LEARNING AgriCultures

Insights from sustainable small-scale farming

MODULE 3 (INTERIM VERSION)

Cropping systems

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This publication forms part of the **Learning AgriCultures** series for educators, providing insights on sustainable small-scale agriculture.

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Please note:
This module is an interim version. We welcome comments and suggestions for improvement.

Foreword to Learning AgriCultures series

Why Learning AgriCultures?

Over the years, the readers of ileia's magazines, as well as our international partner network, have asked for support material explaining the principles behind sustainable small-scale farming. With 25 years of publishing practical cases from around the world, ileia has a wealth of material for exploring this subject. The Learning AgriCultures series is our response to this request. Sustainability translates differently under specific local conditions so this series does not intend to offer solutions to all the problems. Its objective is to stimulate a culture of learning about sustainable small-scale farming. Through probing questions, and a variety of educational resources, we hope that this material helps feed into and provoke discussions and deeper reflections on the important contributions of small-scale farming, and what sustainability means in different contexts faced by students. The series is not intended as a field guide and does not focus on technical details about farming methods. It does however suggest further references for digging deeper into technical questions.

Who is it for?

Learning AgriCultures is a learning resource particularly aimed at educators seeking support material for explaining about sustainable agriculture in their courses, at a university or college level, in special NGO training courses or other professional environments. Courses in which this series could be useful include agriculture, rural development, environmental studies, research & extension, agricultural policy-making. The likely target group will be students who primarily, but not exclusively, (will be) working in developing countries.

What is in it and how can it be used?

The Learning AgriCultures series has seven modules. It explores small-scale (family) farming and how it can become more sustainable. Each module has three learning blocks, looking at its theme from the perspective of: 1) the farm, 2) issues in the wider context that affect farming, and lastly 3) sustainability and governance issues. These learning blocks are followed by a section giving details of educational support materials. Here educators can find and choose from practical cases (mostly drawn from 25 years of articles in ileia's archive), exercises, games, photos, videos, checklists for farm visits as well as further references (free books and websites) that they can use to supplement their courses. A separate glossary of difficult terms, drawings and diagrams explains concepts from throughout the series. It is hoped that the suggested questions, practical examples from around the world, and different kinds of resource material, will enable educators to make their own lesson plans, drawing on what is relevant to their own regional context and student group.

Learning AgriCultures: Insights from sustainable small-scale farming

Module 1 • Sustainable small-scale farming
Module 2 • Soil and water systems
Module 3 • Cropping systems
Module 4 • Livestock systems
Module 5 • Labour and energy in farming
Module 6 • Markets and finance for small-scale farmers
Module 7 • Knowledge for small-scale farming

Summary of this module

This module introduces different aspects of small-scale farmers' cropping systems, focusing on three viewpoints - the farm, wider contextual issues and governance. Small-scale cropping systems are often mixed and highly productive, making use of interactions with other elements on the farm, such as between different crops, and with livestock. Small-scale farming is the source of valuable crop diversity in terms of species as well as varieties. It supplies many crops that would not otherwise be produced, such as those that are important to local food security and markets, such as with underutilised crops. In seeking greater sustainability in cropping systems, one general theme keeps recurring: the need to make use of, conserve and integrate greater diversity into farming systems and the wider landscape. For farmers, increasing diversity provides many advantages and opportunities, although it also presents a number of practical challenges. The advantages include greater adaptability, minimising risk and making use of interactions with different organisms and sub-systems on and around the farm. The challenges of diversity management involve the need to find a good balance between many different elements and high labour and knowledge requirements.

This module describes different aspects of mixed cropping practices. It also looks at how to sustainably intensify cropping systems, through better knowledge and observance of location-specific ecological interactions. It describes recent advances in the development of crop biotechnologies, such as genetic engineering and formal seed systems, which have had a tremendous impact on cropping practices around the world. More and more farmers have access to improved seed as part of a package of chemical inputs and better irrigation. This has increased production of many important crops. However, these developments have also meant that the genetic base for agricultural biodiversity in crop species, varieties, as well as ecosystems, has become narrower. Technological developments and the introduction of intellectual property rights over plant varieties also bring the danger of small-scale farmers having less control over their seed systems. The importance of engaging farmers in land-use planning, crop breeding and conservation, and in implementing policies that value and support the unique characteristics of small-scale farms is highlighted.

Table of Contents

Guide to educators

PURPOSES OF MODULE 3

Figure 1: Educators, the target group of Learning AgriCultures

For educators:

- to learn about a systems approach to teaching about sustainable crop production as part of small-scale farming systems.

For students:

- to understand about crop production dynamics in small-scale farming;
- to learn about how to make cropping practices in small-scale farming more sustainable - and how to support the efforts of small farmers.

How to teach Module 3

About 16 contact hours will be needed to teach this entire module. This does not include time for conducting interviews with farmers, or the time that students will spend on assignments. Educators will need to decide for themselves whether to use the entire module or parts of it when making their lesson plans.

At the end of this section, an example is given of how to make a lesson plan from the material included in this module. The total time required and duration of each lesson will vary depending on the level of the students, the knowledge of the educator and how many games and assignments you choose to include in the course. A very important component of the module is to visit and interview at least one farmer – so that students can better understand the practical realities of farming systems in their area.

What is in Module 3?

This module is the third one in the Learning AgriCultures series. As with the other modules, it includes three learning blocks with theoretical information and a section with support material as Educational Resources. Specifically, the content of this module is as follows:

LEARNING BLOCK 1:
Cropping systems on the farm

This block provides an overview of different kinds of interactions crops have with organisms in the soil, other plants (including trees), predatory and beneficial animals, and farmers. Farmers' management practices are introduced, together with the concept of agrobiodiversity and different ways crop diversity can become a buffer on the farm.

LEARNING BLOCK 2:
Cropping issues in the wider context

Four issues are analysed that have a great impact on cropping systems around the world: activities affecting crops at a landscape or ecosystem level, access to seed and other plant genetic resources, the management of weeds, pests and disease and the sustainable intensification of cropping practices.

LEARNING BLOCK 3:
Toward more sustainable cropping systems

This block describes how governance influences small-scale cropping systems and focuses on three major issues: including farmers in wider land-use planning, intellectual property rights and participatory plant breeding. The module concludes with examples of policies that enable and support sustainable small-scale cropping systems.

EDUCATIONAL RESOURCES:

Different kinds of support material are provided for educators to stimulate deeper insights and discussions in class or as assignments. Throughout the main texts, boxes suggest links to resources (see the list below) and to probing questions that are indicated by the symbols found in Figures 2 and 3.

- **Exercises and games:** for in-class and as assignments, to help deepen understanding of cropping systems.
- **Cases:** suggestions for further reading and assignments based on articles from ileia's magazine archive, to expose students to different practical examples of methods farmers use and to stimulate discussion.
- **Photographs:** for in-class, these can help start discussions with students on the practical implications of different issues raised in the module.
- **Videos:** for in-class, to complement the teachings with visual examples from around the world.
- **Farmer interview(s):** suggested visit with small-scale farmers, checklist and further on-farm exercises for students.
- **Further references:** suggestions for freely available books and interesting websites.

Figure 2: Symbol to indicate link to suggested questions

Figure 3: Symbol to indicate link to educational resources

Glossary for the whole series

This is separate from the module and includes definitions for difficult terms for the whole Learning AgriCultures series.

Making a lesson plan

Three basic questions need to be asked when preparing a lesson plan:
- What do you want your students to learn?
- How are they going to learn it?
- How will you know if they have learned it?

A lesson plan therefore needs to reflect these questions by setting out the learning objectives, aims, or goals of the unit, and how it relates to the whole course. The lesson plan should also include a list of the materials needed and the learning aids and references that you will use. See the example on the next page:

Example of a Lesson Plan

Lesson	The implications of mixing crops in small-scale farming
Time	3 hours
Objectives	After completion of this session participants are able to: • demonstrate an understanding of these concepts: crop agrobiodiversity, polycropping, monocropping, complementarity, synergy, multi-purpose functions and recycling • Recognise different methods of multiple cropping • Realise some of the practical benefits and limitations of mixed cropping practices in small-scale farming.
Prerequisite	Introduction to cropping systems' ecological interactions

Time	Content	Teaching method	Teaching aid
15 min	*Central question:* What is agrobiodiversity and how does it relate to crops?	*Introduction:* agrobiodiversity and link with the last session on cropping systems and ecological interactions. *Plenary discussion:* Ask students what they understand by agrobiodiversity	Blackboard, chalk Elaborate on definition from FAO (Box 3)

Time	Content	Teaching method	Teaching aid
45	*Central question:* How can different kinds of crops grow together and be productive? *Important points:* • Crops' ecological interrelationships • What do we mean by polycultures and monocultures? • Define concepts of complementarity, synergy, multi-purpose functions and recycling • Distinguish between simultaneous and sequential mixes	*Introduction:* mixed cropping *Plenary discussion:* • What are the different ways that crops can compete for and share light, space, nutrients and water? • Compare interactions in monocultures and polycultures (build on previous lesson about ecological interactions)	Blackboard, chalk Use Figure 7 (Crops as part of wider system) Option: Article R2.1 In defence of monocultures
10	BREAK		
80	*Central question:* What different ways are there for mixing crops? *Important points:* • Crop rotation • Multi-cropping • Agroforestry • Home gardens • Underutilised crops • Diversity at edges	*Brainstorm:* • What could be potential benefits and limitations of mixing crops when thinking of interactions? • What about for social or economic factors e.g. labour demands, marketing, food security, nutrition? *Watch a video* e.g. on agroforestry in Guam. Discuss the questions it raises and how they relate to your region	Blackboard, chalk Video R4.1 (21 minutes): Agroforestry in Guam Computer, beamer
10	*Concluding remarks* about small-scale farming and multiple cropping practices	Wrap up and explain group exercise. Respond to questions.	
20	*Central question:* Based on the lesson, can students make a mixed cropping design?	Exercise in small groups: Design a farm's cropping system based on 10-15 crops (start the exercise in class, but complete as homework)	Exercise R1.1

LEARNING BLOCK 1

Cropping systems on the farm

Mohanty Adivasi woman harvesting millet in India, photo from ORRISSAA

How do small-scale farmers around the world manage crops (including trees) in order to get productive livelihoods? In what ways do crops interact with different systems on the farm? What are the different roles that crops play in the farm and how do they contribute to livelihoods? What do we mean by agrobiodiversity? What do we need to consider in order to increase the agrobiodiversity of cropping systems? What different practices do farmers use to maintain diversity in their farms?

1.1 Introduction

The cultivation of crops on arable land is the very foundation of agriculture. How crops are cultivated varies in countless ways around the world, depending on many factors such as the climate and weather patterns, the resource base, soil and water constraints, and the knowledge and access rights of the farmers. Cropping systems vary from extensive and mobile systems such as shifting cultivation, to mixed systems that integrate many elements in the farm, to highly intensive industrial farming, in which large stands of single crops are grown continuously. All of these cropping systems are practised in tropical climates, although in semi-arid and arid environments rainfall (and access to irrigation) limits the timing and extent of agriculture. In (sub) tropical climates mixed cropping, which includes perennial crops and agroforestry (crops together with trees), predominate. In more temperate parts of the world, arable farming is more often based on highly productive and modern input-intensive annual crops, such as cereals.

Regardless of where they are, farmers aim to balance the different ecological needs of the crops that grow in their environment, so as to develop strategies to make their farms more productive. This learning block sets the stage by first describing distinguishing aspects of crops, followed by a look at different ecological interactions between crops and other organisms and processes at the level of the farm. It then focuses on small-scale farmers' crop management practices, and how a diversity-based approach based on multiple cropping can enhance the sustainable productivity of their systems.

1.2 Distinguishing aspects of crops

It is very difficult to make generalisations about crops because of their extreme diversity. They not only look different, offering hugely diverse products from different parts (leaves, roots, tubers, stems, flowers, etc.), with different properties: from foods, medicines, fodder, fibres, fuels, wood, and so on. They also provide a variety of services: the release of oxygen, habitats for beneficial predators, root networks that give stability and structure to the soil and help water permeation. Some crops fix nitrogen or draw nutrients from deep in the soil. Trees and bushes can provide wind breaks, protection from grazing cattle and shelter from the sun. Plants add vitality to even the most barren places, and farmers' cropping systems play a role in shaping landscapes around the world. This section provides an overview of the importance of crops from different vantage points - classification in terms of main products, scientific classes, and according to reproductive strategies and genetics.

1.2.1 Crop products

The UN's Food and Agriculture Organization (FAO) has developed a simple classification system for crops according to the main product type and whether they are a "temporary" or "permanent" (i.e. perennial) crop (see Sub-section 1.2.3). FAO (2010) now classifies all crops according to nine types, as follows:

- **Cereals**: The main cereal crops are (in order of hectares planted globally) wheat, rice, maize, barley, oats, rye and sorghum. Cereal crops or grains are used for food, feed for livestock and in industrial processes producing items such as alcohols and oils. Cereal grains are considered to be "staple crops;" they are grown in greater quantities and provide more calorific energy than any other type of crop. Over half of the global requirement for proteins and calories is met by just three cereals: maize, wheat and rice. There are also many other cereals that are locally extremely important for food security, such as fonio in West and Central Africa, quinoa (technically a "pseudo cereal") in Latin America and teff in Ethiopia (all from Bioversity, 2010).
- **Vegetables and melons**: These are further subdivided into leafy or stem vegetables (e.g. cabbages and artichokes); fruit-bearing vegetables (e.g. cucumbers and pumpkins), root, bulb or tuberous vegetables (e.g. carrots and onions); and mushrooms.
- **Fruit and nuts**: These are further subdivided into (sub) tropical fruits (e.g. bananas, mangoes and avocadoes) and citrus fruits; grapes; berries; pome and stone fruits (e.g. apples, apricots); nuts and "others". Plantain is included here, although it is an important staple crop in some African and Caribbean countries.
- **Oilseed crops: soyabeans**; groundnuts; other temporary oilseed crops (e.g. castor bean, sesame); permanent oilseed crops (coconuts, oil palms).
- **Root/tuber crops with high starch or inulin content**: These differ from those classified as vegetables because of their starch/inulin content. These are also considered to be staple crops. This category includes potatoes; sweet potatoes; cassava; yams and others.
- **Beverage and spice crops**: beverage crops are permanent crops such as coffee, cocoa and maté; spice crops include temporary (e.g. chillies and peppers) and permanent crops (e.g. cinnamon, vanilla and ginger).
- **Leguminous crops**: these include beans, peas and lentils etc. Legumes provide the important service of enhancing the availability of nitrogen in the soil. This is elaborated upon in the next section.
- **Sugar crops**: examples include sugar beet, sugar cane and sweet sorghum.
- **Other crops**: including grasses and fodder crops; fibre crops, medicinal, aromatic, pesticidal crops; rubber; flower crops; tobacco; and others.

It is important to remember that many crops have multiple purposes, which are not reflected in this classification, as they are classified according to their main commercial use. For example, soyabeans are categorised under oilseeds because this is the principle product; although they are also leguminous and as such can provide an important service to soil fertility. Another example is cotton, which is categorised as a fibre crop, but which also produces oil as well as contributing to fodder.

What is (are) the staple crop(s) in your area? Do these crops fullfill other functions as well? What other types of products do small-scale farmers grow there?

1.2.2 Scientific classification

While FAO bases its system on crop-product types, scientists and farmers around the world have long found different ways to classify plants according to common ecological characteristics and appearance. As more is learnt about genetic variability (see next section), scientific classification systems of all organisms will change because they show more clearly whether organisms are (closely) related or not, according to how similar their gene sequences are. Four different classes are introduced here, as they will be referred to the most in this module: "family", "genus", "species" and "variety".

What are examples of legumes in your area? Do farmers plant them in combination with other crops to benefit crop interactions?

- **Family**: this is a group of plants that has many common botanical features that are often easy to recognise. The characteristics of different families can be important for sustainability and can be used as the basis for farmers' strategies in combining crops through inter-cropping (planting different types of crops in the same bed or field) or crop rotation (rotating different crops in the same bed or the same field over time). A very important family of plants for farmers is the Leguminosae (or legume) family. These plants form symbiotic relationships with rhizobia, which belong to the family of bacteria called Rhizobiaceae. When legumes (e.g. beans, peas, soyabeans, groundnuts, lentils, alfalfa, clover, or trees such as Leucaena or Gliricidia, etc.) are planted in inter-crops, green manures or in crop rotation, the rhizobia make nitrogen from the air directly available to other plants.

Box 1: How does symbiosis between legumes and rhizobia work?

Approximately 16 500 species of legumes exist, though not all are able to form an association with nitrogen-fixing bacteria. Rhizobia are single-celled bacteria, approximately one thousandth of a millimetre in length. These bacteria form a mutually beneficial association, or symbiosis, with legume plants. The rhizobia enter into the roots of legume plants which respond by producing a round and visible structure called a root nodule. Taking nitrogen from the air the rhizobia then convert the nitrogen into a form that plants can use, called ammonium. This is known as "nitrogen fixation". Most plants need specific kinds of rhizobia to form nodules. For example, the rhizobia that form nodules on soyabeans cannot form nodules on clover. For nodulation to take place the right plant-rhizobia combination needs to be present. It also requires a healthy soil environment that is not too acid (i.e. has a low pH), or suffer from aluminium toxicity, nutrient deficiencies, salinity, water-logging or the presence of root parasites, such as nematodes. Sometimes it is necessary to inoculate legumes with the correct rhizobia to ensure that nitrogen-fixation will take place.

- **Genus**: This is the "generic" or common name given to a specific group of plants within a family – e.g. Brassica is one of the genera within the family of Brassicaceae or Cruciferae. (The members of this genus are collectively known as cabbages).
- **Species**: This is the more "specific" name of a group of plants within a genus. Together, the genus and species name define one particular plant (with the whole name italicised, the genus capitalised, and the species in lower case – e.g. *Leucaena leucocephala*). For example, the family of Brassicaceae contains

well-known species such as *Brassica oleracea* (cabbage, cauliflower, etc.), *Brassica rapa* (turnip, Chinese cabbage, etc.), *Brassica napus* (rapeseed, etc.), *Raphanus sativus* (common radish), etc.

- **Variety**: Within species, there can further be different varieties or "cultivars" (i.e., cultivated varieties) containing different traits in terms of adaptation to different conditions such as dryness, soil acidity, pest and disease resistance, but also in plant height, maturity cycle, etc.

1.2.3 Reproductive strategies and genetics

To support the best growth of their crops, farmers need to understand their specific life cycles (how long they live and their growth patterns). In addition, crops' different reproductive strategies and the study of genetics provide insights into breeding for desired characteristics.

Figure 4: Understanding the life cycles of different plants such as beans as pictured here, is integral to farming.

Some plants are annuals, meaning they complete their life cycle (from seed to seed) within one year, or growing season. Many food crops are annuals, or are grown as such, including most domesticated cereals. Others are biennials, which take two years or growing seasons to complete their life cycle. During the first season, biennials produce leaves and food storage organs. After over-wintering, they produce flowers, fruit, and seeds in the second season. Carrots, beets, celery, and parsley are examples of biennials – but are usually grown as annual crops for their edible roots, petioles (celery) and leaves (parsley). Lastly there are the perennials, which grow for more than two years and are grouped into two categories: herbaceous or woody perennials. Examples of woody perennials are trees and shrubs.

Figure 5: Flower showing male (stamen) and female (pistil in centre) parts.

It is important to understand the reproductive strategies of crops in farming. All plants require pollination, (fertilisation of flowering plants) to be able to reproduce. Pollination involves the transfer of pollen grains to the female parts of plants. This takes place in different ways:

- **Cross-pollination**: pollen is delivered to a flower from a different plant.
- **Self-pollination**: pollen from one flower pollinates the same flower or other flowers of the same plant.
- **Closed pollination**: a form of self-pollination that occurs before the flower opens.

Cross-pollination and self-pollination are both examples of "open pollination" which is carried out by insects, birds, wind, or other natural mechanisms. In open pollination, there is no control over where the pollen comes from, so the (male parent) source is unknown. This means that plants may develop widely varied genetic traits. Open pollination contrasts with controlled pollination, carried out by breeders in a breeding programme. In this situation, all the seeds of a crop are controlled to be descendants of parents with known traits (or features), and are

EDUCATIONAL RESOURCES
for Module 3

How can students develop a deeper understanding about small-scale farming and sustainable cropping practices? Throughout the three learning blocks, different educational resources have been highlighted that can be used to stimulate discussions and as material for assignments. These include exercises, games, articles, photos, videos, a farmer interview checklist and field exercises, as well as references for further reading. They are brought together in this section.

R1. Exercises and Games

Figure 33: Exercises and games can help students understand issues better.

This section includes three exercises and one role play to support different lessons from the three learning blocks.

R1.1 Planning a field layout for mixed cropping

Objective of the exercise: to better understand about positive and negative interactions between crops in a mixed cropping system.
Time involved: half a day (the field visit will require additional time)
Suggested use: Learning Block 1 (1.4.2: Using crop diversity as a buffer)
Number of participants: divide the students into groups of 5-6
Materials: large sheets of paper and coloured markers

Methodology:

- Think of a typical selection of about 10-15 crops in small farms in your area. Consider staple crops, fruit, vegetables, legumes and crops with high market value. Be sure to also include trees and underutilised crops.
- Use the information in Sub-section 1.4.2 to discuss different relationships of complementarity, synergy, multi-purpose functions and recycling. Also discuss different ways to grow multiple crops together simultaneously or sequentially over time.
- Reflecting on the selection of crops you have made, consider their characteristics and the different kinds of relationships between them. List the characteristics on poster paper. Examples of characteristics include:
  1. **Nutrients:** are there any legumes or crops that need more nutrients?
  2. **Timing:** which crops are fast-growing and which slow-growing?
  3. **Roots:** which crops have shallow root systems and which are deep-rooted?
  4. **Natural repellents:** are there crops (e.g. onion family) that can natural repel insects?
  5. **Length and light:** how tall do the crops get? Which crops can and cannot tolerate shade?
  6. Which crops could form a **favourable rotation** (e.g. five-year cycle)
- Present a design indicating intercropping over one season, as well as a five-year cycle. Discuss the logic behind the design, and present the kinds of relationships (i.e. complementarity, synergy, multi-purpose functions and recycling) you are exploiting.

Discussion:

- Compare different presentations. Which systems would give the most benefit to farmers and why? Which fit the best with typical soil and water conditions?

R2. Articles about practical experiences

Figure 34: Using ileia's article archive can stimulate discussion on practical implications of small-scale cropping systems' sustainability.

Objective: to use articles about small-scale farming experiences from around the world to deepen the lessons from the three learning blocks.
Materials: all articles can be retrieved from the LEARNING pages on ileia's website (www.ileia.org), while a selection of articles (indicated by a green A) is included in the Appendix that follows the Educational Resources section.
Methodology: these articles can be used as additional reading material, as part of classroom discussions, or as part of student assignments. One suggestion is to have students prepare presentations on the basis of the articles, addressing specific questions related to the information contained in the learning blocks. Some questions are suggested.

R2.1 Are polycultures always more sustainable?

Where to use this article: Learning Block 1 – Sub-section 1.4.2

IN DEFENCE OF MONOCULTURES (GLOBAL, 2000)

What it is about: this article challenges the assumption that monocultures can never be sustainable by observing the sustainability of natural stands of wild relatives of annual cereals.

Suggested questions:

- What examples does the author site as being natural monocultures?
- Under what conditions does the author propose that natural monocultures can survive well?
- How do the natural monocultures described by the author differ from monocultures found in modern agricultural cropping systems?
- Does the article answer the question it poses: i.e. is there something that can be learned from natural monocultures that could be of value to sustainable cereal cropping?
- Comparing the three methods, how is labour affected?

R2.2 Crop rotation

Where to use this article: Learning Block 1 – Sub-section 1.4.2 (under Crop rotation)

THE MAMBWE MOUND CULTIVATION SYSTEM (ZAMBIA, 2006)

What it is about: by introducing different practices, including a longer crop rotation based on more crops and planting on mounds, a shifting cultivation system has been sustainably intensified.

R3. Photo gallery

Objectives: To use as illustrations for teaching, to stimulate discussions – to help students understand the links between what is going on in the wider context and cropping systems on the farm.
Total time involved: Presentation during class time (20-30 minutes)
Materials: Photo gallery as powerpoint presentation with beamer, or printout (see Appendix at end of Module)

Methodology:
- Present the photographs and ask a number of questions about the photo to help stimulate ideas: for example, what do they observe in the photo, and what does it mean in relation to cropping systems (reflect on more than simply ecological aspects).
- Use the photographs to discuss similar initiatives in your region.

Photo Nr	Title	Explanation
	**Know the enemy, Karnataka, India**	One part of IPM is to "know the enemy" and release beneficial insects at the right moment. Here, Indian farmers look for insects in a "pheromone trap" in a groundnut field. This is a type of insect trap that uses pheromones (natural or synthetic insect sex attractants) to lure insects. These traps are often used to detect the presence of exotic pests, for sampling, monitoring, or determining the first appearance of a pest in an area.
	**Farmers make their own biopesticide, Cikoneng, Indonesia**	Through IPM activities farmers have developed practices that avoid using pesticides. What used to only be done in the laboratory of the agricultural department is now also done by the farmers. This farm woman is reproducing trichoderma, a fungus which is effective against soil-borne diseases such as root rot. It is particularly useful for dryland crops such as groundnut, black gram, green gram and chickpea.
	**Safe vegatables, Vietnam**	There is an increasing demand by consumers in particularly the urban areas of Vietnam, for "safe" vegetables grown with fewer chemical fertilisers and pesticides. Simple pest-control techniques such as the sticky card are being used by some farmers instead of pesticides.
	**Bare-faced risk, Ecuador**	A farm worker without a protective mask or clothing sprays a crop. Studies show that pesticides can cause health problems, including birth defects, nerve damage, cancer, and other effects that might occur over a long period of time. These problems affect not only those who prepare and apply the pesticides, but also women and children in and around rural households. Not using protection when spraying significantly increases the health risk.
	**Seeds for agro-biodiversity, Tamil Nadu/Karnataka, India**	Women in south India became involved in multiplying seeds of different local varieties of rice, finger millets and other food crops that can be planted in mixed-crop systems. This led to the idea of establishing community seed banks, from which members can get seeds free of charge by agreeing to return twice the amount of seed after the harvest. This was part of a project on agrobiodiversity that focused on identifying and using traditional plant species and varieties.
	**Pest and disease management, the Netherlands**	Good pest and disease management is based on a well-designed crop rotation system. This farmer grows more than eight different crops in one year, and he does not sow the same crop in the same field for at least six years. He grows potatoes, alfalfa, maize, beetroot, wheat, onions, carrots and oats. This long crop rotation helps avoid many diseases.

R4. Videos

Objectives: to offer visual examples from around the world to complement the teachings and to deepen students' understanding of sustainable cropping practices in small-scale farming and practical initiatives towards sustainability.
Total time involved: see video durations below – add time for classroom discussion.
Materials: the videos are available on CD-Rom or can be downloaded from the LEARNING pages on ileia's website; to present the videos, a computer and beamer are needed.
Methodology:

- Present the videos to illustrate points from the lessons and to stimulate discussions on them.
- Use the videos to discuss related issues and initiatives in your region.

R4.1 Agroforesty: A sustainable tropical island land use system

Duration: 21 minutes
Suggested use: Learning Block 1 – Sub-section 1.4.2, to supplement the lesson on Agroforestry
What it is about: this video looks at experiences with different agroforestry methods in Guam. It starts by looking at the relation between economic returns for farmers and sustainable practices. It then goes on to discuss multi-purpose functions of trees and looks at methods such as cropping systems, alley cropping, contour hedgerows and living mulches. (Produced by the College of Micronesia and the University of Guam - Primary funding source: Western Sustainable Agriculture Research and Education (WSARE) grant programme, 2000)

Suggested questions:

- How can agroforestry contribute to spreading risks? What different options do farmers in the video have for spreading risks in their fields?
- What are the trade-offs between short-term profitability ("use", "harvest") and long-term productivity ("plant", "care for") of agroforestry systems.
- What is the influence of an agroforestry system on the soil?

R4.2 Dalit food systems: a new discourse in food and farming

Duration: 29 minutes
Suggested use: Learning Block 1 – Sub-section 1.4.2, to supplement lesson on Underutilised crops
What it is about: this video looks at the importance of underutilised crops (or "uncultivated crops") for food security and livelihoods, focusing on the marginalised population of Dalits (people of the lowest caste) in India (produced by IIED/DDS, 2008)

R5. Farmer visit and field exercises

Figure 35: Visits to farmers bring practical realities alive.

Objectives: To get close to practical realities of small-scale farmers and their cropping issues; to better understand the lessons in the three learning blocks by observing different aspects on 1 or more farms and talking to at least one, but preferably more, farmer(s) directly; and to allow students to get practical experience in interviewing and synthesising information.

Time involved: Take time ahead of the interview to prepare questions and field exercises. The time needed for the visit will depend on how far the farmers live from the school; the interview should last at least 2 hours. Field exercises half a day.

Suggested use: Visits can take place once the lessons in Learning Block 1 have been completed. Waiting until completing Learning Block 2 will allow for more insights into seed systems and IPM.

Materials: For the interview: pen and paper to take notes, tape recorder, camera and/or video camera;
For field exercises, see below.

Methodology:

- If possible, arrange interviews with different farmers, to include both men and women farmers; if possible it is interesting to compare farmers with multiple cropping systems and those with monocultures.
- Prepare a list of questions to ask farmers about different aspects of their cropping practices and their reasons behind their selection processes (see R5.1 for interview checklist).
- Take the opportunity to also do some simple exercises with students, based on observations in the field during the visit (see R5.2 for some ideas).
- Following the visit, ask students to make presentations or a written report on their findings.

R5.1 Farmer interview checklist

Before going into the field:

- Choose a main crop in the region and ask students to make a list of criteria for comparing different varieties of this crop (e.g. fast-growing, tolerance to drought/heavy rainfall, productivity, taste, quality, resistance to pests/ diseases; usefulness of by-products for different purposes; ease of processing; timing of harvests; ease of harvesting; cost and availability of seed; etc.
- Explain to students that it is important to get a better understanding about how farmers' priorities influence which crop varieties they chose. Agricultural research organisations often develop new crop varieties in order to produce higher yields or that are more resistant to pests and diseases. While these

R6. Further references for Module 3

This section provides a list of freely accessible resources that can help educators and students dig deeper into issues explored in this module. Resources include books and guides, as well as websites that offer further resources, photos and videos.

R6.1 Books and field guides

Guide to participatory tools for forest communities

by Kristen Evans et al., 2006. 37 pp. ISBN 9792446567. Center for International Forestry Research (CIFOR), P.O. Box 6596 JKPWB, Jakarta 10065, Indonesia. E-mail: cifor@cgiar.org

Download from: http://www.cifor.cgiar.org/publications/pdf_files/Books/BKristen0601.pdfhThis toolkit contains a collection of participatory tools for environment and development practitioners, researchers and local government leaders. Some of these tools are adaptations of existing methods; others were created specifically for work with forest-dependent communities, for promoting sustainable forest management and the empowerment of these and other natural resource dependent communities. The tools have many applications, including stakeholder identification, decision-making, planning, conflict management, and information collection.

Manage insects on your farm: A guide to ecological strategies

by Miguel A. Altieri, Clara I. Nicholls and Marlene A. Fritz, 2005.128 pp. Sustainable Agriculture Network (SAN) Publications, P.O. Box 753, Waldorf, Maryland 20604-0753, U.S.A. E-mail: sanpubs@sare.org

Download from: http://www.sare.org/publications/insect/insect.pdf

While every farming system is unique, the principles of ecological pest management apply universally. “Manage insects on your farm” highlights the ecological strategies that improve a farm’s natural defences and encourage beneficial insects to attack pests. This book shows how ecologically based pest management works and presents strategies used by farmers around the world to address insect problems. As part of the principles of ecologically based pest management, it describes how to manage soils to minimise the presence of pests, and describes the most common “beneficial agents” on a farm.

Small-scale seed production

by Harry van den Burg, 2004. ISBN 90-77073-43-4. Agrodok no. 37. Agromisa, P.O. Box 41, 6700 AA Wageningen, the Netherlands.

Download from: http://www.agromisa.org/agrodoks/Agromisa-AD-37-E.pdf

This manual presents the general principles behind seed production and the maintenance of cultivars, with special reference to cereal and legume seeds. Written for extension staff and small-scale farmers, it highlights the basic ideas behind inheritance and genetic variation, describing the differences between

self- and cross-pollinated species. The later sections describe the different aspects which determine the quality of seeds, the importance of post-harvest care and the issues to consider when setting up a small seed production business.

Agromisa documents

Download from: www.agromisa.com

Agromisa, the knowledge centre for small-scale sustainable agriculture has a lot of useful manuals and publications (called "Agrodoks"and "AgroSpecials") on plant production, protection and post-harvesting. Some of these publications focus on specific crops and others provide general guidance on cropping systems such as agroforestry or home gardening. The information is downloadable in PDF format in English, French and Portuguese, but ordering hard copies involves costs or follows a system of points for members of CTA. The 50+ manuals include topics such as: Fruit growing in the tropics, Agroforestry, Identification of crop damage, Crop protection, Storage of agricultural products, Plant patenting, etc. (see also specific references at the end of the second and third learning blocks).

Seeds that give: Participatory plant breeding

by Ronnie Vernooy, 2003. ISBN 1-55250-014-4. IDRC, P.O. Box 8500, Ottawa, ON K1G 3H9, Canada. E-mail: info@idrc.ca ;

Download from: www.idrc.ca/seeds

Genetic erosion makes the world's food supply more vulnerable to disease and sudden climatic change - this may be the price to pay for having successfully developed and widely used new high-yielding crop varieties over the last decades. This paradox, and how it is being addressed by a novel plant breeding approach that takes into account the invaluable contribution of small farmers, is the topic of this book. Complementing the book are six case studies from the developing world and a thematic website (www.idrc.ca/seeds).

Manifesto on the future of seeds

by the International Commission on the Future of Food and Agriculture, 2006. ARSIA Secretariat, Regional Government of Tuscany. Via Pietrapina 30, 50121 Florence, Italy.

Download from: http://www.future-food.org

Created in 2003 with the conviction that "a better world is possible" the Commission seeks to shape a new future of food in which small farmers' livelihoods are secure, rural areas are economically and culturally vibrant, ecologically resilient, and citizens have nutritional security. Its work is guided and inspired by the principles elaborated and developed in its Manifesto on the Future of Food.

A guide for conducting Farmer Field Schools on cocoa integrated crop and pest management

by Soniia David et al., 2006. International Institute of Tropical Agriculture (IITA), Sustainable Tree Crops Program. P.O. Box 135, Accra, Ghana. E-mail: stcp-wca@cgiar.org ;

Download from: http://www.treecrops.org

The Farmer Field School (FFS) approach is relatively new to West Africa and

there are few examples of its application to tree crops and perennial crops. Since 2003, the Sustainable Tree Crop Program (STCP) has pioneered FFS on cocoa integrated crop and pest management in Cote d'Ivoire, Ghana, Nigeria and Cameroon. Although it is based on the experience gained from cocoa FFSs, many of the principles and recommendations can be applied to other tree crops. The manual is directed at FFS programme managers and other development practitioners.

Farmers, seeds and varieties: Supporting informal seed supply in Ethiopia

by Marja H. Thijssen, Zewdie Bishaw, Abdurahman Beshir and Walter S. de Boef (eds.), 2008. ISBN 978-90-8585-215-5. Wageningen International, Programme for Capacity Development and Institutional Change, P.O. Box 88, 6700 AA Wageningen, the Netherlands.

Download from: http://www.cdic.wur.nl/UK/publications

While this book was developed in response to issues identified within Ethiopia, the variety of topics and experiences presented in it are also relevant for other regions of the world. It will be of interest to people working in the seed sector, development agents and NGOs working to develop farmer based seed production. The papers were written by the trainers, resource persons and participants of a training programme to improve farmer-based seed production and revitalise the informal seed supply for local crops and varieties in Ethiopia. As such it is a thorough and practical reference and resource book.

IFOAM Training Manual for Seed Saving

edited by K. Vijayalakshmi, Centre for Indian Knowledge Systems, 2008. ISBN 3-934055-68-0. International Federation of Organic Agriculture Movements (IFOAM), Charles-de-Gaulle-Strasse 5, DE-53113, Bonn, Germany.

Download from: http://www.ifoam.org/ (free for IFOAM members)

This training manual provides detailed information on how to save seeds according to organic practices. Topics covered include; community-based seed conservation, seed multiplication, sections on specific crops and examples from the field.

R6.2 Interesting websites

Agrobiodiversity and Climate Change

http://www.agrobiodiversityplatform.org/climate_change

The Agrobiodiversity and Climate Change site gathers and disseminates information on the use of agrobiodiversity by communities facing climate change. Started in April 2008, this project brings together information from rural communities, indigenous peoples and research workers. The website gives you the opportunity to interact and discuss the project's topic, to find and share information on projects concerned with climate change and agrobiodiversity and to check out related news and events.

Bioversity International

http://www.bioversityinternational.org

Bioversity is the world's largest international research organisation dedicated solely to the conservation and use of agricultural biodiversity. It is non-profit and independently operated. The website provides publications about a diverse range of themes related to biodiversity. Their annual magazine Geneflow is available on the website and carries stories from all around the globe, from a wide range of sources including national, regional and international development agencies, non-governmental organisations and research workers.

Coalition to Diversify Income from Underused Crops (CoDI)

http://codi-asia.net

CoDI is a group of organisations in India and Vietnam led by the International Centre for Underutilised Crops. This website describes their activities, all of which aim to increase diversity on farms, link small-scale farmers to markets and improve processing, packaging and marketing skills. The coalition provides community services to help disadvantaged people in India and Vietnam generate sustainable incomes. Their activities include "Food Processing Parks", "Village Crop Fairs" and "Knowledge Fairs". The website also contains useful information about underutilised crops in the two countries and project descriptions and analyses.

Community-Based Natural Resource Management Network

http://www.cbnrm.net

This site provides a network for people working on community-based natural resource management (CBNRM), whether as practitioners, managers and researchers, and an opportunity for them to exchange experiences, manage knowledge, and support learning across countries, sectors, cultures, and languages. The site has a comprehensive resources section, with many links and a lot of references and background information.

Community IPM

http://www.communityipm.org/index.htm\

This site includes many useful documents and teaching materials related to Farmer Field Schools. It was originally created as part of the FAO's Programme for Community IPM in Asia. It is now maintained as an archive of information about the groundbreaking work carried out by government agencies, NGOs and farmer groups carried out under this Programme.

Convention on Biological Diversity

http://www.cbd.int

The website of the Convention on Biological Diversity is a large resource, containing information about the convention itself and the Protocol on Biosafety. It describes various programmes, including Agricultural Biodiversity, Island Biodiversity and Mountain Biodiversity, each complete with updates, background information, activities and links. From the homepage you can sign up to

receive various e-newsletters, and there is also a link to The Green Wave (http://greenwave.cbd.int), a global campaign to educate children and youth about biodiversity.

Ecoagriculture Partners

http://www.ecoagriculture.org/

Ecoagriculture is a strategy for both conservation and rural development. It applies an integrated ecosystem approach to agricultural landscapes that aims to enhance rural livelihoods; conserve or enhance biodiversity and ecosystem services; and develop more sustainable and productive agricultural systems. It draws on diverse elements of production and conservation management systems, through processes of collaboration or coordination between diverse stakeholders (including farmers and rural communities) who are collectively responsible for managing key components of a landscape.

FAO on plant production and protection

www.fao.org

The FAO website contains a wealth of information on different topics. To narrow down your search go to 'Topics' and then 'Plant production and protection'. Here you can find information on different techniques and how FAO is and has been working on that particular theme.

GENET Archive

www.gene.ch/archives.html

This site has been established to support discussions about genetic engineering and to provide information intelligible to non-scientists. At present decisions are being taken which are influencing society and the environment worldwide. New crops are being planted and products derived from them are being sold fraudulently (without labels and risk information) on the world market. Huge areas are being invaded by newly designed organisms whose long-term effects on ecosystems are unknown and may be irreversible. This archive provides plenty of background information on these subjects.

GeneWatch

www.genewatch.org/

GeneWatch UK is an independent organisation concerned with the ethics and risks of genetic engineering. It questions how, why and whether the use of genetic technologies should proceed and believes that the debate over genetic engineering is long overdue. Though GeneWatch is UK based the site is oriented to a worldwide audience and provides a lot of information.

Global Farmer Field School Network and Resource Centre (FFSnet)

http://farmerfieldschool.info

The objective of this FFS network is to support national and regional knowledge sharing, networking and co-ordination among FFS practitioners in order to make FFS interventions more effective. Its works as a decentralised network and resource centre focusing on strategies and mechanisms for institutionalisation

and scaling-up, quality control mechanisms and low cost implementation strategies and mechanisms. The site has a discussion forum and provides access to a broad database that facilitates the exchange of experiences and gives access to many resources and training materials relevant to the study of cropping systems.

Global Plant Clinic

http://www.globalplantclinic.org

The CABI Bioscience Global Plant Clinic provides a comprehensive diagnostic and advisory service for disease problems affecting all tropical crops. The website gives expert advice on the interpretation and application of diagnostic results. It draws on the extensive international experience in a wide range of crops and information from CAB International's Crop Protection Compendium. This service is freely available for people in developing countries involved in agriculture.

INFONET-BioVision Farmer Information Platform

http://www.infonet-biovision.org

This large website provides a wealth of information on organic agriculture and crop husbandry, and ecological ways to prevent and control plant, human and animal pests and diseases. The site describes 44 common crops in detail, giving agronomic information for each with a description of the main pests and diseases and a list of links to other sources of information. Contributions come from farmer groups, local experts and international scientists.

IUCN (International Union for Conservation of Nature)

http://www.iucn.org/

IUCN is the world's oldest and largest global environmental network, with more than 1 000 government and NGO member organisations and almost 11 000 volunteer scientists in more than 160 countries. It conducts scientific research and manages field projects all over the world. These projects bring together governments, NGOs, UN agencies, companies and local communities in developing and implementing policy, laws and best practice for nature conservation. Its headquarters are located in Gland, near Geneva, Switzerland.

La Vía Campesina

http://viacampesina.org/main_en/

Established in 1993, this is the main global advocacy organisation for small-scale farmers. In short, La Vía Campesina calls for greater rights for small-scale farmers, based on fair access to resources such as land and water, fair economic relations, and ability to sustain their families from small-scale farming. One of their key concepts is called "Food sovereignty", introduced in 1996. A PDF document with La Vía Campesina's declaration of food sovereignty can be downloaded from the link: http://www.voiceoftheturtle.org/library/1996%20Declaration%20of%20Food%20Sovereignty.pdf.

People and Plants online

www.rbgkew.org.uk/peopleplants/

People and Plants promotes the sustainable use of plant resources and seeks to integrate the goals of conservation and development. This website is a gateway to information on practical ways of working in applied ethnobotany. Its main focus is on Africa, Asia and the Pacific. Besides newsletters and interesting links, the People and Plants Handbook series provides a source of information on applying ethnobotany to conservation and community development.

Pesticide Action Network

www.pan-international.org/

The Pesticide Action Network (PAN) is a network of more than 600 non-governmental organisations, institutions and individuals in over 90 countries, working to replace the use of hazardous pesticides with ecologically sound and socially just alternatives. Their main aims are to eliminate the use of hazardous pesticides, reduce the overall use, risk and dependence of pesticides and increase support for community-based control over a sustainably produced food supply. Specific information about different pesticides can be found in the site.

Prota (Plant resources of Tropical Africa)

www.prota.org

When PROTA started in 2000, it had a simple technical objective: "to improve access to interdisciplinary data on the plant resources of tropical Africa". PROTA has so far brought together previously dispersed information on about 2 100 useful plants. This information is contained in slightly over 1 200 review articles, mostly arranged by commodity groups "cereals and pulses", "vegetables", "dyes and tannins", "vegetable oils", "timbers" and "medicinal plants". All the information is freely accessible in a web database but is also available in a book and CD series.

Prosea – Plant resources of South-East Asia

www.prosea.org

Functioning since the late 1980s, this organisation has compiled information on plant resources in South East Asia, The site documents information on 6 697 plants from that region, which is available in a series of booklets as well as an electronic databank (e-PROSEA). It is aimed at people working in education, extension, research and industry as well as for end users.

SRI (System of Rice Intensification)

http://ciifad.cornell.edu/sri

A collaborative effort by Tefy Saina (an NGO) and Cornell University's CIIFAD, this website reports on developments in SRI, the System of Rice Intensification. This system is rapidly spreading and being adapted by rice farmers in different parts of the world. It presents details of new techniques, which farmers are encouraged to consider and further improve upon. It provides the opportunity to join discussion groups and the SRI-UPDATE-L, an electronic mailing list about SRI. They also have a blog with global news and views on SRI.

World Agroforestry Centre

http://www.worldagroforestrycentre.org/

The World Agroforestry Centre is an international research organisation supported by the Consultative Group on International Agricultural Research (CGIAR). It works in more than 20 countries in Africa, Asia and Latin America. Farmers have practised agroforestry for years. Agroforestry focuses on the wide range of working trees grown on farms and in rural landscapes. The centre is working on these topics related to the trees, farms, landscapes and global issues. The website is based on the research of the centre and provides a lot of material, from publications to news and learning tools.