
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)

Methodology

- Field walks and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe different sanitation and other cultural management practices in as many adjoining vegetable fields of learning field. Interview other farmers, if necessary. List down all observations related to sanitation practices (e.g., roguing, pruning, leaf removal, disposal of crop residues, etc.), pest and disease occurrence, kind of crops planted, crop stand, etc.

2. Go back to processing area. Brainstorm in small groups and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators.

3. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❏ Did you observe different sanitation practices in the field? What were the most common sanitation practices employed by farmers?
- ❏ Did farmers properly dispose their crop residues? How?
- ❏ Did farmers dispose their crop residues for pest and diseases management?
- ❏ Did you see differences in pest and disease incidence with different sanitation practices? Did you observe any innovative sanitation practices employed by farmers? What were these practices?
- ❏ Why do we have to be very cautious in applying different sanitation methods?
- ❏ What sanitation practices were more appropriate for each pest and disease problem?
- ❏ What other cultural management practices can complement proper sanitation to reduce pest and disease problems in vegetables?

Exercise No. 4.32

Prunning as a pest and disease management strategy for vegetable production

Background and rationale

Regular pruning usually reduces height and yield of a plant, and changes its general configuration. The increased vegetative growth that occurs after pruning does not compensate for decreased photosynthetic area. The new leaves that develop may be larger but fewer than the removed leaves. It is, however, marketable yield that counts and not total yield[107]. Therefore, a vegetable farmer has to decide on the amount of pruning to be done that will result in favorable effects and yet will not reduce marketable yield.

In vegetable production, pruning may also be practiced as a strategy for pest and disease management. In some twig borer-infested solanaceous vegetables, pruning is accomplished on affected plant parts to prevent twig borer larvae from further developing into adults thereby drastically reducing pest population. In some instances, satisfactory disease control can be achieved by simply removing diseased plant parts. For example, lower leaves of bean rust-affected legume vegetables are pruned to reduce disease infection. Late blight-affected potato leaves are pruned to prevent pathogen from reaching tubers[108].

Vegetable farmers in the Cordilleras had many other innovative pruning practices that should be shared with other farmers in FFSs to continuously improve their current best pruning practices. The foregoing exercise was specifically designed for this purpose.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, at any appropriate stage of all vegetables grown in learning field
- When farmers want to learn improved pruning practices from other farmers for any vegetable crop

[107] Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition. SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp385-399.

[108] Quebral, F.C. 1988. What one should know about plant diseases. University of the Philippines Los Baños, College, Laguna, Philippines. pp18-20.

How long will this exercise take?

- Thirty minutes for field walks, farmer interviews, and observations of pruning practices for any vegetables grown in adjoining and learning fields
- Fifteen to 30 minutes for hands-on in pruning of vegetables at any appropriate time during a season-long activity in learning field
- Fifteen to 30 minutes for brainstorming session in processing area every after pruning activity in learning field

Learning objectives

- To make participants aware and understand that some pruning practices can contribute to better pest and disease management in vegetable production.
- To learn and do hands-on of improved pruning practices shared by other farmers for better pest and disease management.

Materials

- Adjoining fields of learning field grown with any vegetables where pruning is practiced
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)
- Field materials (pruning shears, scythe or bolo, and plastic containers)

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks, interview farmers, and observe pruning practices conducted by farmers on vegetables grown in adjoining and learning fields. List down all observations and experiences shared by farmers interviewed.

2. Go back to processing area. Brainstorm in small groups on how to further improve current pruning practices. Develop a procedure on how to do improved pruning practices on the following:

   ✓ Disease-infected foliage or other plant parts;
   ✓ Pest-infested foliage or other plant parts; and
   ✓ Unproductive, unwanted or dead plant parts.

3. Present output of small groups to the big group. Conduct participatory discussions to allow sharing of experiences among participants. Agree on a common procedure to be followed.

4. Do hands-on of appropriate pruning practices for any vegetables in learning field based on the agreed procedure.

5. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendation from this exercise.

Some suggested questions for processing discussion

- ❏ What do we mean by pruning?
- ❏ Did you observe different pruning practices for different vegetables in farmer's fields? How were they compared with vegetables that were not pruned?
- ❏ Why do we need to have different pruning practices for different vegetables?
- ❏ Did you learn from farmers interviewed of better pruning practices for different vegetables? How did they do it?
- ❏ Do we need to practice pruning for any vegetables? How are they done?
- ❏ What changes in appearance of different vegetables did you observe weeks or months after pruning?
- ❏ Were there differences in plant growth and development between pruned and not pruned vegetables?
- ❏ Were there differences in yield between pruned and not pruned vegetables?

Exercise No. 4.33

Minimizing pest and disease occurence through crop diversification

Background and rationale

Crop diversification is planting at the same time in one farm of as many crops to maximize land use and minimize pest and disease occurrence[109]. With this system, number of vegetable crops grown by farmers in his farm depends on such factors as crop preference, technical knowledge, adaptability, market demands, and profitability. Despite inherent advantage of crop diversification, majority of farmers still practice monocropping or planting of one crop or several crops belonging to one family in one farm on a year round basis.

In the Cordilleras, outbreaks of pests (e.g., diamondback moth or DBM in crucifers) and diseases (e.g., clubroot in crucifers, damping off in parsley and cucurbits, and bacterial wilt in solanaceous crops) had been associated with continuous practice of monocropping.

In FFSs, farmers will be able to share their unique experiences in crop diversification through field walk and brainstorming. In this process, they may influence their cofarmers to practice crop diversification instead of monocropping and subsequently reduce pest and disease occurrence in their communities. The foregoing exercise was designed to share these best practices.

When is this exercise most approriate?

- As a special topic on 'Cropping Systems' in the FFS, TOT, and VST sessions
- When farmers want to learn more from other farmers better crop diversification schemes as cultural management strategies against pests and diseases of vegetables

How long will this exercise take?

- Thirty minutes to one hour field walks, observations, and interaction with farmers in vegetable fields
- Thirty minutes to one hour brainstorming session in the processing area

[109] IIBC. 1990. Manual on Biological Control and Biological Methods for Insect Pests in the Tropics. FAO/IRRI/IIBC Training Course on Biological Control in Rice-based Cropping Systems, International Institute of Biological Control, Kuala Lumpur, Malaysia. pp1.1/1-1.2/1 (Part 3).

Learning objectives

- To make participants aware of and understand the contribution of crop diversification for the management of vegetable pests and diseases.
- To learn from other farmers the best crop diversification schemes for management of vegetable pests and diseases.

Materials

- Notebooks, ball pens, Manila papers, marking pens, and masking tapes
- Vegetable fields showing monocropping and crop diversification

Methodology

- Field walk and brainstorming

Steps

1. The participants conduct field walks, observe crops grown or crop combinations followed by interaction with farmers in the area to gather other relevant information on crop diversification. All observations, including severity of pest and disease damages, crop stand, kind of crops grown, cultural practices, etc. should be noted. Sample plants infected with diseases or damaged by pests may be collected for further assessment. Experiences shared by farmers should be noted.

2. The participants return to processing area, brainstorm in small groups, summarize their observations and experiences shared by farmers, and present their outputs to the big group.

3. All learning experiences shared by participants should be synthesized and integrated into one output. Conclusions and recommendations should be drawn from the exercise.

Some suggested questions for processing discussion

- ❑ Did farmers practice monocropping or crop diversification?
- ❑ What crops did farmers in this area grow? What crop combinations did farmers follow?
- ❑ What pests and diseases were observed in areas that practiced monocropping? In areas that practiced crop diversification? Which practice had more pest and disease problems?
- ❑ How can crop diversification help prevent pest and disease outbreaks in the area? What crop combinations had less pest and disease problems?
- ❑ What pests and diseases were common to all crops? What crop combinations should be followed to better manage these pests and diseases?

- ❏ What crop combinations should be avoided to discourage prevalence of these pests and diseases?
- ❏ Will crop diversification minimize pest and disease occurrence? In what ways? Which crops are best for diversification?

Exercise No. 4.34 Crop rotation as a pest and disease management strategy in vegetable production

Background and rationale

Growing two or more crops one after another is called succession cropping. If there is a regular succession of such crops being followed for two or more years, it is more specifically termed crop rotation. Crop rotation, as a cultural management strategy, is used with an idea that a crop susceptible to a pest or disease is followed by a resistant crop or is combined in simultaneous cropping with other crops. There is no build-up of organisms to a high level since growth cycle of organism is broken[110].

In the Cordilleras, crop rotation is the most practical management approach to DBM of crucifers and to many soil-borne diseases of vegetables. Through time, some innovative farmers had designed crop rotation scheme that best suited their location specific requirements. These learning experiences must be constantly shared among farmers in FFSs to improve their current crop rotation practices which will eventually lead to better pest and disease management strategies. This exercise was designed to address this particular concern.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, during discussions on cultural management practices as a component of IPM in vegetable production
- When farmers want to learn from other farmers their best crop rotation schemes as a pest management strategy in vegetable production

How long will this exercise take?

- Thirty minutes for field walks and observations of different crop rotation schemes in adjoining vegetable fields of the learning field
- Thirty minutes to one hour role-playing and brainstorming session in processing area

110 Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition. SEAMEO Regional Center for Graduate Study and Research in Agriculture and University of the Philippines Los Baños, College, Laguna, Philippines. pp280-284.

Learning objectives

- To make participants aware and understand how crop rotation can be used as a pest and disease management strategy in vegetable production.
- To enhance farmers' learning experiences by role-playing how crop rotation works as a pest and disease management strategy in vegetable production.

Materials

- Vegetable fields where different crop rotation schemes can be observed
- Office supplies (Manila papers or blackboard and chalks, notebooks, staplers, crayons, ball pens, and marking pens)

Methodology

- Field walks, role-playing, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe as many crop rotation schemes in adjoining farms of learning field. List down all observations related to crop rotation schemes, degree of pest and disease infestation, kind of crops planted, crop stand, etc.

2. Go back to processing area and do a role-play. A facilitator explains the mechanics of the play to the big group and assigns a crop rotation scheme per small group, as shown below:

   ✓ Group 1 to monocropping scheme (e.g., cabbage is planted year-round)
   ✓ Group 2 to crop rotation scheme 1 (e.g., different crucifers are rotated year-round)
   ✓ Group 3 to crop rotation scheme 2 (e.g., crucifers and potato are rotated year round)
   ✓ Group 4 to crop rotation scheme 3 (e.g., potato and other solanaceous vegetables are rotated year-round)
   ✓ Group 5 to crop rotation scheme 4 (e.g., crucifers, legumes, parsley and solanaceous crops are planted in a succession for two years)

Each group should show possible effects and reactions of crops on different factors contributing to the development and occurrence of pest and diseases. Thus, a play should portray, among others: pest and disease transferred to other crops, pest and disease reduced or controlled, crop rotation scheme less or seriously affected by pests and diseases, etc.

3. Brainstorm in small groups and present output to big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators.

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- What is crop rotation? How do you differentiate crop succession from crop rotation?
- Did you observe different crop rotation scheme in the field? What crop rotation schemes did farmers commonly practice?
- In the role-playing exercise, which was shown as the best crop rotation scheme? Why? What were the important characteristics of a good crop rotation scheme?
- Do you think crop rotation will solve pest and disease problems in your area?
- What benefits can you derive from practicing crop rotation?
- What other cultural practices can complement crop rotation to effectively manage pest and disease problems in vegetable production?

Section 5

Seed Production, Harvest and Postharvest Management Topics

Section 5 Seed Production, Harvest and Postharvest Management Topics

In general, cultural management practices of vegetable crops intended for seed production are similar to those for fresh market or for other consumable products. Planting distance, fertilization, irrigation, and insect pest and disease management practices for both production systems are very similar. However, some basic differences between these systems are[111]:

- Isolation distance is observed in crops intended for seed production to maintain genetic purity by preventing unwanted pollination;

- Pollinators are absolutely necessary in a seed production area, especially where natural pollination is insufficient;

- Regular field inspection and rouging is done on the entire life cycle of vegetable crop to remove from seed production area other crops or cultivars, noxious weeds, off-types, and plants that are deformed, diseased, or infested; and

- Harvesting is undertaken at the most mature stage of seed or stage of physiological maturity of seed, when all food reserves needed by the seed have been accumulated.

[111] Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition. SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp167-175.

On the other hand, losses during and after harvest are distributed throughout the entire marketing chain, from farmer to consumer. These are attributed to three general technical causes, namely: (a) poor quality at harvest, (b) careless harvesting and handling, and (c) improper processing methods[112].

Poor quality at harvest. No amount of treatment can convert produce that is poor in quality at harvest into one of good quality. Quality could, at best, be only maintained. Poor quality produce may be due to: (a) wrong variety (or hybrid) for intended purpose, (b) improper production methods and conditions, and (c) harvesting either immature or over-mature produce.

Careless harvesting and handling. This includes: (a) carelessness during harvesting and physical handling, (b) failure to take into consideration control of environmental factors that affect shelf life of produce, and (c) delay in primary processing.

Improper processing method. Harvested produce has to be processed properly so that good quality at harvest can be maintained. This includes proper methods and conditions in postharvest handling and processing.

Concomitant to production practices, marketing outlets should be seriously considered prior to production of any vegetable crop. Yield should always be correlated with efficient marketing techniques. To increase net return from marketing practices, vegetable produce should be classified according to their perishability, or classify them as essential or nonessential. With this latter classification, proper selection of vegetable crops to produce will be highly relevant with market demand and marketing practices[113].

112 Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition. SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp424-435.

113 PCARRD. 1975. The Philippines Recommends for Vegetable Crops. Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD), Los Baños, Laguna, Philippines. pp147-164.

Likewise, most discovery-based exercises compiled under 'Seed Production, Harvest and Post Harvest Management' section are additional exercises identified in a previous curriculum development workshop[114] which were validated by participants in a recently concluded intensive one-month *Refresher Course for Trainers of IPM in Crucifers and Other Highland Vegetable Crops*[115]. Discovery-based exercises on seed production are, however, supplements to previous exercises under Section 3 (e.g., 'Vegetable Crop Varieties and Vegetable Seed Production' sub-section), Field Guide of Discovery-based Exercises for Vegetable IPM, Volume I.

[114] Binamira, J.S. 1998. A Consultant's Report: Curriculum Development for Trainers and Farmer Field Schools on IPM in Crucifers and Other Highland Vegetable Crops. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Regional Field Unit, Baguio City, Philippines. pp6-23.

[115] Binamira, J.S. 1998. A Consultant's Report: Refresher Course for Trainers of IPM in Crucifers and Other Highland Vegetable Crops. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Regional Field Unit, Baguio City, Philippines. pp15-22.

Exercise No. 5.01

Seed selection and seed production by farmers of self-pollinated (legumes and solanaceous) vegetables

Background and rationale

As mentioned earlier, there are few basic differences between growing of vegetable crops intended for seed production and those crops for fresh market or for other consumable products. For example, isolation distance is necessary and can vary according to crop, its pollination habit, and purpose for which seeds are grown. For self-pollinated crops like solanaceous crops and legumes, isolation distance is small. The minimum isolation distance required for seed production is 25 m in legumes and tomato, and 50 m in bell pepper. Pollinators are not as important for self-pollinated crops as they are for cross-pollinated vegetables[116].

In many instances, farmers themselves, through their experiences, identify outstanding varieties in their specific areas. Species or varieties that produce high yields of good quality products and tolerant to pests and environmental stresses are preferred by farmers. Thus, they are selected for seed production. In the Cordilleras, vegetable farmers usually use harvest from their own or their neighbor's previous crops for seeds in the next cropping season.

Many vegetable farmers use their own or their neighbor's previous harvests as seeds for the next cropping season. While some farmers practice good seed selection, still, many use seeds that are either non-marketable or over matured. In FFSs, many innovative practices can be shared among farmers to ensure sustained availability of cheap but good quality seed materials. This exercise was designed to achieve this particular objective.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when some self-pollinated vegetables (e.g., legumes and solanaceous crops) are grown for seeds in the learning field
- When farmers want to learn from other farmers and do hands-on of proper seed selection and seed production of self-pollinated vegetables (e.g., legumes and solanaceous crops) in their own farms

116 Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition. SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp167-177.

How long will this exercise take?

- Fifteen to 30 minutes weekly field walks, observations, hands-on, and interaction with farmers
- Fifteen to 30 minutes weekly brainstorming session in processing area

Learning objectives

- To create awareness and understanding among participants that seed selection and seed production can be accomplished by farmers in their own farms.
- To learn from other farmers and do hands-on of innovative practices in seed selection and seed production of self-pollinated vegetables (e.g., legumes and solanaceous crops).

Materials

- Office supplies (notebooks, ball pens, marking pens, crayons, Manila papers)
- Other supplies (paper bags, plastic pails, plastic twines, scythes, and tagging materials)
- Self-pollinated vegetables (e.g., legumes and solanaceous crops) grown for seeds in the learning and adjoining fields

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe self-pollinated vegetables (e.g., legumes and solanaceous crops) grown for seeds in learning and adjoining fields. Take note of cultural management practices employed. Interview other farmers, if necessary. List down all observations related to:

   ✓ Uniformity in height
   ✓ Date of flowering (number of days from emergence to flower initiation)
   ✓ Maturity (number of days from emergence to harvest)
   ✓ Pest and diseases incidence (major pest and diseases)
   ✓ Size and shape of pods or fruits (maturity index of crop)

2. Go back to processing area; brainstorm in small groups and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators.

3. Motivate farmers to share their best experiences in seed selection and seed production of self-pollinated vegetables (e.g., legumes, and solanaceous crops) in their own farms, especially on the following:

   ✓ Selection of species or varieties for seed production;
   ✓ Isolation distance between crop varieties;
   ✓ Regular field inspection and roguing; and
   ✓ Harvesting at most mature stage of seed.

4. Facilitate each small group to do hands-on of best experiences in seed selection and seed production in portions of some self-pollinated vegetables (e.g., legumes, and solanaceous crops) grown in learning field, as follows:

   ✓ Determine area needed for farmer's seed requirement (e.g., know farmer's seed requirement per hectare, his normal yield level per cropping, and his estimated production per unit area).
   ✓ Measure and mark boundaries in a portion of some self-pollinated vegetables (e.g., legumes, and solanaceous crops) grown in learning field (using above estimated area).
   ✓ Conduct regular inspection and roguing (regular removal of other cultivars, weeds, off-types, deformed or disease and pest affected plants and other plants whose characteristics do not conform with desired cultivar at early vegetative, flowering, fruiting and harvesting stages).
   ✓ Employ other cultural management practices shared and agreed upon the big group brainstorming session.
   ✓ Take note of all relevant observations and experiences during this activity.

5. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❑ What is a self-pollinated crop? What were the most common self-pollinated vegetable crops observed in the field?
- ❑ Do we need pollinators for self-pollinated vegetables (e.g., legumes and solanaceous crops) intended for seed production?
- ❑ Why do we need to maintain an isolation distance between vegetable crops intended for seed production?
- ❑ Why do we need to conduct regular monitoring and roguing of self-pollinated vegetables (e.g., legumes and solanaceous crops) grown for seed purposes?
- ❑ Which self-pollinated vegetable crops did farmers grow and use for seed purposes?
- ❑ What seed selection and seed production practices did farmers employ for self-pollinated vegetables (e.g., legumes, and solanaceous crops)?
- ❑ Did you learn better seed selection and seed production practices for self-pollinated vegetables (e.g., legumes and solanaceous crops) from other farmers?
- ❑ What cultural management practices are important for self-pollinated vegetables (e.g., legumes and solanaceous crops) grown for seed purposes?

Exercise No. 5.02

Seed selection and seed production by farmers of cross-pollinated (chayote, cucumber, and zucchini) vegetables

Background and rationale

In the Cordilleras, local demand for seed materials of horticultural crops is quite high. For vegetables, this is evident in amount and volume of imported seeds. Plant breeders or scientists from research institutions generally identify the most appropriate species or varieties for seed production. Traditionally, however, farmers themselves, based from their experiences, identify appropriate varieties in their specific areas. Again, although cultural management practices of vegetable crops intended for seed production are similar to those for fresh market, a few differences need utmost considerations.

For cross-pollinated crops like cucurbits and crucifers, maintaining appropriate isolation distance is important to maintain genetic purity by preventing unwanted pollination and unnecessary admixture of seeds at harvest, especially when planting two cultivars of the same crop. The minimum isolation distance for seed production is 400 m in cucurbits, and 1,000 m in crucifers. The presence of pollinators (e.g., ants, bees, wasps, and flies) is necessary for cross-pollinated crops. In cucurbits, assisted pollination, which involves collection of pollen from dehiscing male flowers and manually introducing them on receptive female flowers of the same plant, is sometimes necessary to increase fruit setting[117].

Regular field inspection and roguing should be done throughout the life cycle of crop to remove other crops or cultivars, noxious weeds, off-types, deformed or pest and diseases affected plants, and other plants whose characteristics do not conform with desired cultivar at early and late vegetative, flowering, fruiting, and harvesting stages. Many vegetable farmers use their own or their neighbor's previous harvests as seeds for next cropping.

[117] Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition. SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp167-177.

While some farmers practice good seed selection, still, many use seeds that are either nonmarketable or over matured. In FFSs, many innovative practices can be shared among farmers to ensure sustained availability of cheap but good quality seed materials. This exercise was designed to achieve this particular objective.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, when some cross-pollinated vegetables (e.g., chayote, cucumber, or zucchini) are grown for seeds in learning field
- When farmers want to learn from other farmers and do hands-on of proper seed selection and seed production of some cross-pollinated vegetables (e.g., chayote, cucumber, or zucchini)

How long will this exercise take?

- Fifteen to 30 minutes weekly field walks, observations, hands-on, and interaction with farmers
- Fifteen to 30 minutes weekly brainstorming session in processing area

Learning objectives

- To create awareness and understanding among participants that seed selection and seed production can be accomplished by farmers in their own farms.
- To learn from other farmers and do hands-on of innovative practices in seed selection and seed production of some cross-pollinated vegetables (e.g., chayote, cucumber, or zucchini).

Materials

- Office supplies (notebooks, ball pens, marking pens, crayons, Manila papers)
- Other supplies (paper bags, plastic pails, plastic twines, scythes, and tagging materials)
- Some cross-pollinated vegetables (e.g., chayote, cucumber, or zucchini) grown for seeds in learning and adjoining fields

Methodology

- Field walks, hands-on, and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe cross-pollinated vegetables (e.g., chayote, cucumber, and zucchini) grown for seeds in learning and adjoining fields. Take note of cultural management practices employed. Interview other farmers, if necessary. List down all observations related to:

- ✓ Uniformity in crop stand and vigor at early vegetative stage;
- ✓ Date of flowering (e.g., number of days from emergence to flower initiation);
- ✓ Maturity (e.g., number of days from emergence to harvest);
- ✓ Pest and diseases incidence (e.g., major pest and diseases); and
- ✓ Size and shape of fruits (e.g., maturity index of crop).

2. Go back to processing area; brainstorm in small groups and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. Motivate farmers to share their best experiences in seed selection and seed production of some cross-pollinated vegetables (e.g., chayote, cucumber, or zucchini) in their own farms, especially on the following:

   - ✓ Selection of species or varieties for seed production;
   - ✓ Isolation distance between crop varieties;
   - ✓ Presence of pollinators and conduct of assisted pollination;
   - ✓ Regular field inspection and roguing; and
   - ✓ Harvesting at the most mature stage of seed.

3. Facilitate each small group to do hands-on of best experiences in seed selection and seed production in a portion of some cross-pollinated vegetables (e.g., chayote, cucumber, or zucchini) grown in learning field, as follows:

   - ✓ Determine area needed for farmer's seed requirement (e.g., know farmer's seed requirement per hectare, his normal yield level per cropping, and his estimated production per unit area).
   - ✓ Measure and mark boundaries in a portion of some cross-pollinated vegetables (e.g., chayote, cucumber, or zucchini) grown in learning field (e.g., using above estimated area).
   - ✓ Conduct regular inspection and roguing (e.g., regular removal of other cultivars, weeds, off-types, deformed or disease and pest affected plants and other plants whose characteristics do not conform with desired cultivar at early vegetative, flowering, fruiting and harvesting stages).

- ✓ Ensure presence of pollinators (e.g., providing artificial food or growing flowering plant around) or conducting assisted pollination (e.g., manual pollination of receptive female flowers).
- ✓ Employ other cultural management practices shared and agreed upon in the big group brainstorming session.
- ✓ Take note of all relevant observations and experiences during this activity on a weekly basis.

4. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❑ What is a cross-pollinated crop? What were the most common cross-pollinated vegetable crops observed in farmers' field?
- ❑ Do we need pollinators for cross-pollinated vegetables (e.g., chayote, cucumber, or zucchini) intended for seed production?
- ❑ Why do we need to maintain isolation distance between vegetable crops intended for seed production?
- ❑ Why do we need to conduct regular monitoring and roguing of cross-pollinated vegetables (e.g., chayote, cucumber, or zucchini) grown for seed purposes?
- ❑ Which cross-pollinated vegetable crops did farmers grow and use for seed purposes?
- ❑ What seed selection and seed production practices did farmers employ for cross-pollinated vegetables (e.g., chayote, cucumber, or zucchini)?
- ❑ Did you learn better seed selection and seed production practices for cross-pollinated vegetables (e.g., chayote, cucumber, or zucchini) from other farmers?
- ❑ What cultural management practices are important for some cross-pollinated vegetables (e.g., chayote, cucumber, or zucchini) grown for seed purposes?

Exercise No. 5.03

Determining right maturity in harvesting vegetable crops for seed production and marketing purposes

Background and rationale

Crop maturity varies with the kind, variety, season, and purpose for which vegetables were grown. The right crop maturity normally depends on whether it will be harvested for seed production or marketing as fresh vegetable. For seed production purposes, crops are harvested at the most mature stage of seed. This is also called as the stage of physiological maturity of seed when all food reserves needed by the seed has been accumulated. Thus, it is at its state of maximum dry weight, its highest vigor and quality level[118].

When marketing as fresh vegetable, a certain period is known to be the most appropriate times or schedule of harvesting. This also signifies best time to pick vegetable pods or fruits for them to be more appealing to consumers. Although each crop has its own signs to show that it is ready for harvest (maturity index)[119], produce is often harvested too early if there is a good price for it and a great financial need, or there is a risk of losing crops owing to unfavorable climatic conditions.

Farmers in the Cordilleras had their own experiences in determining the right maturity for their crops and some good reasons for their continuous practice. These best practices must be shared among farmers in FFSs to further improve their understanding in determining right maturity in harvesting their crops either for seed production or marketing purposes. The foregoing exercise was designed to achieve this particular purpose.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, before harvesting of vegetable crops in learning field
- When farmers want to learn from others better ways to determine the right maturity in harvesting crops for seed production or marketing as fresh vegetables

[118] Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition. SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp167-174.

[119] PCARRD. 1985. National Technoguide on Indigenous Vegetable Backyard Gardening. Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD), Los Baños, Laguna, Philippines. pp41-43.

How long will this exercise take?
- Thirty minutes to one-hour for field walks and observations of harvesting operations in vegetables at adjoining fields of learning field
- Thirty minutes to one hour for brainstorming session in processing area

Learning objectives
- To make participants aware and understand how proper timing of harvesting for seed production or marketing purposes can improve productivity and profitability.
- To learn better experiences from other farmers on the proper timing of harvesting vegetables that will improve productivity and profitability.

Materials
- Vegetable crops ready for harvesting in adjoining and learning fields
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)

Methodology
- Field walks and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe vegetable crops ready for harvesting in adjoining and learning fields. Interview other farmers, if necessary. List down all observations related to timing of harvesting, crops planted, crop stand, etc.

2. Go back to processing area. Brainstorm in small groups and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. List down important observations shared by farmers, such as:

    ✓ Crops grown for seed production and for marketing as fresh vegetables;
    ✓ Criteria used in deciding when to harvest crops for seed production and for marketing as fresh vegetables; and
    ✓ Cultural practices followed for crop grown for seed production and for marketing as fresh vegetables.

3. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussions

- ❑ Did you observe vegetable crops grown either for seed production or marketing purposes in farmers' fields?
- ❑ What crops did farmers grow for seed production and marketing as fresh vegetables?
- ❑ When do farmers harvest their crops for seed production purposes? When do farmers harvest their crops for marketing as fresh vegetables?
- ❑ What criteria do farmers use in determining the right time of harvesting for seed production or marketing purposes?
- ❑ Did you observe differences in cultural management practices employed for vegetable crops grown for seed production or marketing purposes?
- ❑ Did you observe differences in pest and disease occurrence between crops grown for seed production and marketing purposes?
- ❑ Did you learn from other farmers their best experiences on the proper timing of harvesting different vegetable crops? How did they do it?
- ❑ What other cultural management practices can complement proper timing of harvesting to improve productivity and profitability of vegetables grown for seed production and marketing purposes?

Exercise No. 5.04

Determining maturity index in harvesting snap beans and green peas grown for seeds

Background and rationale

Maturity index refers to signs expressed by a crop to show that it is ready for harvest[120]. If a crop is grown for seeds, harvesting should be done at the stage of physiological maturity, when seed needed have accumulated all food reserves, is at its state of maximum dry weight and highest vigor and quality level. For any vegetable crop or variety, big seeds have more food reserves than small seeds, all other factors being equal, hence are better seed materials. Plants that are more vigorous flower earlier and give higher yields because of planting big seeds. For seed production of vegetable crops, seeds are harvested when fruits or pods are overmature for consumption[121].

For snap beans and green peas, pods are harvested when yellowish in color or in most cases when they are already starting to dry up. In middle elevation areas of Benguet and Mountain Province, majority of vegetable farmers grow snap beans and green peas due to their adaptability to relatively warmer temperatures. Many farmers depend on legume vegetable seeds produced in their own fields. Thus, qualities of their seeds depend on the proper timing of harvesting and storage.

In FFSs, innovative experiences in determining proper maturity indices of various legume vegetables must be shared among farmers to further improve their existing practices. The foregoing exercise was specifically designed to achieve this purpose.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, before harvesting of legume vegetables intended for seeds in learning field
- When farmers want to learn from others better ways to determine the right maturity index of legume vegetables intended for seeds

[120] PCARRD. 1985. National Technoguide on Indigenous Vegetable Backyard Gardening. Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD), Los Baños, Laguna, Philippines. pp41-43.

[121] Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition. SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños, College, Laguna, Philippines. pp167-174.

How long will this exercise take?

- Thirty minutes to one hour for field walks and observations of proper maturity index for legume vegetables intended for seeds in adjoining and learning fields
- Thirty minutes to one hour for brainstorming session in processing area

Learning objectives

- To make participants aware and understand how harvesting at proper maturity index of legume vegetables intended for seeds can improve productivity and profitability.
- To learn better experiences from other farmers on harvesting at proper maturity index of legume vegetables intended for seeds.

Materials

- Legume vegetables intended for seeds ready for harvesting in adjoining and learning fields
- Office supplies (Manila papers, notebooks, ball pens, and marking pens)

Methodology

- Field walks and brainstorming

Steps

1. Divide participants into smaller groups and ask them to conduct field walks and observe legume vegetables intended for seeds ready for harvesting in adjoining and learning fields. Interview other farmers if necessary. List down all observations related to maturity indices used, timing of harvesting, crops planted, crop stand, etc.

2. Go back to processing area. Brainstorm in small groups and present output to the big group. Conduct participatory discussions to allow sharing of experiences among participants and facilitators. List down important harvest indices shared by farmers, such as:

   ✓ Color of crop foliage at harvesting time;
   ✓ Color, shape, and size of pods or fruits at harvest time;
   ✓ Time to harvest pods or fruits during pod or fruit development stage; and
   ✓ Other criteria considered for harvesting.

3. Synthesize and summarize output of small groups into one big group output. Draw up conclusions and recommendations from this exercise.

Some suggested questions for processing discussion

- ❏ Did you observe some maturity indices used in harvesting legume vegetables grown for seeds in farmers' fields?
- ❏ What maturity indices did farmers use when harvesting snap beans and green peas intended for seeds?
- ❏ What reasons did farmers give for using a particular maturity index when harvesting snap beans and green peas intended for seeds?
- ❏ Did farmers use a different set of maturity indices in harvesting other vegetable crops intended for seeds? What are these maturity indices?
- ❏ Did you observe different seed-borne pests and diseases among legume vegetables intended for seeds harvested at varying maturity indices?
- ❏ Did you learn from other farmers their best experiences on using various maturity indices in harvesting legume vegetables intended for seeds? How did they do it?
- ❏ What other cultural management practices can complement the use of proper maturity index in harvesting legume vegetables intended for seeds, to improve productivity and profitability?

Exercise No. 5.05

Post-harvest handling and primary processing of vegetables[122]

Background and rationale

During plant growth, roots absorb nutrients, moisture, and carbon dioxide from atmosphere. The leaves then convert these into structural components (e.g., cell walls, membranes, and organelles) and food reserves. At harvest, plant parts we are interested in are separated from the rest of the plant, hence, photosynthesis essentially stops.

The harvested produce, therefore, has to depend on food and water reserves it has accumulated during growth to maintain its physiological processes. Theoretically, once food and water reserves decline appreciably, usefulness of produce is greatly diminished, if not ended. As food and water reserves are diminished, the produce's susceptibility to microbial attack also increases, thus resulting in decline of usability.

Food reserves are decreased by degradative (breaking down) processes and by respiration, while water reserves are lost by transpiration. Such decreases in food and water reserves are reflected as moisture loss or shriveling, chemical changes (e.g., change in color, taste, aroma, contents of sugar and vitamins), and textural modifications (e.g., softening, loss of crispiness, and toughening), and greater activity of pathological organisms (e.g., rotting). Any factor that hastens these processes and encourages microbial growth will hasten deterioration. The most important factors are as follows:

- *Temperature.* Low temperature slows down respiration, transpiration, and other processes resulting in deterioration of any produce up to a certain extent. This is the basis of immediately cooling a produce and then keeping it at a low temperature. Most tropical produce cannot, however, withstand temperature lower than 12^{o}C. They show abnormalities like discoloration, development of sunken areas (pitting), and failure to ripen. These are indications of physiological disturbance within a cell. Most crops introduced from temperate zone– like strawberry and cabbage– can tolerate temperatures as low as 0^{o}C.

[122] Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition. SEAMEO Regional Center for Graduate Study and Research (SEARCA) in Agriculture and University of the Philippines Los Baños, College, Laguna, Philippines. pp435-438

- *Oxygen and carbon dioxide.* Oxygen (O_2) and carbon dioxide (CO_2) also influence respiration rate within immediate vicinity of the commodity. Since O_2 is a reactant of respiration, by law of mass action, a decrease in O_2 from 21 percent will slow down respiration rate. Too low concentration of O_2, however, will result in fermentation, giving produce a fermented odor, an off-flavor, which is not desirable.

  On the other hand, since CO_2 is a product of respiration, an increase of CO_2 from 0.03 percent will result in a decrease rate of respiration up to a certain point. Too much accumulation of CO_2, results in CO_2 injury, as manifested by a symptoms like discoloration, off-odor, and off-flavor. A decrease in O_2 and an increase in CO_2 in immediate vicinity of a commodity, therefore, increases storage life. However, a very low amount of O_2 or a high level of CO_2 in a container of produce results in rapid decline in quality.

- *Relative humidity.* Temperature and relative humidity primarily controls the rate of decline in water reserves. The cells of most vegetable produce contain very high amount of moisture. If relative humidity of atmosphere is low, the tendency is for cells to lose water to the atmosphere. Hence, for most produce, higher temperature and lower relative humidity result in faster water loss. Consequently, shriveling occurs.

  At a given temperature, lower relative humidity causes faster transpiration and consequently faster shriveling of produce. High temperatures aggravate low relative humidity. Vegetables are best stored at high relative humidities (e.g., 80-95 percent), but produce should be healthy and containers, as well as storage space, should be clean because microorganisms multiply very fast under high relative humidity.

- *Injuries.* Injuries serve as avenues for entry of microorganisms and easy exit of water from produce. Even if no wound is visible, cells might have been ruptured during careless handling. Fast deterioration of injured cells is a result of evolution of ethylene, faster rate of respiration, and transpiration of injured cells as a response to injury. High levels of ethylene speeds up ripening, causes green produce to turn yellow, and root vegetables to sprout. Therefore, injuries have to be kept to a minimum, if not entirely avoided.

In FFSs, innovative experiences in postharvest handling and primary processing of crucifers and other vegetables must be shared among farmers to further improve their existing practices. The foregoing exercise was specifically designed to achieve this purpose.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, just before harvesting and before start of discussions on 'Harvesting and Postharvest Management in Vegetables'

How long will this exercise take?

- At least one hour for role-playing
- At least one hour for puzzle game
- At least one hour for participatory discussion, using guide questions
- At least half day for field visit (optional)

Learning objectives

- To discuss issues, problems, and concerns in postharvest handling and primary processing of vegetables.
- To build awareness among participants of recent advances in postharvest handling and primary processing of vegetables.
- To discuss some interventions by government and private sector to improve postharvest handling and primary processing of vegetables.

Methodology

- Role-playing, field visit, puzzle game, and guided participatory discussions

Materials

- Manila papers, marking pens, and bond papers (for role-play)
- Five cartolina cardboard (4 x 8 inches of assorted colors), Manila paper, marking pens, paste, scissors, Kraft envelop (for puzzle game)
- Five guide questions (one for each group), Manila paper, marking pens (for participatory discussion)
- Postharvest facilities, traders (for field visit)

Steps

Field Visit:

1. Conduct field visit to postharvest facilities and trading post for vegetables. Expose participants to postharvest facilities and trader operations that are existing for at least five years.

2. Ask participants to observe and interview traders, postharvest personnel and farmers focusing more on objectives of the topic.

Role Play:

3. Divide big group into five smaller groups. Each small group will designate among themselves who will be farmer, trader or feed miller, government or private sector, and researcher. Instructions of roles will be provided by facilitators (to be written in a sheet of paper), as follows:

   ✓ Farmer will focus on prevailing issues and problems on postharvest handling and primary processing operations that concerns farmers;
   ✓ Trader will focus on prevailing issues and problems on postharvest handling and primary processing operations that concern traders or feed millers;
   ✓ Government sector will focus on measures or interventions (e.g., low farm gate price or government support price);
   ✓ Private sector will focus on support to farmers (e.g., no market or procurement or market linkage); and
   ✓ Researcher will focus on recent advancement to cope up with global competitiveness issue (e.g., postharvest handling and primary processing problems in vegetables).

4. Conduct brainstorming sessions in small groups and present role-play to the big group.

5. The facilitator should guide a participatory discussion to synthesize and summarize result of role-play and come up with recommendations as a result of this activity.

Puzzle Game:

6. Facilitators will prepare necessary materials as follows:

   ✓ Make cartolina cardboard cutouts of equal sizes (4 x 8 inches). Each cartolina cardboard will make 7-10 cutouts of equal sizes.
   ✓ Draw cabbage head or parts of matured cabbage plant (whole cabbage plant ready for harvest).
   ✓ Prepare guide questions. (Guide questions will be written on cutouts, kept on Kraft envelopes, and provided as part of puzzle game. These will be used to facilitate participatory discussions or brainstorming session.)

7. Facilitators divide big group into five smaller groups (or use their PTD groupings).

8. Each small group is assigned (by drawing lots) as one of the following: group of farmers, traders or feed millers, government or private sectors, and researchers.

9. Each small group forms a puzzle and answers guide questions written on a completed puzzle.

10. Each small group conducts a brief brainstorming session to answer guide question and present output to the big group.

11. Facilitators guide a participatory discussion to synthesize and summarize salient points and add some key points that may have been left out. The big group also provides additional issues, problems, or concerns and how to address them.

Guided Questions:

12. Facilitators formulate five questions relevant to postharvest handling and primary processing operations in vegetable production.

13. Each small group draws a question, brainstorms for 10 minutes, answers question, and presents output to the big group.

14. Facilitators guide a participatory discussion to solicit reactions from participants and share additional information on issues, problems, and concerns related to postharvest handling and primary processing operations in vegetable production.

Some suggested questions for processing discussion

- ❏ What are the issues, concerns, and problems confronting postharvest handling and primary processing in local vegetable industry? (postharvest handlers and traders)
- ❏ What has been done to address postharvest handling and primary processing in local vegetable industry in the Philippines? (government and private sectors)
- ❏ What are the most recent advancement in postharvest handling and primary processing of vegetables in the Philippines? (researchers)
- ❏ Arrange issues and problems in matrix form, as shown in the example below:

ISSUES/PROBLEMS	PRIVATE/GOVERNMENT INTERVENTIONS	RECENT ADVANCES
1. Low Price	• Government price support	• Pesticide-free product
2. No marketing outlet	• Private sector procurement and market linkages	• Product transformation

Note: Facilitators will have to read some recent postharvest handling and primary processing technologies for latest information. All questions are applicable to VST, TOT, and FFS. FFS will focus only on farmer and trader issues, problems, and concerns. If not addressed during discussions, facilitators will provide inputs on government and private sector interventions and recent technologies.

Exercise No. 5.06 Maintaining quality of vegetables for marketing[123]

Background and rationale

Postharvest operations to which vegetables are subjected vary with crops, distance to which it is transported, and outlet (i.e., whether it is for export, for domestic market, or for processing plant). Generally, vegetable produce are cleaned, sorted, and packed before transporting them, if intended for local market. For export, additional operations have to be done such as weighing, fumigating, and labeling. Cleaning and sorting are also more thorough. For most importing countries, grading is a necessary operation. Grading is sorting according to a set of criteria recognized by the vegetable industry. This set of criteria is termed as standards.

Simple methods can be used to prolong storage life of produce for a few days. For small-scale producers or retailers, or for home use during hot dry season of a year, quality of vegetables can be maintained for longer periods under ordinary conditions by evaporative cooling methods. Cooling occurs when water is evaporated from a moist surface, because it uses heat or respiration coming from the produce in the process of evaporating. At the same time, relative humidity within immediate vicinity of produce is increased, thus minimizing shriveling. These methods include: (a) sprinkling leafy vegetables with water; (b) wrapping with banana leaves; and (c) burying fruit vegetables in moist sand, sawdust, or sterilized soil. Other methods include storing (d) inside a clay jar with water at bottom of jar but not coming in contact with fruit; or (e) inside a wet cloth tent.

In FFSs, innovative experiences in maintaining quality of crucifers and other vegetables for marketing must be shared among farmers to further improve their existing practices. The foregoing exercise was specifically designed to achieve this purpose.

When is this exercise most approriate?

- In FFS, TOT, and VST sessions, after discussion of the topic 'Postharvest Handling and Primary Processing of Vegetables'

.[123] Bautista, O.K. (ed.). 1994. Introduction to Tropical Horticulture. 2nd Edition. SEAMEO Regional Center for Graduate Study and Research (SEARCA) in Agriculture and University of the Philippines Los Baños, College, Laguna, Philippines. pp438-441.

How long will this exercise take?

- Two hours for field visit to some traders or postharvest, where there is ongoing vegetable buying operations (optional for FFS)
- Thirty minutes for role-playing
- At least one hour for participatory discussion in small and big groups

Learning objectives

- To discuss participants' marketing practices, channels, strategies, problems, issues, and concerns affecting them and how these are addressed.
- To develop improved marketing strategies for farmers to increase their incomes.

Materials

- Notebook, ball pen
- Manila paper and marking pen per group
- Some vegetable traders and postharvest handlers, where there is an on-going procurement operation

Methodology

- Field visit, role-playing, and brainstorming

Steps

Field visit:

1. Prior to field visit, facilitators conduct initial interviews of vegetable farmers, traders, or government personnel involved in vegetable procurement.

2. Present initial results of observations or data gathered to participants. Brainstorm in the big group on what data to collect and observe or questions to ask for interviews of farmers. Some examples of questions to be asked are:

   ✓ Is the farmer selling his own vegetable produce individually or through a cooperative? Why? What are the requirements, terms, and conditions?
   ✓ Who sets the selling price? How much do they sell their vegetable produce? Are they satisfied with the price of their produce?
   ✓ What processes were done before they sell their vegetable produce? How many channels do their vegetable produce pass through before reaching traders or postharvest handlers?

3. Participants conduct field visit in small groups to some vegetable traders or trading posts, where there is ongoing vegetable procurement operation and implement procedure agreed upon by the big group. Participants may consider the following factors in marketing vegetables:

   ✓ Know the current price of vegetable produce;
   ✓ Know the transportation cost in marketing;
   ✓ Consider risk and labor in marketing;
   ✓ Know the condition of vegetable produce (e.g., Can it stand long storage?);
   ✓ Know the expected damage or loss in storage and marketing of vegetable produce;
   ✓ Bid or canvass for higher market prices; and
   ✓ Know the supply and demand situation.

4. Go back to the session hall, consolidate outputs of field visit in small groups, and report it to the big group.

Role-playing:

5. Divide big group into five smaller groups and give them their respective assignments or tasks.

6. Three small groups role-play their vegetable marketing practices, problems, or concerns and how these are addressed. Group leaders assign the following roles to their group members, such as:

   ✓ One participant as trader;
   ✓ One participant as government representative;
   ✓ Two participants as farmers; and
   ✓ One participant as an assembler (e.g., whenever applicable).

7. Two groups act as observers to record and report practices, channels, strategies, problems, issues and concerns, and recommendations made to address some problems or issues portrayed in role-play.

8. Facilitators guide a participatory discussion to synthesize and summarize results of this exercise.

Some suggested questions for processing discussion

- ❏ In what form do farmers normally sell their vegetable produce? Why?
- ❏ When do they sell their produce? Why?
- ❏ Where do farmers get their market information?
- ❏ Do farmers grade and pack their vegetable produce before selling or marketing?
- ❏ Do farmers store their vegetable produce before selling or marketing?
- ❏ What storage practices do farmers employ before selling or marketing their vegetable produce?
- ❏ Who sets the selling price for vegetable produce? What are the bases of the set buying or selling price? Are farmers satisfied with the selling or buying price set? Why?
- ❏ Who buys the farmer's vegetable produce? Why did farmers prefer to sell their vegetable produce to them?
- ❏ Do farmers sell their vegetable produce individually or through a cooperative? Why?
- ❏ What are some of the farmers' common vegetable marketing problems, issues, or concerns and how do they address them?

Glossary

Glossary

Agricultural lime	are lime materials containing oxides, hydroxides, or carbonates of calcium (Ca) and magnesium (Mg) that are applied to the soil to reduce soil acidity.
Agroecosystem analysis (AESA)	refers to the weekly study of the components of crop agroecosystem, such as the plant morphology, agronomy, herbivores, natural enemies of the herbivores, diseases, rats, weather, water, weeds, etc., in the 'learning field', which will lead into a process useful for decision-making.
Activity	is a generic term for participatory training experiences such as exercises, games, role-plays, small group experiences, and instrumentation.
Amensalism	occurs when one species is suppressed while a second is not affected, typically a result of toxin production.
Ammonium phosphate (ammophos)	is a chemical fertilizer material, which is a rich source of nitrogen and phosphorus elements or nutrients.
Ammonium sulfate (ammosul)	is a chemical fertilizer material, which is a rich source of nitrogen and sulfur elements or nutrients.
Aphids	are soft-bodied tiny insects whose color normally varies from yellowish-green to dark olive-green or almost dull black, which cause injury by sucking up cell sap of plants.
Avoidance	is a fundamental principle in pest and disease management, which alters environment by making it less favorable to growth and development of a pest or a pathogen.

Bacteria	are considered the simplest of plants. They are tiny, consist of only one cell, and multiply by cell division as frequently as every 10-15 minutes. They lack green pigments and cannot produce their own food. Most of them gain entry through wounds or natural openings found on the surface of the plants. Once inside, the bacteria multiply rapidly, break down the plant tissue, and usually move throughout the plant.
Bacterial diseases	refer to diseases that are caused by bacteria. The most common symptoms of bacterial diseases on plants are maceration or disintegration of tissues, 'water-soaked' appearance, and 'foul' odor.
Bacterial oozing technique (BOT)	is a practical tool used by farmers for identifying bacterial wilt disease of solanaceous vegetables. This consists of putting a cutting of suspected diseased plant part in a glass filled with tap water to allow a cloudy bacterial fluid to ooze from that plant part to the water.
Bacterial wilt	is a bacterial disease of solanaceous crops causing rapid wilting, stunting and death in tomato, and wilting of younger leaves or slight yellowing of leaves in potato.
'Ballot box' evaluation (BBE)	is a simple, easy-to-use pre- or post-training evaluation tool for farmers and extension workers of their knowledge and skills in integrated pest management (IPM). A participant selects an appropriate 'ballot box' where he or she drops his or her code number representing the correct answer.
Baseline data	are agronomic, demographic, socioeconomic, and other related data gathered from farmer field school (FFS) participants, which are used for comparison with current data when stakeholders review and assess impact of local IPM programs on farmer-participants and their communities.
Bean fly	is a pest of leguminous vegetables belonging to the fly family, whose yellowish to reddish maggots hatch from the eggs to feed as miners, working down the petiole into the stem of plants.
Behavior	refers to any observable or visible action or activity performed by the learner.

Beneficial insects	refer to insect groups that give benefit to farmers in terms of insect pest reduction and improvement of yield and quality of products. A beneficial insect can either be a parasitoid or a predator that controls the population of pests or pollinators.
Beneficial microorganism	refers to a soil-borne organism that give benefit to farmers in terms of suppressing harmful soil-borne plant pathogens which consequently improve yield and quality of products. Beneficial microorganisms interact with harmful microorganisms through competition, amensalism, or parasitism.
Bench terracing	is an effective erosion control measure practiced in the Cordilleras, which consists of creating a series of level strips running across the slope.
Big group discussion	is a term used to describe the use of big groups (e.g., plenary sessions) in identifying and solving problem by participatory discussion.
Biological control	is the use of living organisms such as parasitoids, predators, and disease organisms to control pest populations.
Biological control agents	refer to any living organism used in reducing pest population in vegetable farms.
Black cutworm	is a lepidopterous pest of vegetables whose blackish larva remains buried below the surface of the ground level and attacks the root and base of crop during the first two weeks of crop growth.
Borer insects	refer to a group of destructive insects whose immature stages bore or make tunnels on fruit or stem of plant.
Brainstorming	is a basic and highly popular tool for group problem solving. It can be used to identify problems, to suggest causes for problems and to propose solutions for problems. The technique emphasizes deferred judgement and quantity to get quality.
Cabbage butterfly	is a butterfly whose caterpillar feeds and produces big holes on the foliage of cabbage and other cruciferous crops.

Cabbage moth	is a brownish gray pyralid moth whose larva attacks the growing point, which often results to non-formation of head or perforations on the leaves of cabbage and other cruciferous crops during heavy infestation.
Cage trap	is a type of trapping material made of appropriate wire mess, which is used in collecting and controlling field and house rats.
Calendar insecticide application	means any scheduled insecticide treatment undertaken with no consideration for pest density or anticipated crop loss.
Case study	is a technique designed to give group training in solving problems and making decisions. The facilitator's role is typically catalytic rather than didactic.
Certified seed	is a high quality seed intended for commercial planting that passes through the seed certification standard of the Philippine Seed Industry Board in terms of genetic purity and identity. A certified seed is classified by a certifying agency depending upon its quality either as a breeder, a foundation, a registered, a certified, or a good seed.
Chemical control	means any strategy or method that employs the application of any pesticide to control pests.
Chewing insects	refer to a group of destructive insects whose destructive stages have a mandibulate or chewing mouthparts.
Club root	is fungal disease of crucifers causing swelling of the roots with characteristic club-like shapes and a reduction of fine lateral roots. The later reduces the ability to absorb water resulting to stunted growth and death of the plants under dry climatic conditions.
Common cutworm	is a lepidopterous pest of vegetables whose greenish to blackish-brown larva is voracious feeder and feed actively at night. Damage consists of feeding on young and mature leaves of the host-making large holes on leaf blade.
Competition	is a condition where there is a suppression of one organism as two species struggle for limiting quantities of nutrients, oxygen, or other common requirements.

Composting	refers to a process involving the breakdown of organic materials through the action of decomposers (e.g., microorganisms and macroorganisms) to form small bits of organic matter called compost.
Content	refers to the subject matter or topics taken up in an activity or activities to attain the objectives.
Contour planting or farming	refers to a method of farming where cultivation is accomplished by plowing across the slope following the contour lines rather than up and down.
Cost and return analysis	is an analysis of the cost of production relative to net return in an enterprise. Usually, the lower the cost of production, the higher is the net return for a particular enterprise.
Cost of production	refers to the amount of labor, power, and material input costs in each operation for every enterprise.
Critiquing	is an activity to assess the progress and the effectiveness of learning in terms of learning processes, relationships, physical environment, and problems and issues relevant to learning as expressed by the participants.
Crop residue-inhabiting pests	refer to all pests whose main harborage or habitat, in the absence of a suitable host, is crop residue, such as weeds or any plant debris often left in the field after harvest.
Crop diversification	refers to the planting at the same time in on-farm or field of as many crops to maximize land uses and minimize pest and disease occurrence depending on such factors as crop preference, technical knowledge, adaptability, market demands, and profitability.
Cross-pollinated vegetables	are vegetables wherein pods or fruit setting result from union of female (ovule) and male (pollen) reproductive cells of two different plants, varieties, or cultivars.
Crop rotation	refers to the growing of two or more crops after another in a regular succession for two or more years with an idea that a crop susceptible to a pest or disease is followed by a resistant crop or combined in simultaneous cropping with other crops.

Crop sequencing	refers to proper arrangement of crops planted in succession to maximize production. A good cropping sequence is one that will conserve or improve nutritional status of the soil, add organic matter, improve soil structure, protect land from erosion and, ultimately, give high yield.
Cucurbits	are vegetable crops belonging to the cucurbit family. Some examples are squash, cucumber, chayote, zucchini, watermelon, bitter gourd, and loofah.
Cultural control	is the modification of the environment by making the area less attractive to pests (e.g., tillage, planting date, crop rotation, etc.).
Curd- or head-forming vegetables	are vegetable crops grown primarily for their flowers or terminal buds technically known as curds or heads, respectively. Some of these vegetables are Chinese cabbage, cabbage, head lettuce, broccoli, and cauliflower.
Cutworm	is a polyphagous moth whose caterpillar is basically a leaf-eater, which can severely defoliate a crop when population is heavy.
Damping off	is a fungal disease of cruciferous, solanaceous, leguminous, and cucurbit crops at seedling stage, which can be distinguished by the presence of water-soaked lesions on the hypocotyl or reddish-brown lesions at the base of seedlings at or just below the ground level.
Dehaulming	is a cultural management practice which consists of defoliating potato crop, leaving at least one-foot stem intact on tubers, and keeping rows well hilled-up to prevent late blight spores from getting in contact with the tubers. Tubers are not harvested for at least two weeks after diseased foliage had been cut off to allow time for spores to be washed off.
Debate	is a participant-involving technique, structured formally or informally, to generate varying viewpoints on an issue or problem.
Destructive insects	refer to a group of insects that feed on vegetable crops; specifically on leaves, stems, flowers, and fruits, causing damage to these crops thereby affecting yield or quality of produce.

Diadegma	is a larval parasitoid used in vegetable production as a biological control agent against the diamondback moth (DBM) of cabbage and other cruciferous vegetables.
Diamondback moth (DBM)	is a small gray moth with a diamond pattern at the back when its wings are closed, whose larva feeds on the leaves of cabbage and other cruciferous crops.
Didactic teaching	is a traditional approach to teaching or instructing, entailing the dissemination of facts, knowledge, information, manual skills, etc. Today it is contrasted with experiential or discovery-based learning.
Discovery-based learning	is a learning process accomplished by doing and experiencing as opposed to listening, observing, reading, viewing, etc. It is synonymous with experiential learning.
Dormancy	refers to the inability of a seed, a bulb or a tuber to germinate after harvest even when provided with the necessary conditions for germination.
Downy mildew	is a fungal disease of solanaceous and cucurbit crops, which appear as yellow spots on the surface of the leaves with a purplish downy growth on the lower surface. These yellow spots may soon turn reddish-brown and eventually kill the leaves.
East-west row growing	refers to vegetable growing in east-west row orientation or in relation to the rising and setting of the sun.
Ecology	consists of all the organisms at a given locality and their interactions with each other and with the physical environment.
Ecosystem	is a biological community considered in relation to its physical environment.
Eradication	is a fundamental principle in pest and disease management, which involves the elimination of a pest or pathogen once it has become established on plant or in a cropping area.

Evaluation	is the process of assessing the effectiveness of various learning activities, the participants, the facilitators and the conduct of the whole program.
Evaporative cooling method (ECM)	is a simple method used to prolong the storage life of vegetable produce, under ordinary conditions for a few days, where cooling occurs when water is evaporated from a moist surface using heat or respiration coming from the produce in the process of evaporating.
Exclusion	is a fundamental principle in pest and disease management, which includes exclusionary measures to prevent a pest or pathogen from entering and becoming established in a non-infested or non-infected area.
Exercise	is a structured learning experience marked by a learning goal, high participation, and structure. Its overall purpose is to generate data from participant analysis.
Facilitator	is a trainer or specialist who, as a change agent, structures learning situations and experiences with the end result of enhancing the learner's capabilities to be sensitive to his or her own processes and behavior. He is one who functions in a way to allow participants to assume responsibility for his or her own learning. The term is in contrast to the more didactic instructor, teacher, lecturer, presentor, etc.
Farmers' crop protection (FCP) practice	refers to usual crop protection practice of farmers prior to the introduction of integrated pest management (IPM) practice in any vegetable production area. Normally, an FCP consists of a calendar-scheduled pesticide application for the control of pests and diseases.
Farmer field school (FFS),	by design, is a 'school without walls', where about twenty five farmers meet once a week for the duration of the cropping season from planting to harvest. In each weekly session of an FFS, the farmers, working in-groups, conduct agroecosystem analysis (AESA), team building activities and special topics. Special topics are designed based on immediate problems encountered by farmers in their farming activities. Trained FFS facilitators allow farmers to be experts, facilitating them to bring forth and examine their own experiences.

Feedbacking	is a way of receiving information from or giving to one or more participants or facilitators concerning one's behavior, attitudes and relationships in a learning situation.
'Feel' method	is a common field method of classifying soil texture for vegetable production by its feel or by rubbing soil between thumb and fingers.
Fertilizer management	means any strategy or method that will lead to effective and efficient use of fertilizers in crop production.
Field day	is an occasion when farmers and facilitators show other people or the community what they have learned and the results of their participatory technology development (PTD) activities.
Field trip or field visit	is a planned visit or tour to a given area, site, laboratory, field, plantation, project, etc. to study its operation in depth, learn lessons and to report back thereon. The field trip is typically a team project or activity, although not universally so.
Field walk	is a planned observation accomplished by walking in a nearby field a training site to have a first hand experience of an issue or problem related to the training. Observations in a field walk are synthesized through small and big group discussions.
Flea beetle	is an insect pest belonging to the beetle family, whose adult eats out 'pin holes' on the leaves of the host plants. If attack is excessive, the leaves fall and the plants may be completely defoliated.
Folk media presentation	is a learning tool used to convey a developmental message using the most appropriate local medium that is familiar to a group of people. Local songs, dances, poems, proverbs, stories, tales, legends, and drama are some of the common forms of folk media.
Fruit worm	is a lepidopterous pest whose larva tunnels into the fruit and feed voraciously on the tissues causing fruit to rot and subsequently fall off.

Fungal diseases	refer to diseases caused by fungi. The general symptoms of fungal diseases on plants are the presence of 'cottony-like' and 'dry' appearances (e.g., leaf spots) of infected plant parts.
Fungi	are tiny, simple plants commonly called molds. Since they do not have green color, they lack the ability to make their own food. They depend upon living host plants for food. Thus, they are parasites, and in the course of their feeding, most produce diseases on their host plants.
Fusarium wilt	is a fungal disease of solanaceous, leguminous, and cucurbit crops, which can be distinguished by the presence of a reddish discoloration on the roots, which gradually darkens and finally turns brown. The diseased plants are stunted and during dry weather, the leaves turn yellow and drop.
Game	is an experiential learning activity marked by a learning goal, competition, rules, scores or outcomes and oftentimes with winners and losers. Games may be content-laden or be a 'pure' game devoid of content.
Grading	refers to the sorting of vegetable produce according to a set of criteria recognized by the vegetable industry.
Green leaf manuring (GLM)	refers to the soil incorporation of plants grown outside an area where it is not intended before their flowering stage as a source of organic matter. Weeds gathered on side of terraces such as wild sunflowers, when incorporated in vegetable fields are classified as green leaf manures.
Green manuring (GM)	refers to the soil incorporation of plants grown at a site where it is needed before their flowering stage as a source of organic matter. All fast-growing weeds when incorporated before flowering at land preparation and hilling-up operations are classified as green manures.
Gross return	refers to the product of price and volume relative to the type of produce in every enterprise.
Group dynamics	is a process of interaction of a group at work. It includes such processes as communication, goal setting, decision-making, support giving, and leadership.

Hilling-up	is a cultural management practice whereby soil is cultivated and raised at the base of plants primarily to enhance better root development, improve anchorage, and suppress growth of weeds. Hilling-up also disturbs development of other soil-borne pests and exposes to sunlight many soil-borne plant pathogens that thrive near the base of plants.
Hot water treatment	is a practical soil sterilization technique used by farmers to control some soil-borne diseases of vegetables in the seedbed.
Hydroization	is a pre-sowing hardening technique to induce drought resistance, which consists of soaking seeds for 1-48 hours depending on seeds, and then air drying to their original moisture content before sowing.
Insect pathogens	refer to a group of biological control agents, mostly parasitic microorganisms, used to control insect pests of vegetables. Some insect pathogens infecting various insect pests are viruses, bacteria, and fungi.
Insecticide	is a pesticide or chemical used to control insect pests.
Insecticide non-user	refers to a farmer or individual that does not use any insecticide to control insect pests.
Insecticide	user refers to a farmer or individual that uses insecticides to control insect pests.
Interaction	refers to the dynamics among participants, including communication patterns, relationships, role assumptions, etc.
Integrated pest management (IPM)	is a pest management strategy that builds on biological control as its foundation. In practice, it develops farmer's ability of making critical and informed decisions that renders production systems more productive, profitable and sustainable. Thus, it makes farmers experts in their own fields.
Integrated crop management (ICM)	refers to all management strategies that are ecologically, economically, and socially acceptable. Therefore, IPM and integrated soil management (ISM) are integral part of ICM.

Integrated soil management (ISM)	includes efficient soil nutrient, water and weed management, effective soil borne pest and disease management as well as effective use of soil microorganisms for better crop productivity. Consequently, ISM aims to allow a grower to produce optimum yield and sustained long-term returns.
Integration	is that stage of learning where the learner is able to piece together the learning in an activity and sees the value in its application to his or her real life situation.
KASAKALIKASAN	is the acronym for Kasaganaan ng Sakahan at Kalikasan. It means Nature is Agriculture's Bounty. It is the Philippine Government's program that seeks to popularize Integrated Pest Management (IPM).
Labor and power cost	refers to the amount of labor and power spent in each operation for every enterprise which is expressed in man-days, man-animal days, or man-machine days.
Leaffolder	is a lepidopterous pest whose larvae feeds on leaf tissue and, as it becomes older, folds the leaf to form a tube.
Leafhopper	is a pest belonging to the cicada family whose nymphs and adults attack solanaceous vegetables. As it feeds, it injects a toxic substance, which produces a condition known as 'hopperburn'.
Leafminer	is a small grayish fly whose larvae mine in-between the leaf epidermis which when several of them work in the same leaf, develop blotch and turn the entire leaf white and wither, resulting in the stunting of subsequent growth and ultimately in poor yield.
Leaf spot	is a fungal disease of cucurbit and leguminous vegetables characterized by the presence of spots, circular to irregularly shaped, with tan or gray centers, and surrounded with reddish-brown to dark-brown margins.
Leafy vegetables	are vegetables grown mainly for their leaves. Some examples of leafy vegetables are pechay, mustard, lettuce, celery, 'kangkong' (swamp cabbage), and 'kulitis' (amaranth).

Learner-centered training refers to a training situation wherein participants are given the opportunity to assume responsibility for their own learning.

Learning field is that portion of a farmers field school measuring at least 1,000 square meters, containing a farmer-run comparative study of integrated pest management (IPM) and farmers crop protection (FCP) practices. It is in this field that farmers practice agroecosystem analysis (AESA) which include plant health, water management, weather, nutrient management, weed density, disease surveillance, and observation and collection of insect pests, beneficial predators, and parasites. Farmers interpret data from the learning field through direct experience using AESA to make field management decisions and develop a vision of balanced ecological processes.

Lecture method is a didactic instructional method, involving one-way communication from the active presentor to a more or less passive audience or trainee group.

Leguminous vegetables are vegetables belonging to the legume or pulse family. Some examples of leguminous vegetables are bush long bean, cowpea, snap beans, sweet peas, garden peas, chicken peas, and winged beans.

Liming refers to the addition of lime to reduce soil acidity or until the soil pH is within that required for optimum plant growth. Available iron, aluminum, and hydrogen must be replaced by Ca and Mg bases through liming to decrease soil acidity. Adding oxides, hydroxides, or carbonates of calcium and magnesium commonly does this.

Material input cost is the total cost of all materials used in each enterprise such as seeds, fertilizers, and herbicides, among others.

Maturity index refers to signs expressed by a crop to show that it is ready for harvest.

Methodology refers to the various ways and means by which the dissemination of concepts, ideas, knowledge, and skills can be affected. This may include the definition of instructional media and the materials to be used as aids in facilitating the learning process.

Miner insects	refer to a group of destructive insects whose immature stages puncture or mine on leaves down to petiole and stem of plant.
Mulching	is the practice of covering bare soil around the stem of a growing plant with a layer of organic materials, plastic, and other appropriate materials primarily to conserve soil moisture, suppress growth of weeds, minimize splash soil erosion, and soft rot or other soil-borne disease infections.
Natural enemy	refers to a beneficial insect, a predator, a parasitoid or an insect pathogen utilized for the control of insect pests.
Natural pest control	is the conservation of beneficial insects, predators, and parasitoids by preventing their destruction or preserving their habitat. Choice of plant varieties, maintenance of alternative hosts, and proper soil management are among the tactics employed to keep beneficial species active and populous enough to control pests.
Need-based or threshold-based insecticide application	means any insecticide treatment undertaken only when actual pest population exceeds a predetermined threshold level.
Nematodes	are active, slender, threadlike roundworms about 1/70th of an inch long. Their mouthpart is equipped with a tiny spear or stylet, which they use to puncture plant cells to obtain plant juices. A number of plant parasitic nematodes feed from the outside of the roots, stems, buds, and leaves. Others feed by tunneling through the roots.
Net return or net income	refers to the difference between gross return less and total cost of labor and materials in every enterprise.
Nitrogen fertilizer	refers to any fertilizer material containing nitrogen element or compound.
Nutrient management	means any strategy or method that will lead to effective and efficient use of nutrients in crop production.

Nonformal education (NFE)	is a participatory learning approach that encourages the learners to see themselves as source of knowledge about the real world and to work with the knowledge they have from their own experience in the learning process.
Objective	refers to the desired organizational and behavioral attributes or characteristics to be attained after conducting an activity.
Organic fertilizer	refers to any fertilizer made from organic materials, such as decomposed animal and plant materials, which when applied to the soil, will supply nutrients or elements to crops in slower and smaller quantities than a chemical fertilizer.
Overhead irrigation	is a method of irrigation where water is applied either in form of a fine mist (spraying) or spray simulating rain (sprinkling). Water may be manually applied by use of watering cans or mechanically applied under pressure and at pre-determined intervals.
Panel discussion	is a term used to describe the use of panel of interrogators and discussants in identifying, discussing and solving problem. This activity is an effective tool in helping participants to develop their capability to communicate ideas and knowledge with other participants.
Parasitism or predation	refers to direct attack of one organism on another.
Parasitoid	is a beneficial insect that lives for a while in or upon the body of a single host pest species or a few closely related species but gradually destroys or kills it.
Participant	refers to a person who is the focus of learning activity and who is expected to participate actively in the learning process.
Participatory technology development (PTD)	is the process of collective and collaborative inquiry with the purpose of initiating community actions on solving local problems.
Pest management	an ecologically-based strategy of maintaining pest population below the economic injury level by the use of any or all control techniques that are economically and socially acceptable.

Pesticide	is a compound or chemical, such as acaricide, insecticide, herbicide, fungicide, nematicide, rodenticide, and the like, that is used to control pests and diseases.
Pesticide non-user	refers to a farmer or individual that does not use any pesticide to control pests and diseases.
Pesticide user	refers to a farmer or individual that uses pesticides to control pests and diseases.
pH	is an expression of soil reaction (e.g., acid, neutral, or alkaline), which is the negative logarithm of the hydrogen ion concentration. Acidity denotes an excess of H+ ions over OH- ions and alkalinity denotes the opposite. At neutral reaction, the H+ and OH- ion concentrations are equal.
Phosphorus fertilizer	refers to any fertilizer material containing phosphorus elements or nutrients.
Physiological disorders	refer to all plant abnormalities or disorders that are caused by one of combinations of non-infectious organisms, nutrient deficiencies or toxicities, and chemical injuries or toxic residues.
Physiological maturity	is when seed have accumulated all food reserves, is at its state of maximum dry weight, and highest vigor and quality level.
Pod borer	is lepidopterous pest attacking leguminous vegetables whose larvae are voracious feeders on inflorescence with developing pods resulting to underdeveloped pods.
Pollinators	are beneficial insects that pollinate flowers of some vegetable crops like cucumber, chayote, snap beans, green peas, bell pepper and tomato. Wild bees and honeybees are the most predominant pollinators of vegetables.
Potassium fertilizer	refers to any fertilizer material containing potassium element or nutrient.
Powdery mildew	is a fungal disease of parsley and leguminous vegetables characterized by small, discrete, white moldy spots on the upper surface of the leaflets, which rapidly enlarge to an indefinite size until they coalesce.

Predators	refer to a group of biological control agents that are free-living throughout their entire life cycles. A predator can be a beneficial insect or arthropod (e.g., spider) that feed on many different species of prey (e.g., insect pests or arthropods) by quickly eating them or sucking their body fluids.
Pricking-off	refers to initial transplanting of some vegetable seedlings (e.g., celery and lettuce) to give them greater space in which to grow before finally transplanting in the main field.
Problem solving	is the process of effective decision-making. The skills, which relate to the classic model of decision-making, are how to: (a) define the problem, (b) generate data about the problem, and (c) generates ideas or alternate courses of action for problem resolution, (d) choose among the alternative solution, and (e) implement the solution or decision.
Process	refers to the dynamics of interplay of behaviors within the learning situations leading to the attainment of the training objectives.
Processing	is a way of surfacing experiences and insights of participants and interpreting these into the learning context.
Productivity	refers to the increase in yield resulting from improved decision-making skills among farmers associated with integrated pest management (IPM) practices such as selection of appropriate varieties, use of biological control agents (e.g., *Diadegma* or *Cotesia*), correct timing of fertilizer application, and sound water management.
Profitability	refers to the increase in farmers' net income associated with increased yields and decreased production costs as a result of the IPM program.
Protection	is a fundamental principle in pest and disease management, which is achieved through interposing a protective barrier between pest or pathogen and susceptible plant.
Pruning	a practical cultural management strategy, which includes the removal of all diseased and weak plant parts (e.g., leaves, stems, flowers, or fruits).

'Pulling the guts 'technique' is a practical tool used by farmers to determine the degree of larval parasitism by Diadegma semiclausum wasp or diamondback moth (DBM) of crucifers.

Puzzle refers to a fun-type form of experiential learning that is designed to stimulate participant curiosity, creativity, and a problem-solving orientation. In some cases, puzzle is used 'just for fun.'

Repellent crops are crops with pest repelling properties, which are grown in-between or around the area planted to vegetable crops to repel some specific destructive pests of a particular vegetable crop.

Resistance is a fundamental principle in pest and disease management referring to the development and use of cultivars that can thwart or impede activity or a pest or a pathogen.

Resistant variety means any crop variety that can resist the adverse effect or damage caused by insect pests, diseases, and adverse environment.

Return on investment refers to the ratio between net return or income and the total cost of production in every enterprise.

Roguing refers to the removal of off-types in crops intended for seed production. It also means the removal of diseased plants with the accompanying pathogens for disease management. Roguing must be done continuously if it is to be successful.

Role-playing is a learning technique in which participants act out and thus experience real-life roles and situations. It is both a form of simulation and experiential learning.

Root feeders refer to a group of destructive insects whose immature stages and some adults of insect feed on living roots or base of plants, causing stunted growth or death of plants.

Root knot nematode (RKN) is kind of nematode which causes swellings or knots on the roots of affected plants known as galls. Plants affected by this nematode become stunted and wilt readily in hot, dry weather.

Root, tuber and bulb vegetables	are vegetable crops primarily grown for their swollen underground stems or roots. Examples are sweet potato, onion, garlic, carrot, radish, potato, and ginger.
Sanitation	is a practical cultural management practice aimed at reducing either the source of inoculum or the exposure of the plants to infection. Sanitation excludes use of chemicals or biological control agents (BCA).
Sap transmission technique (STT)	is a practical tool used by facilitators to show to farmers how virus diseases are transmitted in vegetable fields.
Scaring materials	are repellent materials (e.g., scarecrow, used video, or music tapes), which are installed in vegetable fields to scare and repel rats, thus avoiding infestation.
Secondary pest	is a pest that does not normally cause economic damage, except when insecticide application destroys its natural enemies.
Seed production	refers to the multiplication of seeds selected for planting in the succeeding seasons in isolation. In farmers' fields, these seeds are produced naturally in self- or cross-pollinating varieties.
Seed selection	is a process by which farmers select seeds from their standing vegetable crops as mother plants for planting or seed multiplication in the succeeding seasons. From the source mother plants, only the best fruits or pods are selected. From these fruits or pods, only the best seeds are selected. For any variety, big seeds are selected because they have more food reserves than small seeds, all other factors being equal, hence better seed materials.
Self-pollinated vegetables	are vegetables wherein pods or fruit setting results from union of female (ovule) and male (pollen) reproductive cells of the same plant, variety, or cultivar.
Shoot and fruit borers	are lepidopterous pests attacking solanaceous vegetables at all development stages. At early vegetative stage, the larvae feed on the stem, shoots, and leaves. Later, at fruit setting, the larvae bore into the fruits rendering them unusable for marketing and storage.

Simulation or simulation game	is a learning activity designed to reflect reality. It may range from a role-play and an in-basket exercise to a mock military invasion. It can be a learning activity akin to real life marked by such game attributes as competition, scores, outcomes, winners and losers.
Small group discussion	is a term used to describe the use of small groups (e.g., break-up sessions) in identifying and solving problem by participatory discussion.
Sloping agricultural land technology (SALT) or alley cropping system (ACS)	refers to a method of farming or cropping system whereby hedges are used along contour lines. In this system, the strips slow down and spread water movement, thus reducing the likelihood of serious erosion in cultivated areas.
Soil biodiversity	refers to the relative abundance and varied population of living organisms, both animals and plants, in soils, which interact to influence profoundly the physical and chemical trends in soil changes.
Soil-borne organisms	refer to all harmful and beneficial organisms living in the soil. Some soil-borne organisms are involved in the degradation of higher plant tissues. Even while, growing, plants are subject to attack by some soil-borne organisms.
Soil fertility	refers to inherent capacity of a soil to supply nutrients to plants in adequate amounts and in suitable proportions.
Soil horizons	are the individual layers in a soil profile. The upper layers of a soil profile generally contain considerable amounts of organic matter and are usually darkened appreciably because of such an accumulation.
Soil-inhabiting pests	refer to all pests whose main harborage or habitat, in the absence of a suitable host, is the soil.
Soil productivity	refers to the ability of a soil to yield crops and is a broader term since soil fertility is only one of the factors that determine the magnitude of crop yields.

Soil profile	refers to the vertical section of a soil showing the presence of more or less distinct horizontal layers. Every well-developed, undisturbed soil has its own distinctive profile characteristics, which are used, in soil classification and survey and are of great importance. In judging a soil, one must consider its whole profile.
Soil solarization	is a cultural management practice whereby soil under is exposed to sunlight for some time after cultivation to kill soil-borne pests and disease-causing pathogens in prepared seedbeds, beds, or plots intended for growing of vegetables.
Soil structure	refers to the arrangement of soil particles into groups or aggregates. The soil texture and soil structure help determine not only the nutrient-supplying ability of soil solids but also the supply of water and air so important to plant life.
Soil texture	is concerned with the size of mineral particles. Specifically, it refers to the relative proportions of particles at various sizes in a given soil.
Solanaceous vegetables	are vegetable crops belonging to the solanaceous or nightshade family, whose economically useful parts are the fruits, such as tomato, eggplant and pepper. Potato belongs to this family, although it can also be classified under root, tuber and bulb vegetables because it is grown for its tuber and is cultivated in a similar manner as the root and bulb vegetables.
Specialist	refers to a facilitator of a Training of Trainers (TOT), who is a graduate of an intensive four-month, six days a week season-long Training of Specialists (TOS) in non-formal education techniques for integrated pest management (IPM).
Stratification	is presowing activity whereby seeds are placed between layers of moist sand, soil, or sawdust at high and low temperatures so that action of water and high and low temperatures will soften the seed coat.
Sucking insects	refer to a group of destructive insects, which have piercing-sucking mouthparts.

Surface irrigation or flooding	is a method of irrigation where water flows on soil surface, then later seeps downward, or moves vertically (surface flooding), moves along a canal or horizontally (furrow flooding) in soil until it reaches the roots of plants.
Sustainable agriculture	means any principle, method, and practice that aims to make agriculture economically viable, ecologically sound, socially just and humane (equitable), culturally appropriate, and grounded on holistic science.
Synchronous planting	involves planting of crops at the same time in a large scale to take advantage of hostile environmental conditions for pests at the stage new plants are most susceptible to pest attack. Synchronization is ideal in cases where product prices are nonfluctuating and irrigation water is available year round.
Team building	is an organized effort to improve team effectiveness. It is a process consisting of a series of synergy-building exercises designed to promote group cohesiveness and effectiveness in performing and achieving their common goals and tasks. It may relate to defining and clarifying policies or goals; to reviewing and refining procedures; to seeking out ways to be more innovative and creative; to improving management practices in such areas as communication, decision-making, delegation, planning, coaching, career development and initiatives; to improving relationships between team members; to improve external relations (e.g., with local government units); to improve relations with other work teams; and to improving services.
Therapy	is a fundamental principle in pest and disease management referring to treatment of plants infested by a pest or infected by a pathogen.
Thinning	refers to a cultural management practice, which involves the removal of undesirable plants to ease out overcrowding of seedlings, allow better penetration of sunlight, permit proper aeration or more rapid drying of dew or rain on foliage after a down pour, and minimize nutrient competition.
Thrips	are minute insect pests whose nymphs and adults suck the plant sap causing the leaves to turn yellow, then silvery-white, and later assumed a withered or blasted appearance.

Training of specialist (TOS)	is an intensive four-month, six-day-a-week season-long training course in nonformal education (NFE) techniques and integrated pest management (IPM) for extension and crop protection specialists.
Trap crops	are alternate or susceptible crops planted within a particular vegetable area to attract some specific destructive pests of a particular vegetable crop thereby reducing their adverse effects to that particular vegetable crop.
Trellising	is a cultural management practice in vegetable, which involves training vegetable crops to grow on trellis to improve quality of products and avoid rotting of fruits associated with soil-borne pathogen.
Training team	refers to a group of facilitators who work together to see to it that the learning process supports the objectives of the learning activities.
Training of trainers (TOT)	is an intensive four-month, three-days-a-week season-long training course in nonformal education (NFE) techniques and integrated pest management (IPM) for extension workers.
Trainer	refers to a facilitator of a farmer field school (FFS), who is a graduate of an intensive four-month, three-days-a-week season-long Training of Trainers (TOT) in nonformal education techniques for integrated pest management (IPM).
Trapping	is a cultural management practice, which attracts insect pests to trap materials for the purpose of controlling them. The trap materials may contain non-pesticide baits such as sex attractant or an attractive food source for insect pest.
Tuber moth	is an insect pest attacking potato tubers whose larvae form blotch mines on the leaves which later becomes dry and brittle and tunnel on the tubers.
Urea	is a chemical fertilizer material, which is a rich source of nitrogen element or nutrient.
Tymo virus disease	is a disease affecting cucurbits, particularly chayote, caused by virus infection, which is characterized by overgrowth, stunting, yellowing, curling, and mottling.

Varietal adaptability	refers to the ability of a specific crop to grow productively under specific local conditions such as resistance to local pests, diseases, and environmental stresses.
Vegetable specialist training (VST)	is an intensive four-month, six-day a week season-long training of specialists (TOS) in nonformal education (NFE) techniques and integrated pest management (IPM) for extension and crop protection specialists in vegetable production.
Vernalization	is a process by which seeds are subjected to cold temperature treatment before germination to trigger process of flowering at the later stage of crop development.
Viruses	are infectious particles that attack many forms of life, including bacteria and plants. They are so tiny that they can only be seen with an electron microscope.
Virus diseases	refer to diseases that are caused by viruses. The general symptoms of virus diseases on plants are leaf discoloration, stunting, leaf-rolling or twisting, and vein clearing.
Water floating technique (WFT)	is a practical tool used by farmers in determining the presence of cyst nematodes in potato fields.
Water holding capacity (WHC)	refers to the amount of water a soil can hold which is proportionately related to the physical condition and organic matter content of the soil. Soils high in organic matter are darker in color and have greater water holding capacities than do soils low in organic matter.
Water management	means any strategy or method that will lead to effective and efficient use of water in crop production.
Weed management	means any strategy or method that will lead to effective and efficient suppression of weed population.
White fly	is a small white insect pest belonging to the fly family. They congregate on the undersides of the leaves where they suck juices and secrete honeydew. Severe infestation can cause plants to wilt.

Workshop refers to a 'hands on', highly participatory learning effort wherein participants learn by doing. Typically, the group is small enough to ensure adequate rapport and intimacy.

Yellow sticky trap is a type of trapping material, which uses different bases, sticky substances, and shades of yellow color to trap adults of white flies and leafminers.

References

References

Alexander, M. 1977. Introduction to soil microbiology. 2nd Edition. John Wiley and Sons, Inc., New York, USA. 467p.

Balaki, E.T[124]. 1998. Personal communication.

Bautista, O.K. (Ed.) 1994. Introduction to tropical horticulture. 2nd Edition. SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA) and University of the Philippines Los Baños (UPLB), College, Laguna, Philippines. 598p.

Binamira, J.S. 1998. A Consultant's Report: An Evaluation of the Impact of the IPM in Crucifers in the Cordilleras. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Field Unit, Baguio City, Philippines. 62p.

Binamira, J.S. 1998. A Consultant's Report: Refresher Course for Trainers of IPM in Crucifers and Other Highland Vegetable Crops. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Regional Field Unit, Baguio City, Philippines. 90p.

Binamira, J.S. 1998. A Consultant's Report: Curriculum Development for Trainers and Farmer Field Schools on IPM in Crucifers and Other Highland Vegetable Crops. Cordillera Highland Agricultural Resources Management Project, Department of Agriculture, CAR Regional Field Unit, Baguio City, Philippines. 71p.

[124] Professor of Agronomy and Director of Extension, Benguet State University (BSU), La Trinidad, Benguet, Philippines

Binamira, J.S. 2000. The Search for the National Filipino Corn Farmer Award (Draft Guidelines). National Agricultural and Fishery Council, Department of Agriculture, Diliman Quezon City, Philippines. 16p.

Brady, N.C. 1985. The nature and properties of soils. 9th Edition. Macmillan Publishing Company, Inc., 866 Third Avenue, New York, New York, USA. 750 p.

Callo, Jr. D.P. 1989. Azolla adaptability and utilization on farmers' fields. In Azolla: Its Culture, Management and Utilization in the Philippines. National Azolla Action Program (NAAP), University of the Philippines Los Baños, College, Laguna, Philippines. pp109-128.

Callo, Jr. D.P. 1993. Recent Development on the Utilization of Soil Microorganisms for Biological Control of Plant Pathogens. Term paper submitted in partial fulfillment of the requirement for Advance Soil Microbiology, Institute of Graduate School, Gregorio Araneta University Foundation, Malabon City, Philippines. 28p.

Callo, Jr. D.P. 2000. Travel report of leafminer infestation in Buguias, Benguet from 05-08 January 2000. ASEAN IPM Knowledge Network Center, SEAMEO Regional Center for Graduate Study and Research in Agriculture, College, Laguna, Philippines. 6p.

Callo, Jr. D.P., W.R. Cuaterno, and H.A. Tauli (eds.). 1999. Handbook of Non-Formal Education and Team Building Exercises for Integrated Pest Management. SEAMEO Regional Center for Graduate Study and Research in Agriculture, College, Laguna, Philippines. 206p.

Cardona, Jr. E.V[125]. 1998. Personal communications.

Davide, R.G. 1990. Biological control of plant pathogens: progress and constraints in the Philippines. Phil. Phytopath. 26:pp1-7.

[125] Professor of Entomoilogy, College of Agriculture, Benguet State University (BSU), La Trinidad, Benguet, Philippines

Davies, D.V., D.J. Eagle and J.B. Finney. 1972. Soil Management. Farming Press Limited, Fenton House, Wharfedale Road, Ipswich, Suffolk, Great Britain. 254 p.

Denevan, W.M. and B.L. Turner. 1974. Forms, functions and associations of raised field in the old world tropics. Tropical Geography 39: 25-33.

FARM. 1998. Facilitator's Manual: Farmer Field School on Integrated Soil Management. Farmer-centered Agricultural Resource Management (FARM) Programme, Food and Agriculture Organization Regional Office for Asia-Pacific, Bangkok, Thailand. 218p.

Hope, A. and Timmel S. 1994. Training for Transformation 1: A Handbook for Community Workers. Mambo Press, Gweru, Zimbabwe. 147P.

IIBC. 1996. Integrated Pest Management for Highland Vegetables, Volume 4: Training Guide for Participatory Action Towards Discovery Learning. International Institute for Biological Control, BPI Compound, Baguio City, Philippines. 260p.

IIBC. 1990. Manual on Biological Control and Biological Methods for Insect Pests in the Tropics. FAO/IRRI/IIBC Training Course on Biological Control in Rice-based Cropping Systems, International Institute of Biological Control, Kuala Lumpur, Malaysia. pp2.3/1-3.2/4 (Part 1), pp1.3/2-1.3/10 (Part 2) and pp2.6/1-2.6/8 (Part 3).

Kudan, S.L[126]. 1998. Personal communication.

Medina, J.R[127]. 1998. Personal communication.

Milagrosa, S.P[128]. 1998. Personal communication.

126 Professor of Horticulture, College of Agriculture, Benguet State University (BSU), La Trinidad, Benguet, Philippines

127 Associate Professor of Entomology, Department of Entomology, College of Agriculture, University of the Philippines Los Baños (UPLB), College, Laguna, Philippines

128 Professor of Plant Pathology, College of Agriculture, Benguet State University (BSU), La Trinidad, Benguet, Philippines

Ortigas, C.D. 1997. Training for Empowerment. Office of Research and Publication, Ateneo de Manila University, Loyola Heights, Quezon City. 156p.

PCARRD. 1985. National Technoguide on Indigenous Vegetable Backyard Gardening. Philippine Council for Agriculture and Resources Research and Development (PCARRD), Los Baños, Laguna, Philippines. 69p.

PCARRD. 1975. The Philippines Recommends for Vegetable Crops. Philippine Council for Agriculture and Resources Research and Development, Los Baños, Laguna, Philippines. 164p.

Philippine National IPM Program. 1997. Field Guide of Discovery-based Exercises for Vegetable IPM (Volume I). National Agricultural and Fishery Council, Department of Agriculture, Diliman, Quezon ci5ty, Philippines. 1-1/6-40p.

Philippine National IPM Program. 1993. Kasaganaan ng Sakahan at Kalikasan (KASAKALIKASAN), The National IPM Program Document. National Agricultural and Fishery Council (NAFC), Department of Agriculture, Elliptical Road, Diliman, Quezon City, Philippines. 52p.

Quebral, F.C. 1988. What one should know about plant diseases. University of the Philippines Los Baños, College, Laguna, Philippines. 65p.

Settle, W. 1999. Living soil: A source book for IPM training. United Nations-Food and Agriculture Organization (UN-FAO) Programme for Community IPM in Asia, Jl. Jati Padang, Pasar Minggu, Jakarta, Indonesia. pp 5.

Shepard, B.M., Carner, G.R., Barrion, A.T., Ooi, P.A.C, and van den Berg, H. 1999. Insects and Their Natural Enemies Associated with Vegetables and Soybean in Southeast Asia. Quality Printing Company, Orangeburn, South Carolina, USA 108p.

Society for Participatory Research in Asia. 1987. Participatory Training for Adult Educators. Society for Participatory Research in Asia Publication, New Delhi, India. 105p.

Tabinga, G.A. and A.O. Gagni. 1985. Corn Production in the Philippines. Department of Development Communication, University of the Philippines at Los Baños, College, Laguna, Philippines. 122p.

Zandstra, H.G. 1978. Soil management for rice-based cropping systems. In: Soil and Rice. International Rice Research Institute (IRRI), Los Baños, Laguna, The Philippines. 825 p.

Annexes

Annex A

List of participants in the *Technical and Program Administration Review Workshop of the IPM in Crucifers Component of the National IPM Program* held on 03-06 August 1998 at Agricultural Training Institute, BSU Compound, La Trinidad, Benguet.

Department of Agriculture-Cordillera Highland Agricultural Resources Management Project (DA-CHARM)

1. Dr. Cameron P. Odsey, Project Manager
2. Dr. Joseph J.C. Madamba, Consultant (Deputy Team Leader)
3. Dr. Carlos A. Fernandez, Consultant
4. Mr. Israel Carlos, Consultant
5. Mr. Freddie T. Langpaoen, Technical Staff (IPM Specialist)
6. Mr. Roland A. Carpio, Technical Staff (IPM Specialist)
7. Mr. Inocencio B. Bernard, Technical Staff (IPM Specialist)
8. Ms. Joan D. Bacbac, Agriculturist II
9. Ms. Laarni A. Supnet, Secretarial Staff
10. Mr. Patricio Ananayo, Senior Agriculturist
11. Mr. Delfin R. Acay, Technical Staff

Department of Agriculture- Cordillera Administrative Regional Field Unit (DA-CARFU)

12. Dr. Elizabeth A. Verzola, Assistant Regional Director (Regional IPM Coordinator)
13. Mr. Landis B. Teofilo, Senior Agriculturist (IPM Specialist)
14. Ms. Araceli B. Pedro, Technical Staff (FFS Facilitator)
15. Mr. Noelito C. Villa, Agriculturist II (IPM Specialist)
16. Mr. Nicasio S. Baucas, Agriculturist II (IPM Specialist)
17. Mr. Robert Domoguen, Regional Information Officer
18. Ms. Myer Mula, Agriculturist II (FFS Facilitator)

Local Government Unit's Provincial and Municipal IPM Coordinators (LGU-IPM Coordinators)

19. Ms. Mary Frances W. Buanzi, Agriculturist II (IPM Specialist), Office of Provincial Agriculturist, Mt. Province
20. Mr. Dexter Dimas, Agricultural Technician (IPM Specialist), Office of Provincial Agriculturist, Benguet
21. Mr. Alfredo V. Pilay, Municipal Agricultural Officer (FFS Facilitator), Atok, Benguet
22. Mr. Constancio Molitas, Agricultural Technician (FFS Facilitator), Tublay, Benguet
23. Mr. Ramon Anacisco, Agricultural Technician (FFS Facilitator), Sablan, Benguet
24. Mr. Perfecto B. Cayat, Agricultural Technician (FFS Facilitator), Kibungan, Benguet
25. Mr. Asano E. Aban, Agricultural Technician (FFS Facilitators), Buguias, Mt. Province
26. Ms. Rosita V. Alubia, Agricultural Technician (FFS Facilitator), Tuba, Benguet
27. Ms. Marife A. Lucaney, Agricultural Technician (FFS Facilitator), Sabangan, Mt. Province
28. Ms. Ana L. Ngade, Agricultural Technician (FFS Facilitator), Tadian, Mt. Province
29. Mr. Basanio Wasing, Agricultural Technician (FFS Facilitator), Bakun, Mt. Province
30. Mr. Peter Ticag, Agricultural Technologist (FFS Facilitator), Sagada, Mt. Province
31. Mr. Nicolas Pawid, Agriculturist II (FFS Facilitator), Office of the Provincial Agriculturist, Benguet
32. Mr. Renato M. Falag-ey, Agricultural Technician (FFS Facilitator), Bontoc, Mt. Province

Benguet State University and Highland Agriculture Resources Research and Development Consortium (BSU-HARRDEC)

33. Dr. Eulogio V. Cardona, Jr., Professor, College of Agriculture
34. Dr. Sergia P. Milagrosa, Professor, College of Agriculture
35. Ms. Zyla C. Macasieb, Regional Applied Communication Program Coordinator, HARRDEC
36. Dr. Edwin T. Balaki, Professor and Director of Extension
37. Dr. Lily Ann Lando, Assistant Professor, College of Agriculture

Agricultural Training Institute-National Training Center (ATI-NTC)

38. Ms. Luz M. Palengleng, Training Specialist (IPM Specialist)
39. Ms. Janette C. Visayan, Senior Agriculturist (IPM Specialist)

Department of Agriculture-Central Cordillera Agricultural Project (DA-CECAP)

40. Ms. Vilma C. Du, Chief Agriculturist

Bureau of Plant Industry-Baguio National Research and Development Center (BPI-BNRDC)

41. Ms. Teresita Kayad-Mangili, Senior Agriculturist

Integrated Pest Management-Farmer Field School Farmer-Leaders (IPM-FFS Farmer-Leaders)

42. Mr. Samuel P. Felix, FFS Farmer-Facilitator and President, Atok Federation of Farmer Field Schools
43. Mr. Pedro Talsan, FFS Farmer-Leader (Provincial IPM Chairman, Kibungan, Benguet
44. Mr. Arcadio Bulagsay, FFS Farmer-Leader, Bontoc, Mt. Province
45. Mr. Date Coyan-an, FFS Farmer-Leader, Bot-oan Farmers' Association, Bontoc, Mt. Province

KASAKALIKASAN National Program Office (IPM-NPO) and ASEAN IPM Knowledge Network Center (ASEAN IPM)

46. Dr. Jesus S. Binamira, National Program Officer, KASAKALIKASAN
47. Mr. Damaso P. Callo, Jr., Project Specialist, ASEAN IPM
48. Ms. Harriet Tauli, Technical Staff, KASAKALIKASAN

Annex B

List of participants in the *Curriculum Development Workshop for the Refresher Course for Trainers of IPM in Crucifers and Other Highland Vegetable Crops* held on 10-14 August 1998 at ATI-NTC, BSU Compound, La Trinidad, Benguet.

Department of Agriculture, Cordillera Administrative Regional Field Unit (DA-CARFU)

1. Mr. Landis B. Teofilo, Senior Agriculturist (Vegetable IPM Specialist)
2. Ms. Teresita A. Paytocan, Agriculturist II (Vegetable IPM Trainer)
3. Ms. Araceli B. Pedro, Technical Staff (Vegetable IPM Trainer)

Department of Agriculture, Cordillera Highland Agricultural Resources Management (DA-CHARM) Project

4. Mr. Freddie T. Langpaoen, Technical Staff (Vegetable IPM Specialist)
5. Mr. Roland A. Carpio, Technical Staff (Vegetable IPM Specialist)
6. Mr. Inocencio B. Bernard, Technical Staff (Vegetable IPM Specialist)
7. Ms. Joan D. Bacbac, Technical Staff (Extensionist)
8. Ms. Laarni A. Supnet, Documentor

Agricultural Training Institute, National Training Center (ATI-NTC)

9. Ms. Luz M. Palengleng, Training Specialist (Vegetable IPM Specialist)
10. Ms. Janette T. Visayan, Senior Agriculturist (Rice IPM Specialist)
11. Mr. Edwin C. Dicksen, Agriculturist II (Rice IPM Specialist)
12. Mr. Charles C. Sagudan, Agriculturist II (Vegetable IPM Trainer)

National IPM Program (KASAKALIKASAN) and ASEAN IPM Knowledge Center (ASEAN IPM)

13. Ms. Harriet A. Tauli, Non-Formal Education Specialist, KASAKALIKASAN
14. Mr. Alvin S. Fajardo, Vegetable Specialist, KASAKALIKASAN
15. Mr. Damaso P. Callo, Jr., Project Specialist, ASEAN IPM

Benguet State University (BSU)

16. Dr. Edwin T. Balaki, Professor and Director of Extension
17. Dr. Sergia P. Milagrosa, Professor, College of Agriculture
18. Dr. Eulogio V. Cardona, Jr., Professor, College of Agriculture
19. Prof. Silvestre L. Kudan, Professor, College of Agriculture
20. Prof. Paz Dalang, Professor, Northern Philippines Root Crops Research and Training Center (NPRCRTC)

Annex C

List of training participants, facilitators and resource persons in the one-month intensive *Refresher Course for Trainers of Integrated Pest Management (RCT-IPM) in Crucifers and Other Highland Vegetable Crops* held on 27 September to 17 October 1998 held at Bineng, La Trinidad, Benguet.

Participants (Local Government Unit, Benguet Province):

1. Mr. Nicholas L. Pawid, Agriculturist II,
   Office of the Provincial Agriculturist, Benguet
2. Mr. Denson G. Tomin, Agricultural Technologist,
   Office of Municipal Agriculturist, Kapangan
3. Mr. Marcos B. Baucas, Agricultural Technologist,
   Office of Provincial Agriculturist, Benguet
4. Mr. Basanio T. Wasing, Agriculturist II,
   Office of Municipal Agriculturist, Bakun
5. Mr. James G. Lopez, Agricultural Technologist,
   Office of Municipal Agriculturist, Buguias
6. Mr. Dexter B. Dimas, Provincial IPM Coordinator,
   Office of Provincial Agriculturist, Benguet
7. Mr. Ramon M. Anacioco, Agricultural Technologist,
   Office of Municipal Agriculturist, Sablan
8. Ms. Victoria C. Marcelino, Agricultural Technologist,
   Office of Municipal Agriculturist, Atok
9. Ms. Annabelle I. Saingan, Agricultural Technologist,
   Office of Municipal Agriculturist, Tuba
10. Ms. Cherry L. Sano, Agricultural Technologist,
    Office of Municipal Agriculturist, Atok
11. Ms. Edna I. Raymundo, Agricultural Technologist,
    Office of Municipal Agriculturist, Kibungan
12. Ms. Jocelyn T. Martin, Agricultural Technologist,
    Office of Municipal Agriculturist, Tublay
13. Mr. Perfecto B. Cayat, Agricultural Technologist,
    Office of Municipal Agriculturist, Kibungan
14. Ms. Annie B. Sebiano, Agricultural Technologist,
    Office of Municipal Agriculturist, Kibungan

15. Ms. Rosita V. Alubia, Agricultural Technologist, Office of Municipal Agriculturist, Tuba
16. Ms. Susan K. Aniban, Agricultural Technologist, Office of Municipal Agriculturist, Tublay
17. Ms. Louisa L. Carbonel, Agricultural Technologist, Office of Municipal Agriculturist, Bakun
18. Mr. Esteban R. Reboldela, Agricultural Technologist, Office of Municipal Agriculturist, Sablan
19. Ms. Josephine C. Apili, Agricultural Technologist, Office of Municipal Agriculturist, Kapangan

Participants (Local Government Unit, Mountain Province):

20. Ms. Juliet P. Banoca, Agricultural Technologist, Office of Municipal Agriculturist, Besao
21. Ms. Marifee A. Lucaney, Agricultural Technologist, Office of Municipal Agriculturist, Sabangan
22. Ms. Fructosa D. Mamanteo, Agricultural Technologist, Office of Municipal Agriculturist, Sabangan
23. Mr. Renato M. Falag-ey, Agricultural Technologist, Office of Municipal Agriculturist, Bontoc

Facilitators and Technical Resource Persons:

24. Dr. Jesus S. Binamira, IPM Consultant, Department of Agriculture, Cordillera Highland Agricultural Resources Management (DA-CHARM) Project
25. Mr. Inocencio B. Bernard, Technical Staff, Department of Agriculture, Cordillera Highland Agricultural Resources Management (DA-CHARM) Project
26. Mr. Charlie C. Sagudan, Agriculturist II, National Training Center, Agricultural Training Institute, Cordillera Administrative Region (NTC-ATI-CAR)
27. Mr. Freddie T. Langpaoen, Technical Staff, Department of Agriculture, Cordillera Highland Agricultural Resources Management (DA-CHARM) Project

28. Ms. Araceli B. Pedro, Technical Staff, Department of Agriculture, Cordillera Administrative Regional Field Unit (DA-CARFU)
29. Mr. Roland A. Carpio, Technical Staff, Department of Agriculture, Cordillera Highland Agricultural Resources Management (DA-CHARM) Project
30. Mr. Landis B. Teofilo, Agriculturist II, Department of Agriculture, Cordillera Administrative Regional Field Unit (DA-CARFU)
31. Ms. Luz M. Palengleng, Training Specialist II, Agricultural Training Institute, National Training Center (ATI-NTC), Cordillera Administrative Region (CAR)
32. Ms. Harriet A. Tauli, Technical Staff, National Program Office, KASAKALIKASAN (IPM-NPO)
33. Mr. Damaso P. Callo, Jr., Training and Curriculum Development Specialist, ASEAN IPM Knowledge Network Center, SEAMEO-SEARCA (ASEAN IPM-SEARCA)
34. Dr. Edwin T. Balaki, Professor, College of Agriculture (CA) and Director of Extension, Benguet State University (BSU)
35. Dr. Sergia P. Milagrosa, Professor, College of Agriculture, Benguet State University (CA-BSU)
36. Dr. Jose R. Medina, Associate Professor, University of the Philippines Los Baños, College of Agriculture (UPLBCA)
37. Prof. Silvestre S. Kudan, Professor, College of Agriculture, Benguet State University (CA-BSU)

Annex D

List of FFS farmer-graduates who validated discovery-based exercises for FFS and PTD studies on crucifers and other vegetables in the Cordilleras.

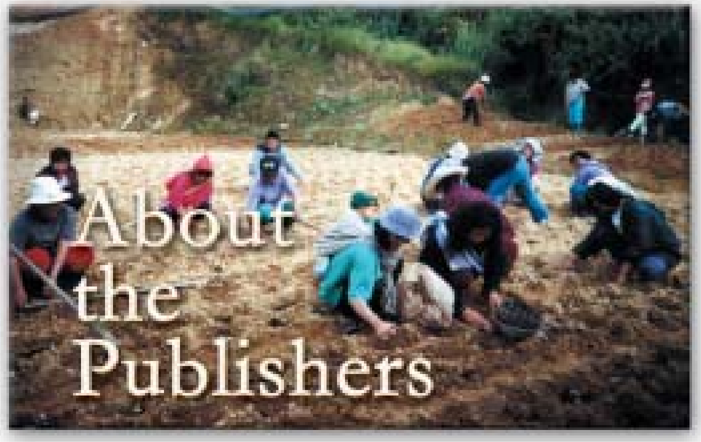
1. Mr. Marino A. Namuro, Poblacion, Tublay, Benguet
2. Mr. Alinos P. Apasen, Poblacion, Tublay, Benguet
3. Mr. Luis N. Ganioning, Poblacion, Tublay, Benguet
4. Ms. Marelyn S. Namuro, Poblacion, Tublay, Benguet
5. Ms. Edith A. Guzman, Poblacion, Tublay, Benguet
6. Mr. Molly C. Amsing, Poblacion, Tublay, Benguet
7. Ms. Ester G. Moyao, Poblacion, Tublay, Benguet
8. Mr. Ben P. Rimando, Poblacion, Tublay, Benguet
9. Mr. Juan A. Mendoza, Bineng, La Trinidad, Benguet
10. Mr. Romeo C. Abriam, Bineng, La Trinidad, Benguet
11. Mr. Atos C. Ebbes, Bineng, La Trinidad, Benguet
12. Mr. Floyd P. Costina, Bineng, La Trinidad, Benguet
13. Mr. Donald S. Aladjoe, Bineng, La Trinidad, Benguet
14. Mr. Delmer T. Shagol, Bineng, La Trinidad, Benguet
15. Mr. John P. Zarate, Bineng, La Trinidad, Benguet
16. Mr. David K. Sulano, Bineng, La Trinidad, Benguet
17. Mr. Arthur shontogan , Bineng, La Trinidad, Benguet
18. Ms. Geraldine M. Mendoza, Bineng, La Trinidad, Benguet
19. Mr. Roger Lacamen, Bineng, La Trinidad, Benguet
20. Mr. Brando B. Yadno, Bineng, La Trinidad, Benguet
21. Ms. Juanita B. Aoas, Bineng, La Trinidad, Benguet
22. Ms. Angela S. Alfredo, Bayabas, La Trinidad, Benguet
23. Mr. Benio D. Walsi-en, Bayabas, La Trinidad, Benguet
24. Ms. Julia T. Limuwas, Bayabas, La Trinidad, Benguet
25. Ms. Marcita D. Timatim, Bayabas, La Trinidad, Benguet
26. Mr. Jason P. Baldos, Bayabas, La Trinidad, Benguet
27. Ms. Nida S. Todiano, Bayabas, La Trinidad, Benguet
28. Ms. Julia S. Miguel, Bayabas, La Trinidad, Benguet
29. Mr. Jose M. Timatim, Bayabas, La Trinidad, Benguet
30. Mr. Raymund T. Lino, Bayabas, La Trinidad, Benguet
31. Mr. Paquito L. Balinsoy, Bayabas, La Trinidad, Benguet
32. Mr. Nestor Tap-ayao, Bayabas, La Trinidad, Benguet
33. Ms. Erma B. Ignas, Poblacion, Tuba, Benguet

34. Ms. Nena P. Polon, Poblacion, Tuba, Benguet
35. Mr. Peter F. Agustin, Poblacion, Tuba, Benguet
36. Ms. Leticia M. Vicente, Poblacion, Tuba, Benguet
37. Mr. Bernard C. Balting, Poblacion, Tuba, Benguet
38. Mr. Artos O. Ponciano, Poblacion, Tuba, Benguet
39. Mr. Paulino L. Agustin, Poblacion, Tuba, Benguet
40. Mr. Galo A. Vicente, Poblacion, Tuba, Benguet
41. Ms. Piana B. Pul-ling, Poblacion, Tuba, Benguet
42. Ms. Honoria B. Bito, Poblacion, Tuba, Benguet
43. Mr. Victor P. Dulay, Poblacion, Tuba, Benguet
44. Mr. Allan F. Ben-ek, Poblacion, Tuba, Benguet
45. Ms. Rufina F. Ben-ek, Poblacion, Tuba, Benguet
46. Mr. Federico C. Carias, Poblacion, Tuba, Benguet
47. Ms. Teresa B. Carias, Poblacion, Tuba, Benguet
48. Ms. Maxima E. Benawe, Poblacion, Tuba, Benguet
49. Mr. Morris P. Polon, Poblacion, Tuba, Benguet
50. Mr. Edman O. Bito, Poblacion, Tuba, Benguet
51. Mr. Alfredo E. Paldo, Poblacion, Tuba, Benguet
52. Mr. Zaldy B. Guileng, Poblacion, Tuba, Benguet
53. Ms. Alma B. Segundo, Poblacion, Tuba, Benguet
54. Ms. Maria V. Guileng, Poblacion, Tuba, Benguet

Annex E

List of non-FFS and FFS farmer-graduates from Bineng, La Trinidad, Benguet, who validated the Baseline Survey Form (BSF Form A) for Crucifers and Other Highland Vegetable Crops.

1. Ms. Ester G. Moyao, FFS farmer-graduate
2. Mr. Robert S. Batolne, FFS farmer-graduate
3. Mr. June M. Wakat, FFS farmer-graduate
4. Ms. Marlyn C. Amsing, FFS farmer-graduate
5. Ms. Lydia L. Wagsi, Non-FFS farmer-graduate
6. Mr. Lito N. Lorena, Non-FFS farmer-graduate
7. Ms. Angeline E. Canuto, Non-FFS farmer-graduate
8. Ms. Mendora E. Guiloan, Non-FFS farmer-graduate



About the Publishers

KASAKALIKASAN is the acronym for Kasaganaan ng Sakahan at Kalikasan. It means Nature is Agriculture's Bounty. It is is the Philippine program that seeks to popularize integrated pest management (IPM). The Philippine Department of Agriculture implements KASAKALIKASAN in collaboration with LGUs and nongovernment organizations in participating provinces and municipalities. The Program seeks to assist farmers in developing their ability to make critical and informed decisions that render production systems for rice and other crops more productive, profitable and sustainable. KASAKALIKASAN is the Philippine government's commitment to Agenda 21 of the United Nations Conference on Environment and Development in promoting sustainable agriculture and rural development.

The **Cordillera Highland Agricultural Resources Management (CHARM) Project** is an agricultural development project aimed at reducing poverty in the Cordilleras by increasing disposable incomes of smallholder farm families in target areas through community mobilization and resource management, rural infrastructure development, agricultural support services, and project management. The Philippine Department of Agriculture in collaboration with local government units and nongovernment organizations implements CHARM in 82 barangays in 16 municipalities in three Cordillera provinces, namely Abra, Benguet and Mt. Province. The Government of the Philippines, Asian Development Bank, and International Funds for Agricultural Development jointly fund CHARM.

The **ASEAN IPM Knowledge Network (ASEAN IPM)** is an initiative to accumulate the vast collection of knowledge capital on integrated pest management (IPM) that can be reused and shared by the national IPM programs in the ASEAN region. ASEAN IPM is an electronic, Internet-like, wide-area network composed of each ASEAN member country with its regional center located at SEARCA in the Philippines. Its mission is to help governments improve the effectiveness of their program implementation by making knowledge sharing easy among their national IPM programs.

The **SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA)** is one of the 14 regional research and training centers of the Southeast Asian Ministers of Education Organization (SEAMEO), an intergovernmental body founded in 1965 to promote cooperation among Southeast Asian nations through activities in education, science, and culture. SEAMEO SEARCA's programs are designed to accelerate sustainable agriculture and rural development through human resource development, research, technology transfer, and communication. The University of the Philippines Los Baños hosts it. It is supported by donations from SEAMEO member and associate member states, other governments, and various international donor agencies.

Photos from **Cordillera Highland Agricultural Resources Management (CHARM) Project**