TRAINING MANUAL

IFOAM
INTERNATIONAL FEDERATION OF ORGANIC AGRICULTURE MOVEMENTS

IFOAM TRAINING MANUAL

for Seed Saving

EDITED BY

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COMPILED BY

Centre for Indian Knowledge Systems
Real-world solutions from traditional science.

PREFACE

This manual was commissioned by IFOAM and funded through its program "IFOAM – Growing Organic II" (I-GO II) which aims to strengthen the Organic Movement in Developing Countries. I-GO II is funded by HIVOS, Netherlands and the "Fund for Sustainable Biodiversity Management" of the Dutch Government, managed by HIVOS and NOVIB

The manual has been compiled by Centre for Indian Knowledge Systems (India).

Feedback and suggestions for improvements are welcome!

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ISBN: 978-3-940946-35-5

PREFACE

Preface

Many organizations in tropical countries, probably most of them NGOs, are engaged in training activities on various topics related to organic agriculture. IFOAM has been involved in the facilitation of training activities by making suitable material and approaches available. One of the important areas of organic agriculture is the production and saving of seeds. Seeds are very basic to agriculture and it is very important for the farmer to have access to his/her own seeds. This training manual for organic seed saving was developed to help farmers in the tropics to save and multiply their seeds. A large part of information found in this manual is based on the experience of several seed savers in the field. Besides this existing material was also collected, screened and simplified for the manual. The Centre for Indian Knowledge Systems (CIKS, India), was given the task of putting together this manual.

This manual contains information on the various aspects of community seed banking. It provides detailed information on the various steps involved in seed saving and multiplication. It also gives information on multiplication techniques for specific crops. Examples of community seed saving are also provided.

The training manual was commissioned by IFOAM and funded through its program IFOAM-GROWING ORGANIC II (I-GO II). The development of this manual is the start of a continuing process. The training manual shall be a living document, modified and further developed by those who use it. All copyrights are retained by IFOAM.

We hope that this training manual will be an inspiring source for all its users. We invite all to contribute their suggestions and material for further improvements of the manual. Contact: headoffice@ifoam.org.

Acknowledgment

The development of this training manual was possible only through the active collaboration of the following organizations whose contribution is herewith acknowledged:

- IFOAM for funding, for facilitating and for providing feedback.
- The contributing partner CIKS for giving shape to this manual.

Special thanks go to the following persons who supported the development of this manual with their tireless work:

- Martin Eimer, Louise Luttikolt (concept, feed back)
- S. Arumugasamy, Subhashini Sridhar, T.D. Nirmala Devi, R. Abarna Thooyavathy, René Piamonte (contributions)
- Sashikala Asirvatham (editorial assistance)
- T.D. Nirmala Devi (drawings)
- S.U. Saravanakumar, K. Vijayalakshmi, CIKS library (photographs)
- S. Ramesh (secretarial assistance)
- Anand Ramachandran (layout and design)

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Principles of Organic Agriculture

Preamble
These Principles are the roots from which organic agriculture grows and develops. They express the contribution that organic agriculture can make to the world, and a vision to improve all agriculture in a global context.

Agriculture is one of humankind's most basic activities because all people need to nourish themselves daily. History, culture and community values are embedded in agriculture. The Principles apply to agriculture in the broadest sense, including the way people tend soils, water, plants and animals in order to produce, prepare and distribute food and other goods. They concern the way people interact with living landscapes, relate to one another and shape the legacy of future generations.

The Principles of Organic Agriculture serve to inspire the organic movement in its full diversity. They guide IFOAM's development of positions, programs and standards. Furthermore, they are presented with a vision of their world-wide adoption.

Organic agriculture is based on:

- The principle of health
- The principle of ecology
- The principle of fairness
- The principle of care

Each principle is articulated through a statement followed by an explanation. The principles are to be used as a whole. They are composed as ethical principles to inspire action.

Principle of health

Organic Agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible.

This principle points out that the health of individuals and communities cannot be separated from the health of ecosystems - healthy soils produce healthy crops that foster the health of animals and people.

Health is the wholeness and integrity of living systems. It is not simply the absence of illness, but the maintenance of physical, mental, social and ecological well-being. Immunity, resilience and regeneration are key characteristics of health.

The role of organic agriculture, whether in farming, processing, distribution, or consumption, is to sustain and enhance the health of ecosystems and organisms from the smallest in the soil to human beings. In particular, organic agriculture is intended to produce high quality, nutritious food that contributes to preventive health care and well-being. In view of this it should avoid the use of fertilizers, pesticides, animal drugs and food additives that may have adverse health effects.

Principle of ecology

Organic Agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them.

This principle roots organic agriculture within living ecological systems. It states that production is to be based on ecological processes, and recycling. Nourishment and well-being are achieved through the ecology of the specific production environment. For example, in the case of crops this is the living soil; for animals it is the farm ecosystem; for fish and marine organisms, the aquatic environment.

Organic farming, pastoral and wild harvest systems should fit the cycles and ecological balances in nature. These cycles are universal but their operation is site-specific. Organic management must be adapted to local conditions, ecology, culture and scale. Inputs should be reduced by reuse, recycling and efficient management of materials and energy in order to maintain and improve environmental quality and conserve resources.

Organic agriculture should attain ecological balance through the design of farming systems, establishment of habitats and maintenance of genetic and agricultural diversity. Those who produce, process, trade, or consume organic products should protect and benefit the common environment including landscapes, climate, habitats, biodiversity, air and water.

Principle of fairness

Organic Agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities

Fairness is characterized by equity, respect, justice and stewardship of the shared world, both among people and in their relations to other living beings.

This principle emphasizes that those involved in organic agriculture should conduct human relationships in a manner that ensures fairness at all levels and to all parties – farmers, workers, processors, distributors, traders and consumers. Organic agriculture should provide everyone involved with a good quality of life, and contribute to food sovereignty and reduction of poverty. It aims to produce a sufficient supply of good quality food and other products.

This principle insists that animals should be provided with the conditions and opportunities of life that accord with their physiology, natural behavior and well-being.

Natural and environmental resources that are used for production and consumption should be managed in a way that is socially and ecologically just and should be held in trust for future generations. Fairness requires systems of production, distribution and trade that are open and equitable and account for real environmental and social costs.

Principle of care

Organic Agriculture should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment.

Organic agriculture is a living and dynamic system that responds to internal and external demands and conditions. Practitioners of organic agriculture can enhance efficiency and increase productivity, but this should not be at the risk of jeopardizing health and well-being. Consequently, new technologies need to be assessed and existing methods reviewed. Given the incomplete understanding of ecosystems and agriculture, care must be taken.

This principle states that precaution and responsibility are the key concerns in management, development and technology choices in organic agriculture. Science is necessary to ensure that organic agriculture is healthy, safe and ecologically sound. However, scientific knowledge alone is not sufficient. Practical experience, accumulated wisdom and traditional and indigenous knowledge offer valid solutions, tested by time. Organic agriculture should prevent significant risks by adopting appropriate technologies and rejecting unpredictable ones, such as genetic engineering. Decisions should reflect the values and needs of all who might be affected, through transparent and participatory processes

1 Introduction

1 Introduction

1.1 About the Training Manual

1.1.1 Aims and Scope

The Training Manual was developed to improve the quality and the availability of didactic material on seed saving in tropical countries. It offers a resource basis for trainers with the idea of encouraging individual adaptation and further development of the material according to the needs. The Training Manual can be used as a guide and source book to implement training programs. It will help develop the structure of a training course or workshop and provide material and ideas for its organisation. The Manual can also serve as a handbook for those who want to get a more clear and complete idea on the basics of seed saving.

It is anticipated that the trainers and trainees already have some agricultural background and that the training activities will focus on aspects specifically relevant to seed saving. The Manual attempts to provide a comprehensive introduction to all relevant fields related to seed saving.

Target Groups
The Training Manual addresses trainers and resource persons who are engaged in training activities on seed saving. It can be used to facilitate trainings for trainers and extension workers, but also directly for farmers interested in learning about seed saving. The main focus is on on-farm conservation and multiplication.

Trainings on seed saving can address a wide range of participants. For some of them, the knowledge provided in the Manual will be too basic and the trainers will have to consult the recommended readings to get more detailed information and knowledge. For others, the provided topics and ideas are already too scientific or the language too complicated, such that trainers may need to simplify the theory and use local examples for illustration.

Geographical Scope
The main focus of the Manual is on small farming in tropical developing countries, though some parts can also be applied to other regions. The tropics, however, include humid and arid or semi-arid regions with their various types of crops and farming systems. Therefore, the manual addresses mostly topics of general relevance. Ideas and guidelines are given on how to address specific topics and problems for the region where the training is held.

Training approach
The Training Manual is based on a training approach combining lectures, illustrations and demonstrations, and active participation of the trainees. A balanced mix of these elements allows understanding of seed saving through listening, seeing, experience sharing and trying. It is assumed that participants can contribute to the program of the training based on their background and experience. Therefore, interactive elements and practical exposure (field visits) in the course are highly encouraged and the Manual will aid their implementation.

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1.1.2 Structure

The training Manual is divided into 7 sections: an introduction to the Manual containing recommendations on the didactic and organisational aspects of a training program, the five core chapters dealing with the basic topics of seed saving (need and methods to conserve biodiversity, community based seed conservation, seed multiplication for utilisation, seed multiplication techniques for specific crops and on-farm conservation examples from the field) and an Annex containing glossary and a list of sources.

Each page of section 2 to 6 is divided into two parts: a theory part (left) and a didactic part (right):

Theory part
On the left side of each page, the theoretical basis is explained in brief texts in a logical order. Each chapter starts with a brief introduction to the topic, followed by several subchapters containing brief theory paragraphs. Part of these paragraphs directly refer to a transparency and / or to a recommendation for an interactive element, which are given on the right side of the page.

Didactic part
The right side provides suggestions for interactive elements such as brainstorming exercises, discussions, group work, experience sharing, demonstrations, excursions etc. The didactic part also includes small pictures of the transparencies which are given in full size at the end of the manual. Each transparency is followed by a legend describing what is seen on the transparency. The illustrations (e.g. arrangements for interactive elements) are meant for the trainer but do not need to be shown to the participants. The right side of each chapter starts with the main lessons to be learnt and concludes with a short list of recommended readings.

1.1.3 How to use the Training Manual

The relevance of topics covered in this Manual will vary depending on the focus of the offered training and the region. The modular system allows for selection of single elements of a section or chapter and for combination of elements from different sections or chapters. In addition to the selected examples, trainers can and should include local examples and integrate their own material. The Manual aims to provide a source for training material and ideas rather than being a readymade curriculum for a training program.

Transparencies
The transparencies are a central element of the Training Manual. They have their emphasis on illustrations rather than on text. Many of them contain a large amount of information, which requires one to spend adequate time presenting each transparency. This was found appropriate for the type of trainings the Manual aims to facilitate. Some trainers prefer to show the main points of their lecture in keywords while presenting. If needed, extra text transparencies based on the theory parts and the trainer's own supplements can be easily prepared. Trainers are also encouraged to add transparencies with own photos, drawings, tables etc.

Apart from direct presentation, the selected transparencies can also serve as a handout for the participants. Where overhead projection is not used or not available, the transparencies may still be used on the board or for poster presentations.

Adaptation
The style and content of the Manual may be too sophisticated for some participants and too simple for others. Trainers are highly encouraged to adapt the material to the requirements of the audience. If a deeper examination of a certain subject deems necessary, the trainer can consult the recommended readings. The same is true for the transparencies and for the interactive elements: trainers are invited to adapt them to the local conditions and to get inspired to develop their own ones.

The plan is to have the Training Manual translated into other languages in the future. Local names can be added on the transparencies to make sure participants understand the content and the text.

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1.2 Organising Training Courses

1.2.1 Steps for Preparing Training Courses

The following questions should help you to prepare a successful training program:

1st Step: What is your target group?
The effect of your training will depend on whether you address the right group of people in the right way. Therefore, you should first consider your target group: To whom do you want to address the training? How can you make sure that these people are participating? What is their motivation to participate? Also, think of what is the maximum number of people you can handle in the training. The more participatory the training is, the less participants can be admitted. In case you have to select from a larger group of participants, you should think about the selection procedure and criteria.

2nd Step: What are the objectives of the training?
Once the target group is clear, the next step is to define what you want to achieve with the training. Which kind of knowledge, awareness and skills do you want to develop among the participants? Is it the same as what the participants want to learn? During the training, but especially towards the end of a course, you should check whether these objectives have been reached. The participant's opinion can be assessed with simple evaluation or feedback methods as described in chapter 1.4.

3rd Step: Which topics should be covered?
Next you should think about the topics which must be tackled in order to achieve the training objectives. Arrange the topics in a logical order so as to help the participants find their way through the training. Is it possible to include the participant's expectations and wishes?

When selecting the topics you want to cover in a specific session, first think about what is your main message and what are the important points the participants MUST know. Do not try to be complete, but relevant. The participants will not keep more than a few points per session in their memory. Therefore, repeat your main points time and again and structure your session around them. Use illustrative examples to reinforce your main points.

4th Step: Which training methods should be used?
How can the selected topics and the lessons learnt be most efficiently transferred to the participants? Speech is an important method of transferring knowledge, but people learn more efficiently if they not only hear but also see, feel, experience and discover new things. A sound mix of different training methods can therefore help to make the training more effective and interesting. For many topics, the trainer will not have a readymade solution at hand, but ideas and solutions must be developed together with the participants. Find ways in which participants can contribute their own experience and interact in the training. Also, think of other resource persons who can cover a certain topic. Some ideas on interactive elements are provided in chapter 1.4 as well as in sections 2 to 6 of the Training Manual.

1.2.2 Developing a Training Schedule

Appropriate Timing
When planning the training schedule, keep the following points in mind:

- Participants won't listen to you for more than 20 minutes.
- Break the monotony with visual material, exercises, stories, contributions of participants, ice breakers, jokes etc.
- Plan for sufficient time and stick to the timing you have promised.
- If possible avoid lectures or presentations directly after lunch! Schedule exercises, games and excursions instead to make participants move.

Preparing a planning sheet and schedule
Thorough planning of topics and their timing in the available training period is a must. A template and a planning sheet for a one week training should be prepared keeping in mind the specific needs of the target group. Schedules should be presented in the beginning of the training and adapted according to the feedback of the participants.

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1.2.3 Preparing the Training Site

The training room
When selecting and preparing the training room, keep the following points in mind:

- Can everyone see and hear the resource person?
- Is there sufficient space for interaction and group work?
- Are presentation aids available? such as: OHP, slide projector, video, flip charts, black board, pin board etc.
- Is there a sufficient number of chairs and tables available?

Seating arrangements
The way in which chairs and tables are arranged in the class room can have a considerable influence on the training atmosphere. The typical classroom arrangements can make participants feel being spectators of an event in which they are not really involved.

In the training approach of this manual, group work is an important element of the training. Seating arrangements should allow participants to be comfortable during classes. In order to avoid wasting time moving chairs and tables around, arrangements should ideally be made in a way allowing both lectures and group work sessions. The training room arrangement given below has proven to be useful for this type of training.

Training aids
There are sophisticated aids available for presentations, but good training courses can also be arranged using more simple facilities. Below is a list of some typical training aids. It can be used as a checklist when preparing for the training course.

- Overhead projector
- Slide projector
- Video projector (if suitable videos are available)
- White or black board with suitable chalk or pens
- Large paper sheets or flip charts
- Pin board to attach paper sheets
- Colored paper cards
- Marker pens, transparency sheet pens
- Glue sticks, scissors, tape, pins
- Materials for demonstration (soil samples, plants, photos etc.)
- Selected books and reading material

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1.3 What Trainers Should Know About Training

(The following paragraphs are adapted from "Participatory Learning and Action", Pretty et. al, and "Agricultural Extension", LBL, two excellent documents on training and didactics.)

1.3.1 Training Adults

Part of the nature of education is that it is a continuous process. People not only learn in seminars and courses, but also from their environment and their relationships. Besides knowledge and understanding, they gain skills, habits and values.

Adult education in our context has two general aims which are closely linked to each other:

- Creating awareness: development of the consciousness and personality
- Facilitating action: transferring new knowledge, skills and methods

Assistance in problem solving
If adult education is to be effective, it must assist the participants in solving problems. As a first step, training should support the participants in understanding the problem. For this it can help to compare the problem with a similar problem of others, e.g. in a case study. By strengthening the participant's feeling of self esteem, one can initiate the second step in the learning process: the identification of an appropriate solution to the problem. Besides introducing new ways of solving the problem, the trainer should also help to assess possible consequences of actions and offer assistance in making decisions.

1.3.2 How adults learn

Adults learn in a different way to children. As we grow older, it is more difficult to store new information in our long-term memory. Therefore, the words of a lecturer may end up overwhelming listeners and will not be digested. It can only last if the trainee internalises the new knowledge and makes it their own.

Characteristics of a learning adult
The table below gives some characteristics of adults which should be considered when arranging training courses.

Background	Consequence
Adults are in practical life situations	• they are problem-oriented • they learn with a goal in mind • they want to learn what they can use in practice
Adults bring along their experience	• participant's heads are no empty vessels which need to be filled • new information must be matched with expectations and experience • they want to connect what they learn with their practical life
Adults take part voluntarily and invest their scarce time	• they have high expectations of content and relevance of the training • they want to make decisions about what they learn, and how
Adults want to take part actively	• they want to ask questions and discuss the issues • they want to contribute their own opinion and experience • they want to be treated as an equal

All learning is best done through active involvement. There is a simple principle on how adults learn most effectively:
What I hear I forget,
What I see I remember,
What I tried with my own hands, I shall know how to do,
What I discover myself, I shall use.

1.3.3 The Importance of Motivation

Unless motivated, participants will not and cannot learn. The participant's initial motivation to attend the training is very important. There are many reasons why participants are not particularly motivated or have lost motivation. For example,

- They attend the workshop only because they have been told to do so while it is against their personal wishes;
- Their minds are elsewhere, e.g. with the pile of work mounting up in their usual work place;
- They have been taught all this before and feel they already know it;
- They have misconceptions about you or your organisation.

The above mentioned points show the importance of addressing the appropriate target group, selecting suitable participants and informing them clearly about the aims and contents of the training. On the other hand, you should know about the participant's motivation and expectations in order to address them in a suitable way.

If you want your training to be effective, you need to motivate the participants over and over again. Make the participants interested, awake their curiosity by telling a story, encourage them to reflect and ask questions, make them feel that they are experts who can contribute with their experience etc. Equally important is that you avoid 'motivation killers' like providing ready-made solutions, giving orders, using threats ("If you don't do it my way then..."), moralising or lecturing, ridiculing participants, not keeping your word etc.

1.3.4 What makes a good trainer?

Good preparation is crucial for a successful trainer. This includes:

- Sufficient knowledge on the topic
- Adequate preparation of the training structure and contents
- Elaborating appropriate and interesting training materials
- Proper organisation of logistical arrangements

The following questions may help to address some principles of a successful trainer:

Some principles for trainers	Some questions
• Direct the education at clearly defined target groups.	• Whom do I want to address?
• Tackle relevant problems.	• What are the target group's main problems and aims?
• Indicate clearly what the aims and contents of the training are.	• Are the participants convinced that the training is relevant for them?
• Make sure that the participants take an active part.	• How can they contribute to the training? Do they feel necessary and involved?
• Request frequent feedback from the participants.	• "What is your opinion on this issue? What do you think about this lesson/ exercise/ theory?"

In order to be successful, the social skills of a trainer should not to be neglected. These include:

- A warm and open personality;
- Showing appreciation of the participants;
- The ability to bring the group together;
- Enthusiasm for the subject area and an ability to transfer it to the participants;
- Readiness to admit own knowledge gaps, openness to listen and to learn;
- Flexibility to respond to the participants needs;
- Ability to communicate in an interesting way (being a good story teller);
- Creativity in inventing interactive elements and practical exercises.

1.3.5 Teaching or Facilitating?

What is your role as a trainer in adult education? On the one side, a trainer can be a person transferring his knowledge and experience to the participants by telling them about it. On the other side, a trainer can facilitate the learning process the participant is going through during the training. There are two general models of a trainer, i.e.:

The lecturer: imparts knowledge, reveals subjects, explains the context, shows examples, creates awareness;

The facilitator: asks challenging questions, creates an atmosphere of learning, provides the opportunity for positive experience, promotes the participants self-confidence.

In practical training courses you will probably have a combined role. For some issues it will be necessary to give theory lessons. However, try to limit your lectures to a maximum of 20 minutes each, followed by an interactive part. In the beginning of a training, explain to the participants how you see your own role.

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1.4 Interactive Training Methods

Below you will find some training methods which should help you to motivate participants in the course and give them an active role in the learning process. Which method is most appropriate for a specific objective will depend on the target group as well as on the personality of the trainer.

a) Introduction Round
Objectives and Application
In order to build up a team spirit, but also to make participants feel their active participation is taken seriously, a short introduction toward the beginning of the training is virtually a must. If you ask the participants not only to give their name and background, but also their motivation, expectations or doubts concerning the training, you can serve two purposes.

Implementation

- Prepare a board or chart with some possible objectives on the one side and doubts concerning the training on the other side
- Each participant gets a limited number of stickers (2 – 3 colored points or similar, if not available, marker pens will do)
- Ask the participants to introduce themselves by giving their name, organisation, profession, origin or whatever information appears relevant
- Directly after the introduction, the participant can place their stickers on the objectives and doubts which they find most important
- Each participant can then explain in a few words why they made this choice

Alternatively, instead of objectives and doubts you can write down statements concerning organic farming which express a certain attitude. The participants can state their agreement with the statements by pinning their points (two colors, one for agreement, one for disagreement) to the statements accordingly.

Rules

- No participant gets more than 3 minutes to speak
- Participants make their own choice about where to place the two votes
- Resource persons follow the same procedure of introducing themselves as participants.

Illustration: Using cards and stickers for identifying the objectives and interests of participants during an introduction.

b) Brainstorming
Objectives and Application
The objective of a brainstorming session is to collect as many ideas and as much information as possible related to a specific topic. Participants are encouraged to let their ideas flow freely, getting inspiration from previous ideas.

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The creative flow of ideas should not be streamlined or influenced in any way. No idea, however crazy, should be rejected. Brainstorming can be used whenever ideas or information of a yet undefined field needs to be identified.

Implementation

- Inform the participants about the aim of the brainstorming session
- Prepare a board or paper chart visible to all participants
- Write the central topic or question on the board
- Appoint one or two recorders who note down the ideas
- Fix a period of time for collecting the ideas (10 – 15 min.)
- Ask the group to call out their ideas one by one, following the rules
- The recorder(s) note(s) down each vote randomly spread over the board
- Allow requests for clarification and questions concerning the ideas
- Discussing the result, building groups of ideas, evaluation
- Conclusions

Rules

- Absolute silence during the brainstorming, no questions, no comments
- Only one idea per vote, not more than 3 words per idea, no explanations
- For giving an idea: stand up, speak clearly, sit down

- If some participants place one idea after the other while others do not dare to speak you may interfere and encourage the silent ones.

Illustration: Results of a brainstorming session

c) Group Work
Objectives and Application
Whenever a topic needs to be elaborated by the participants themselves, but it is too complex to do it in the plenary, a group work can help. It also allows division of tasks and therefore an efficient process. In small groups, participants have more occasion for interaction, it involves them more than plenary sessions, they make the training more vivid and give the resource persons the chance to get some rest.

Implementation
Forming groups can be done in various ways:

- Randomly (counting, distributing numbers or colors): mixes people and ensures exchange
- Homogenous groups (region wise, gender, background etc.): allows identification of a specific stakeholder's point of view and prevents some participants dominating others (e.g. scientists dominating farm women)
- With free choice of the topic (assign topics to locations or tables, participants move there): each participant can deal with the topic they are most interested in
- According to the seating arrangements: saves time, but does not mix people

The option which is most appropriate will depend on the purpose of the group work as well as the composition of the group.

The groups should be provided clear instructions on their task. These can be given in an oral introduction, in writing on task sheets, with the help of group facilitators who have previously been instructed, or with a combination of the above. It may help if the resource person goes from group to group to see whether questions come up or to help groups who are lost with their task.


Illustration: Group work on Seed Conservation

d) Sharing the results of group work
Objectives and Application
When delegating tasks to groups, the results will need to be presented to the plenary in the end. These presentations should enable each group to share their ideas and honour their contribution. At the same time, the presentations should also be interesting for the audience and therefore should avoid endless monologues and repetitions.

Implementation

- Each group documents their main points in a few words on flip charts or transparency sheets
- Each group selects a speaker who prepares the presentation
- If the groups have got different tasks, each should be given equal time and attention for their presentation (it is wise to strictly restrict the time per group)
- If all groups have the same task and topic, you can avoid repetitions if the first group does a complete presentation and the following ones restrict themselves to the points which have not been mentioned
- At the end of each presentation ask for questions and feedback from the audience
- At the end summarize and comment on the results

e) Participant's Contributions

Objectives and Application

Adult participants are experts in their respective fields, and many will bring a lot of practical experience and knowledge with them. Utilizing selected participants as resource persons for specific topics allows you to draw on relevant practical experience, make the participants really feel involved and valued and last but not least add some variety to the lecturing and some rest for the trainers.

Implementation

- Select topics in the training schedule which can be delegated to participants (or external resource persons)
- Or find out whether some participants have special knowledge or experience in one field and see whether you can integrate their topic into the program
- Ask the concerned participant whether they would be willing to prepare a contribution on the selected topic
- Clearly agree on the objective and scope of the contribution, especially on the exact contents, messages, means of presentation and time frame
- Make sure that the contribution fits into the overall concept and structure of the training

f) Using Cards

Objectives and Application

Continuous visualisation of results during a group process can help to make the process more clear and efficient. Paper or cardboard cards are a handy tool for collecting, structuring and documenting elements of a complex topic or task. Pinned to a larger chart, they have the advantage of being able to be re-arranged in the process as needed. Cards of different colors, sizes or shapes allow inclusion of additional types of information.

Implementation

- Prepare paper or cardboard cards of different colors and of appropriate size (min. 10 x 15 cm)
- Provide a sufficient number of marker pens, pins or removable glue sticks
- Introduce the group to the objective and expected outcome of the task
- If appropriate, give an example or provide a template for the structure
- Associate the colors and shapes of the cards with attributes or categories
- Ask the group members to note down elements of the overall structure on the cards, keeping in mind the significance allocated to the colors or shapes
- As soon as a group member has noted down an element, the card should be pinned to the board
- Once the board gets filled, single cards will need to be re-arranged, altered or replaced
- When the structure seems to be final, ask the group to check its logic and completeness again and then permanently fix it to the chart
- Let the groups present their charts to the audience

Rules

- Cards should be readable from at least 3m distance
- Only one idea or topic per card
- Cards should only be removed with the consent of the person who wrote them

g) Role Plays

Objectives and Application

In role plays, participants use their own ideas and experience to play defined real life situations. Role plays can help to better understand the attitude of stakeholders in a complex situation or conflict, or to analyse how things are happening and why. They can also be used to exercise a practical procedure after learning it in theory. Role plays are quite exposing for the actors and therefore will only function well if there is a certain team spirit and atmosphere of trust.

Implementation

- Define the objective of the role play and the tasks of the actors
- Prepare the "stage" and the necessary properties
- Select actors for the play and clarify their role
- Ask the observers to note down their observations, possibly giving them certain points to focus on
- Introduce the role play and let it start
- Ask the actors what they observed or felt during the role play
- Ask the observers what they noticed
- Summarize and conclude the lessons learnt

Rules

- Respect a person's dignity, prevent participants losing face
- A role play must be concluded with a de-briefing, allowing the actors to talk about their observations and feelings

h) Panel Discussion

Objectives and Application

Some issues related to seed saving will provoke conflicting attitudes. Discussions can help to form personal opinions considering different points of view. In a panel discussion, selected stakeholders representing different attitudes to the issue are given the chance to share their ideas in front of the audience. The discussion is guided by a mediator who addresses questions to the single panel members. In a second part, the audience gets the chance to address questions to the panel members.

Preparation

- Define the topic of the discussion as clearly and specifically as possible
- Identify the different groups of stakeholders in the issue
- Select people from the participants or outside representing the stakeholder groups
- Prepare questions which you want to address to the panel members, leading them through the different aspects of the topic
- Arrange a meeting with the panel members, get to know about their back-ground, inform them of the questions you plan to address, to whom you plan to address them and explain the procedure of the panel discussion
- Prepare the panel: chairs, name plates (mediator seated in the middle), refreshments.

Implementation

- The mediator introduces the topic of the panel discussion, presents the panel members, explains the procedure and the rules (ca. 5 min)
- The mediator addresses specific questions to the single panel members (ca. 20 min)
- The audience may address specific questions to single panel members (ca. 20 min)
- The moderator summarises the results of the discussion and concludes

Rules

- Each panel member gets about equal total time to speak; the mediator is entitled to cut off long speeches
- Stick to the topic; the mediator is entitled to interrupt and to turn down questions which are off the topic
- No personal offences
- Questions from the audience: only one question at a time, no mere statements

1 Introduction

i) Excursions
Objectives and Application
When dealing with farming, nothing can be more efficient, convincing and long lasting than practical exposure to farming. An excursion to an organic farm will allow participants to combine theory with practical experience and associate the lectures with the problems and conditions of real life situations. At the same time, excursions will bring a change to the class room monotony and for this reason are best placed in the middle of the training program.

Implementation

- Select a suitable farm and check the farmer's willingness to contribute
- Inform the farmer on what their role will be and whether you want to engage them as a resource person
- Prepare transport and food, if needed
- Inform the participants of the purpose and schedule of the excursion
- Start with a farm walk, if possible guided by the farmer who explains their production
- Give the participants a chance to interview the farmer
- Discussing the observations and conclusions
- Recommendations of the group to the farmer?
- Feedback to the farmer

Rules

- The farmer and the farm should not be affected
- Keep the group together, or split them into sub-groups if too big to handle
- When moving around, wait until all group members follow up and make sure that everyone can hear the "guide"

Illustration: Discussion during a farm excursion in a training in India.

j) Getting Feedback from the participants
Objectives and Application
In the end of a training program, the trainer should get feedback from the participants in order to be able to further improve the program. It is also a good occasion for the participants to recollect what they have learnt and to make their own conclusions about the program.

1 Introduction

Two methods to get feedback from the participants are described below:

Questionnaire

- Prepare a questionnaire which participants can fill in anonymously, e.g. by validating the quality of certain aspects on a scale from 1 to 5 (or from bad to very good). Points to evaluate could be:
- Appropriateness of the topics; which topics are missing?
- Practical relevance of the lessons learnt
- Valuation of single sessions
- Appropriateness of the schedule and timing
- Competence of the resource persons
- Preparation of the course
- Quality of the handout and course documents
- Degree of interaction with the participants
- Course facilities

Brainstorming on lessons learnt

Let the participants recall the lessons they have learnt, the answers they have had and the conclusions which they have made. For this, prepare large paper sheets on which you note the topics covered in the training and the single sub-chapters or sessions related to the topic. Divide the participants into groups and equip each with a topic sheet, small paper cards of one color per group, marker pens and glue pens. The members of each group should brainstorm the conclusions they have come to during the training, note them down in keywords on the paper cards and stick them to the respective point. After a few minutes, all paper sheets should rotate to the next group which will then do the same exercise on the new topics. Once all the groups have finished with all the topic sheets, fix the sheets to the wall and discuss the results with the participants.

It is always useful to conclude the training with an open discussion in which all participants get the chance to provide their personal feedback to the trainers. Suggestions for improvements should be noted down in order to use them for organising further training programs.

Illustration: Concluding session in a training in India, brainstorming on the lessons learnt

Recommended Readings

"Participatory Learning and Action", Pretty et.al

"Agricultural Extension", Bolliger, E., et.al

"Directorio Instituciones Capacitacion Agroecologica", IFOAM

"Training and Education Opportunities for Tropical Organic Agriculture", van Beuningen et.al

"Agricultural Innovations on farmers fields", Scheuermeier et.al

"Organic Agriculture Curriculum for Africa", KIOF

2 Need and Methods to Conserve Biodiversity

2 Need and Methods to Conserve Biodiversity

2.1 Introduction

It is a well-known fact that the so-called “third world” is home to almost all the world’s areas of high crop diversity and is also the origin of most of the world’s food crops. According to one rigorous attempt made by the Russian scientist Nikolai I. Vivalov (1887–1943), of the world’s 14 biodiversity hotspots, 12 are located in Asia, Africa and Southern and Central America and only 2 of them are located in Northern America and Northern Europe. It is, therefore, not surprising that these areas are the ones that have nurtured major human civilizations for the last five millennia.

2 Need and Methods to Conserve Biodiversity

2.2 Problems with Genetic Uniformity

The last five centuries, which encompasses the ages of exploration, discovery and conquests of these lands by the people of European origin (beginning in the 1490s by the voyages of Columbus), represents a period of major upheaval and disruption in many of these biodiversity hotspots. Large efforts were made to carry species that were native to one part of the world to widely different geographic areas and cultivate them there on a large scale. This was also accompanied, in some cases, by the introduction and monoculture (cultivation of one single variety) cultivation of exotic and alien species on extremely large areas of land, with predictably disastrous results. Whereas agriculture was once at the center of preserving and encouraging genetic diversity, today the adoption of high yielding, uniform cultivars (cultivars are varieties produced by cultivation) and, in some cases regulation of approved varieties has led to a considerable reduction in the number of genetically viable species in agriculture.

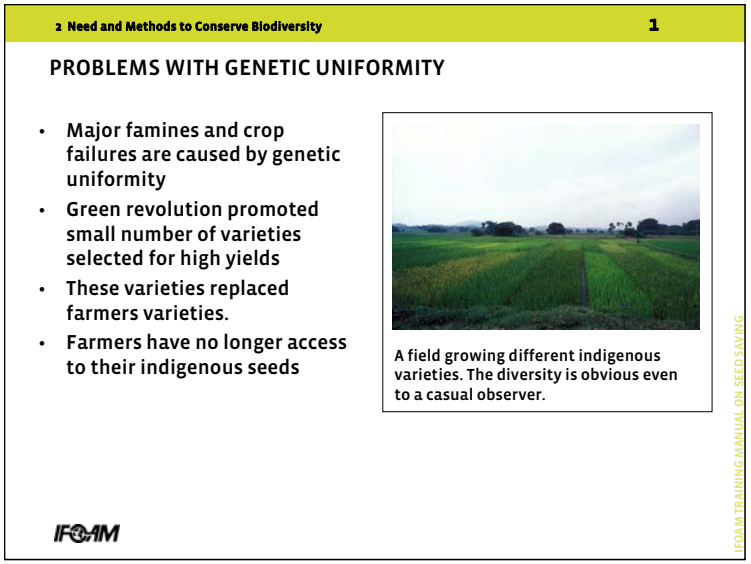
In the last 150 years, there have been nine major famines/crop failures that can be traced to large scale cultivation based on genetic uniformity. These range from the 1846 Irish potato famine and the attempts to cultivate coffee in Sri Lanka in 1800 to more recent events such as the failure of the rice crop in Indonesia in 1974, where three million tonnes of rice were destroyed, and the failure of the citrus crop in Florida, USA in 1984, where 18 million trees were destroyed. In the decades following the Second World War, many governments in the third world have promoted the Green Revolution package of farming, which has in practice meant the selection and large scale promotion of a small number of varieties of major crops such as paddy and wheat. They have been selected solely because they can produce high yields in response to heavy doses of chemical fertilizers. Since the 1950s, this has led to a situation where most often farmers no longer have access to the incredible number of varieties of traditional seeds that they had been cultivating through the millennia and that contributed to their food and nutritional security.

Lessons to be learnt

Introduction of high yielding varieties has led to the loss of genetic diversity

Major famines and crop failures can be traced to genetic uniformity

Purely commercial enterprises focus only on breeding hybrids and contribute to genetic uniformity



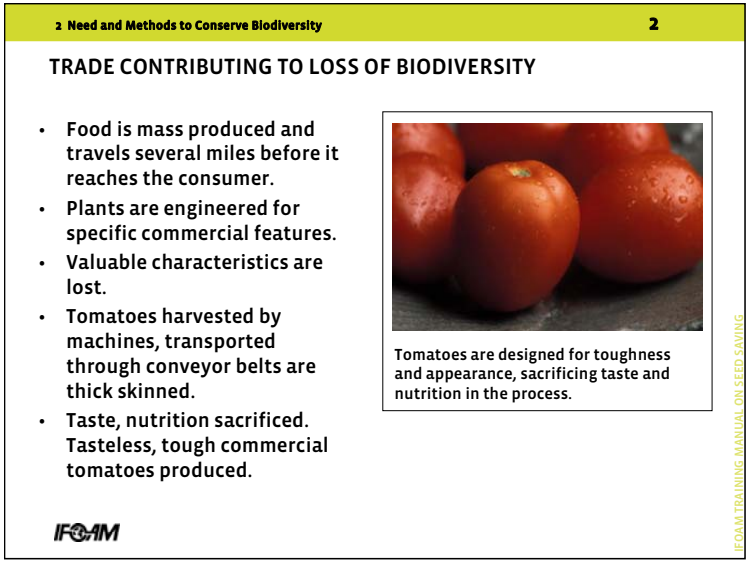
Transparency 2(1) : Problems with genetic uniformity

2 Need and Methods to Conserve Biodiversity

2.2.1 Trade and loss of diversity

Today food is mass produced and distributed, often travelling many miles before it reaches the consumer. This pattern of distribution dictates plant breeding and seed production across the world. When plants are engineered for very specific commercial features, other valuable characteristics are inevitably lost. For example, tomatoes that are designed to be harvested by machines, dumped onto conveyor belts and transported over long distances are very tough and thick skinned. However, taste and nutrition are sacrificed in this breeding process. The result is tasteless and tough commercial tomatoes.

Several commercial enterprises focus only on breeding hybrids. These are varieties resulting from natural or artificial pollination between genetically distinct parents. They are not concerned with open pollinated varieties which are stable varieties resulting from the pollination between the same or genetically similar parents. These hybrids cannot be used for seed saving because they revert to their highly inbred parents or are simply sterile like mules. Moreover, hybrids are genetically uniform. Hybrid seeds produce identical plants and these can easily succumb to pests or diseases. Differences among plants however allow for different reactions to pests. Uniformity is not a desirable characteristic in this case.

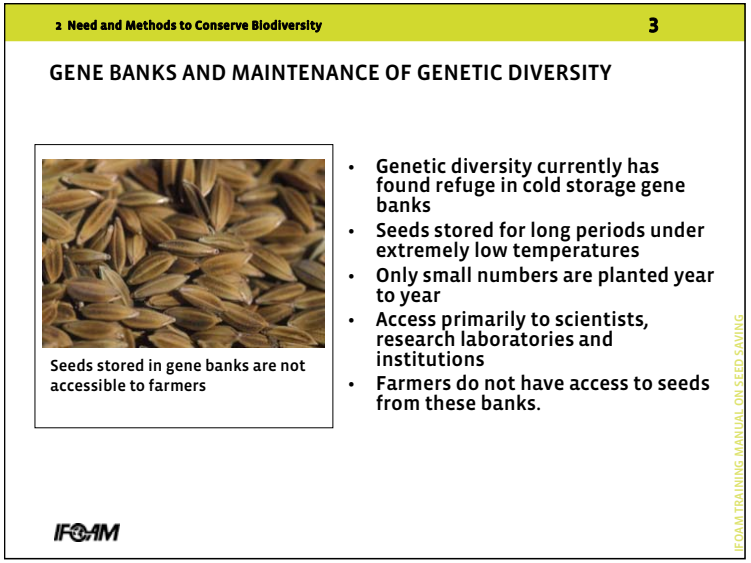


Transparency 2(2) : Trade contributing to loss of biodiversity

2 Need and Methods to Conserve Biodiversity

2.2.2 Gene banks

In many cases, the wide diversity and genetic stock of crops has slowly disappeared from the fields and partly found refuge in state-supported gene banks or seed banks. A majority of these banks are arrangements whereby seeds can be stored for very long periods under extremely low temperatures; only a small number of them are planted year to year. However, these seed storage centers are primarily for scientists, research laboratories and institutions rather than for the farmers who were the original source and the suppliers of the seeds as well as the information regarding them.



Transparency 2(3) : Gene banks and maintenance of genetic diversity

2 Need and Methods to Conserve Biodiversity

2.3 Community-based Conservation

Communities across the world have conserved seeds for several centuries through on-farm cultivation across time and space. Farmers had their own time tested practices of collecting, storing, multiplying and also evaluating the many species that were conserved by them. Modernization of cultivation methods has undermined the indigenous knowledge and has also contributed to the erosion of plant genetic resources.
National and International efforts for conserving genetic resources have mainly concentrated on maintaining *ex situ* collections. "*Ex situ*" literally means "out of site", that is, not in a plant's original or natural environment. This has been the predominant mode of conservation for the past 20 years. This has certain characteristics which are very different from the conservation done by farmers in the field (*in situ* conservation). The features of both these conservation methods would be compared in the next chapter.

For an *in situ* conservation program to be successful, organically cultivated on-farm conservation has great significance. The following are the benefits of organic agriculture based seed production by farmers.

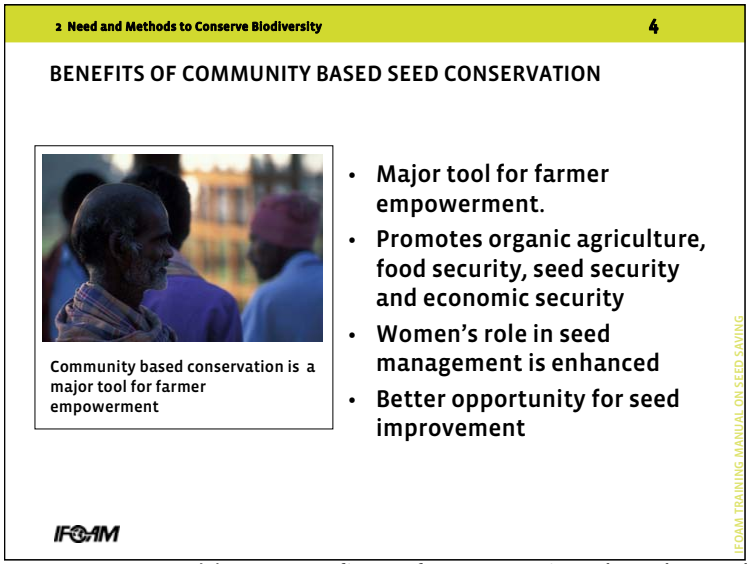
- It is a major tool towards farmer empowerment.
- Seed supply and quality are assured. Farmers can plant what they want and at any time they deem is right.
- Reduction of production costs.
- There is better opportunity for seed improvement; seeds selected or varieties produced would have traits that favour organic agriculture.
- Higher adaptability of the seeds to the farmers' environment, management systems and mixed cropping.
- Reduced exposure to chemicals.
- Genetic diversity will be sustained since farmers tend to maintain more than one kind of seed, continuously selecting and even deliberately mixing varieties. Varied preferences of farmers translate to a wider collection overall.
- Women's role in seed management, which is traditionally strong, will be enhanced.

Lessons to be learnt

National and international efforts to conserve genetic diversity focus mainly on ex situ conservation

Farmers all over the world have been responsible for on farm conservation of indigenous genetic resources

Organic Agriculture based seed production contributes to food security and genetic diversity



Transparency 2(4) : Benefits of community based seed conservation

Recommended Readings

"Challenges and Opportunities for Organic Agriculture and the Seed Industry", FAO
"Organic Agriculture and Biodiversity", Sue Stolton
"The Violence of the Green Revolution", Vandana Shiva
"Nature's Harvest", Vandana Shiva et.al
"The Role of the Private Sector and Trade", Rice, T.

3 Community Based Seed Conservation

3 Community Based Seed Conservation

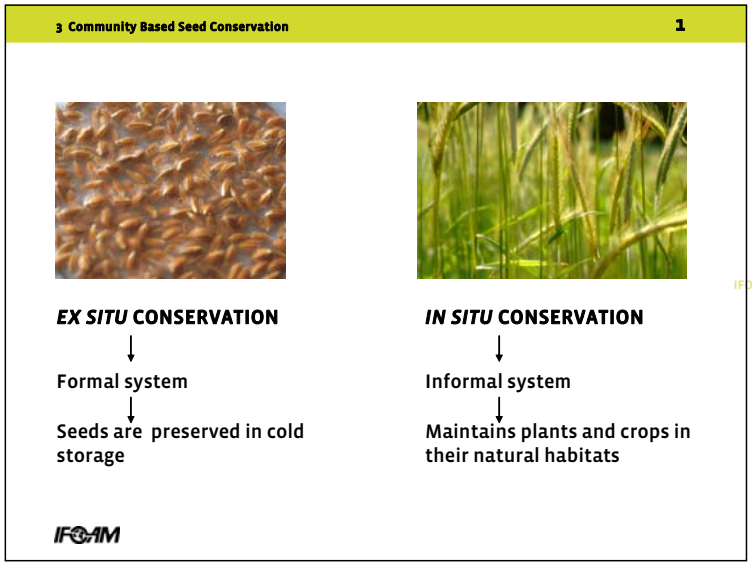
3.1 Introduction

The specific characteristics and traits of a plant variety are found in its seed. A seed is the beginning as well as the end of the life-cycle of a plant. In the *ex situ* method of conservation which is the formal method for seed conservation, a survey of regions is conducted to find out the pattern and extent of the distribution of species and varieties within species and also to discover rare genetic materials (such as medicinal plants, drought-resistant plants, etc.). The seeds collected are preserved in gene banks in cold storage, i.e., the conservation is done outside of the natural habitat of the plants.

In contrast to *ex situ* conservation, *in situ* conservation maintains plants and crops in their natural habitats. This allows the evolutionary process that shaped their genetic diversity and adaptability to continue undisturbed. It also permits the study of species in their natural environment and serves as a natural genetic reservoir. It is extremely appropriate for habitats and varieties that are under threat, for areas where traditional farming is still prevalent and also for crops that are often enriched by gene exchange with wild relatives. *In situ* conservation can be in the form of national parks and forests, biological and ecological reserves or on-farm conservation of cultivated crops. On-farm conservation of genetic resources is successfully carried out across the world by decentralized community seed banks (CSBs).

Lessons to be learnt

In ex situ conservation seeds are preserved in cold storage which inhibits the evolutionary process
In situ conservation is done in the natural habitats which allows evolutionary process to take place undisturbed
In situ conservation is very important for varieties under threat



Transparency 3(1) : Introduction to types of conservation methods.

3 Community Based Seed Conservation

3.2 Desirable Features of a Community Seed Bank

For CSBs to be sustainable, the following criteria must be kept in mind.

Community seed banks must be owned and managed by an organized group (with active, motivated members) such as People's Organizations (PO) or Farmers' Associations (FA). This is to ensure that the resources are pooled and that maintenance of the bank is feasible. In such cases, management will also be decentralized and free from the control of seed corporations. The local group will get the benefits, both immediate and long term.

The seed banks must be living, i.e., conservation should be done on farm. This ensures that the collection will continue to evolve with the environment or climatic changes and pressures, build up of new pests and pathogens and soil quality degradation. It is important that seeds evolve with changing or improving farming systems.

It is desirable for CSBs to be supported, at least partly, by NGOs or concerned university scientists and researchers as they can provide or augment technical and logistic support. They can also help source funds to sustain the endeavour.

Lessons to be learnt

Community seed banks must be decentralized

A community seed bank is an important component for genetic conservation

Members of community seed banks must be well versed with the methods and principles of genetic conservation

Transparency 3(2) : Desirable features of a community seed bank

3 Community Based Seed Conservation

The collections and accessions must include or be dominated by indigenous traditional varieties and wild relatives. If possible, farmer-bred lines should also form part of this collection.
Community seed banks should have sufficient facilities to store the materials collected.
Seeds must be always available to any interested member (subject to non-restrictive policies for sharing resources) of the group, and there should also be an active sharing and exchange policy between other groups.
A CSB is a strategic tool for genetic resource conservation. Wherever possible, it is important to obtain the cooperation and involvement of the immediate community in the work of the CSB as this will create effective social awareness. This could also invite the attention and help of local authorities in promoting activities of the seed banks.
Members of the CSB should be trained in the principles and methodology of genetic conservation, in basic characterization and documentation work based on some criteria relevant to farmers' needs.
Some simple on-farm research should be encouraged within the CSBs to help evaluate the performance of promising cultivars. This will help build up the technical capacity of those in charge of the seed bank and also increase their interest and motivation.
Seed varieties that are found to have characteristics acceptable to farmers after testing and evaluation must be promoted for use in adaptability trials in other locations, in participatory farmer plant breeding and also in production. The seeds collected (or at least those marked as "promising varieties") should be properly documented before they are made available to users.
Community seed banks, if possible, should also serve as training centers for participatory plant breeding.

Transparency 3(3) : Desirable features of a community seed banks - cont'd.

Exercise : Setting up a community seed bank

Ask the participants to put down points that they would consider as important while setting up a community seed bank. Ask them to come up with a plan for their area. Discuss the plan in detail.

3 Community Based Seed Conservation

COMPARISON OF TWO TYPES OF SEED CONSERVATION

Gene Bank	*Community Seed Bank (CSB)*
It is the conventional seed bank.	It is the farmers' seed bank.
It is a formal system.	It is an informal integrated system.
Seeds are stored under cold conditions.	Seeds are conserved under natural conditions as part of cropping patterns.
In this system there is no room for co-evolution.	There is ample scope for co-evolution and it is continuous.
For maintenance expensive high technology methods are used.	Can be maintained with limited resources and technologies used are simple and farmer friendly.
The main emphasis is on genes that may be useful in breeding.	The emphasis is more on community seed supply which is an important component of sustainable agriculture.
The focus is on exploiting for higher yields.	The focus is mainly on integration of many individual cultivars.
Market needs are given priority while breeding.	Subsistence, food security and food priority is given more importance.
It is a highly centralized in approach and capital intensive.	It is need based and decentralized. Can be maintained at a low cost.
The main beneficiaries are breeders, biotechnologists and researchers.	The main beneficiaries are farmers, peoples' organization, farmers' organization, farmers' association and the community.

Illustration 3(1) : Community seed conservation effort in Asia.

3 Community Based Seed Conservation

3.3 Components of a Community-based Conservation Program

A community based conservation program has to constantly adapt itself to the various needs that arise from time to time. The various stages of a CSB vary from program to program. The priorities of local communities are an important component in all CSB programs. The various stages of a CSB program are

- Survey and planning
- Collection and documentation
- Seed evaluation
- Multiplication and utilization
- Seed testing, planting out for multiplication (this includes testing for seed viability, germination techniques, seed dormancy and keeping accessions pure).
- Seed treatment, processing and storage

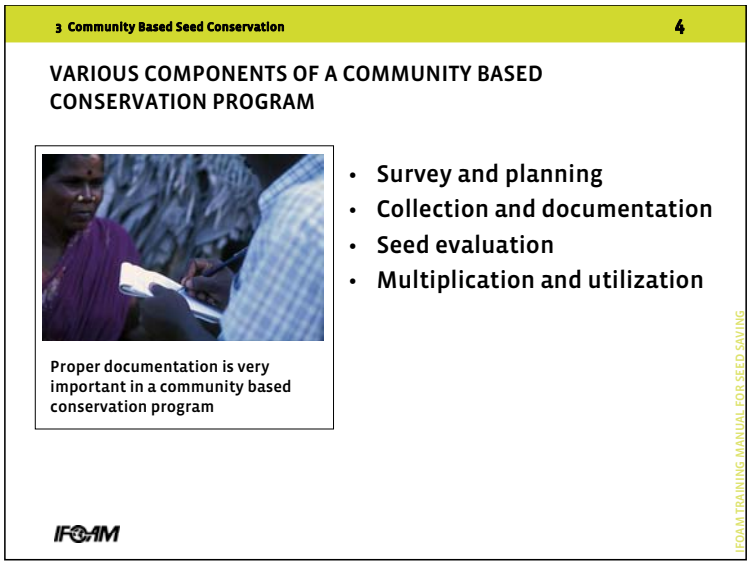
In a farmer-run community-based conservation program, some of these steps overlap. In the following sections, the various stages in the development of CSBs are discussed.

Lessons to be learnt

Farmers play a central role in a community based seed conservation program

Appreciation and understanding of local knowledge is vital for community based conservation

Farmers' criteria for conservation is very often different from the scientists' criteria



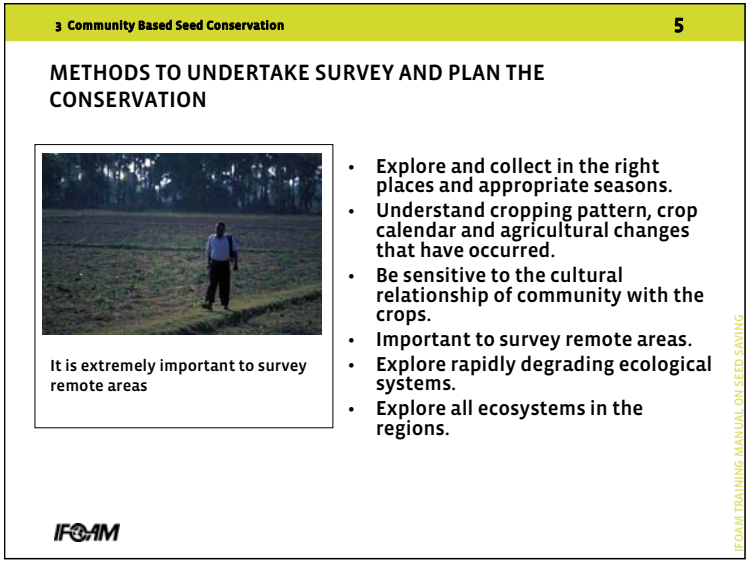
Transparency 3(4) : The various components of a community based conservation program

3 Community Based Seed Conservation

3.3.1 Survey and Planning

Exploration and collection need to be carefully planned to make sure that collection is done in the right places during the appropriate seasons. A proper knowledge of the distribution of the crop diversity in the regions is essential. It is also important to know the cropping pattern, the crop calendar and any agricultural changes that have occurred over the years. The sowing and harvesting time may vary depending on the irrigation facilities available, the lay of the land, climate and altitude. If the project is not undertaken by the community but by an NGO, it is important for the NGO to understand and be sensitive to the cultural relationship that the community has with its crops.

A survey of the whole region should be done to identify the varieties that are grown there and those that are in the process of becoming extinct. In places where high yielding varieties and hybrids have spread, diversity may be relatively low. Special efforts should be made to reach remote villages to identify farmers who still grow traditional varieties. These farmers should also be involved in the conservation program. Priority should be given to crop diversity exploration in areas that are facing rapid ecological degradation because of development, deforestation and natural calamities. It is also important to keep in mind the various ecosystems within regions. Sometimes, even within short distances there may be different micro-ecosystems (because of the lay of the land, sunny areas vs. shady areas, or areas near a water source such as banks of rivers and so on). Even if the same plant variety is found growing in different micro-ecosystems, the variety from each micro-ecosystem should be counted as a separate accession (an individual sample of seeds or plants entering into a collection). Backyards and kitchen gardens should also be given special attention as threatened and rare species may be growing there for personal use.



Transparency 3(5) : Methods to undertake survey and plan the conservation

Practical exercise : Planning a survey

Decide upon an area where a survey can be done. Ask the participants to take a detailed look at the area map and also collect information from the local people about that area. Based on the information collected ask them to come up with the plan as to where all in the area the survey for seeds can be undertaken and why.

3 Community Based Seed Conservation

3.3.2 Collection and Documentation

Where to collect?
Seeds conserved by farmers are not just a product of nature but also an expression of their culture. Hence, seeds would be different where local people are ethnically and culturally different. This is because they would have selected and conserved seeds according to their lifestyles and knowledge systems. It is important to involve farmers in collection because they know who is farming differently. The following should be kept in mind while selecting areas for collection.

- Seeds should be collected from farmers and regions where indigenous cultivation practices are still in existence.
- Indigenous seeds should not have been displaced by green revolution varieties.
- There is usually more genetic diversity in areas where monocultures have not spread, and therefore, in such areas, several sampling sites should be available for collection.

Transparency 3(6) : Places for collection

3 Community Based Seed Conservation

Criteria for collection

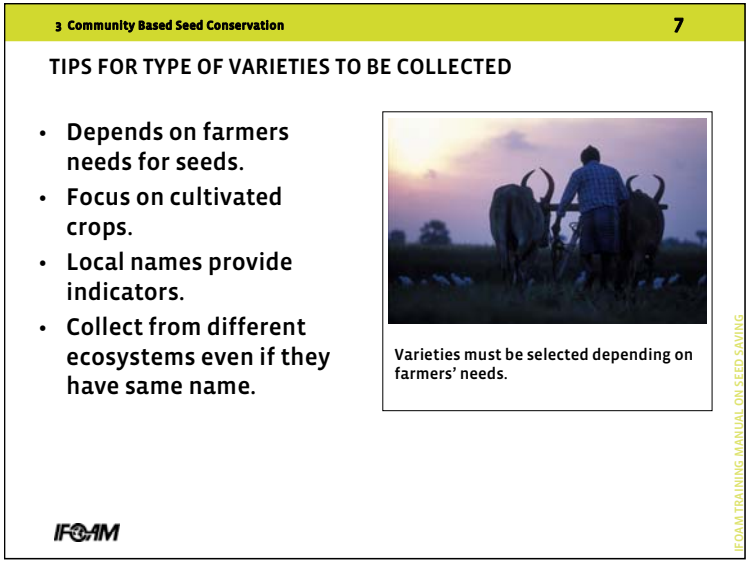
The varieties that need to be collected depends on the farmers needs for seeds of different crops. The community seed supply systems are not just conservation programs and hence the focus has to be on cultivated crops. Importance should be given to varieties with specific needs that farmers have for particular crop varieties with specific characteristics. These generally include characteristics like high yield, disease and pest resistance, medicinal and fodder value, palatability, color, texture, flavor etc. Farmers' system of distinguishing varietal diversity in individual crops is very sophisticated. Very often, the nomenclature they use in local languages describes the characteristics of the crop variety. Local names of crops are very good indicators for deciding what to collect.
As a practical rule, the following should be kept in mind during collection.

- Collect when the varieties are distinct.
- Collect where there is a marked difference in the elevation and where a natural hindrance is met.
- Collect from places where local people are ethnically and culturally different. Collect from every eco region within the field.

When to collect?

It is very important to plan the time of collection. One has to choose the right season, the right days and also the right time of the day. The following should be kept in mind while deciding when to collect.

- The ideal time to collect is soon after harvest.
- Market days are excellent opportunities for seed collection. Small quantities of seeds are traditionally sold by farmers at weekly markets (shandys/fairs).
- The best time for seed collection is when all the dew has evaporated from the plants.



Transparency 3(7) : Tips for type of varieties to be collected

Practical exercise : Local names as indicators

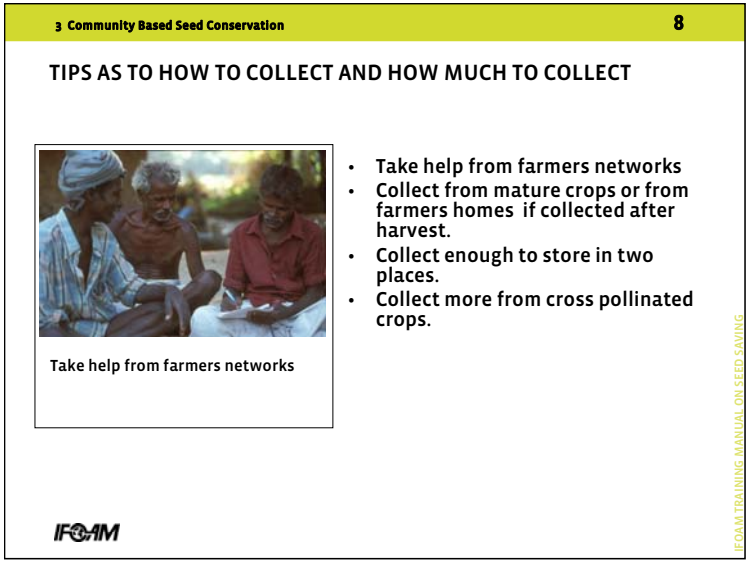
Collect local names of crops and discuss amongst the participants as to what type of indication they provide in terms of its quality.

How to collect?

- Farmers' networks are the best mechanisms for seed collection.
- Farmers generally know who in the region still grows traditional varieties.
- Seed collection can normally be done in the field when crops are mature or after harvest from the homes of farmers.

How much to collect?

- The most important rule is to collect as much as the farmer can spare.
- Whenever possible, enough of the seeds should be collected so that they can be stored in two different locations.
- As a rule, more seeds should be collected from cross-pollinated crops and medicinal plants.
- In the case of trees that require grafting, two to three cuttings should be collected from each randomly selected tree.



Transparency 3(8) : Tips as to how to collect and how much to collect

Collection equipment

Formal missions collecting seeds normally require and use cloth or plastic bags, scissors, knives, collection forms, note books and clip boards. In rural areas, farmers improvise with materials and methods to suit availability of resources and match it with their needs. They can use whatever containers they can find to collect and store seeds.

Documentation

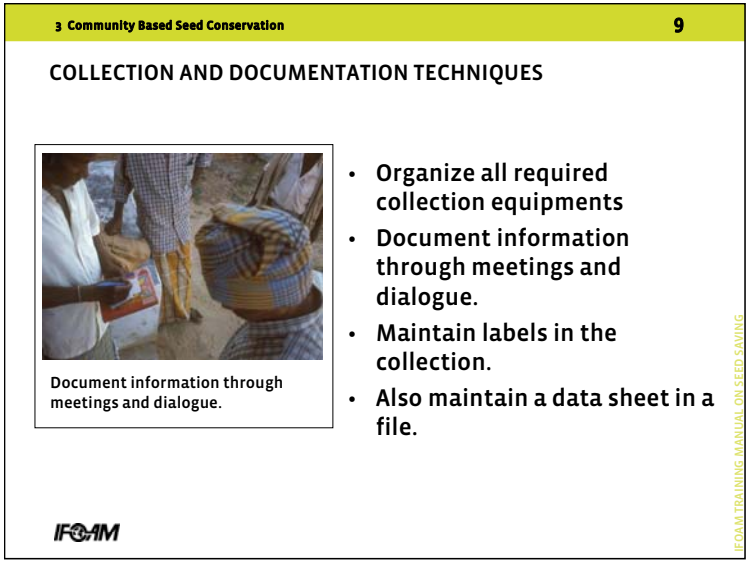
Memorizing from oral culture is very often used as a substitute for paper. Instant documentation may not be feasible but is necessary. Information about plant varieties can be obtained through meetings, dialogue and partnerships between NGOs and farmers, etc.

Labels are essential for the collection. Moisture-proof labels should be put on seed bags, jars or boxes, preferably both outside and inside. A separate label or data sheet in a file should be maintained.

Information for labels should be gathered during seed collection and it should be brief. It should include the

- Common and vernacular names of the plant
- Locality and date of collection
- Collector's name and collection number, if used.
- Donor's name and address

Additional information, which can be filled in after the collection has been brought in, can be maintained in the files. This should include the scientific name of the plant, the altitude of the collection point, etc.



Transparency 3(9) : Collection and documentation techniques

3 Community Based Seed Conservation

Seed container information (labels)

1. One outside the seed container
2. One inside the seed container

Label information

1. Local name(s)
2. Scientific name
3. Farmer's/donor's name and address
4. Collector's name and address
5. Collection location (local description)
6. Date of collection
7. Date of storage
8. Location of further documentation

File card information

(Two copies to be filed separately in case of loss)

1. Copy of label information
2. Detailed description of sample location
3. Storage locations and status
4. Germination test and grow out records
5. Unusual seed/plant characteristics.

3 Community Based Seed Conservation

3.3.3 Seed Evaluation

The seed varieties should be characterized and evaluated according to the requirements of the farmers. In characterization and evaluation, the following criteria should be kept in mind.

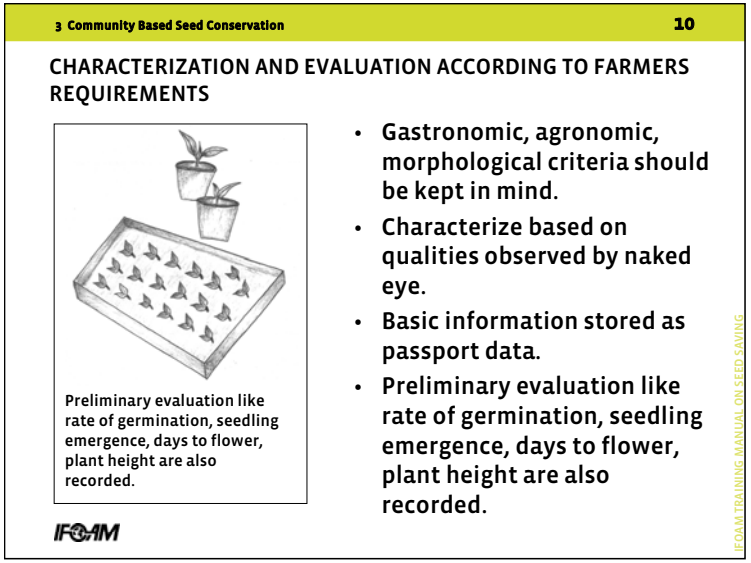
- Gastronomic criteria, which includes taste and cooking time
- Agronomic criteria, which includes the ability to compete with weeds, maturity period and tolerance to drought, pests, diseases, etc.
- Morphological criteria like grain and fodder yield, height of the plant, tillering potential and so on
- Opportunities available for processing
- Storage quality of the seeds
- Resistance to bird damage
- Adaptation to the environment and cultural value

Characterization
Characterization is carried out on the basis of qualities that are inheritable and can easily be observed by the naked eye such as growth habits, pubescence, plant pigmentation, leaf and glume (outer part of the coat in cereals that cover the grain), pod shape, seed color, etc.

Passport data
Passport data comprises all the basic information recorded by the collector during collection, as mentioned under the heading documentation.

Preliminary evaluation
Additional traits that are thought to be desirable by farmers for a particular crop species should also be recorded in the file card, for example, the rate of germination, seedling emergence, days to flower and mature and plant height. These are mostly observed in the field. In many cases, this can be done during the grow-out period.

To characterize each accession, a representative number of plants should be randomly selected. The observed data is registered. For cross-pollinated crops, spikes or pods from 20–35 different plants should be used. For self-pollinated crops, five to ten plants can be taken for observation.



Transparency 3(10) : characterization and evaluation according to farmers requirements.

Discussion : Farmers' criteria for selecting varieties

Take up a particular variety preferred by the farmers. Discuss why farmers prefer this variety and what are the criteria for their preference.

3 Community Based Seed Conservation

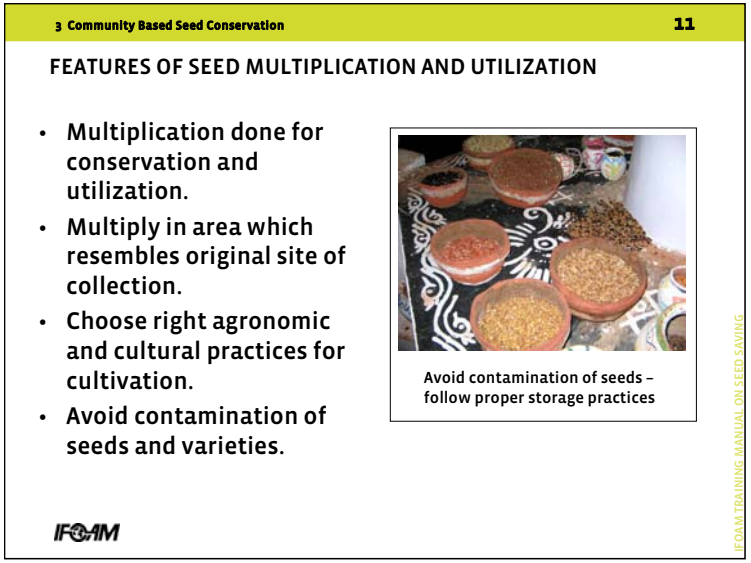
3.3.4 Seed Multiplication and Utilization

Multiplication of the seeds is the essential next step and is required to increase the number of seeds available for conservation and utilization. Seed varieties must be increased in suitable sites, using acceptable agronomic practices.

Precautions to be taken during regeneration and multiplication

- The site and soil type used during multiplication should resemble that of the original site.
- The optimum sowing date, exact seed rate and appropriate spacing should be chosen.
- Right cultural practices should be followed
- Harvesting should be carried out at the right time of maturity, giving priority to shattering types.
- Special care should be taken to avoid contamination of seeds during threshing and drying.

Seed multiplication and utilization is discussed in greater detail in the next two chapters



Transparency 3(11) : Features of seed multiplication and utilization

Recommended Readings

"Establishment of Community Seed Bank", RFSTE and Navdanya

"Cultivating Diversity", Shiva, V., et.al

"The Seed Keepers", Shiva, V., et.al

"Crops of Truth", Satheesh, P.V., et.al

4 Seed Multiplication for Utilization

4 Seed Multiplication for Utilization

4.1 Introduction

Seed saving is an activity that is well within the reach of farmers in terms of infrastructure, equipment and knowledge. All stages of seed production and saving should be carefully planned to avoid problems and to help keep costs within reasonable limits.

For a seed conservation program to be successful, information is required for every major stage of the process. For example, information is required on

- The cultivation of a healthy crop, harvesting, post harvest handling and processing (cleaning, drying, etc.)
- The type of dormancy of the seeds.
- The storage methods that are allowed in organic agriculture.
- Quality management and germination tests and record keeping.

The main points to be considered for seed multiplication are the selection of the site, species and variety and field management. Additionally, seed harvests should also be planned and carried out during the proper time or season to ensure the successful production of high quality seeds.

Lessons to be learnt

Careful planning is required at all stages of a seed saving program for it to be successful

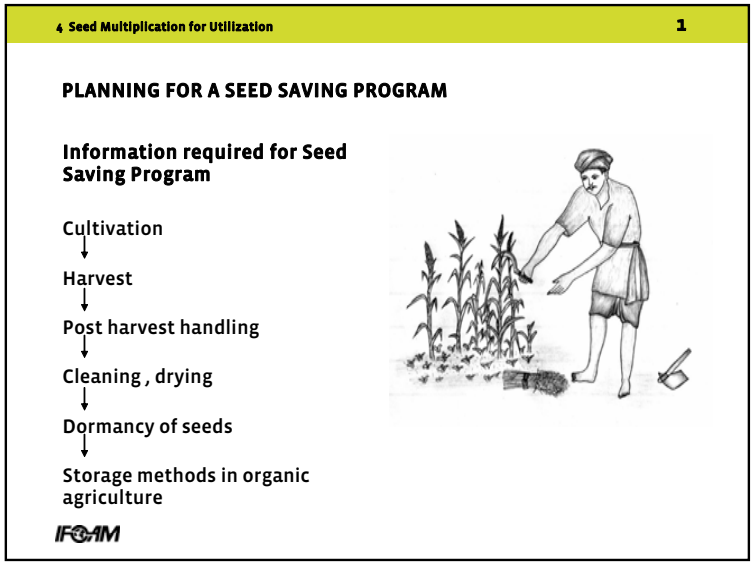
It is important to keep in mind farmers' preferences while choosing the varieties for conservation

A well managed field is the key for successful seed multiplication

Extreme care should be taken during harvest to maintain seed quality

Motivation - Collecting Information for a Seed Saving Program

Ask the participants to list the important information required before starting a seed saving program. After this present the transparency. Check if all the components mentioned in the transparency have been covered and also if any additional points have been included by the participants.

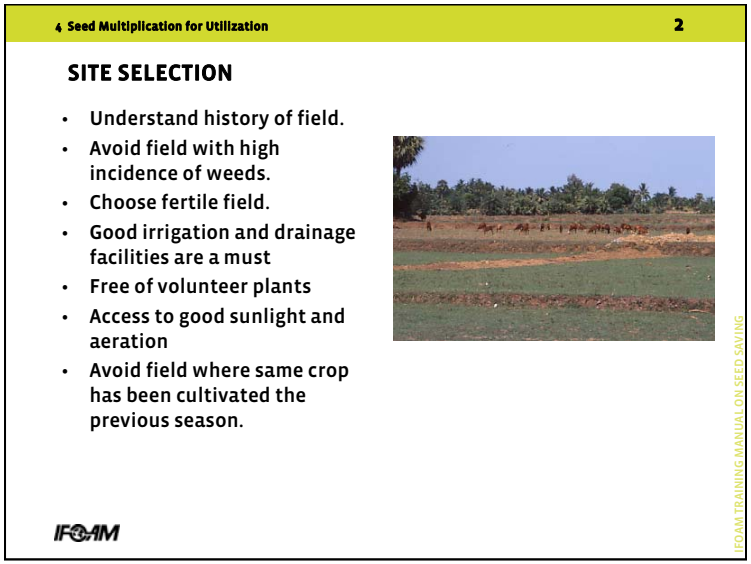


Transparency 4(1) : Components of a seed saving program

4 Seed Multiplication for Utilization

4.1.1 Site Selection

The history of the field in which the seeds are to be multiplied should be taken into consideration. However, there is no need for the land selected to be superior to that used to grow normal crops. The field should not have a high incidence of weeds and should be reasonably fertile with good irrigation and drainage facilities. It should be free of volunteer plants and have good sunlight and aeration. The field should not have been grown with the same crop in the previous season.



Transparency 4(2) : factors to be considered before selecting a site for seed multiplication

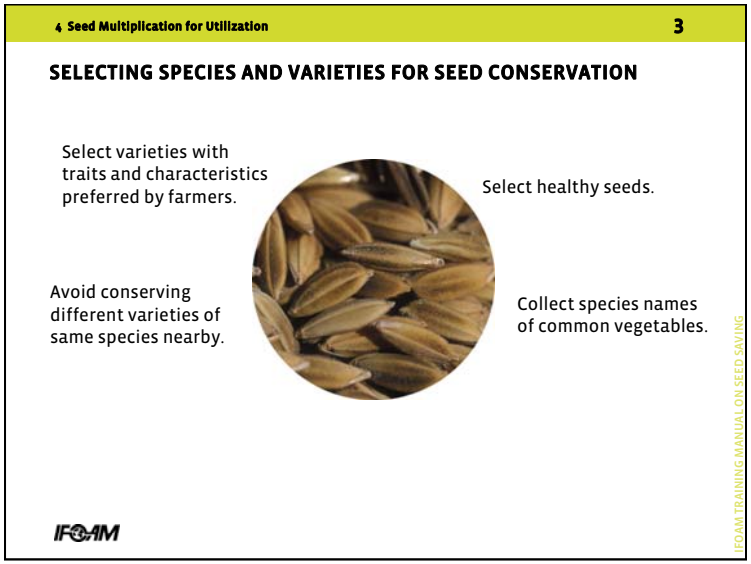
Group work : Identifying Suitable Fields

Make a visit to some nearby fields with the participants. Ask them to identify which fields are suitable for seed multiplication and which are not. Ask them also to provide reasons for the same.

4 Seed Multiplication for Utilization

4.1.2 Species and Varieties Selection

The traits and characteristics that are preferred by the farmers of the region are important criteria for selecting a species for seed conservation. Only healthy seeds should be selected. Different varieties of plants within the same species will cross with each other. Crosses are, however, rare between plants that belong to different species. It is therefore important to know the species names of common vegetables for the proper preservation of specific plant varieties. This is required to avoid choosing undesired varieties or crossing among common vegetables.



Transparency 4 (3) : Methods for selecting species and varieties for seed conservation.

Discussion : Characteristics of locally preferred varieties

Ask the participants to list the names of varieties of different crops cultivated in their region and also list the preferred varieties. Why are they preferred? List the characteristics that are preferred by local people and farmers.

4 Seed Multiplication for Utilization

4.1.3 Field Management

Soil preparation
Soil should be prepared in such a way that it favours the uniform germination of seeds. It should have good physical conditions (neatly ploughed without any lumps). The soil chosen should be suitable for the crop to be grown.

Fertility
Good quality organic fertilizers and compost, which are able to provide the essential nutrients, should be used. Green manure crops are recommended for producing sufficient biomass. A crop with balanced fertilization will produce better, uniformly healthier plants and exhibit a lower percentage of damping off.

Irrigation
Well irrigated plants produce seeds of high quality and quantity. Irrigation systems should efficiently control water deficit or excess.

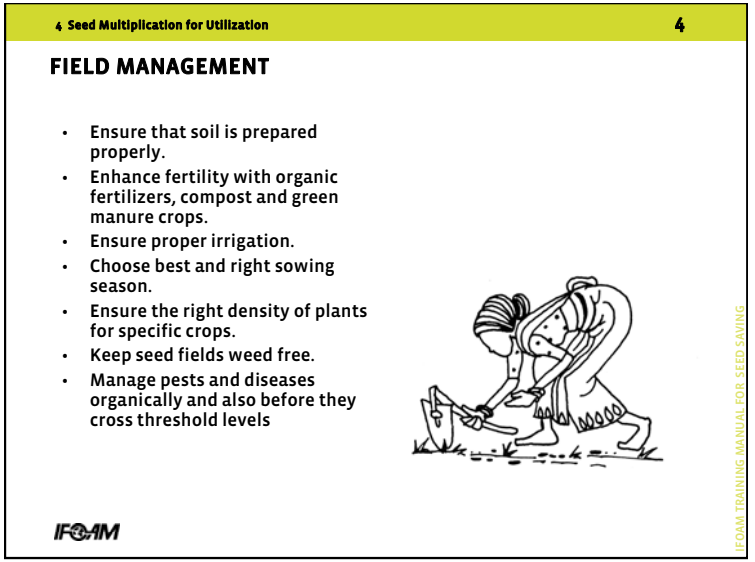
Seeds
The origin of the seeds collected should be well established, and the seeds should have high varietal purity. The selected variety should be of traceable origin and of a good quality to ensure healthy yields of high quality seeds.

Sowing
The best sowing season for many crops depends on photoperiod, temperature and rainfall distribution during the different stages of the growth of the species. Absence of rainfall at the initial stage of ripening produces the best quality seeds. Seeds harvested in dry seasons are always of better quality than those picked when final ripening occurs during the rainy season. Sowing methods, however, do not significantly affect seed quality.

Plant density
The density of plants in the field directly influences plant behavior and health and seed quality. If the planting is dense, it increases the possibility of damping off and disease propagation and seed quality will be affected. On the other hand, too low a density could lead to higher weed infestation and uneven ripening, causing problems in seed production. The right density for a specific crop has to be maintained.

Motivation – Components of field management

Discuss with the participants the various components of field management. Ask them to put down points as to why they consider these components important. Present the transparency after this discussion.



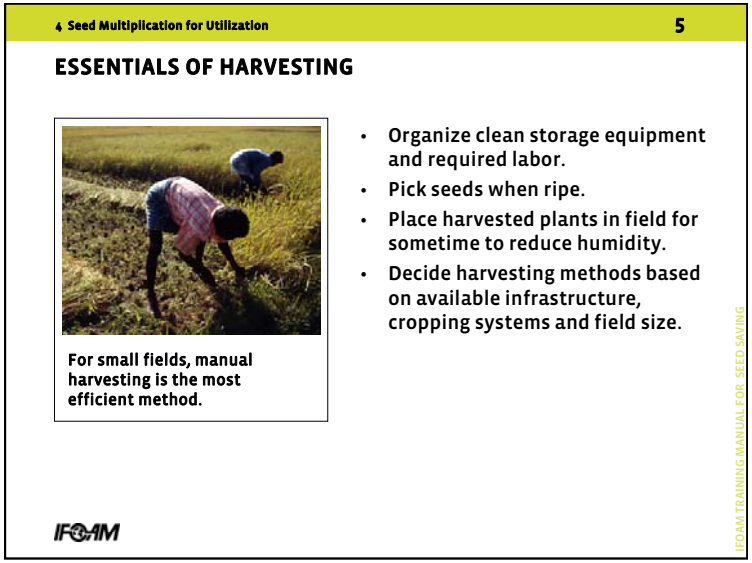
Transparency 4(4) : Components of field management for seed multiplication

Weed control
Significant weed infestation in seed fields makes harvesting difficult. It also risks seed quality as the seeds could get contaminated with the residue of other plants. Weed removal is essential at all stages of crop and is the best method of obtaining seeds free of contaminants.

Pest and disease management
At all stages, it is important to undertake special efforts to manage pests and diseases in the crops maintained for seed production.

4.1.4 Harvesting

Harvesting is one of the activities that has an important effect on maintaining seed quality. Therefore, proper planning should be carried out before a field is harvested. Clean storage equipment and the required labour should be available. It is best to pick seeds when they are ripe. For an efficient harvest, plants should remain on the field for some time in order to reduce seed humidity. Harvest methods should be based on the available infrastructure, the cropping system (mixed or monocropping) and the field size. Manual harvesting may require more labour but is the most efficient method of maintaining seed quality since it reduces the chances of mechanical damage. It is the method most recommended for the collection of small quantities of seeds. For small quantities of seeds, simple, low cost equipment and procedures can be used to obtain good quality seeds. Basic equipment that can be obtained at low cost and used by farmers themselves should be employed (e.g., soil driers, scales, humidity-measuring equipment, etc.).



Transparency 4(5) : Points to be kept in mind before harvesting.

Discussion : Preparation for harvest

Discuss with the participants regarding preparation for harvesting. Points mentioned by various participants may vary from area to area. Discuss reasons for the variation.

4 Seed Multiplication for Utilization

4.2 Seed Testing

It is important for the farmer to test seeds for viability, i.e., germination capacity. This is an important component of the seed multiplication effort because if the seed has a low germination capacity then care should be taken so that it can be multiplied. Seeds should also be tested for parameters other than viability, as discussed in this section. The quality of seeds can be tested when buying, selling, giving or sharing seeds. It can also be determined while sorting, sowing or planting seeds.

4.2.1 Seed Health

Healthy seeds are those that are free from pests and diseases. Seeds need to be examined carefully for blemishes or stains on the seed coat. Seeds need to be checked for moulds or holes caused by insects or eggs of insects. The infected seeds should be removed from the clean ones.
Certain diseases can only be observed after the seeds are planted. Germinating seeds can show symptoms of fungi or bacteria. Fungal or bacterial infections can be recognized because they make seeds watery or shiny or smell bad. Most infections can be killed by soaking seeds in hot water (50° C) for 30 minutes.

4.2.2 Seed Purity

Contaminants like dirt, stones, leaves or other seeds and broken seeds should be removed, and the seeds should be cleaned before being stored or given to others.

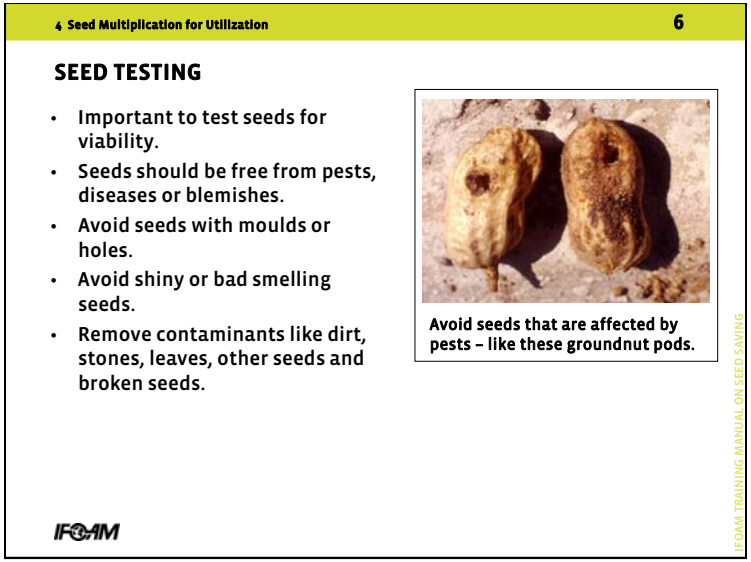
Lessons to be learnt

To maintain healthy seeds ensure that they are free from pests, diseases and contaminants

Germination tests are important to maintain viable seeds

Seeds that do not germinate need not be unviable. They could be dormant

Characteristics of seeds should be understood to plan storage and preservation



Transparency 4(6) : Components of seed testing.

Practical exercise : Seed testing

Place different types of seeds before the participants. Have a mixture of good seeds and bad seeds. Ask the participants to select the seeds suitable for cultivation and provide reasons for the same.

4 Seed Multiplication for Utilization

4.2.3 Seed Germination

***In situ* testing**

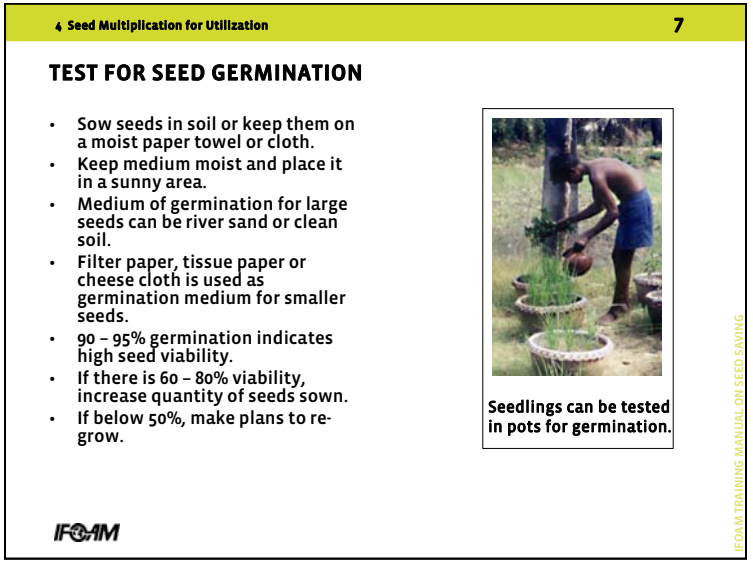
The resumption of active growth by the embryo (seed) that results in the rupture of the seed coat and the emergence of a young plant is known as germination. The ability of a seed to germinate is its viability or vigour. Before planting, it is important to make sure that seeds or planting materials have a high germination potential or vigour. Weak seeds (low vigour) will die under field conditions, and if they survive, will most likely be attacked by pests and diseases immediately. The viability or vigour of seeds varies from species to species. For example, onion seeds are viable for a year, whereas seeds of some cucumber varieties are viable for more than four years. A seed viability test can be conducted either by sowing the seeds in soil or keeping them on a moist paper towel or cloth. The medium should be kept moist and placed in a sunny area. For large seeds, river sand or clean soil can be used as a germination medium. Boiling water should be poured on the soil before use to kill germs. For smaller seeds, filter paper, tissue paper or cheese cloth can be used as a germination medium. Place the medium with the seeds in a box or plastic bag which allows air to penetrate. After a few days, count the number of normal seedlings. Calculate the percentage germination.

$$\% \text{ germination} = \frac{\text{number of normal seedlings}}{\text{total number of seeds germinated}} \times 100$$

The more seeds taken for percentage germination, the more accurate the results would be. Also replicate testing. The number of seeds to plant can be calculated as follows :

$$\text{Number of seeds to be planted} = \frac{\text{desired number of plants}}{\% \text{ germination}}$$

A germination rate of 90–95% is an indication of high seed viability. If it is between 60–80%, the quantity of seeds sown should be increased to compensate for the poor germination rate. If germination falls below 50%, plans should be made to re-grow the seeds.



Transparency 4(7) : Method to perform test for seed germination in pots.

Practical exercise : Germination Tests

Have a set of seeds from various sources. Ask the participants to perform germination tests and provide the results.

4 Seed Multiplication for Utilization

Seeds of vegetables, pulses and cereals should be soaked in water before the germination test. Only the seeds that sink should be used for sowing. To enable hard seeds/nuts to germinate faster, the seed coat should be rubbed against a hard surface to make it thinner. The seeds may also crack slightly. After being rubbed, they should be soaked in hot water before sowing.

Factors influencing germination

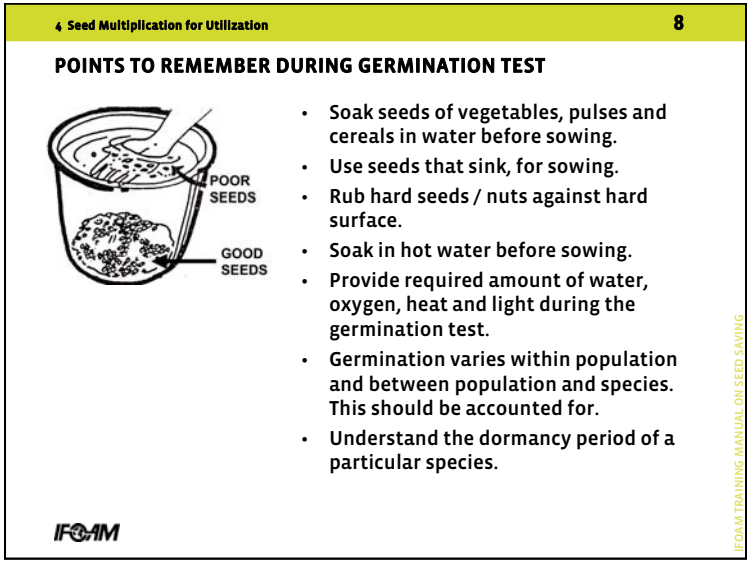
Germination is influenced by the amount of water, oxygen, heat and light the seeds are exposed to. The first three are essential components. Lack of water prevents germination and the presence of too much water also creates problems. Excessive water reduces the amount of oxygen available to seeds, and this causes abnormal germination or failure of germination. Very low or very high temperatures also prevent germination of all seeds. The time taken for individual seeds to germinate varies within a population and also between populations and species. The germination test period should take this into account.

Seed dormancy

If a viable seed does not germinate in conditions when it normally would, it is said to be dormant. Dormancy in seed reduces,

- After ripening or post harvest maturation
- When seeds are stored in a dry state
- When the outer covering of the seeds are removed

Take some water in a vessel and drop an egg in it. Keep adding salt to it slowly until the egg reaches the surface of the water. When the paddy seeds are dropped in this water, the good quality seeds will sink into the water. Remove the unviable seeds that float on the surface of the water. Wash the selected seeds in good water for 2 – 3 times to remove the salt deposits. If this is not done, the germination capacity of the seeds will be affected. By this method, the unviable seeds can be removed completely. This method should be followed when there is more of chaff.



Transparency 4(8) : Points to be kept in mind while performing the germination test.

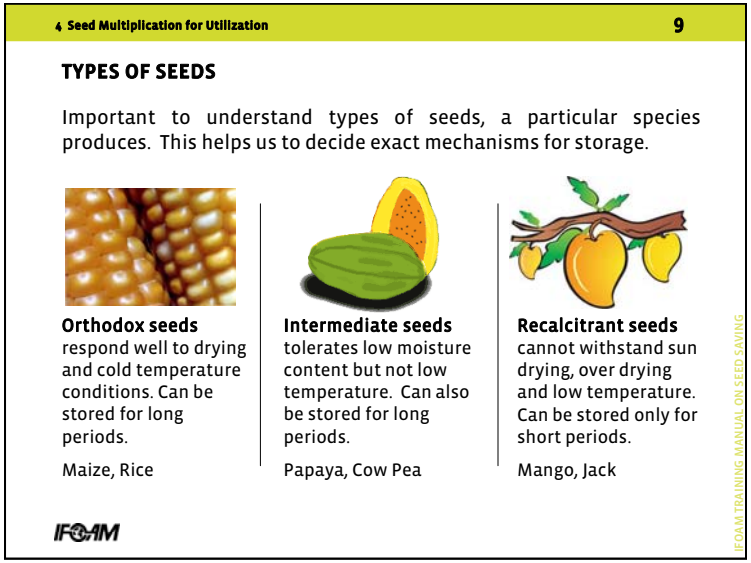
4.2.4 Orthodox, Recalcitrant and Intermediate Seeds

A major concern in seed technology is keeping seeds viable until the next planting season. This depends on the type of seeds that a particular species produces: orthodox, recalcitrant or intermediate. The characteristics of these types of seeds is given in the table below. It is important to know these characteristics so that seed storage and preservation can be planned accordingly

Orthodox, Recalcitrant, and Intermediate Seeds

Orthodox seeds	Intermediate seeds	Recalcitrant seeds
▪ Respond well to drying and cold temperature conditions	▪ A newly discovered type of seed that falls between the orthodox and recalcitrant categories in terms of response to drying and temperature; tolerates drying to a low moisture content but not to a low temperature	▪ Sun drying, over-drying and low temperature storage are generally fatal to these seeds
▪ Can be stored for long periods (years) under controlled conditions	▪ Can be stored for long periods like orthodox seeds	▪ Can be stored in ambient conditions but only for short periods(days to several weeks); can tolerate slightly lower moisture levels and temperatures (especially temperate recalcitrants)
▪ Examples are rice, corn, annual vegetables and other small seeds ▪ Cereals: barley. maize, millet, oats, quinoa, rice, rye, sorghum, wheat, etc. ▪ Vegetables: amaranths, beets, cabbage, carrot, chillies, egg-plant, lettuce, onion, tomato	▪ Examples are papaya, citrus, coffee and some palms (royal palm, African oil) ▪ Legumes: beans, cowpeas, fava, chick pea, lentils, peas, soya beans ▪ Vegetables: asparagus	▪ Examples are durian, lanzones, jackfruit, mango, dipterocarp species and many other large-seeded fruits

Note: Some apparently short-lived seeds may not be truly recalcitrant. They might have developed hardseededness or dormancy upon drying, or may only be damaged upon fast reabsorption of moisture during germination.



Transparency 4(9) : Classification of seeds based on storage period.

4 Seed Multiplication for Utilization

4.3 Nursery Techniques for Raising Seedlings

The most common method for raising seedlings from vegetable seeds is direct sowing. Certain vegetable seeds perform better if they are initially sown in containers or seed beds and then transplanted. In this section, the basic steps involved in nursery techniques are discussed.

4.3.1 Selecting and Preparing Containers for Planting

Raising seedlings in a container allows a farmer to choose the right type of medium for growing seedlings. The container that is chosen should be deep enough to allow seedlings to take root. It should also be wide enough to prevent cramping. The container should be cleaned properly to make sure that it does not contain any fungal spores or insect pests and should be provided with adequate drainage to avoid the damping off disease that destroys seedlings.

4.3.2 Preparation of the Soil Medium

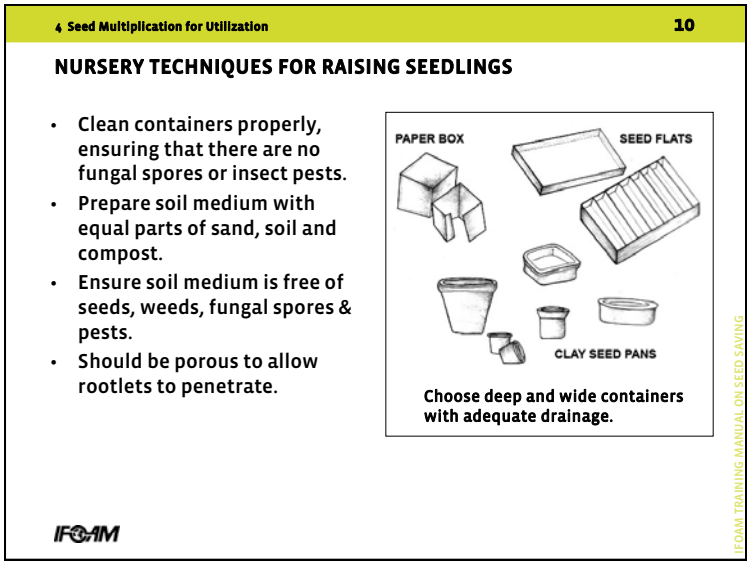
The soil medium that is used should be free of seeds of weeds, fungus spores and pests. It should also be porous enough to allow delicate rootlets to penetrate and to admit sufficient air and moisture. A mixture of equal parts of sand, soil and compost should be prepared.

Lessons to be learnt

For better performance of certain vegetable seeds raising them initially in a nursery helps

Raising seedlings in a nursery is a little expensive and hence not suitable for short duration crops

Seeds of rare varieties can be raised in a nursery and then transplanted to ensure better care



Transparency 4(10) : Nursery techniques used for raising seedlings.

Practical exercise : Preparing nursery

Place different types of seeds before the participants. Also provide them with containers. Ask them to prepare the nursery for a few varieties. They should also be asked to follow various steps up to getting it ready for transplantation.

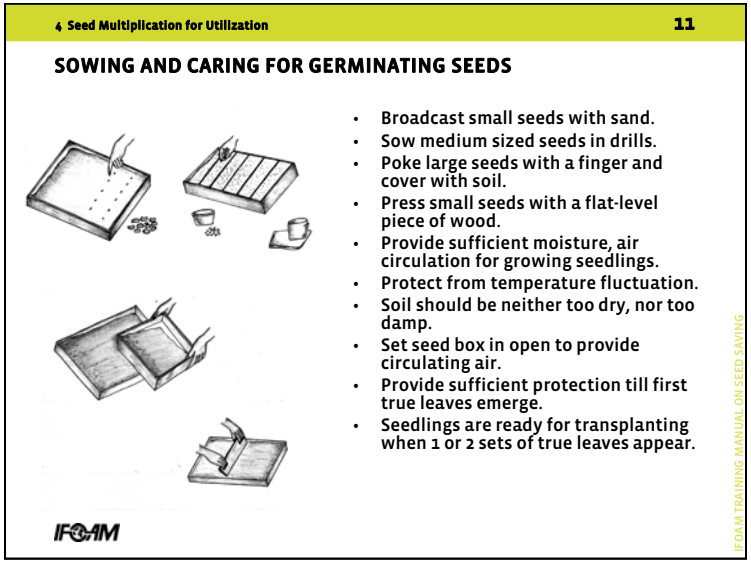
4 Seed Multiplication for Utilization

4.3.3 Sowing the Seeds

Small seeds should be broadcast together with the sand. Medium-sized seeds should be sown in drills. Large seeds need only be poked in slightly with a finger. Seeds should be covered by the soil medium. This is done by sifting soil through a fine sieve held above the seed bed. Large seeds should be covered to a depth equal to twice their width. Small seeds need not be covered but should be pressed gently into the soil with a flat, level piece of wood.

4.3.4 Caring for Germinating Seeds

Sufficient moisture and air circulation should be provided for the growing seedlings. They should also be protected from temperature fluctuations. The soil should be neither too dry nor too damp as both these conditions can be harmful to seeds. The seed box should be set in the open. If it is kept indoors, seedlings may not get enough circulating air. Seedlings should be given adequate protection till the first true leaves emerge. When one or two sets of true leaves appear, the seedlings are ready for transplanting.



Transparency 4(11) : Sowing and caring for the germinating seeds.

Practical exercise : Providing right conditions for germination

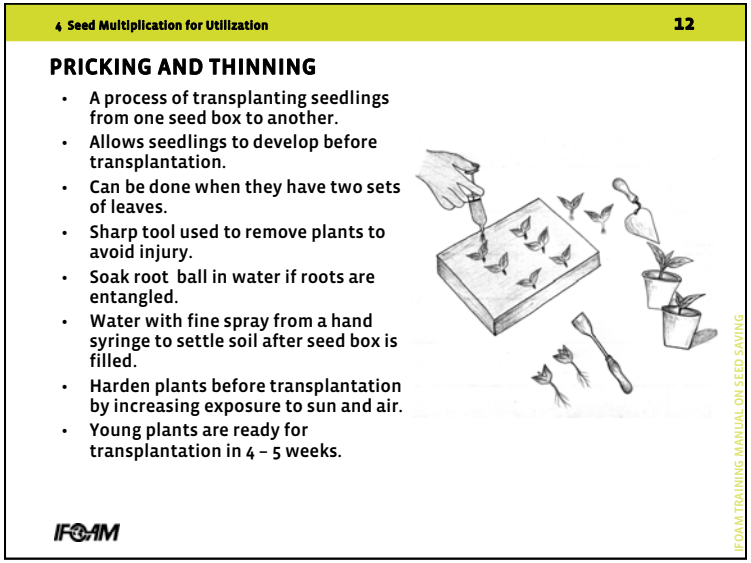
Ask the participants to place some of the containers in which the nursery has been raised in a closed room not exposed to sunlight. Observe what happens and discuss with them the reasons for the same.

4 Seed Multiplication for Utilization

4.3.5 Pricking/thinning

Pricking/thinning is a process of transplanting seedlings from one seed box to another. It allows the seedlings to start developing root and leaf systems before they are transplanted in the field. Pricking/thinning can be done as soon as the seedlings have two sets of leaves. A sharp tool can be used to remove the plants to avoid injury to them. If roots are entangled, they can be separated by soaking the root ball in water.

After the seed box is filled, it can be watered with a fine spray from a hand syringe to settle the soil around the roots. This also refreshes wilted stems and leaves. If the plants are particularly soft and show signs of wilting, the box should be covered with a sheet of newspaper or with another box turned upside down. Young plants will be ready for transplantation in the field in about four to five weeks. The plants to be transplanted should be hardened by gradually increasing their exposure to sun and air.



Transparency 4(12) : Pricking and thinning of seedlings

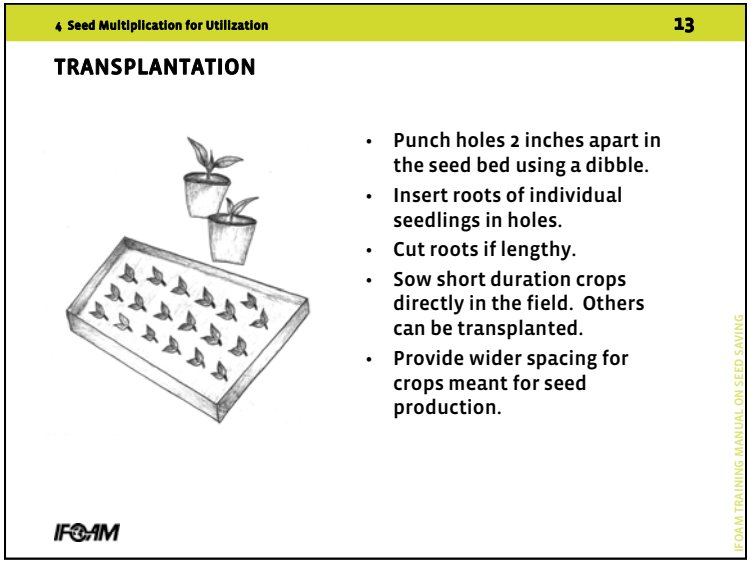
Practical exercise : Pricking and thinning

Ask participants to practice pricking and thinning of seedlings from the nursery they have already raised.

4 Seed Multiplication for Utilization

4.3.6 Transplantation

Holes should be punched 5 cms apart in the seed bed using a dibble. The roots of the individual seedlings should be inserted in the holes and firmed in using either the dibble or the fore and middle fingers. If roots of the seedlings are lengthy, they should be cut using shears or a sharp knife. If a crop has a life span of three to four months, it needs to be transplanted after it has been in the nursery for three to four weeks. Growing seeds in a nursery and transplantation are expensive. Hence, very short duration crops like okra and radish are sown directly in the field. Crops like tomato or brinjal need to be grown in a nursery before they can be transplanted. If the crops are meant for seed production, they need to be provided with wider spacing than normal crops.



Transparency 4(13) : Preparing for transplantation of seedlings

4 Seed Multiplication for Utilization

4.4 Keeping Accessions Pure

4.4.1 Pollination

Seeds are produced from flowers, and flowers have to be pollinated in order to produce seeds. Pollen is the fertilizing powder that comes from the male part of the flower, the anther. Pollination occurs when pollen comes into contact with the female part of the flower, the stigma or pistil. Plants may be self-pollinated or cross-pollinated.

Self-pollination
In the case of self-pollination, plants can produce seeds without another plant. The pollen from the same flower or from another flower on the same plant is used for pollination. Some of the examples of self-pollinated plants are tomatoes, beans, cowpeas, etc.

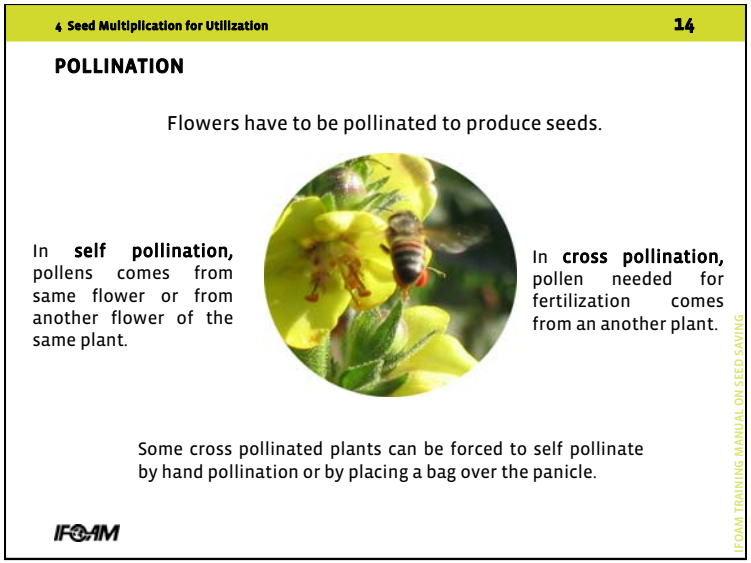
Cross-pollination
In cross-pollination, the pollen needed for fertilization has to come from another plant. These plants cannot produce seeds if only one plant is planted because there will be no source of pollen. Some examples of cross-pollinated plants are water melon, cucumber, bottle gourd, bitter gourd, etc. Certain cross-pollinated plants such as maize can be forced to self-pollinate by hand pollination or, as in the case of bajra, by placing a bag over the panicle. The following steps will help maintain the purity of the seeds while planting out.

Lessons to be learnt

It is important to understand the pollination behavior of plants to maintain accessions pure

There are techniques available to prevent unwanted pollination as well as to totally exclude insects

Rouging is a simple yet critical technique for maintaining purity



Transparency 4(14) : Different types of pollination

4 Seed Multiplication for Utilization

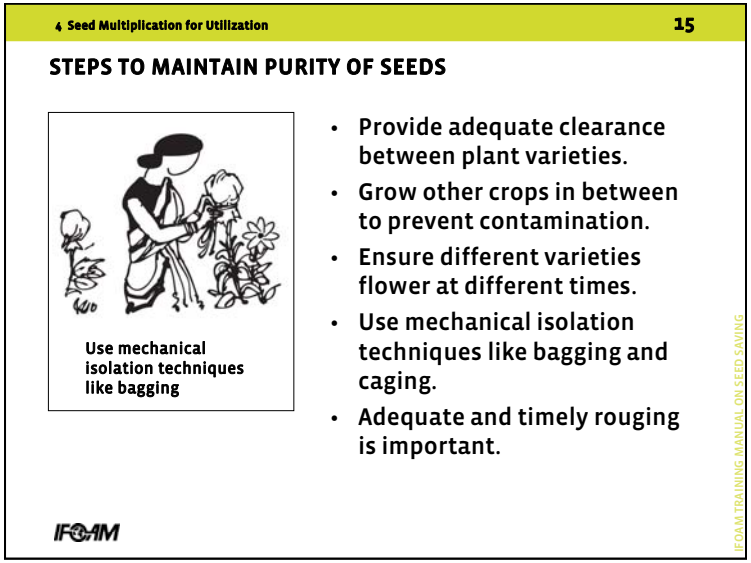
Growing plants apart
Pure seeds can be produced by ensuring that there is adequate clearance between two or more plant varieties. Alternately, other crops can be grown in between to prevent contamination from insects or wind-blown pollen.

Time isolation
Time isolation is suitable in those cases where all the plants of a crop flower simultaneously and for only a short time. It is possible if irrigation facilities allow staggered planting. Different varieties of corn and sunflower could be planted at different time intervals to make sure that the flowering takes place at different times.

Bagging techniques
Bagging is a form of mechanical isolation that prevents unwanted pollination. It is useful for small quantities of seeds. It involves covering the flowering portion of a plant in order to isolate those flowers from insect pollinators or wind-blown pollen. Different materials such as fine polyester cloth, nylon stockings, mosquito nets and paper bags can be used for bagging. Plastic bags should be avoided since they do not allow air circulation. The base of the bag should be tightly secured around the stem. It may also be necessary to wrap a cotton ball tightly around the flower stem before securing the bag with a twist tie, in order to prevent insects from crawling into the bag. This process is useful for tomatoes and capsicums.

Caging techniques
Caging is another mechanical isolation technique that allows for the total exclusion of insects. This technique can be used for chillies and brinjal. Cages can be made from steel or wooden rods stuck into the ground to create a dome-shaped structure that can then be covered with a wire or mesh. For a row of plants, a common semicircular tunnel can be made, which can be shifted as and when required.

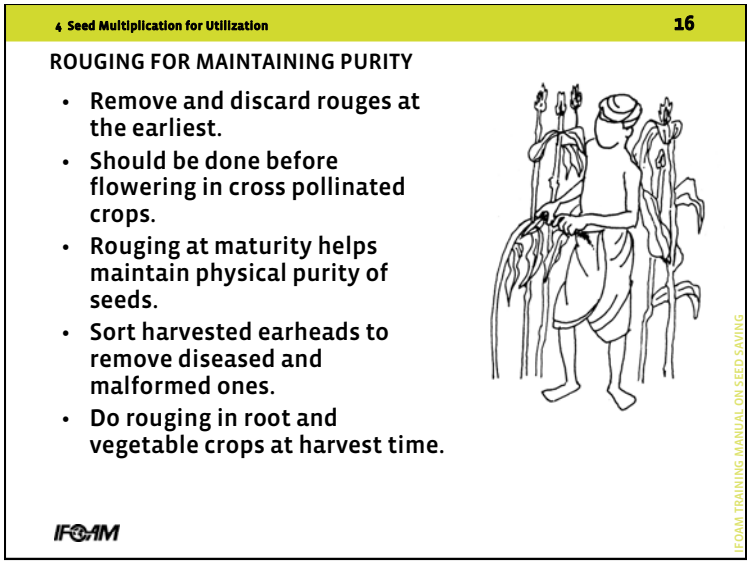
Caged plants can be pollinated by introducing pollinators such as trapped flies or newly emerged bees. The cage has to be large enough to cover the plants and allow the insects some flying space. Alternately, caged plants can also be hand pollinated to produce pure seeds. After the pollination has been carried out by the hand, the female blossom must then be protected from contamination with foreign pollen using a bag.



Transparency 4 (15) : Various steps to be adopted to maintain purity of seeds.

4.4.2 Rouging

Adequate and timely rouging is very important to keep accessions pure. Rouges are different from normal plants and should be pulled out and discarded at the earliest possible stage of growth, especially before flowering in cross-pollinated crops, to avoid genetic contamination. In some crops, rouging at the early vegetative stage may be necessary to remove virus- affected plants. Rouging at maturity may also be necessary to remove types that were not distinguishable earlier. This helps maintain the physical purity of seeds. Sorting of harvested earheads may be necessary in some crops to remove textured, off-color, diseased or malformed earheads. In root and vegetable crops, rouging should be done at harvest time.



Transparency 4 (16) : Rouging to maintain purity of varieties

Practical exercise : Bagging and rouging techniques

Take the participants for a field visit. Ask them to practice bagging and rouging techniques with specific plants.

4 Seed Multiplication for Utilization

4.5 Selection and Collection of Seeds

4.5.1 Criteria for Selection

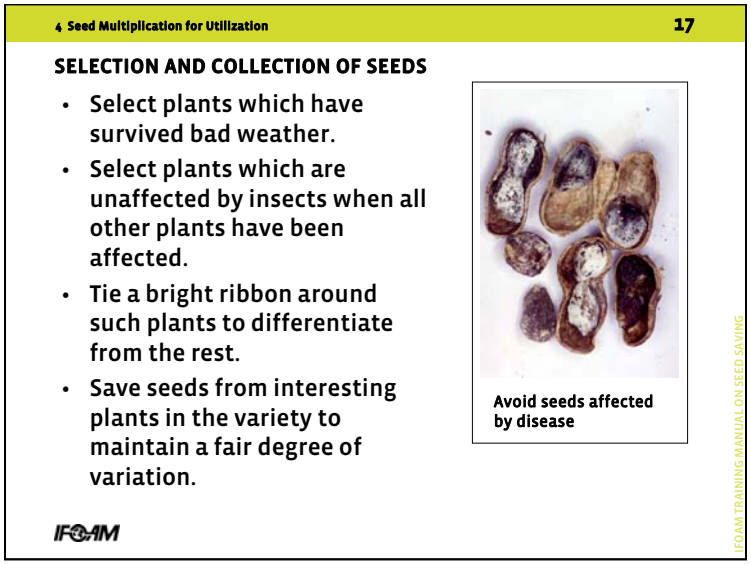
To get seeds of a high quality, the plants selected should have exceptional characteristics such as being able to survive extended periods of bad weather or being unaffected when all other plants are attacked by insects. The best plants should be marked by tying a bright ribbon around them so that everyone knows they are special. Over time and with care, plants can be fashioned to suit the needs of farmers and consumers. The largest and best looking plants are naturally considered for collection. However, it is important to save seeds from other interesting plants in the variety in order to maintain a fair degree of variation. This is what open pollination is all about as opposed to the production of uniform hybrids, where all the plants are identical. Optimum variability is essential as it allows a crop to adapt itself to changes whether in the soil or because of cultivation methods, latitude, planting time or climate.

The procedure used to select seeds/planting material of various species of plants is given in the following pages.

Lessons to be learnt

Collecting seeds from interesting plants is important rather than from best looking plants

For cross pollinated crops seeds from more plants should be saved to maintain variable characteristics



Transparency 4 (17) : Factors to be considered while selecting and collecting seeds.

Practical exercise : Choosing plants for seed selection.

Take the participants for a field visit. Ask them to survey the field and choose plants suitable for seed collection. Discuss with them the rationale for selecting these plants.

Do this for as many crops as possible. The criteria for selection has been mentioned in transparencies 4(18) – 4(21)

4 Seed Multiplication for Utilization

Cereals and millets

In the case of millets like finger millet, foxtail millet and barnyard millet, long heavy earheads should be selected and cut. In the case of paddy, the healthy earhead should be cut. Alternately, the entire plant can be cut and kept apart from the rest of the harvest. Earheads chosen for seeds should not be affected by disease, must be free of insects and chaff and should also be fully ripe. The harvest should be piled up and kept for about two days before being threshed and stored.

Pulses

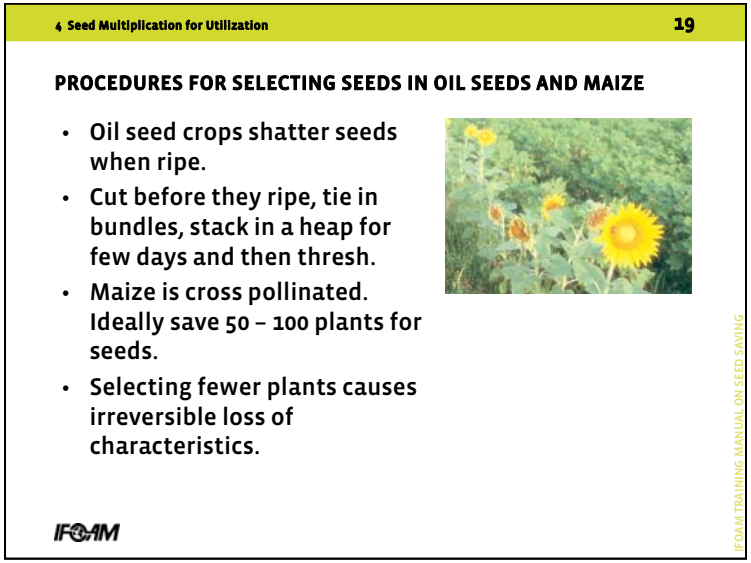
There are certain legumes whose pods do not snap and scatter seeds. Such pods should be picked from the plants only after they are fully dry. This will ensure that the seeds are well formed and mature. The pods of certain legumes snap. In such cases, the entire plants should be cut before the pods are dry. The plants should be kept for a few days to mature and then threshed.

Transparency 4(18) : Seed selection in cereals, millets and pulses.

4 Seed Multiplication for Utilization

Oil seeds
Some oil seed crops like sesame and mustard shatter their seeds when fully ripe. They should be cut just before they ripen, tied in bundles, stacked in a heap for a few days and then threshed to obtain seeds.

Maize
Maize is a cross-pollinated crop and, hence, ideally 50–100 plants should be saved for seed conservation. If only a few plants are selected, there is a danger of irreversible loss of characteristics. For example, multicolored corn may lose some colors and also some of its insect-resistant qualities. There may also be a loss in earliness and productivity.



Transparency 4 (19) : Seed selection in oil seeds and maize.

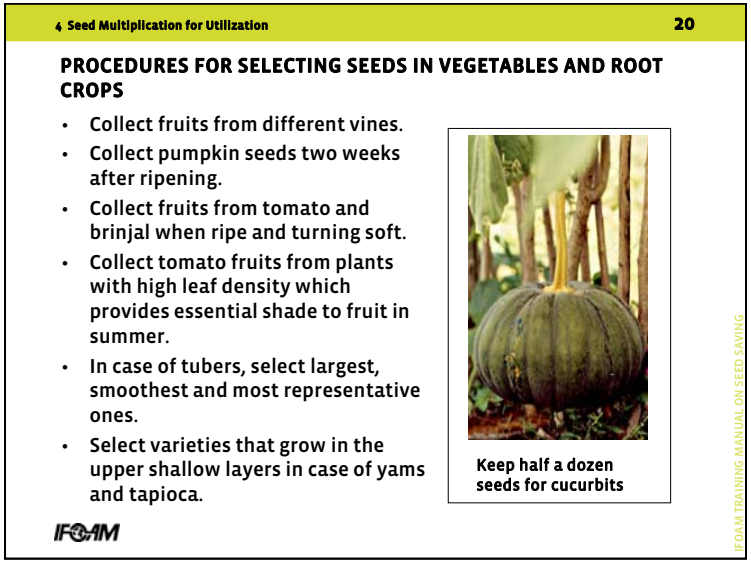
4 Seed Multiplication for Utilization

Vegetables

For cucurbits like pumpkins, melons and cucumbers, it is best to keep half a dozen fruits. The seeds should be collected from fruits of different vines rather than from only a single vine. Pumpkin seeds should be collected a couple of weeks after the fruit ripens. In the case of cucumber and ladies finger, the fruits should be allowed to reach full size and then left for another three weeks to allow the seeds to mature. Tomato and brinjal fruits should be collected for seeds when they are ripe and turning soft. In the case of tomatoes, the fruits should preferably be picked from plants with a high leaf density since this gives essential shade to the fruit in the summer heat.

Root crops

In the case of tubers of potatoes or rhizomes of ginger, the largest, smoothest and most representative specimens should be selected. In the case of yams and tapioca, the varieties that grow in the upper shallow soil layers should be selected (the deep-seated varieties are difficult to break underground).



Transparency 4(20) : Procedures for selecting vegetable seeds and root crops.

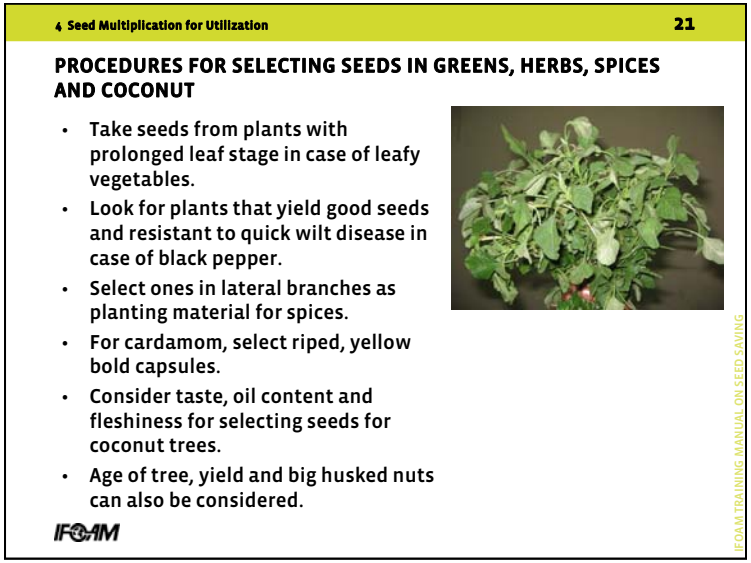
4 Seed Multiplication for Utilization

Greens and herbs
In the case of leafy vegetables, seeds should be taken from plants with a prolonged leaf stage rather than from the ones that send up stalks very early in the season.

Spices
In the case of black pepper, vines that yield good seeds and are resistant to quick wilt disease should be looked for. The ones with lateral braches should be selected as planting material. In the case of cardamom, ripe, yellow bold capsules should be selected.

Coconut
Coconut trees live for a long time and selection of good seeds is very important. Taste, oil content and fleshiness should be taken into consideration during seed selection. The other important characteristics to be looked for are

- The age of the tree (35–40 years of age)
- Strong trees with 25–30 leaves and a yield of 200–250 coconuts per year
- Big husked nuts that are round and produce a metallic sound when tapped



Transparency 4(21) : Procedures for seed selection in greens, herbs, spices and coconut.

4 Seed Multiplication for Utilization

4.6 Seed Processing

This section takes a look at the overall principles of processing seeds before storage.

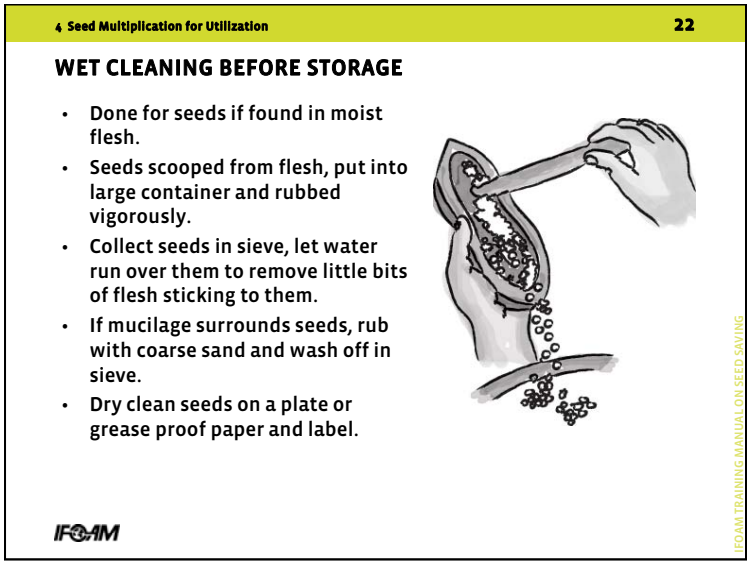
4.6.1 Cleaning

Chaff and stems invariably harbour insects that could attack stored seeds. However, with some care and attention, chaff and stems can be removed using nothing more complicated than ordinary kitchen utensils. The method used to clean seeds depends on how they are found on the plant. Wet or dry cleaning or winnowing could be used.

Wet cleaning
Plants that carry seeds in their moist flesh can be processed by wet cleaning. Examples are tomatoes, cucumbers and pumpkins. The seeds should be scooped from the flesh and put into a large container and rubbed vigorously. The seeds should be collected in a sieve and water should be run over them to remove all the little bits of flesh sticking to them. If mucilage surrounds the seeds, just washing with water will not help. The wet seeds should be gently rubbed with coarse sand and the mucilage should be washed off in a sieve. The clean seeds should be dried on a plate or a greaseproof paper for ten days and then labelled.

Lessons to be learnt

Whether seeds should be cleaned wet or dry depends on whether seeds are carried in moist flesh or mature in a dry pod or case
The shape of the container used for winnowing determines it's efficiency
Drying seeds properly is the key for proper storage



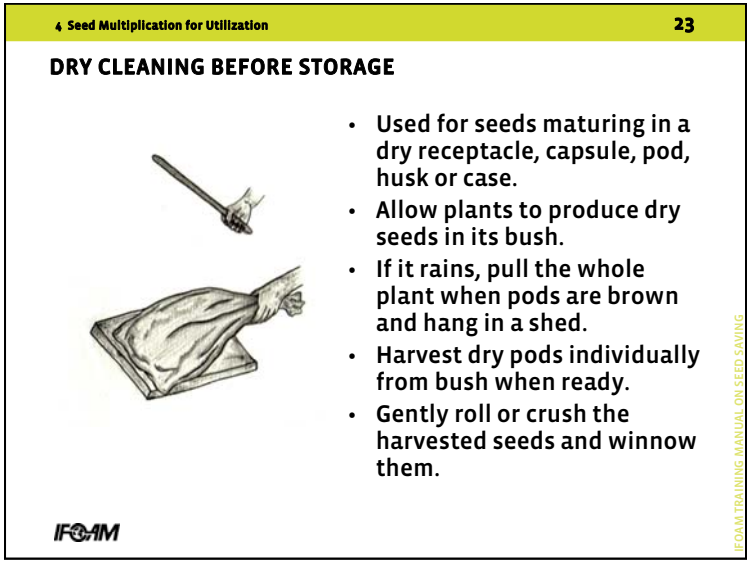
Transparency 4(22) : Wet cleaning of seeds before storage

Practical exercise : Wet cleaning technique.

Have a collection of moist, fleshy fruits. Ask the participants to practice the wet cleaning technique.

Dry cleaning

Dry cleaning can be used for seeds maturing in a dry receptacle, capsule, pod, husk or case. Examples are beans, peas, sweet corn, popcorn, maize, radish, lettuce, carrot, onion, beet, okra and various garden flowers. The plant should be allowed to produce dry seeds on its bush. If it rains, the whole plant should be pulled out when the pods are brown and hung in a shed or under a verandah. Dry pods can also be individually harvested from the bush as soon as they are ready. They should be gently rolled or crushed and winnowed.



Transparency 4(23) : Dry cleaning of seeds before storage

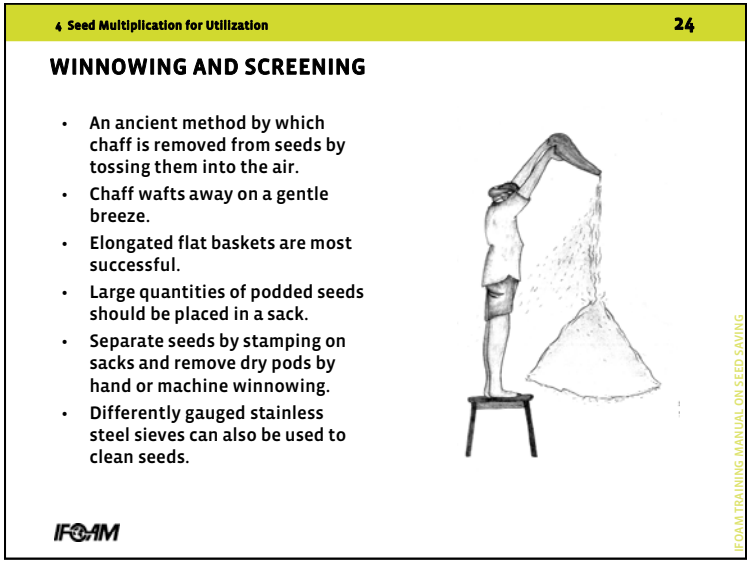
Checking participants' comprehension

Provide the participants with a list of plants and ask them to say whether the seeds should be cleaned dry or wet, and give reasons for the same.

4 Seed Multiplication for Utilization

Winnowing
Winnowing is an ancient method by which chaff is removed from seeds by tossing them into the air. The chaff wafts away on a gentle breeze. Using this process, calyxes, stems, old petals, husks and dead reproductive organs of the flowers and fruits can be separated from seeds. The secret of the success behind winnowing lies in the shape of the vessel used. An elongated flat basket has proven to be the most successful. Another method involves putting the seeds in a bowl and shaking them till the debris drifts to the top. A consistent gentle blowing or the use of a little fan will help lift the chaff away. Large quantities of podded seeds (like beans, peas and okra) can be placed in a sack. The seeds can then be separated by stamping on the sacks. Dried pods can be removed either by hand or by machine winnowing.

Screening
Differently gauged stainless steel sieves mounted on wooden frames can be used to clean seeds. First, a sieve with a gauge large enough to let the seeds go through is used. Large debris is left on the sieve and can be thrown away. The chaff that is smaller than the seeds can be separated using a smaller gauge sieve.



Transparency 4(24) : Winnowing and screening before storage

Group discussion : Indigenous pre-storage practices

Ask the participants to discuss amongst themselves various indigenous pre-storage practices followed in their areas. Analyse the merits and demerits of the same.

4 Seed Multiplication for Utilization

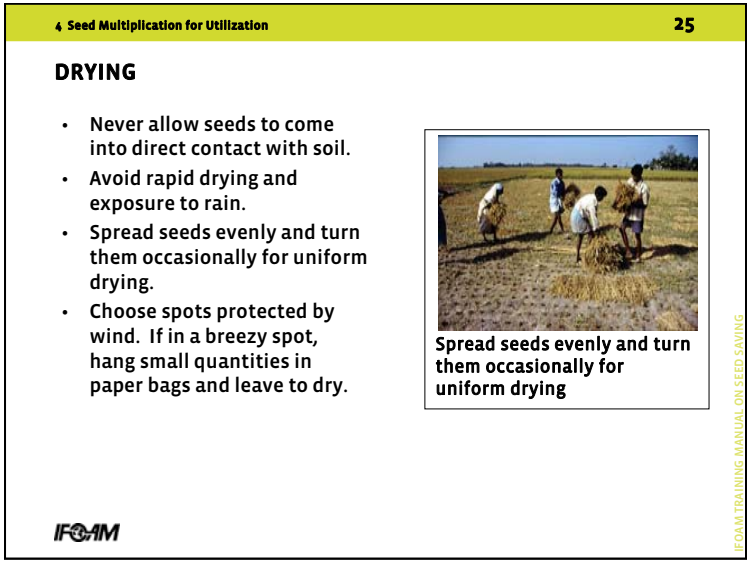
4.6.2 Drying

Care should be taken while drying seeds. Seeds can easily be ruined if they are too moist when stored. Some seeds might have to go through two drying processes: the first after harvest when the seeds are inside their capsules or pods (this ensures that all the seeds are mature) and the second after winnowing.

Drying is simply the removal of moisture through evaporation. Drying seeds helps keep them pest and disease free. The various methods of drying seeds include natural drying; sun drying; unheated, heated and dehumidified air drying; drying with desiccants such as silica gel and other high technology methods such as vacuum drying and freeze drying.

Points to remember while drying seeds

- Seeds should never be allowed to come into direct contact with the soil or ground. Direct contact leads to contamination with soil microorganisms, which will lower the quality of seeds. A wedge should be used so that seeds can be dried above the ground.
- Rapid drying is not recommended as this usually lowers seed germination and hardens the seed coat. The seed then becomes impermeable to water when planted. It is also not advisable to dry seeds under the sun when it is at its most intense between 11 a.–2 p.m. because the seeds will be killed.
- Seeds should not be exposed to rain.
- For uniform drying, seeds should be spread evenly, say on newspaper, and they should be turned occasionally. The spot chosen should be protected from the wind.
- Alternately, in a breezy spot, small quantities of seeds can be hung in paper bags and left to dry.
- Small quantities of seeds could be kept in a bowl on a window sill out of the sun. The seeds should be turned occasionally.



Transparency 4(25) : Drying seeds before storage

Analysis

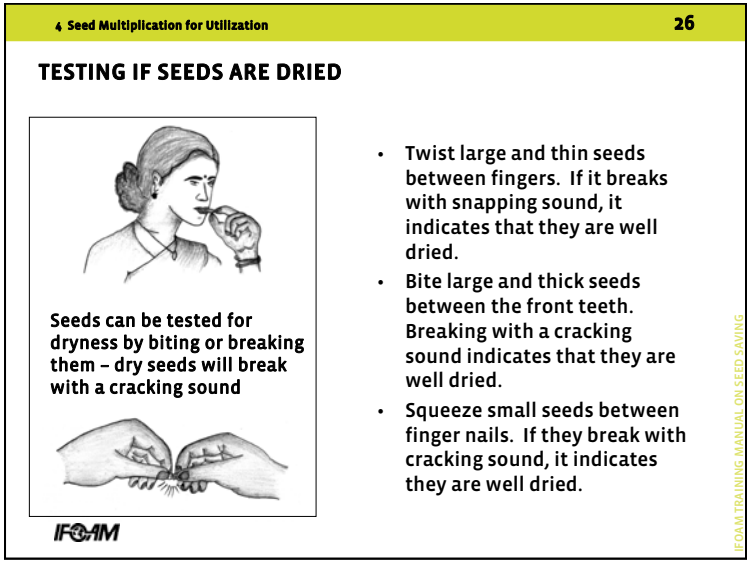
Ask the participants to provide reasons as to why some of the above mentioned practices should be carried out during drying. Explain what would happen if they were not carried out.

4 Seed Multiplication for Utilization

Tests to determine whether seeds are well dried

There are several indigenous methods available to determine whether seeds are well dried. These are simple, sophisticated and accurate techniques. The following indigenous techniques can be used to test if seeds are dried sufficiently.

- Large and thin seeds should be twisted between the fingers. If they break with a snapping sound, it is an indication that they are well dried.
- Large and thick seeds should be bitten by placing them between the front teeth. If they break with a cracking sound, it is an indication that they are well dried.
- Small seeds can be squeezed between the finger nails. If they break with a cracking sound, it is an indication that they are well dried.



Transparency 4(26) : Testing seeds for dryness

Practical exercise : Testing for dryness

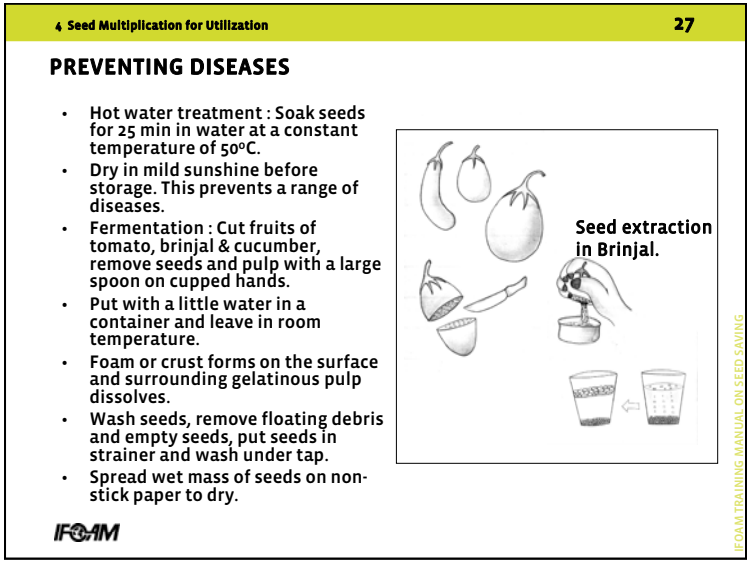
Ask the participants to practically test out the dryness of various seeds based on the techniques provided above. Also ask them if they know of any other techniques practiced in their areas.

4.6.3 Preventing Diseases

There are two simple and safe methods of preventing disease in seeds. One is hot water treatment and the other is fermentation.

Hot water treatment
Hot water treatment is a safe method for treating seeds for diseases such as black rot, black leaf spot and black leg in cabbage; bacterial canker in tomato and downy mildew in spinach; etc. Seeds should be soaked for about 25 minutes in water that is maintained at a constant temperature of 50° C. The temperature should not be allowed to exceed this value. After this process, the seeds should be dried in mild sunshine.

Fermentation
The seeds of tomato and cucumber can be treated by this process to rid them of unwanted seed diseases caused by bacteria and yeast. The fruits should be cut and the seeds and pulp removed with a large spoon or cupped hands and put with a little water in a container. When this mixture is left at room temperature for a few days, a foam or crust will form on the surface because of fermentation. The surrounding gelatinous pulp dissolves as a result. The seeds can be washed in a bowl of water. The debris and empty seeds will float and can be poured away. The seeds can be put in a strainer and washed under the tap. The wet mass of seeds can be spread out on a non-stick paper to dry. In this way, perfectly cleaned seeds can be obtained.



Transparency 4(27) : Techniques for disease prevention

4 Seed Multiplication for Utilization

4.7 Storing Seeds

4.7.1 Need for Good Seed Storage Practices

Approximately 30% of the seed in storage all over the world is lost because of insects, rodents and moulds. Good storage practices are required to minimize this loss.

4.7.2 Principles of Storage

Seeds have to be stored because there is usually a gap between harvest and planting. The main objective or purpose of seed storage is to ensure that seeds remain in good physical and physiological condition, i.e., they maintain their germination level, from the time they are harvested until they are planted. The main principles of storage are given below.

- Storage conditions should be dry and cool.
- Seeds should be protected from pests.
- Proper sanitary conditions should be maintained.
- Before storage, seeds should be dried to safe moisture limits.
- Only seeds that have a high germination rate and have been cleaned well and treated should be stored.

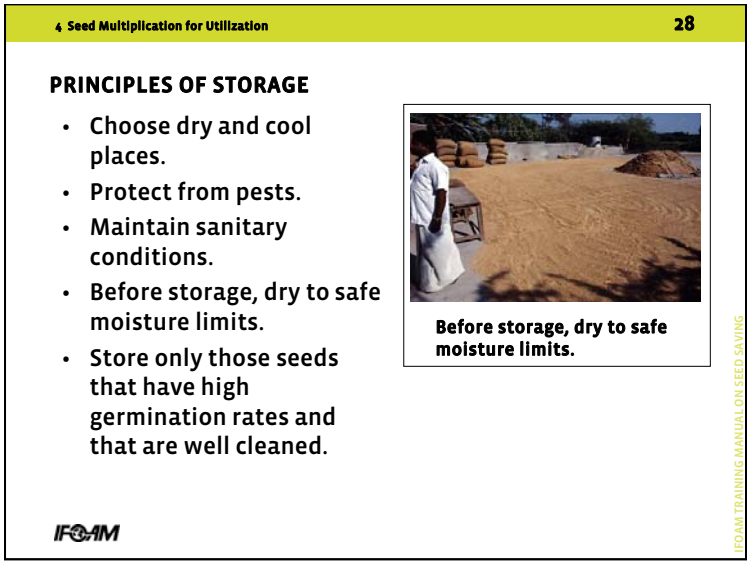
Lessons to be learnt

Processing seeds properly is as important as providing good storage conditions

Maintaining the right moisture content increases the storage potential of seeds

Motivation

Ask the participants to list various measures to be followed during storage. Ask them to also give reasons for the same. Then project the transparency and see if all points have been covered and if additional points have been provided.



Transparency 4(28) : Essential principles of storage

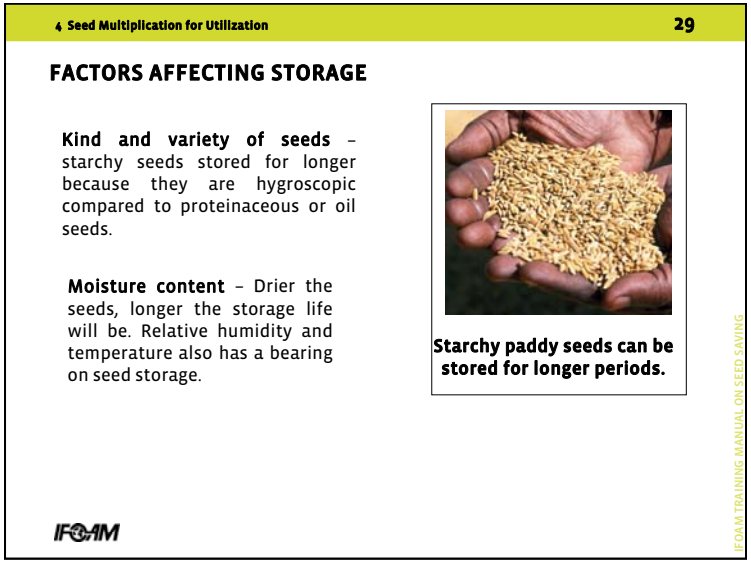
4 Seed Multiplication for Utilization

Factors affecting storage
There are several factors that affect the viability of seeds in storage. Some of these are listed below.

Kind and variety of seeds
The storage of seeds is influenced considerably by the kind or variety of the seeds. Some seeds are short-lived like onion, soy bean and groundnut. Normally, starchy seeds because of their hygroscopic nature can be stored for longer periods compared to proteinaceous or oily seeds.

Initial quality of seeds
There are several environmental conditions that influence seed quality right from the time the seed reaches physiological maturity up to harvest. Factors such as soil conditions, mineral nutrients, deficiencies during plant growth, moisture stress, temperature stress and damage by insects or diseases may affect seed quality even when the seed is still on the mother plant. Even with the best storage conditions, the initial quality of the seed cannot be improved up on (except for the dormant seed) but can only be maintained.

Moisture content
The most important factor influencing seed viability during storage is its moisture content. As the moisture content of a seed increases, so too does its rate of deterioration. The drier the seeds, the longer storage life will be. Moisture content enhances the biological activity in seeds and causes excessive heating and also promotes mould and insect activity.



Transparency 4(29) : Factors affecting storage

According to Harrington's thumb rule, a 1% decrease in seed moisture content nearly doubles the storage potential of the seed. This rule is applicable only at a moisture range of 5–14% because at moisture levels below 5% physicochemical reactions may take place and at levels above 14% fungi and insects become active. Another rule of Harrington states that for every 5° C decrease in storage temperature, seed life is doubled. This holds good only for temperatures in the range of 0–50° C.

There are also exceptions to this rule, e.g., for a few crops like chillies, brinjal and okra. The safe moisture content also depends upon the period of storage, the storage structures used, the kind and variety of seeds and the packing materials used. For cereals under open storage conditions, maintaining a moisture content of 10% is necessary, whereas a moisture content of 4–8% may be satisfactory for storage in sealed containers, depending on the type of seed.

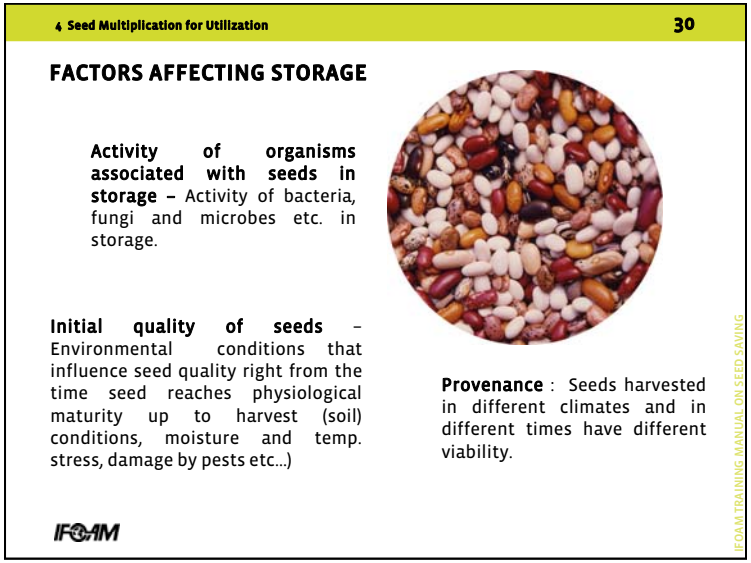
Desiccants like silica gel can maintain the moisture content in equilibrium at a relative humidity (RH) of 45%. When silica gel turns pink, it should be replaced. It can be heated and reused. The safe moisture levels for some seeds is given below.

Seed type	Maximum moisture content [%]
Wheat	13.5
Maize	13.5
Paddy rice	15.0
Milled rice	13.0
Sorghum	13.5
Millet	16.0
Beans	15.0
Cowpea	15.0

Relative humidity and temperature during storage
Seeds are hygroscopic. They attain a specific and characteristic moisture content when they are subjected to a given level of atmospheric humidity at a particular temperature (equilibrium moisture content). The equilibrium moisture content for a particular kind of seed at a given RH tends to increase as temperature decreases and the deterioration starts.

The equilibrium moisture content is different for different kinds of seeds. For oily seeds, it is lower than for starchy seeds at the same RH and temperature.

Provenance
Seeds that are harvested in different climates or at different times show differences in viability. They would have been subjected to different preharvest conditions and this



Transparency 4(30) : Factors affecting storage cont'd

would have caused different levels of deterioration by the time the seeds were harvested.

Activity of organisms associated with seeds in storage
Bacteria, fungi, mites, insects, rodents and birds may affect seeds in storage. The following table provides the temperature and RH ranges that influence the multiplication of the various biological agents that infest stored seeds.

Organism	Temperature[° C]		Relative humidity [%]
	Range for multiplication	Optimum range	
Insects	21–42	27–37	30–95
Mites	8– 31	19–31	60–100
Fungi	8–80	20–40	60–100
Microbes	8–80	26–28	91–100

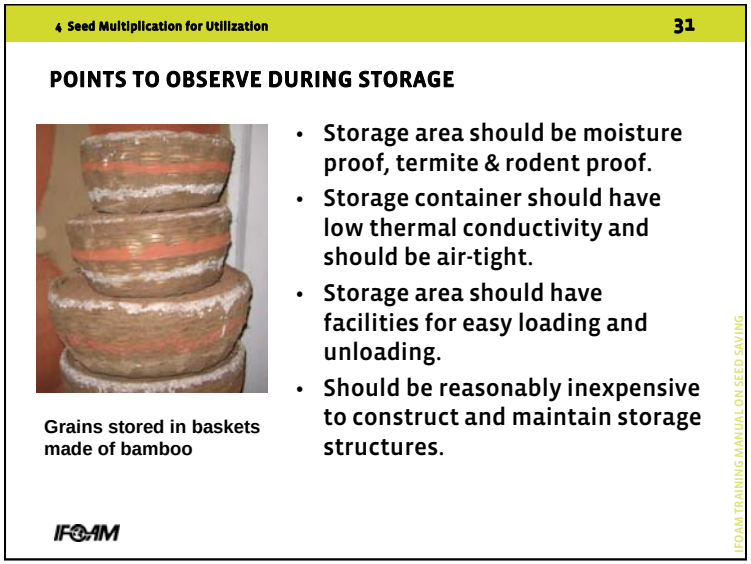
Analysis of participants' comprehension

Ask the participants to put down various factors affecting storage and provide justification for the same

4.7.3 Things to Remember During Storage

The storage area should be moisture proof – this is essential to maintain the moisture content of seeds. Moisture-proof containers include sealed tins or aluminium cans, glass jars with gasketed lids or pouches of laminated aluminium foil. If the RH can be maintained or is low, seeds can also be stored in paper envelopes.

The storage area should be rodent and termite proof, and have facilities for easy loading and unloading. Storage containers should be airtight, have a low thermal conductivity and be reasonably inexpensive to construct and maintain.



Transparency 4(31) : Points to observe during storage

4 Seed Multiplication for Utilization

4.8 Storage Structures

4.8.1 Gunny Bags

Gunny bags are ideal for storing seeds since they are cheap and durable.

Advantages

- They are easier to handle than any other container. Labelling is also easy.
- They do not require any special building; they can just as well be stacked in huts.
- They allow air to move through and cool the seeds.

Treatment of gunny bags before storage

Before storing seeds in gunny bags, the bags can be treated with a neem kernel solution. A 10% neem kernel solution should be used. See page 53 for details of the preparation of a neem kernel solution. The solution should be used immediately after preparation. The gunny bags should be allowed to soak in the solution for 15 minutes. If the gunny bags are new, they should be soaked for half an hour. If the gunny bags have close meshes and small pores, a thinner solution should be used. The wet bags should be dried in the shade and not in direct sunlight. Once dry, the bags can be used to store seeds, which will now be protected from pest attack for four months.

4.8.2 Storing Small Amount of Seeds

The outside casing of gourds can be used for the storage of vegetable seeds. It was an ancient practice to use the outside casing of certain fruits and vegetables for seed storage. Alternately, even gourd-shaped vessels made of clay or any other suitable locally available material can be used for storage. These serve as air tight containers. If gourd-shaped baskets are used, the outer part should be covered with mud plaster and care should be taken that the plaster is tightly packed.

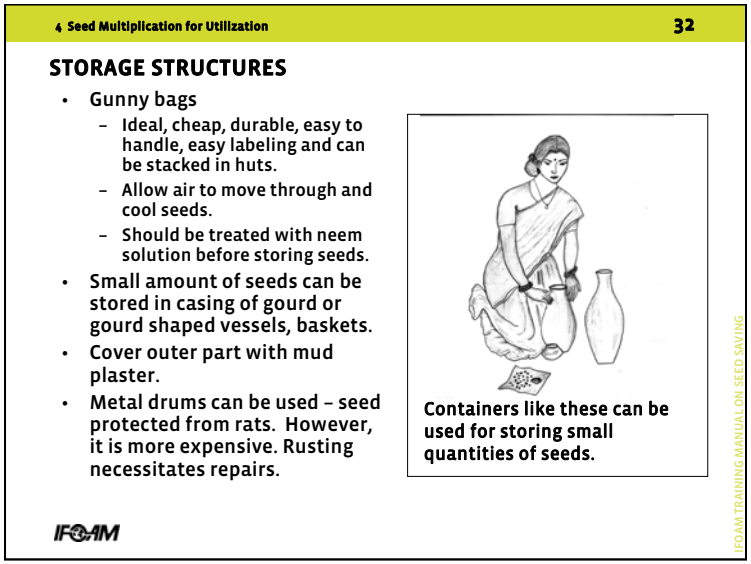
Advantages

- They save space since they can be hung on the wall.
- It is easy to check for insect infestation.

Lessons to be learnt

It is possible to store seeds in inexpensive gunny bags if we ensure that the bags are treated properly before storage

There are a number of indigenous techniques available for pest control during storage and one has to choose region specific and suitable techniques



Transparency 4(32) : Storage structures

4.8.3 Storage Using Metal Drums

Most farmers use 220 litre oil drums for storing sorghum, maize, millet, cowpeas and groundnuts. One drum can hold about 660 kg of seeds. This is a good storage container. The drum should be clean and dry before being used for storage. It should be filled with the seeds using a funnel. The opening should be closed with a cap.

Advantages

- The seed is protected from rats.
- It is easy to fumigate seeds stored in drums.

Disadvantages

- Metal drums are relatively more expensive than gunny bags.
- Rusting and the subsequent need to make repairs can make the drums ineffective for storage.

4.8.4 Storage Using Metal Bins

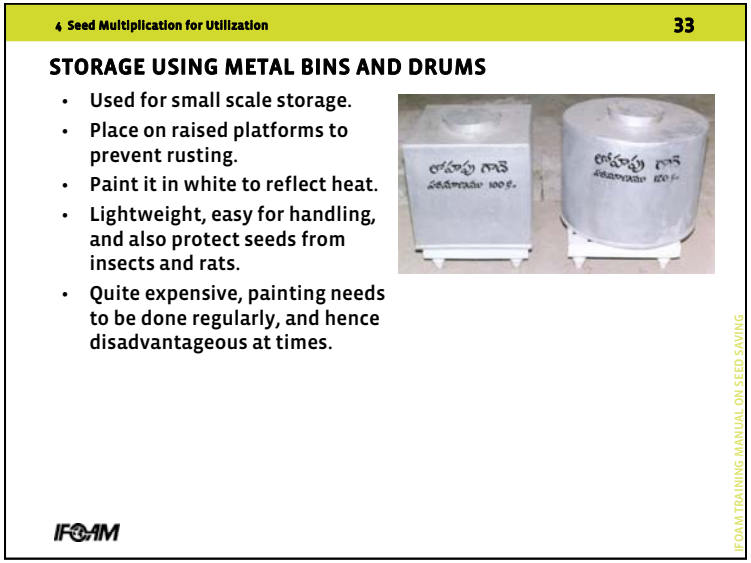
Metal bins can be used for small-scale storage. To prevent the bottom of the bins from coming into contact with water, the bins should be placed on raised platforms or cement bases. If this is not done, the bottom of the bins may rust. The bins should be painted white to reflect heat or the seeds inside may get too hot. The paint also protects the bins from rust

Advantages

- They are light weight and can be handled easily.
- They protect the seeds from insects and rats if well sealed and kept above the ground.

Disadvantages

- They are quite expensive
- Metal rusts quickly in hot places. Hence, painting needs to be done regularly to protect the bins from rust.



Transparency 4(33) : Storage using metal bins and drums

Group Discussion : Storage structures

Ask the participants to list various types of storage structures used in their areas and analyze the advantages and disadvantages of the same.

4 Seed Multiplication for Utilization

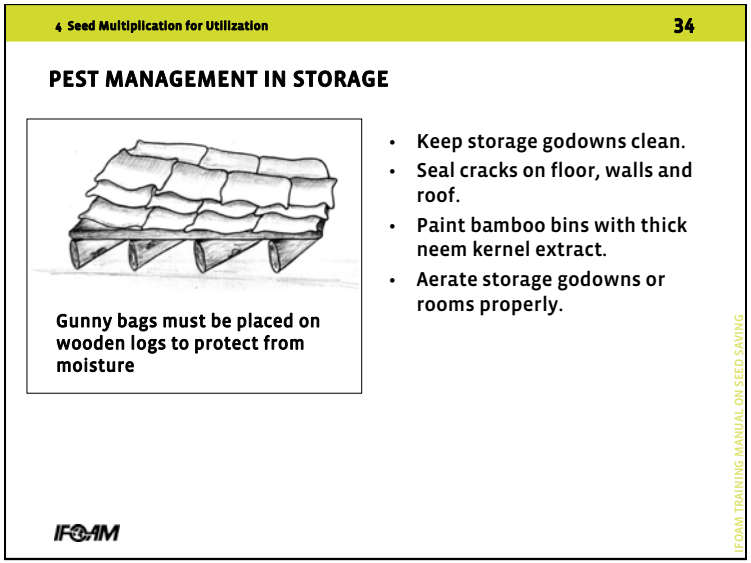
4.8.5 Pest Management in Storage

Pests affecting seeds during storage can be managed by a variety of organic methods. One has to constantly monitor the seeds that are stored and look out for any pests. It is important to undertake management of these pests at a very early stage. The following are some of the steps that could be undertaken to manage pests in storage.

- Storage godowns should be kept clean. Any waste and unwanted materials should be periodically removed from the godowns.
- All cracks on the floor, walls and roof should be sealed.
- The stored seeds should not have a moisture content of more than 12%.
- Gunny bags should be stacked so that there is proper aeration between them.
- If the seeds are to be stored in gunny bags for long periods, the gunny bags should be dried in the sun once in three months to prevent pest attack.
- Gunny bags containing seeds should not be placed directly on the floor. They should be placed on wooden logs about 35 cm above ground level to protect the seeds from moisture and to prevent pest attack.
- When the seeds are stored in mud pots, the mouth of the pot should be properly sealed with neem leaf paste to prevent the entry of pests.
- Pest attack during storage can be prevented by mixing the seeds with neem oil. For example, 1 kg of paddy seeds should be mixed with 10 ml of neem oil and dried in the shade before storage.

Motivation

Ask the participants to list various techniques that could be used for pest management during storage. After this, project the transparencies 3(34) and 3(35).

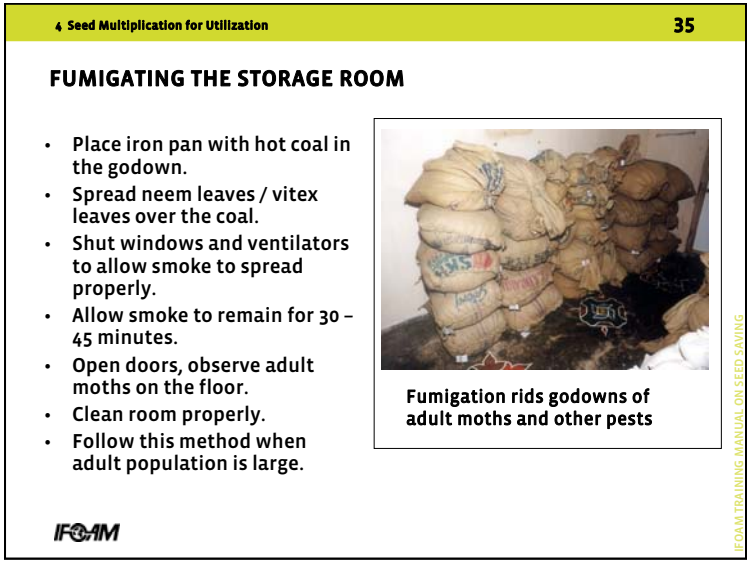


Transparency 4(34) : Pest management techniques for seed storage

- Gunny bags used for seed storage should be treated with 10% neem kernel extract before use, as described earlier in this section. This treatment can protect seeds from pests for about four months.
- In store rooms, neem kernel extract or neem oil should be used along with the cow dung that is used for cleaning the mud floor and mud walls.
- If bamboo bins are used for storage, the bins can be painted with thick neem kernel extract. This prevents pests from getting into the bins.
- The seeds stored in godowns can be protected from pests by placing the leaves of vitex, neem and pongam on gunny bags and in different places in the godown.
- While filling gunny bags, for every 20 kg of seeds, two handfuls of powdered vitex, neem and pongam leaves should be spread. In this way, seeds can be protected from pests for more than a year.
- Storage godowns or rooms should be properly aerated.

Fumigating the storage room

Adult moths can be controlled by fumigation. An iron pan with hot coals should be placed in the godown. Fresh neem leaves or vitex leaves should be spread over the coal. All doors, windows and ventilators should be shut during this process to allow the smoke to spread properly. The smoke should be allowed to remain in the room fo r 30–45 minutes. When the doors are opened, the adult moths that were affected by the smoke will be found lying on the floor. Later, the room should be cleaned properly. This method should be followed when the adult population of moths is large.



Transparency 4(35) : Fumigation technique to prevent pests in the storage room.

4 Seed Multiplication for Utilization

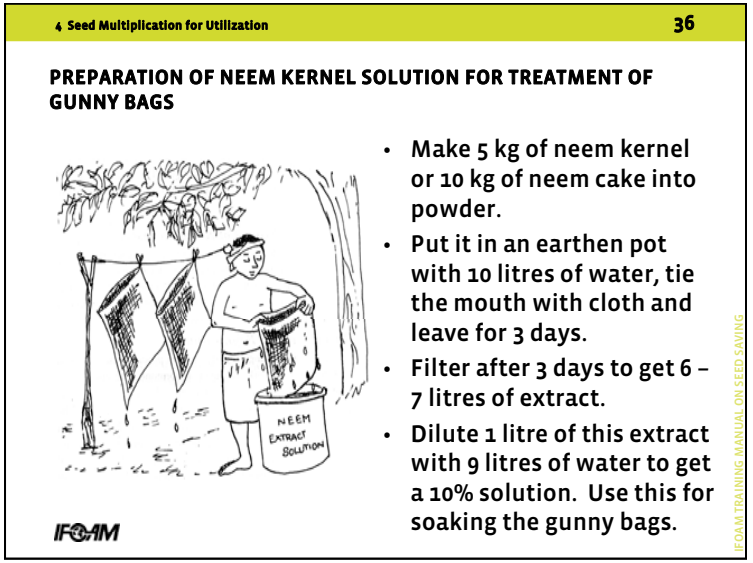
Preparation of Neem Kernel Extract and Solution

1. Preparation of extract
To obtain 6–7 litres of extract, use 5 kg of neem kernels or, if this is not available, 10 kg of neem cake. Gently pound the neem kernels or cake into powder .Place the powder in an earthen pot and add 10 litres of water. Tie the mouth of the pot securely with a cloth and leave for three days. After three days, filter the solution to obtain the 6–7 litres of extract.

2. Preparation of a 10% solution
Dilute 1 litre of extract with 9 litres of water to get a 10% neem kernel solution.

3. Preparation of 1 litre of extract
Only 100 g of neem kernel powder is necessary. Put the powder in a cloth pouch and soak it in water overnight. In the morning, squeeze the pouch to get the extract.

Note : If Neem tree is not available in your part of the world, find out what can be the local alternative to Neem.



Transparency 4(36) : Preparation of neem kernel extract for treatment of storage gunny bags.

Group Discussion : Plants for pest control

Ask the participants to list various plants used for pest control in their areas. Also share the ways in which they are used.

Recommended Readings

"Sustainable Agriculture and Biodiversity Conservation", Basu, P.
"On- farm Conservation of Seeds Diversity", GREEN Foundation
"In situ Conservation of Agricultural Biodiversity", Regassa Feyissa

5 Seed Multiplication Techniques for Specific Crops

5 Seed Multiplication Techniques for Specific Crops

5.1 Introduction

The previous chapter dealt with all the different stages of the process of seed multiplication in a general way. In this chapter, as the title indicates, seed multiplication techniques for specific crops are presented. For easy reference, these crops have been categorized as cereals, pulses, oil seeds and vegetables. Altogether, under these headings, the seed multiplication techniques for 26 different crop species have been covered, taking care to include some of the most important crops from each category. The number of crop species covered here, though by no means exhaustive, can be considered representative.

Motivation and field exercises : Seed multiplication techniques

Ask the participants to list the seed multiplication techniques for specific crops before projecting the transparency specific to that crop. Compare the details obtained from the participants with those found in the transparency.

Take the participants for field visits. See that they visit fields where different types of crops are cultivated. Ask them to have a discussion on the seed multiplication techniques based on what they have observed in the field.

Illustration 5(1) : A egg-plant seed multiplication field.

5 Seed Multiplication Techniques for Specific Crops

5.2 Seed Multiplication for Cereals

5.2.1 Paddy (*Oryza sativa*)

Method of seed multiplication

Paddy is a self-pollinated crop, with cross-pollination to the extent of 0–4%. Seeds are normally sown and planted in isolation. Seeds should be allowed to set by open pollination and then multiplied. The isolation distance to be used between different varieties is 3 m. If space isolation is not possible, time isolation of over 21 days or barrier isolation using 2 m high polythene sheets should be tried. Barrier crops like sesbania, sugarcane and maize covering a distance of 3 m could also be used for isolation.

Harvesting

Paddy is physiologically mature when the green seeds have turned a straw yellow color. Earheads should be harvested when the seeds have attained their maximum physiological maturity, i.e., when at least 90% of the seeds are straw colored. Irrigation to the seed multiplication plot should be withheld at this point of time as this hastens the drying of the plants/seeds. Plants should be harvested with their panicles intact.

Threshing

Harvested plants should be stacked on a clean threshing floor. The threshing should preferably be carried out by hand beating. To prevent mechanical injury to the seeds during threshing, their moisture content should be in the range of 15–18%.

Drying and storage

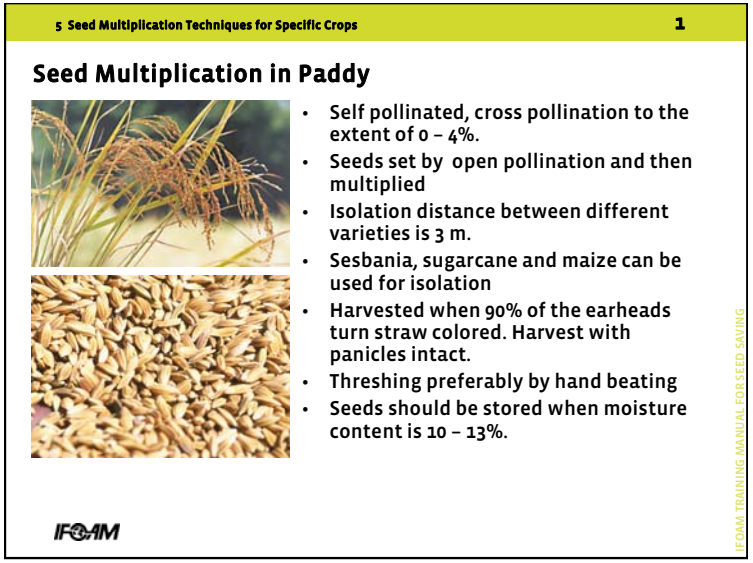
To store seeds safely, they should be dried to a moisture content of 10–13%. Normally, paddy seeds can be stored for one to two years under ambient storage conditions without much reduction in germination potential, provided they are free from rice moth.

Lessons to be learnt

Barrier crops can be used for isolation of varieties in paddy

Rain affects seed setting and hence care should be taken to see that pollination does not coincide with rain

There should be a time gap between harvesting and threshing



Transparency 5(1) : Seed multiplication techniques for paddy

5 Seed Multiplication Techniques for Specific Crops

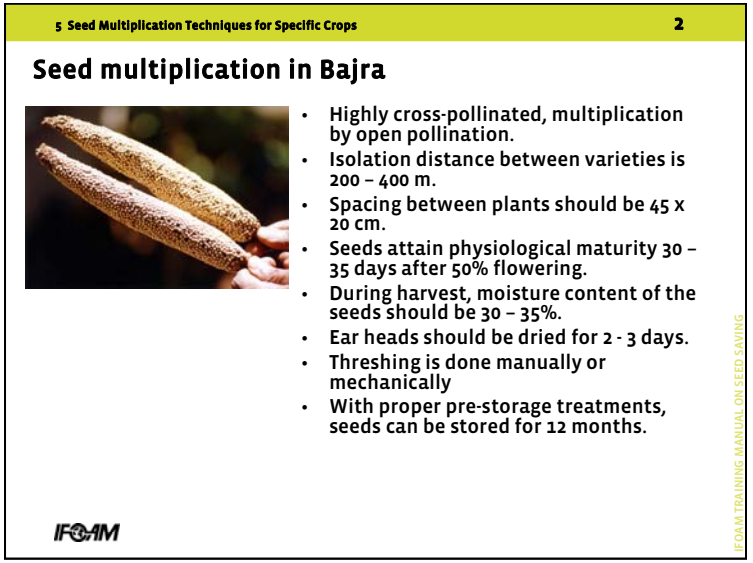
5.2.2 Bajra (*Pennisetum typhoides)*

Method of seed multiplication
Bajra is a highly cross-pollinated crop. Seed multiplication is usually carried out by open pollination. The isolation distance to be maintained between varieties is 200–400 m. For effective seed setting, pollination should not coincide with rain. The spacing between plants should be 45 × 20 cm.

Harvesting
The seeds attain physiological maturity 30–35 days after 50% flowering. At this stage, the seed color changes from green to straw yellow. A dunken layer also forms at the point of attachment to the panicle. The moisture content of the seeds at this stage is normally 30–35%. Maturation of earheads may not be uniform because of the tillering habit, and hence, the harvest should be carried out in two pickings.

Threshing
Earheads should be dried for two to three days on a threshing floor. Threshing should be carried out either manually (stick beating) or mechanically at a moisture content of 15–18%.

Drying and storage
Seeds can be stored for up to 12 months after proper pre-storage treatment.



Transparency 5(2) : Seed multiplication techniques for bajra

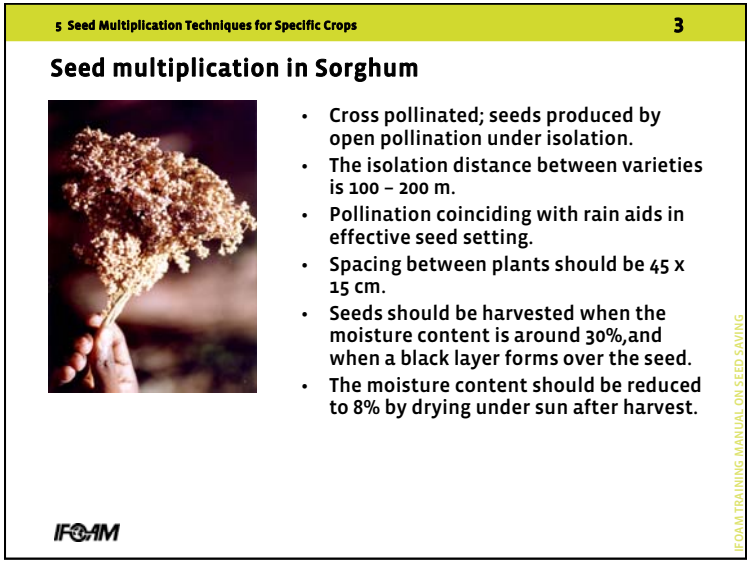
5.2.3 Sorghum (*Sorghum vulgare*)

Method of seed multiplication
Sorghum is often a cross-pollinated crop. Seeds should be produced by open pollination under isolation. The isolation distance to be maintained between varieties is 100–200 m. Pollination should not coincide with rain for effective seed setting. The temperature favourable for seed setting is 37° C. The spacing between plants should be 45 × 15 cm.

Harvesting
Seeds attain physiological maturity 40–45 days after 50% flowering, when the seed moisture content is around 30%. A black layer also forms over the seed, which serves as an external symptom of physiological maturity. Earheads should be harvested at this point of time.

Threshing
At the time of threshing, the seed moisture content should be reduced to around 15–18%. Threshing is normally done by beating the earheads with bamboo sticks.

Drying and storage
After threshing, the moisture content should be reduced to 8% by drying under the sun. Seeds can be stored for up to 12 months under open storage conditions, provided they are not attacked by storage pests.



Transparency 5(3) : Seed multiplication techniques for sorghum

5 Seed Multiplication Techniques for Specific Crops

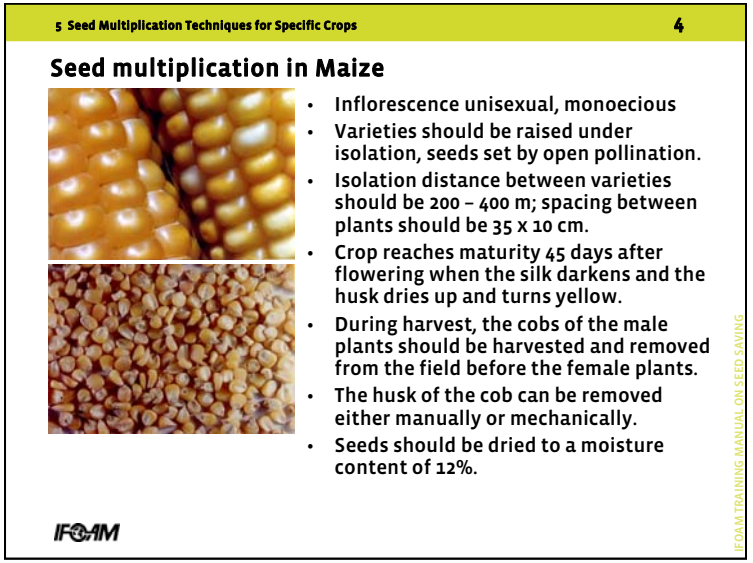
5.2.4 Maize (*Zea mays*)

Method of seed multiplication
The inflorescence is unisexual and monoecious. The varieties should be raised under isolation and the seeds should be allowed to set by open pollination. The isolation distance that should be maintained between varieties is 200–400 m. The spacing between plants should be 45 × 10 cm.

Harvesting
The visual symptoms of physiological maturity are the darkening of the silk and the drying up of the husk to yellow. The crop reaches physiological maturity 45 days after flowering. The cobs of the male plants should be harvested first and removed from the field before the female cobs are harvested.

Threshing
On the threshing floor, the husk of the cob should be removed either manually or mechanically using a maize dehusker.

Drying and storage
For safe handling, the shelled seeds should be dried to a moisture content of 12%. The seeds can be stored for up to one year in gunny/cloth bags.



Transparency 5(4) : Seed multiplication techniques for maize

5 Seed Multiplication Techniques for Specific Crops

5.3 Seed Multiplication for Pulses

5.3.1 Red Gram (*Cajanus cajan)*

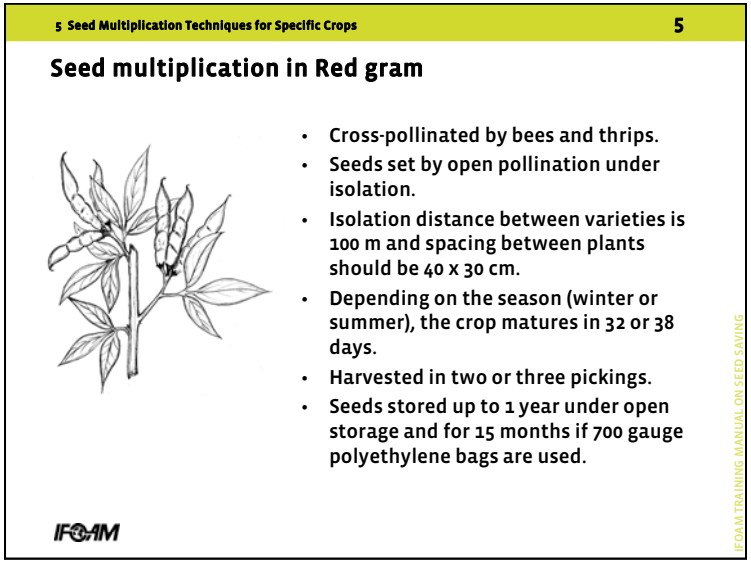
Method of seed multiplication
Red gram is a cross-pollinated crop. The cross-pollination is brought about mainly by bees and thrips. The seeds should be allowed to set by open pollination under isolation. The isolation distance that should be maintained between varieties is 100 m. The spacing between plants should be 40 × 30 cm.

Harvesting
The crop attains physiological maturity in 32 or 38 days, respectively, after anthesis, depending on whether it is winter or summer. Mature pods should be harvested in two or three pickings. Rain at the time of harvest increases the chances of the formation of off-color and dimbled seeds.

Drying and storage
After being dried under the sun and before being stored, the seeds should be mixed with a powder made of the leaves of neem and vitex and the rinds of the fruits *Sepindus laurifolius* and *Accacia concinna* (soap nut powder) in a 1:100 ratio. To avoid Bruchid infestation, seeds can also be mixed with activated clay in a 1:100 ratio. Seeds can be stored for up to 1 year under open storage conditions and for 15 months if 700 gauge polyethylene bags are used.

Lessons to be learnt

Seeds of pulses are affected to a large extent by Bruchid beetles and a number of organic methods are available for the control of the same



Transparency 5(5) : Seed multiplication techniques for red gram

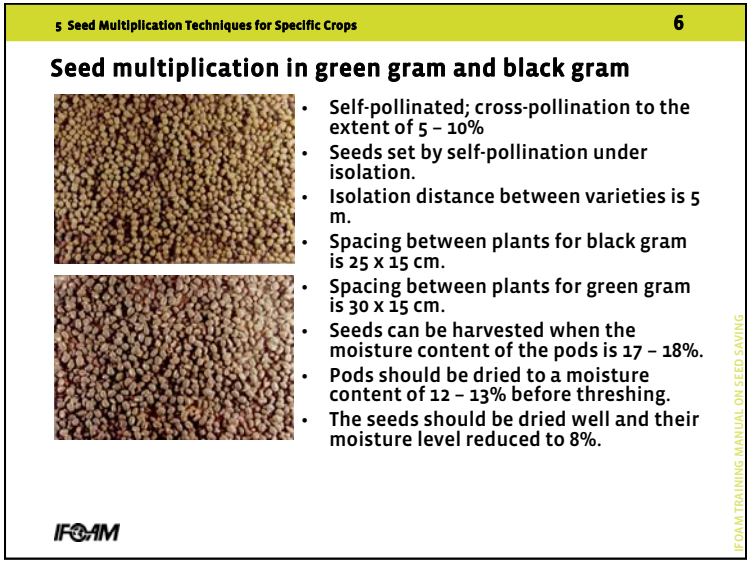
5 Seed Multiplication Techniques for Specific Crops

5.3.2 Green Gram and Black Gram (*Vigna radiata* and *Vigna mungo*)

Method of seed multiplication
Green gram and black gram are highly self-pollinated crops, with cross-pollination to the extent of 5–10%. The seeds should be allowed to set by self-pollination under isolation. The isolation distance that should be maintained between varieties is 5 m. The spacing between plants for green gram and black gram should be 30 × 15 cm and 25 × 15 cm, respectively.

Harvesting
Seeds attain physiological maturity 30 days after 50% flowering. The black gram pod turns black, while the green gram pod turns brown. At this stage, the moisture content of the pods will be 17–18%.

Drying and storage
The pods should be dried to a moisture content of 12–13% and then threshed and precleaned. The seeds should be dried well and their moisture level reduced to 8%. The seeds should be mixed with a 3% neem seed kernel powder as it is very effective for controlling storage pests, especially infestations of the bruchid beetle.



Transparency 5(6) : Seed multiplication techniques for green and black gram

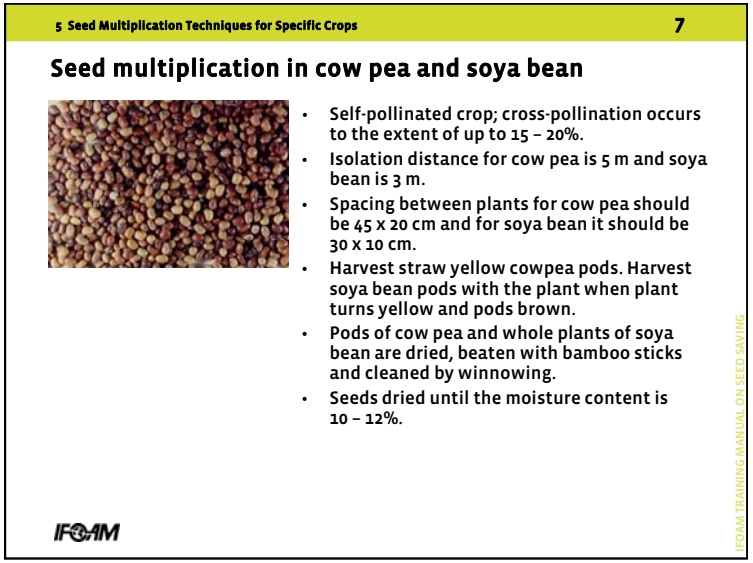
5.3.3 Cowpea and Soya Bean (*Vigna unguiculata* and *Glycine max*)

Method of seed multiplication
Cowpea and soya bean are self-pollinated crops. For cowpea, the cross-pollination occurs to the extent of up to 15–20% and is achieved mainly through insects. Varieties should be raised with an isolation distance of 5 m for cowpea and 3 m for soya bean. The spacing between plants for cowpea and soya bean should be 45 × 20 cm and 30 × 10 cm, respectively.

Harvesting
Mature cowpea pods will be straw yellow in color. The pods can be harvested by picking. Soya bean seeds attain physiological maturity 23–25 days after anthesis, and this can be observed by external symptoms like the yellowing of the plant and the browning of the pods. This crop should be harvested at once, pods intact along with the plant.

Threshing
Pods of cowpea and whole plants of soya bean should be dried and beaten with bamboo sticks to remove the seeds. The seeds should then be cleaned by winnowing.

Drying and storage
The seeds should be dried under the sun until the moisture content is 10–12%. The seeds can be stored for up to one year under open storage conditions.



Transparency 5(7) : Seed multiplication techniques for cow pea and soya bean

5 Seed Multiplication Techniques for Specific Crops

5.4 Seed Multiplication for Oil Seeds

5.4.1 Groundnut (*Arachis hypogaea*)

Method of seed multiplication

Groundnut is a self-pollinated crop, with cross-pollination to the extent of 0–5%. The crop should be raised under isolation, and the seeds should be produced by self-pollination. The isolation distance that should be maintained between varieties is 3 m.

Harvesting

When the crop is physiologically mature, the older leaves will dry up and fall off, the top leaves will start yellowing and the inner side of the pod will turn black and the seeds inside will move freely. While harvesting, the whole plant should be uprooted. At this stage, the moisture content of the seed will be 35–40%. Harvesting and maturation should not coincide with the rainy season as this will lead to *in situ* germination of seeds.

Drying and storage

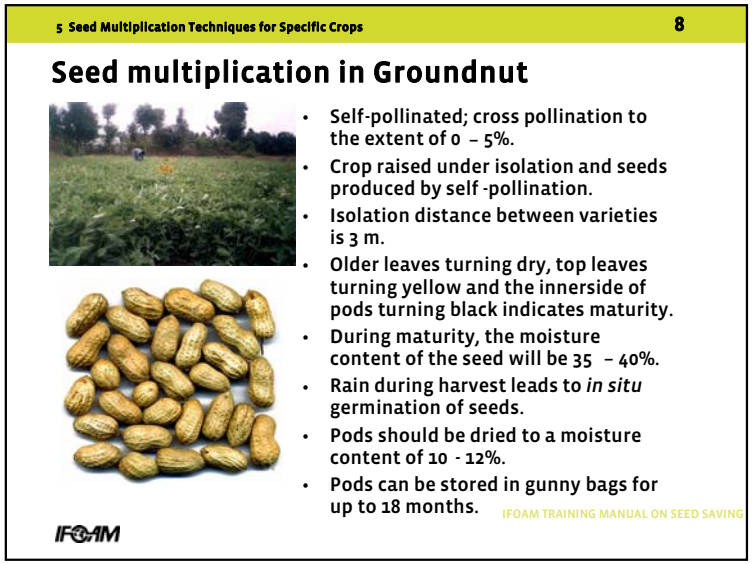
The pods should be dried under the sun to a moisture content of 10–12%. Groundnut can be stored as pods till sowing and hence, can be stored in gunny bags. Under ambient conditions, the pods can be stored for up to 18 months.

Lessons to be learnt

There are specific signs that can be observed in the crops which indicates seed maturity.

Harvest should be done only at this stage

Sunflower seeds exhibit dormancy



Transparency 5(8) : Seed multiplication techniques for groundnut

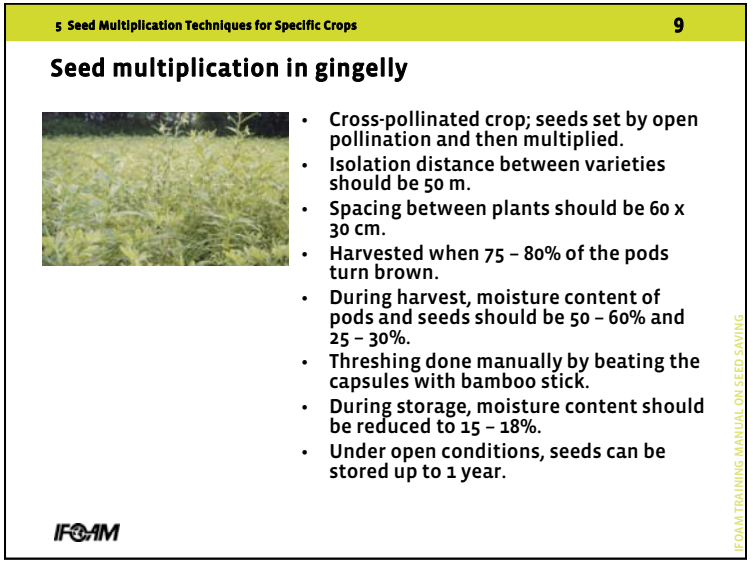
5.4.2 Gingelly (*Sesamum orientale*)

Method of seed multiplication
Gingelly is often a cross-pollinated crop. Seeds should be allowed to set by open pollination and then multiplied. The crop should be raised under isolation. The isolation distance that should be maintained between varieties is 50 m. The spacing between plants should be 60 × 30 cm (11 plants/m2).

Harvesting
Harvesting should be carried out when 75–80% of the pods have turned brown and a few at the bottom have dehisced. The moisture content of the pods and seeds at this stage will be 50–60% and 25–30%, respectively. If seeds in the 10th capsule from the bottom turn black, the harvest can be taken up for the black-seeded varieties. If harvest is delayed, the capsule will dehisce, resulting in yield reduction.

Threshing
Threshing should be carried out manually by beating the capsules with pliable bamboo sticks.

Drying and storage
Plants with immature pods at the terminal edge should be stacked upside down for three days. During this period, the moisture content should reduce to 15–18%. Seeds can be stored for up to one year under open storage conditions.



Transparency 5(9) : Seed multiplication techniques for gingelly

5 Seed Multiplication Techniques for Specific Crops

5.4.3 Sunflower (*Helianthus annuus*)

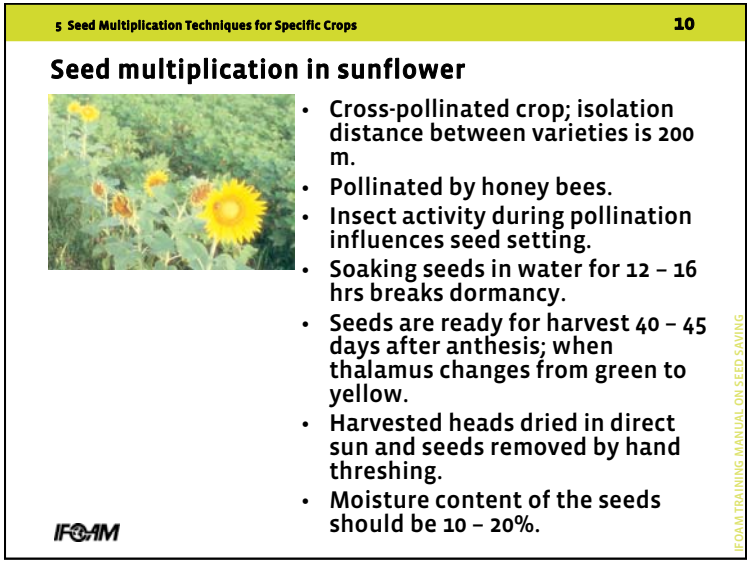
Method of seed multiplication
Sunflower is a cross-pollinated crop. The isolation distance that should be maintained between varieties is 200 m. Anthesis takes place between 5–8 a.m., and pollen grains are viable for 12 hours. Self incompatibility leads to cross-pollination. Honey bees are the pollinating agents. When insect activity during pollination is low, it leads to poor seed setting and formation of poorly filled seeds.

Dormancy breaking
To break dormancy, the seeds should be soaked in water for 12–16 hours. Seeds can also be leached in running water.

Harvesting
The seeds attain physiological maturity 40–45 days after anthesis. At this stage, the thalamus changes from green to yellow. The heads are harvested in one picking.

Threshing
The harvested earheads should be dried under the sun, and the seeds removed by hand threshing.

Drying and storage
After threshing, the seeds should be dried under the sun to reduce the moisture content to 10–12%. The seeds can be stored in gunny bags for up to 10 months and in 700 gauge polyethylene bags for about 15–18 months.



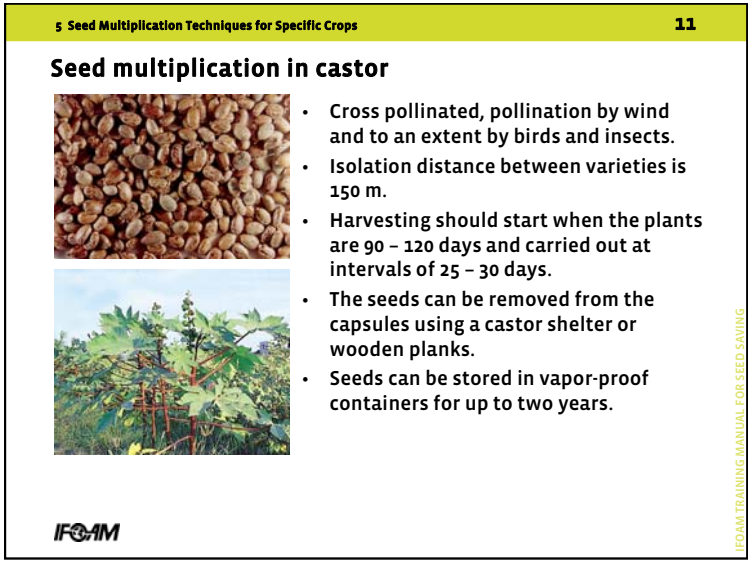
Transparency 5(10) : Seed multiplication techniques for sunflower

5.4.4 Castor (*Ricinus communis*)

Method of seed multiplication
Castor is often a cross-pollinated crop. Pollination is brought about mainly by wind and, to some extent, by birds and insects. The isolation distance that should maintained between varieties is 150 m. Female flowers set seed and fruits and develop before the male flowers open on the same inflorescence. The anthers burst explosively on drying and scatter copious amounts of pollen. The success of cross-pollination depends on the proportion of female and male flowers on the inflorescence.

Harvesting
Castor produces four or five sequentially ordered spikes, which can be harvested conveniently in three or four pickings. Harvesting should start when the plants are 90–120 days old and should be carried out at intervals of 25–30 days. When one or more capsules show signs of drying, the mature racemes should be cut without damaging the secondaries. Premature harvesting leads to reduced seed weight, oil content and germination capacity. Since shattering is not a problem in any variety, harvesting can be delayed until all capsules in the spike are fully dried.

Drying and storage
The capsules should be dried in the sun. Seeds should be removed from capsules using a castor sheller or wooden planks. Seeds can be stored for up to two years in vapour-proof containers.



Transparency 5(11) : Seed multiplication techniques for castor

5 Seed Multiplication Techniques for Specific Crops

5.5 Seed Multiplication for Vegetables

5.5.1 Amaranth (*Amaranthus sp.)*

Method of seed multiplication
Amarnath is a cross-pollinated crop. Cross-pollination is achieved mainly through wind. The isolation distance between varieties should be at least 400 m. To improve the quality of seed multiplication, inferior plants should be removed before flowering.

Harvesting
Physiological maturation of seed heads can be observed from bottom to top. To maximize seed harvest, near-mature seed heads should be collected every now and then since fully ripened heads tend to drop their seeds.

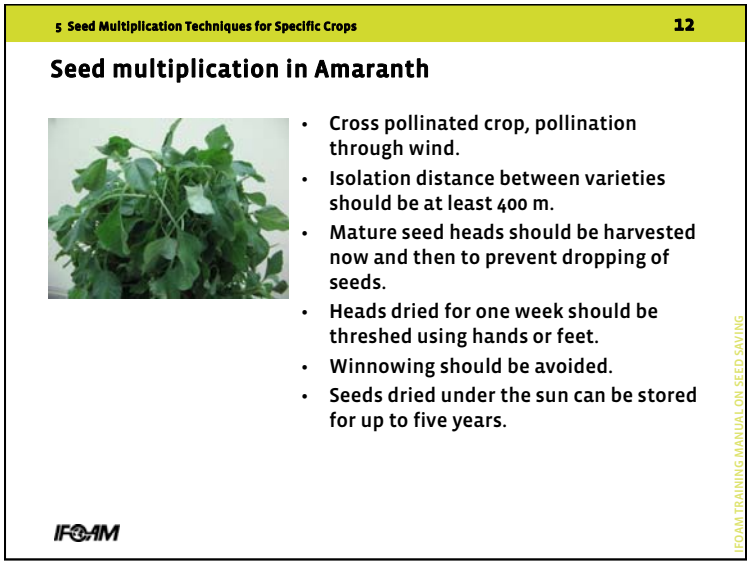
Threshing
The seed heads should be dried for one week and threshed using hands or feet. Winnowing should be avoided since the seeds are small and light. To separate the debris from the seeds, the seeds should be heaped in a bowl and tossed. The debris will collect at the top and can be blown away.

Drying and storage
The seeds should be dried under the sun. Amaranth seeds are generally recognized as long-lived, and under open storage conditions, seeds can be stored for up to five years.

Lessons to be learnt

Under appropriate storage conditions vegetable seeds can be stored for several years

For cross pollinated vegetables the isolation distance between varieties is large to maintain purity



Transparency 5(12) : Seed multiplication techniques for amaranth

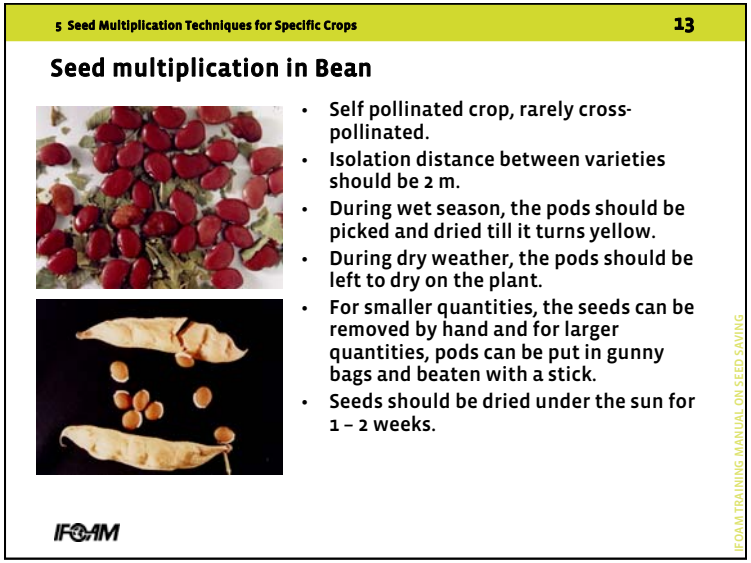
5.5.2 Bean (*Phaseolus vulgaris*)

Method of seed multiplication
Bean is a self-pollinated crop. Cross-pollination rarely occurs since self-pollination takes place before the flower opens. The isolation distance that should be maintained between varieties is 2 m.

Harvesting
During the wet season, the bean pods should be picked and dried progressively till the pod turns yellow. During dry weather, the bean pods can be left to dry on the plant. In dwarf varieties, pods that have attained physiological maturity will turn yellow brown. While harvesting, the whole plant should be uprooted and dried well before threshing.

Threshing
Bean seeds should be removed from pods by hand, if the quantity is low. For larger quantities, the pods should be put in gunny bags and beaten with a stick.

Drying and storage
Seeds should be dried under the sun for one or two weeks. The dryness of seeds can be determined by biting the seeds gently; no impression should be made on the seeds. Coating seeds with edible oil will prevent weevil infestation. Under appropriate storage conditions, bean seeds can be stored for three years.



Transparency 5(13) : Seed multiplication techniques for bean

5 Seed Multiplication Techniques for Specific Crops

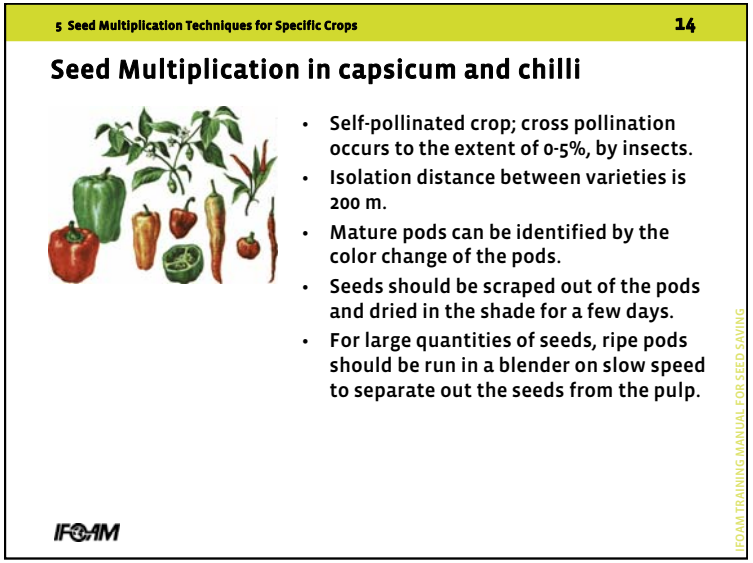
5.5.3 Capsicum and Chilli (*Capsicum annuum* and *Capsicum frutescens)*

Method of seed multiplication
Capsicum and chilli are often self-pollinated crops, but cross-pollination occurs to the extent of 0–5% and this maintains the vigour of offspring. Cross-pollination is achieved mainly through insects. Seeds should be allowed to set by self-pollination. The isolation distance that should be maintained between varieties is 200 m. A minimum isolation distance of 50 m should be maintained to avoid crossing.

Harvesting
The physiological maturation of chilli and capsicum can be identified by the color of the pods. Mature pods should be harvested soon after the pods attain the final color for that variety.

Threshing
The seeds should be scraped out of the pods and dried in the shade for a few days. For large quantities of seeds, the ripe pods should be put with water in a blender on slow speed. Pulp will rise to the top, whereas seeds will settle to the bottom and can be collected after the water has been decanted.

Drying and storage
The seeds should be dried in the shade for a few days. When seeds are kept under cold, dark and dry storage conditions, they will remain viable for five years.



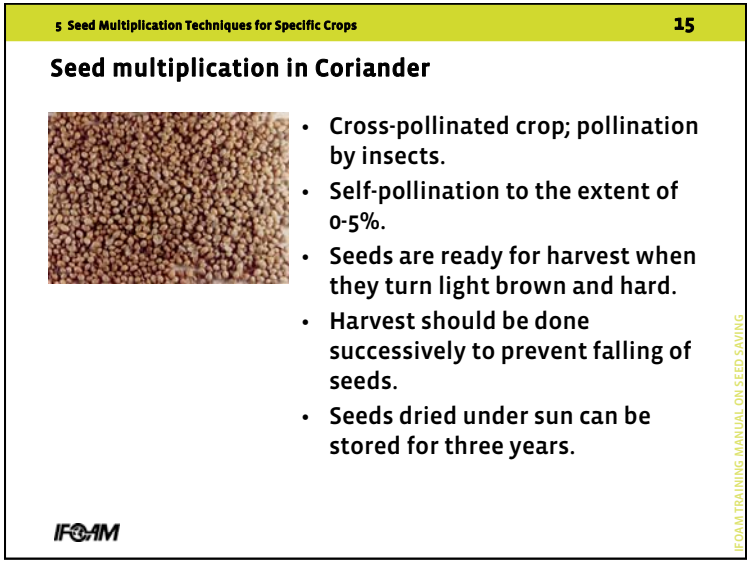
Transparency 5(14) : Seed multiplication techniques for capsicum and chilli

5.5.4 Coriander (*Coriandrum sativum)*

Method of seed multiplication
Coriander is a naturally cross-pollinated crop, with pollination being achieved mainly through insects. Self-pollination may occur to the extent of 0–5 %.

Harvesting
The seeds are physically mature when they turn light brown and are hard. Seeds should be harvested successively, since the smallest disturbance makes the seeds fall when ripe.

Drying and storing
The seeds should be dried thoroughly under the sun before storage. Under suitable conditions, the seeds can be stored for three years.



Transparency 5(15) : Seed multiplication techniques for coriander

5 Seed Multiplication Techniques for Specific Crops

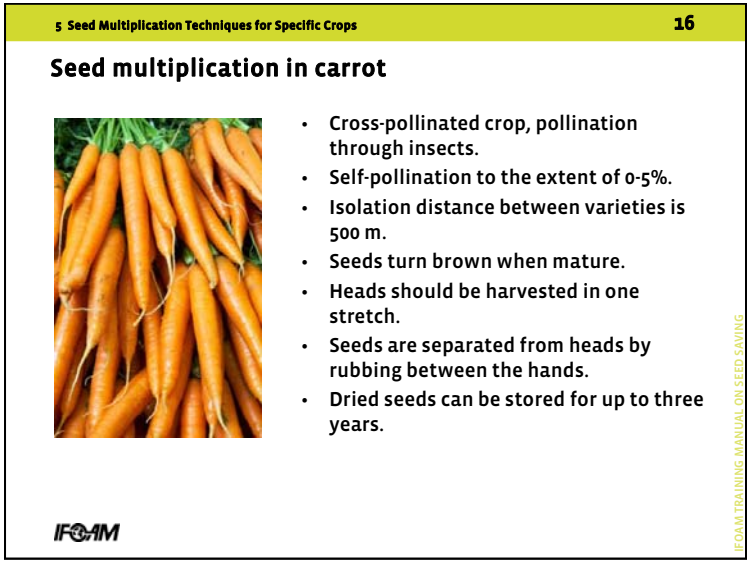
5.5.5 Carrot (*Daucus carota*)

Method of seed multiplication
Carrot is a cross-pollinated crop. Self-pollination may occur to the extent of 0–5%. Cross-pollination is achieved through insects. The isolation distance that should be maintained between varieties is 500 m.

Harvesting
Seed heads will turn brown when they are physiologically mature. If it rains during harvest time, the branches should be cut off and dried indoors. The heads should be harvested all in one go.

Threshing
The dried seed heads should be rubbed between the hands to separate the seeds from the heads. The seeds should be winnowed to remove the debris.

Drying and storage
Seeds should be dried completely before storage. In a cool, dark and dry environment, seeds can be stored for up to three years.



Transparency 5(16) : Seed multiplication techniques for carrot

5 Seed Multiplication Techniques for Specific Crops

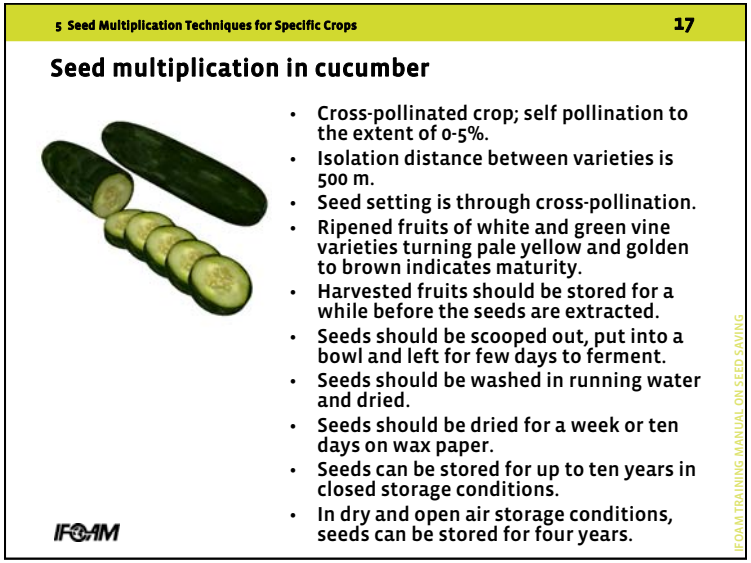
5.5.6 Cucumber (*Cucumis sativus*)

Method of seed multiplication
Cucumber is a cross-pollinated crop, with self-pollination occurring to the extent of 0–5%. The isolation distance that should be maintained between varieties is 500 m. If more than one variety is grown, pollination will have to be carried out by hand. Seeds should be allowed to set through cross-pollination.

Harvesting
The fully ripened fruit of white and green vine varieties will turn pale yellow and golden to brown, respectively. The color change marks the physiological maturity of the fruits. Mature fruits should be harvested and stored for a while before the seeds are extracted.

Threshing
During threshing, pulp along with seeds should be scooped out and put into a bowl and left for few days to ferment. During this period, the jelly around the seeds will dissolve and seed-borne diseases will be removed. The seeds should then be washed thoroughly in running water and dried.

Drying and storage
After threshing, seeds should be dried for a week or ten days on wax paper or a sieve. In closed storage conditions, seeds can be stored for up to ten years. In dry climates and under open air storage conditions, seeds can be stored for four years.



Transparency 5(17) : Seed multiplication techniques for cucumber

5 Seed Multiplication Techniques for Specific Crops

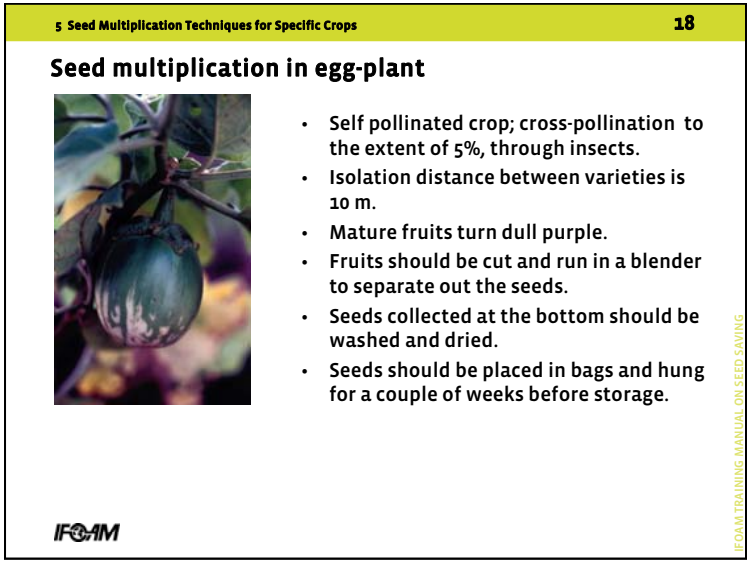
5.5.7 Egg-plant (*Solanum melongena*)

Method of seed multiplication
Egg-plant is a self-pollinated crop. Cross-pollination occurs to the extent of 5% and is achieved mainly through insects. The isolation distance that should be maintained between varieties is 10 m.

Harvesting
The physiological maturity of the fruits is marked by a change in color: mature fruits of different varieties will vary in color from yellow to dull purple. Mature fruits should be picked and hung in sheds until their color dulls.

Threshing
Fruits should be cut into cubes and put with water in a blender on slow speed. The water with mass, the pulp, will rise to the top and can be poured out. The seeds, which would have settled to the bottom, can be collected. The seeds should be washed again and dried.

Drying and storing
The thoroughly washed seeds should be dried on a sieve for a day or so. They should then be placed in paper bags and hung for a couple of weeks before storage. Under optimum storage conditions seeds, can be stored for five years.



Transparency 5(18) : Seed multiplication techniques for egg-plant

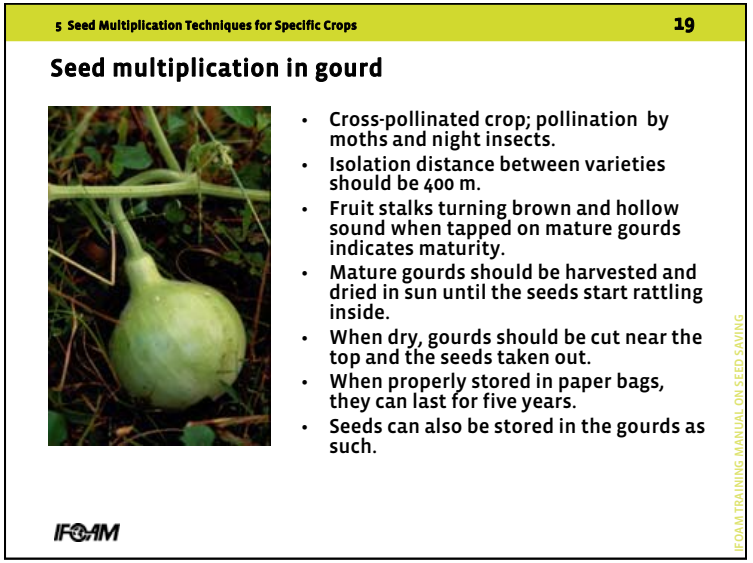
5.5.8 Gourd (*Lagenaria siceraria*)

Method of seed multiplication
Gourd is a cross-pollinated crop. Gourds are totally dependent on moths and other night insects for pollination. Gourd varieties will cross-pollinate with each other. The isolation distance that should be maintained between varieties is 400 m.

Harvesting
Mature gourds sound hollow when tapped, and their fruit stalks turn from green to brown. The mature gourds should be nicked off and dried under the sun until the seeds start rattling inside.

Threshing
When the seeds start rattling inside the gourd, they are ready to be removed. The gourd should be cut near the top and the seeds shaken out. The dry flesh around the seeds can be removed by hand rubbing.

Drying and storage
The seeds removed from the gourds will only need a little more drying. When seeds are stored in paper bags, they can last for five years under proper storage conditions. Seeds can also be stored in their natural container, the gourd itself.



Transparency 5(19) : Seed multiplication techniques for gourd

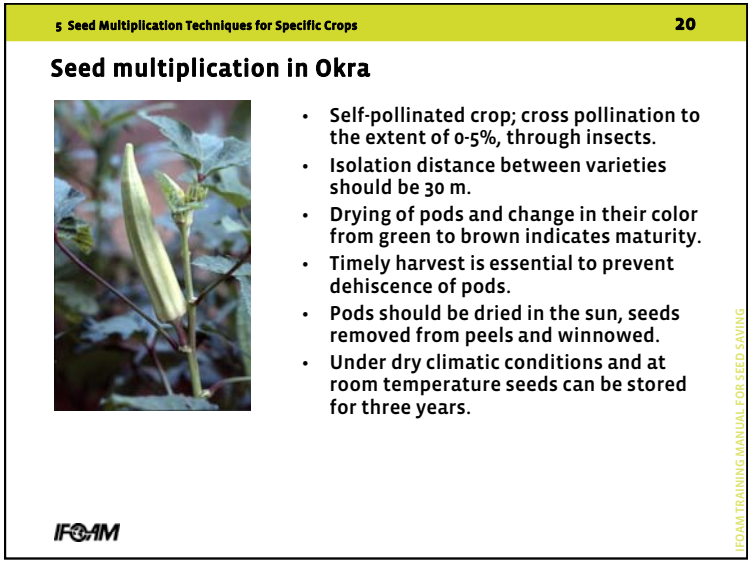
5.5.9 Okra (*Abelmoschus esculentus*)

Method of seed multiplication
Okra is a self-pollinated crop, with cross-pollination occurring to the extent of 0–5%, through insects. The isolation distance that should be maintained between varieties is 30 m. Seeds should be allowed to set by self-pollination, The occasional cross-pollination is a biological necessity to maintain the vigour of offspring.

Harvesting
The physiological maturity of pods is marked by a change in color from green to brown and by the drying of the pod. Pods should be harvested at the right time, since dried pods tend to dehisce with very little force.

Threshing
Harvested pods should be dried under the sun. The seeds should be removed from the peels of the pods and winnowed to remove the debris.

Drying and storage
The seeds should be dried well before storage. Under dry climatic conditions and at room temperature, seeds can be stored for three years. Fifty percent of the seeds that are stored in a cool, dark place will germinate after five years.



Transparency 5(20) : Seed multiplication techniques for okra

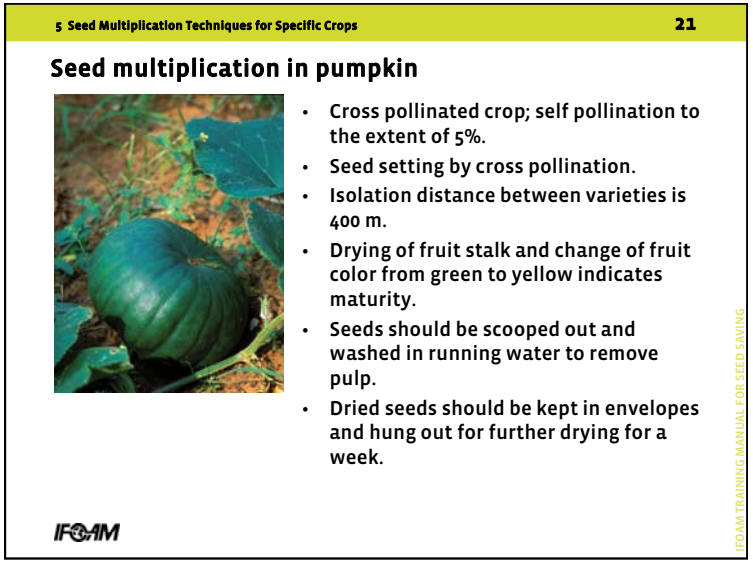
5.5.10 Pumpkin (*Cucurbita maxima*)

Method of seed multiplication
Pumpkin is a cross-pollinated crop. Self-pollination may occur to the extent of 5%. Seeds should be allowed to set by cross-pollination. The isolation distance that should be maintained between varieties is 400 m. If two varieties are grown in proximity, hand pollination will be necessary.

Harvesting
The physiological maturity of fruits is indicated by a change in color from green to yellow and by the drying of the fruit stalks. Mature fruits should be harvested and kept for a few weeks before threshing.

Threshing
The seeds should be scooped out and repeatedly washed in running water in order to get rid of the pulp. The seeds should then be dried.

Drying and storage
Before storage, seeds should be put in envelopes and hung out for further drying for about a week. If seeds are stored in an environment that is dry with even temperatures, they will last three to ten years.



Transparency 5(21) : Seed multiplication techniques for pumpkin

5 Seed Multiplication Techniques for Specific Crops

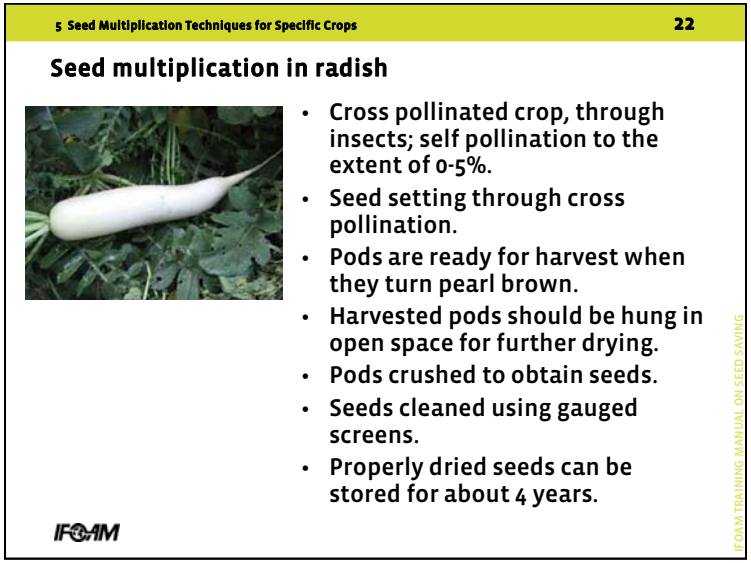
5.5.11 Radish (*Raphanus sativus*)

Method of seed multiplication
Radish is a cross-pollinated crop. Cross-pollination is achieved through insects, and self-pollination occurs to the extent of 0–5%. Seeds should be set only through cross-pollination.

Harvesting
Physiologically mature pods are a pearl-brown color. These pods should be cut and hung in an open space like a shed for further drying. The pods can also be picked individually and dried on screens.

Threshing
The pods do not shatter, and hence, they have to be crushed to obtain the seeds. Seeds should be cleaned using gauged screens.

Drying and storage
Depending on the weather, seeds should be dried in a shady place for a week or two. Seeds should be dried thoroughly before storage. Under proper storage conditions, seeds can be stored for about four years.



Transparency 5(22) : Seed multiplication techniques for radish

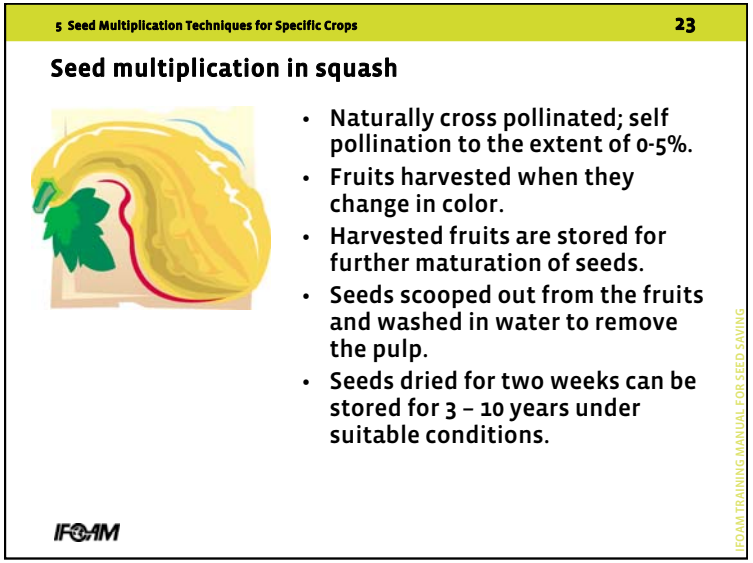
5.5.12 Squash (*Cucurbita pepo)*

Method of seed multiplication
Squash is a naturally cross-pollinated crop. Self-pollination occurs to the extent of 0–5%.

Harvesting
Change in the color of the fruit is the indication of physiological maturity. Mature fruits should be picked and stored for the further maturation of seeds.

Threshing
Seeds should be scooped out from the mature fruits and washed in water to get rid of the pulp around them. The seeds should then be dried in the shade.

Drying and storage
Seeds should be dried for about two weeks. Under suitable storage conditions, seeds can be stored for three to ten years.



Transparency 5(23) : Seed multiplication techniques for squash

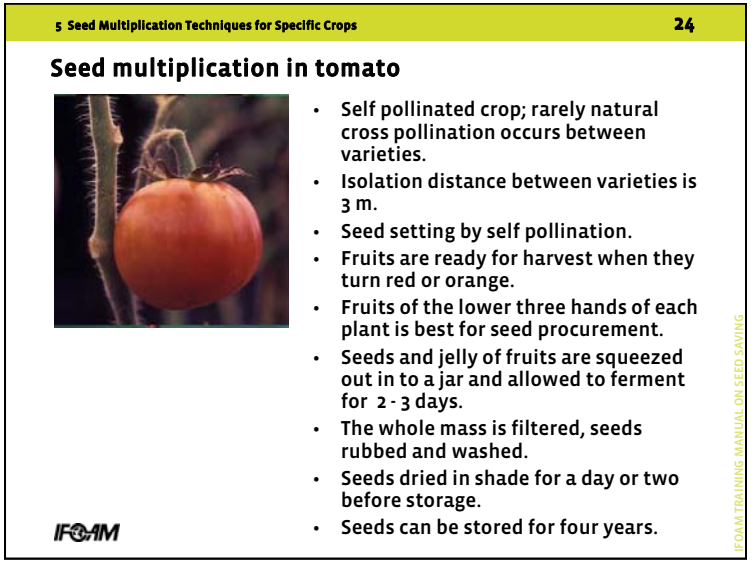
5.5.13 Tomato (*Lycopersicum esculentum*)

Method of seed multiplication
Tomato is a self-pollinated crop but some amount of natural cross-pollination will occur between varieties, and this maintains the vigour of offspring. The isolation distance that should be maintained between varieties is 3 m. Seeds should be set by self-pollination.

Harvesting
The fruits are physiologically mature when their color changes from green to red/orange. The fruits of the lower three hands of each plant is the best for seed procurement. The fruits that should be harvested are those that are ripe just beyond the eating stage.

Threshing
The seeds and jelly of mature fruits should be squeezed into a jar and left in a warm spot for two to three days to allow fermentation to take place. The whole mass should then be poured through a sieve, and the seeds should be rubbed and washed.

Drying and storage
Seeds should be dried in the shade for a day or two before storage. Under optimum conditions, seeds can be stored for up to four years.



Transparency 5(24) : Seed multiplication techniques for tomato

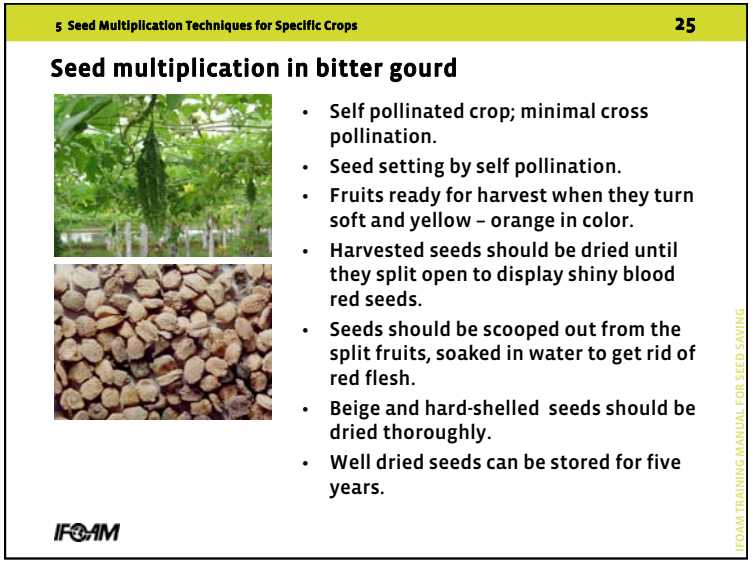
5.5.14 Bitter Gourd (*Momordica charantia*)

Method of seed multiplication
Bitter gourd is a self-pollinated crop, with minimal cross-pollination, which, however, helps maintain the vigour of offspring. Seeds should only be set through self-pollination, since it is the rule.

Harvesting
Physiologically mature fruits of bitter gourd will be soft and yellow-orange in color. Mature fruits should be harvested and dried until they split open and dramatically display rows of shiny blood-red seeds.

Threshing
The seeds should be scooped out from the split fruits and soaked in water for a day to get rid of the red flesh. The seeds should then be washed repeatedly and dried.

Drying and storage
The beige and hard-shelled seeds should be dried thoroughly before storing. The well-dried seeds can be stored for about five years under suitable storage conditions.



Transparency 5(25) : Seed multiplication techniques for bitter gourd

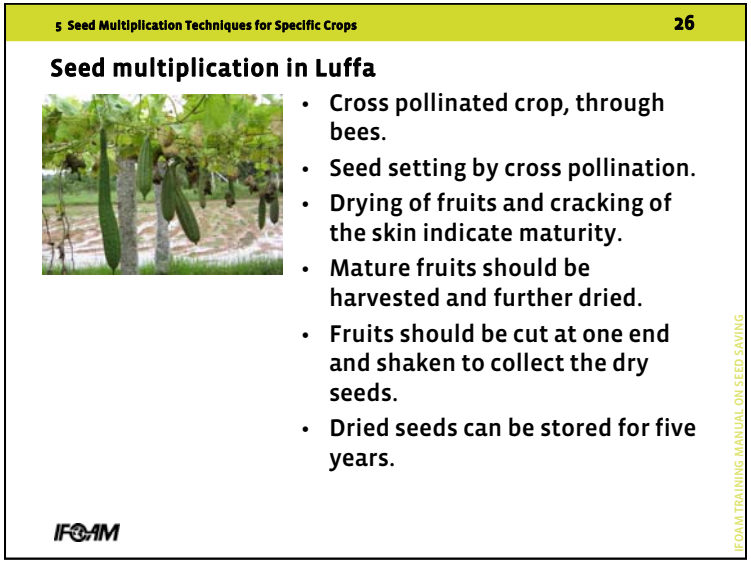
5.5.15 Luffa (*Luffa acutangula*)

Method of seed multiplication
Luffa is a cross-pollinated crop. Cross-pollination occurs through bees. Seeds should be allowed to set by cross-pollination.

Harvesting
The drying of the fruits on the vine and the cracking of the skin of the fruit are the signs of physiological maturity. The mature fruits should be harvested and dried further.

Threshing
The mature fruits should be cut open at one end and shaken. The seeds held by the dry fibre will come out. Further cleaning of seeds is not necessary.

Drying and storage
Seeds should be dried well before storage. Under proper storage conditions, seeds can be stored for up to five years.



Transparency 5(26) : Seed multiplication techniques for luffa

Recommended Readings

"Indigenous Rice Varieties – 1", Arumugasamy, S., et.al
"Seed Production and Quality Control", Bhaskaran, M., et.al
"The Seed Savers Hand Book", Michel et.al
"Seed Science and Technology", Vanangamudi, K., et.al
"Genetic Conservation and Sustainable Agriculture", Fernandez, P.

6 On-farm conservation – Examples from the field

6 On-farm conservation – Examples from the field

6.1 Introduction

There are a large number of grassroot efforts that have taken up on-farm conservation of genetic resources. These conservation efforts primarily deal with farmers and local communities. This chapter illustrates a few such efforts that are in progress. The coverage of the groups illustrated is by no means exhaustive and must only be considered as representative of this effort. It is meant to promote sharing and exchange of information as well as materials wherever desirable and feasible, and also lead to the formation of networks and coalitions in this important area of work.

Lessons to be learnt

There are a number of grass root level efforts across the world to conserve indigenous genetic resources

Knowledge of these efforts can strengthen community based conservation

Illustration 6(1) : On-farm biodynamic production and breeding of carrot seeds in ABD – Botucatu, Sao Paulo, Brazil.

6 On-farm conservation – Examples from the field

6.2 Seed Production in Senegal, West Africa

6.2.1 The Organization

In 2002, representatives from nine farmers' organizations met at a training program for seed production. A year later, they decided to work as a group and formed the Senegalese Association of Farmer Seed Producers (ASPSP – Association Sénégalaise de Producteurs de Semences Paysannes). The members of ASPSP have varied backgrounds: some grow cereals, while others grow vegetables; some are professional and some are beginners.

ASPSP has created a list of the local varieties existing in each member's zone. The list also mentions varieties that have been lost and those that have become very rare. For farmers, ASPSP organizes study tours and exchange activities with other organizations that have special experience, and it conducts training events and regional fairs. It brings out a catalogue.

Objectives
Most farmers are full time farmers, but are not full time breeders. ASPSP's objective is "to produce all our seeds and preserve traditional varieties", that is, to make Senegal autonomous in seeds and preserve its genetic heritage.
Location
ASPSP is working in many different areas (northern, southern, eastern and central) in Senegal, West Africa.

6.2.2 ASPSP's Experience

At the center of the country, near the capital, market gardening is completely commercialized and all the seeds used are bought from Holland or France. Elsewhere in the country, farming is much more traditional, making use of local crop varieties and knowledge.

In ASPSP areas, Senegalese farmers use mass selection as a breeding method to produce seeds of a variety of crops including cereals such as rice, millet, sorghum, maize and fonio and vegetables such as beans, peppers, tomato, salad, gombo, bitter aubergine, sweet potato and squash. Each variety is cultivated on a different type of soil, and the ones that grow the fastest or have the most beautiful earheads are marked by attaching something to them. The selected plants are allowed to ripen longer and are protected from birds by being put in envelopes.

Lessons to be learnt

Mass selection is used by farmers as one of the methods for breeding

Lack of financial resources can prevent successful conservation

Group discussion : On-farm conservation

Ask the participants to discuss various on-farm conservation efforts that are being undertaken in their respective areas. Compare notes and examine the commonalities and differences.

6 On-farm conservation – Examples from the field

As farmers do not have fenced growing areas, the major problem faced by them is free range cattle. They also lack places they can use for seed conservation programs as well as the necessary tools and equipment required for the work.

Many farmers are conscious that they are losing their traditional and ancient knowledge. Hence, they feel that there should be more training programs and also more opportunities to meet with old people who can impart information on traditional practices.

The farmer seed producers, who came together to create ASPSP, are in the process of strengthening their organization and towards this end have identified the following key activities they would like to undertake:

- To obtain know-how on the organization of seed banks
- To identify more individuals to cultivate seeds
- To obtain know-how on retrieving lost knowledge
- To raise the funds needed for the required tools and equipment
- To conduct regular follow-up programs.

In spite of all the work that has still to be done, the farmer seed producers of ASPSP feel less dependent than other farmers because they have ready access to seeds, even during lean seasons.

6 On-farm conservation – Examples from the field

6.3 *In situ* Conservation of Native Cultivars and Their Wild Relatives in Peru

6.3.1 The Organization

The "*In situ* Conservation of Native Crops and their Wild Relatives" Project is an initiative of several institutions of the UNDP, including the GEF (Global Environmental Facility), and several institutions of Peru, comprising 6 national executive institutions and 14 associated public sector institutions and NGOs. The National Executive Agency is the coordinating agency and gets technical support from more than 50 agronomists in the field as well as 5 professionals located in different regions.

Objectives
Peru is important for the genetic diversity of its crops and other plants. The long-term goal of this project is the conservation of the agro biodiversity in Peru. Thus, the *In situ* Project is working towards the preservation of cultivated native species and their wild relatives in Peru.

Location
The activities of the *In situ* Project are being undertaken in 8 "micro gene centers" (genetically important areas) located in 12 departments, 32 provinces and 52 districts of the country, as it is considered important not to limit Project activities to only a few locations. This will maximize the intra-specific diversity. The *In situ* Project works in 131 rural communities with approximately 1,000 families and with more than 300 peasants who are "experts" in the conservation of native crops in their fields.

6.3.2 The Work Carried Out by the *In situ* Project

The Project targeted 12 important crop species for its conservation efforts: camu camu, granadilla, aguaje, kaniha, maize, quinua, beans, arracacha, maca, cassava, sweet potato and potato. These are predominantly native crops that had either originated in Peru or had adapted well to local conditions and they were chosen because

- They have a real or potential importance for food security, e.g., potato, maize, quinua, beans, sweet potato, etc.
- Of their intra-species diversity
- They are at risk owing to endemism or genetic erosion, e.g., arracacha
- Of their cultural and social importance
- Of their adaptability to various ecosystems, e.g., camu camu, granadilla

Lessons to be learnt

Cooperation between public and private institutions can contribute to a successful conservation program

Using traditional practices for maintaining genetic diversity is an important factor

Illustration 6(2) : Circular rings of Moray in Cusco, Peru; an ancient Inca laboratory for plant breeding

- Of their potential for commercial production
- They are already being extensively cultivated, e.g., aguaje

Apart from the above crop species, the Project has also identified 21 secondary species that are cultivated in small quantities.

The strategic measures adopted by the Project include

- designating the Project cultivation areas as "Special Management Areas";
- providing incentives to encourage participating farmers, communities and organizations to conserve crop genetic diversity;
- increasing the market acceptability of a broader range of native cultivars both within the six target areas and outside;
- maintaining genetic diversity using traditional practices both within as well as between the target areas;
- developing a sound information base and monitoring system to document genetic diversity, the traditional knowledge systems that sustain it and the experiences the Project has had with the marketing of traditional crops; providing a mechanism by which the stakeholder organizations and institutions of the six Project areas can obtain information on best practices and the lessons learned.

The *In situ* Project has three important characteristics:

- It has involved in its work thousands of rural families that have for centuries maintained as part of their culture the conservation and use of native crops and their numerous varieties.
- Its work depends on the tight cooperation between public and private institutions, who are united in the common effort of supporting the conservation of the agro biodiversity of Peru.
- Its work is spread throughout the length and breadth of Peru and makes use of various local traditions and cultures of agro biodiversity conservation. This benefits not only Peru, but also anyone in the whole world who is in search of food security.

Illustration 6(3) : Diversity of Andean seeds in Seed Festival in Huanuco, Peru.

6.4 Empowering Farmers for Rural Development in the Philippines

6.4.1 The Organization

The Green Revolution created problems for farmers in the Philippines and this led to the emergence of organizations seeking alternative solutions. Highly successful amongst these is the Farmer-Scientist Partnership for Development (MASIPAG), which was started in 1985 as a response to growing concerns by farmers over their dependent situation. In 1985, MASIPAG comprised five peoples'/farmers' organizations (POs/FOs). However, by 1999, MASIPAG had grown to 484 FOs and a total membership of 20,864 farmers. That same year 62% of the members planted MASIPAG rice varieties on 17,165 hectares of cultivated land. Today, land area has increased along with membership, which now includes 46 NGO partners (from an initial 3) and 24 academic scientists.

The phenomenal growth of MASIPAG is due to its commitment to improving the quality of life of resource poor farmers through supporting their participation and empowerment in the development process. The three stakeholders sectors in the Partnership are:

- farmers who have become active partners in development,
- scientists who provide technical support, and
- non-governmental organizations that are responsible for organization and coordination.

Objectives

MASIPAG's ultimate goal is to improve the quality of life of resource poor farmers and empower them through

- participatory planning and development,
- effective and efficient utilization of locally available resources and farmer-developed/adapted technologies, and
- giving access and control of production resources, seeds, technology and land, to farmers.

Lessons to be learnt

Farmer scientist partnerships can help strengthen community based conservation efforts

Empowerment of farmers with technologies for consevation is very important

6.4.2 The Work Carried Out by MASIPAG

The approach MASIPAG takes has five strategies:

1. Farmer-scientist partnership to combine the theories and technical knowledge of the scientists to that of the experience and practical knowledge of the farmers
2. Bottom-up approach to prioritize community needs, problems and aspirations
3. Farmer-led research and training through the farmer-managed trial farm–cum-training centers
4. Farmer-to-farmer mode of technology transfer
5. Advocacy for sustainable/organic agriculture, genuine agrarian reform and other issues affecting farmers.

All farmers have to do to join MASIPAG is to signify their intention to do so. Others who aspire to be partner members either need to have an existing organization or have to start one. Support is available from several sources to give advice on organizing a local group, e.g., there may be a community or PO in the area. Roving technicians from MASIPAG or partner NGOs are also available to help.

Initially, an orientation workshop about local and global trends in agriculture as well as alternatives like sustainable organic agriculture is conducted by farmer trainers from the nearest PO, or by technical staff from either the regional office or from the national secretariat. Then, the farmers must establish a trial farm where they plant 50–100 traditional varieties and MASIPAG rice 'selections'. The farmers decided to start with the traditional rice varieties because they do not require much capital input and are ecologically adapted to diverse agro ecological conditions. The traditional rice varieties can also be improved later.

MASIPAG uses the term selection for seed that cannot technically be called a variety because it does not meet the criteria for purity and uniformity. These seeds are used to increase genetic variability, allowing selections more chances to adapt to environmental conditions. The farmers observe the characteristics of the different varieties and selections to assess them for their suitability to local environmental conditions and pest resistance. The top ten performing locally adapted varieties are then chosen for planting. Some farmers also carry out further verification trials on their farms by planting the top 10–15 varieties before finally selecting 2–5. Farmers are given between 100 g to 1 kg of seeds per variety so that initially they must re-learn the important skill of mass-producing seeds.

6 On-farm conservation – Examples from the field

An important spin-off of the community level organizing is that the mosaic effect of the different neighbouring varieties creates a barrier to pests and diseases because of the differential resistance between varieties. The trial farm involves no cost to the farmers except for the collective work required for its maintenance. By planting several varieties on their farms, farmers also benefit from the different rates of plant maturation. Harvest is spaced over a longer period, enabling farmers to spread out their work and do it themselves without having to hire in costly outside labour.

Some positive outcomes of MASIPAG's work

Empowering farmers
MASIPAG has been fairly successful in employing the bottom-up approach through POs. The POs have become a vehicle for consolidating and coordinating farmers' collective interest and knowledge, while local leaders are the facilitators of such technological developments. Through their organizations, they have been able to articulate, process and implement development approaches and solutions appropriate to specific situations. Sustainability of this development work has also been enhanced by local POs, which remain highly effective at spreading the concept at the local level through workshops and training, using only a minimum of resources. The scientists in the end have simply provided technical backing and the NGOs have ably assisted in organizational strengthening and networking.

Access and control of seeds: Perhaps one major and concrete realization of empowerment of farmers is that they now have control over seeds. The diverse variety of seeds maintained and readily available to them through their trial farms is making farmers very proud.

Development and control of technology: An integral component of farmers' empowerment is their ability to develop, improve and modify technology. Since MASIPAG farmers have also been trained to actually carry out plant breeding and management, as well as evaluation and selection of plant cultivars, they can now develop seeds on the basis of their resources, priorities or perceived needs.

Advocacy: Land tenure is a problem in many countries in the South. It has many ramifications that are not favourable to farmers. Realizing this, MASIPAG farmers also participate in the advocacy of genuine agrarian reform.

MASIPAG has joined local and international campaigns opposing genetically modified organisms and patenting of life forms.

6 On-farm conservation – Examples from the field

Farmer-managed trial farms

Every PO that wants to become a MASIPAG partner must be willing to establish and maintain a trial farm. Currently, there are 230 farmer-managed trial farms throughout the country. Farmer-led research is carried with the trial farm as the laboratory. About 50–100 MASIPAG rice selections are usually provided. These are planted side by side, and the farmers are taught to observe, measure and monitor certain agronomic characteristics. Locally adapted varieties are then selected. Breeding is mostly done on the central back-up station but also takes place on the trial farms or by individual farmers. The trial farm also serves as a seed bank for *in situ* conservation of genetic resources.

Trial farms have multiple uses. For example, just before harvesting, field days are organized where non-member farmers and local government officials are invited to evaluate the performance of the varieties. Thus, the trial farms act as a tool for advocacy and are used to lobby local government officials and to convince other farmers of the effectiveness of the MASIPAG approach. Farmer-managed trial farms are important for creative organizing. Inactive members of POs usually become active upon knowing the concrete benefits. Non-member farmers often volunteer to become members of the PO so that they can access the seeds and technology or else organize their own FOs.

Results and impacts

Economic: The yields of MASIPAG-bred rice and some selected traditional varieties are in most cases higher or similar to those of high yielding varieties.

Health: MASIPAG farmers practice alternative pest management, the principle of which focuses on maintaining ecological balance in the farm. This has allowed the return of diverse food sources, contributing to better nutrition of the farming family.

Diversity and the environment: The recovery and maintenance of 668 traditional rice varieties contributes to the conservation of the staple food of the Philippines. Improvement of these varieties through a modified bulk selection breeding strategy has produced 539 MASIPAG selections. All of these are maintained in the central back-up farm, which is the main source of the seeds that are distributed to trial farms throughout the country.

Social equity and cultural sensitivity

Through MASIPAG, farmers are not only articulating their needs but are now addressing and solving their own problems. They are developing technologies to improve production of their staple food and emphasizing low cost production systems. Volunteer farmer-trainers are now teaching other farmers. Through their local POs, farmers can now also negotiate with local government to address farmers' concerns.

6 On-farm conservation – Examples from the field

Future challenges

The greatest threat to this farmer-scientist partnership initiative is the second wave of the Green Revolution, the 'Gene Revolution', and its transcendent issues of patenting life forms and processes. MASIPAG farmers are becoming more resolute in advocating what they have started as their only alternative. They contend that MASIPAG was their alternative to the Green Revolution and that it will also be their alternative to the Gene Revolution. For as long as seeds are in their hands, they have the capacity to develop and improve technologies, and for as long as they remain organized, they are insulated from the damaging effects of the new technology. The farmers will determine their own history.

6 On-farm conservation – Examples from the field

6.5 Women, Home Gardens and Agro Biodiversity: A Study from Bangladesh

6.5.1 Introduction

Home gardens are a prominent feature of rural Bangladesh and are found in almost all village households. They are worked and managed exclusively by women. They are located within the walls of the family compound and function as fresh pantries from which women can harvest produce for the daily meal. Women have strong preferences for using traditional local varieties instead of modern high yielding commercial varieties in their home gardens. They consider local varieties to be uniquely adapted to local agro ecological conditions, and feel that they represent a significant cultural legacy. By saving seeds from home gardens and exchanging them with their neighbours, friends and relatives, they are able to maintain a considerable amount of agro biodiversity.

Study objectives
The aim of the study was to find out how women's preferences and the choices they made in their home gardens influenced the cultivation of various crops. It also aimed to determine how best to promote the cultivation and conservation of species found in home gardens.

Study location
The study was carried out in 2002 in two villages in Bangladesh – Bishnapur and Baushid – that lie in the flood plains of West-Central Bangladesh, approximately two hours from the capital, Dhaka. Although Bishnapur is less remote and more independent agriculturally than Baushid, both villages have the same level of home garden production. The study surveyed 75 adult women. Their average age was 35 years and most had little formal education. Nearly all the women who participated in the study were economically vulnerable and their families suffered regularly from periods of food shortages.

6.5.2 The Study

The study found that home gardens in Bishnapur and Baushid contain a high concentration of crop and varietal diversity in remarkably small areas. Gardens are made on any ground available near the house, e.g., courtyards. Some 60% of the women said their home gardens were less than 50 m^2 in size, but even so they were growing an average of 16 different crops and an astonishing number of fruit, vegetable and spice species. Women reported that they sowed a large number of crops per plot in order to

Lessons to be learnt
Rural women play a major role in conservation efforts
Womens' knowledge of genetic resources is very sophisticated

Illustration 6(4) : Rural women in Bangladesh have a sophisticated understanding of their agricultural systems.

minimize risk and maximize overall yield. In total, 25 different fruit crops, 29 vegetable crops and 12 spice crops are cultivated in the two villages. Indigenous squashes, gourds and greens are the most commonly grown vegetables, and local varieties of mangos, jackfruit and papaya as well as guava, banana and grapefruit are popular in all households. The crops grown require comparatively little room and roofs and fences are used as trellises to maximize vertical and horizontal space. The local varieties used by women gardeners have been selected for their ability to thrive under this type of intensive cultivation system. The local varieties are highly productive, require few external inputs and are able to survive the floods that regularly affect Bangladesh.

The study found that the women in Bishnapur and Baushid have a very sophisticated understanding of their agricultural systems and precise criteria for determining the varieties they use. When asked to list the most desirable characteristics of local home garden crops, their answers revealed not only a complex decision-making process but also the multiple uses for which they managed the different varieties. Because their needs are subsistence rather than commercially oriented, women emphasized features such as taste, agro ecological adaptation, culinary usefulness and nutritional value. However, they also considered yield to be important and felt that local varieties performed well under home garden conditions. The women like local vegetable varieties because they mean something to them and are a part of their culture and food traditions. They also prefer local varieties for their home gardens because they are better adapted to local climate, soil and disease conditions and can be grown without the fertilizers and pesticides needed for commercial varieties. In both Bishnapur and Baushid, there are hardly any households that used pesticides in their home gardens and only 17% use chemical fertilizers. Women found that local varieties respond well to organic pest control measures, such as ashes, jute seed powder and fermented rice water and thrive on organic fertilizers such as cow dung, compost, ashes and courtyard sweepings.

Though seeds for high yielding varieties are readily available in both villages, women still prefer to rely on their local seed networks, and only 10% of women said they use one or more high yielding varieties in their home gardens. Several women said they had tried them but had not continued to grow them for reasons that included not liking the taste or texture of the fruits and vegetables they produced; poor cooking qualities; the length of time and fuel required for cooking and, in some cases, a very short growing season that meant the crop could not be harvested gradually in accordance with household need.

The study found that harvest from the home gardens supplements the household's rice supply. Over half the women interviewed also reported marketing garden produce when there was a seasonal surplus in order to increase their household income. Several of the women specialize in selling local varieties of fruit and vegetable seed to earn extra cash.

6 On-farm conservation – Examples from the field

Women are responsible for all the tasks associated with developing and maintaining the family's home garden, including deciding what to grow, land preparation, weeding, harvesting and saving seed. Their work in the home garden is seen as an extension of their domestic duties and is integrated into their daily routine. Women of all educational levels, ages and incomes cultivate home gardens. The art of home gardening has been passed down from generation to generation through oral tradition, observation and hands-on experience. At every stage of their lives, women are involved in some aspect of home gardening and the fact that women are secluded in the home, in accordance with the traditions of Bangladesh, means they cooperate on home gardening tasks. This encourages, the flow of information on crop selection, planting methods and processing. In addition, young women obtain local varieties of seeds by inheriting them from their mothers or mothers-in-law. New brides often bring horticultural seeds from their home villages when they marry, thus furthering the diffusion of varieties. The high rate of seed sharing within communities and among neighbouring villages further promotes crop genetic diversity.

Conclusion

Home gardens in Bangladesh are often overlooked as serious sources of food. In fact, they are successful examples of how locally adapted varieties support food security and have an important economic, dietary, cultural and agro ecological function. They also play a role in the financial security of rural households and help reduce dependence on vegetables and fruits from the local market. Although increased cultivation of high yielding varieties of rice in Bangladesh has led to an overall decrease in traditional field crops, such as local rice varieties, oil seeds, pulses and millets, home gardens continue to be sanctuaries of agro biodiversity.

It has been suggested that NGOs should encourage informal learning networks through which older women can pass on knowledge about the cultivation of these varieties and that they promote the training of young women in seed management for local, garden crops. NGOs could also start educational campaigns to encourage the use of local varieties and in this way strengthen the understanding that high yielding varieties are not the only option.

Recommended Readings

"Home Gardens : A Cultural Responsibility", Emily Oakley
"Seeds of Plenty Seeds of Hope", Vijayalakshmi, K., et.al
"Using Diversity", Louise Sperling et.al
"Seed Quest", GREEN Foundation
"Participatory Conservation", IUCN

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In the following pages glossary of technical terms, bibliography which contains reference material in the form of books and journals, web sites of related interest are given.

7 Annex

7.1 Glossary

ACCESSION: An individual sample of seeds or plants that have entered into a collection in a seed bank.

AGRARIAN REFORM: Redistribution of – (i.e.) transfer of ownership of agricultural land. Transfer of ownership from wealthy owners with extensive land holdings to individual (or) collective ownership by those who work on the land.

AGROECOLOGY: The science of applying ecological concepts and principles to the design, development and management of sustainable agricultural systems.

ALIEN SPECIES: Species that do not naturally occur within an area and that have usually arrived in the area as a result of human intervention. Alien species often have adverse effects on native species as a result of competition.

ANTHESIS: The process of dehiscence of anthers and the period of pollen distribution - See also Dehiscence.

BAGGING AND CAGING TECHNIQUES: Techniques to prevent the pollination of plants of a different species and variety. This also prevents pollination by insects.

BARRIER CROPS: The separation of a crop by raising a barrier in between two crops / varieties in order to avoid contamination. Thickly grown dense crops like Casuarina, Daincha, Sesbania etc. can be planted as the barrier crops.

BIODIVERSITY HOTSPOT: Biogeographic region that is both a significant reservoir of biodiversity and is also threatened with destruction. The term specifically refers to 25 biologically rich areas around the world that have lost at least 70% of their original habitat.

BREEDING: The art and science of developing plant lines with desirable characters for human purposes. Controlled crossing, selection are the key components of plant breeding.

CO-EVOLUTION: The evolution of two or more independent species, each adapting to changes in the other. It is common in symbiotic associations.

COMMUNITY SEED BANK: Organized seed storage in a community. They operate semi-formally and are made up of individually stored, locally multiplied, farmers' and modern varieties of seed. (Or) "Community seed banks" store seeds from a wide range of individuals, informal groups and NGOs who share seeds among themselves, sometimes only occasionally. Seed is primarily retained from own production with no formal quality control, but individual selection process and handling skills are involved.

CROSS POLLINATION: When the pollen of one flower gets deposited on the stigma of another flower either on the same plant or on a different plant of the same kind.

CULTIVAR: A cultivated variety (genetic strain) of a domesticated crop or plant.

CULTURAL PRACTICE: The oldest and effective method of pest suppression. Practices like, deep ploughing and burning of crop residues, synchronous planting of crop fields, planting trap crops, intercropping, crop rotation, tillage and use of pest-free seeds and planting material are examples of cultural practices.

DAMPING OFF: An infection of the basal portion of the nursery seedlings and young plants caused by fungus, resulting in decomposition of the plants.

DEHISCENCE: Act of anthers becoming ripe and bursting to discharge the dry pollens. The time when this takes place is called anthesis.

DESICCATE: Process of drying seeds completely in order to preserve it.

ENDEMISM: Restricted to a specific region or locality.

EX SITU CONSERVATION: Conserving species outside the original habitat or natural environment.

EXOTIC SPECIES: A species that has been introduced from another geographic region to an area outside its natural range.

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FUMIGATION: The application of smoke, vapour or gas for the purpose of disinfecting or destroying pests or microorganisms.

GENE BANK: A facility established for the ex situ conservation of seeds, tissues, or reproductive cells of plants or animals.

GENETIC RESOURCES: Germplasm that includes the entire array of cultivars in the crop species, related wild species in the genus and hybrids between the wild and cultivated species.

GENETIC UNIFORMITY: A variety that has all the unique characteristics of its mother. It can be maintained by isolation of a crop by a specified distance from other varieties (or) contaminants. See varietal purity.

GLUME: The two chaffy basal bracts of a paddy spikelet.

GREEN MANURE CROPS: Plants that can absorb atmospheric nitrogen with the help of certain microorganisms found in their root nodules and convert it into a form, which can be used by the soil. Eg. Most of the Leguminosae members.

GREEN REVOLUTION: An aggressive effort between 1950 and 1975, where agricultural scientists applied modern principles of genetics and breeding to improve crops grown primarily in less developed countries.

HYBRID: Varieties resulting from natural or artificial pollination between genetically distinct parents. Commercially, the parents used to produce hybrids are usually inbred for specific characteristics.

HYGROSCOPIC: That which readily absorbs moisture.

IN SITU CONSERVATION: A conservation method of preserving the genetic diversity in the original habitat or natural environment.

INBREEDING: Crossing of closely related individuals.

MONECIOUS: Plants with separate male flowers and female flowers on the same plant.

MONOCULTURE: Cultivation of a single species or variety over a large expanse of land.

NATIVE CULTIVAR: A race (or) variety of a plant growing in one place, that has been selected intentionally and maintained through cultivation.

ON-FARM CONSERVATION: See in situ conservation.

OPEN POLLINATION: Pollination occuring by insects, birds, wind, or other natural mechanisms. The seeds of open-pollinated plants will produce new generations of those plants.

PANICLE: When axis of raceme branches and the flowers are borne not directly on the axis but on its branches then the inflorescence is called a panicle.

PATENT: A government grant of a temporary monopoly right on an innovative process or product.

PHOTOPERIOD: The duration of an organism's daily exposure to light, considered especially with regard to the effect of the exposure on growth and development.

PRICKING / THINNING: The process of transplanting seedlings from one seed box to another. This step enhances the seedlings to develop the root and shoot systems before they are left to fend for themselves.

PROVENANCE: The seeds harvested in different climates (or) at different times show differences in viability. This is because they would have been subjected to different preharvest conditions, which would have caused different amounts of deterioration by the time the seeds are harvested.

PUBESCENCE: The hairy growth on the surface of the plant body.

RACEME: It is a definite inflorescence, with the main axis bearing stalked flowers, which are borne acropetally (i.e.) flowers are produced in succession from the base upwards, so that the oldest members are at the base and the youngest at the top.

ROUGING: The act of removing undesirable plants. The removal of individual plants, which deviate in a significant manner from the normal or average type of a variety. A step in the maintenance of purity in an established variety or in the attainment of purity in a new variety.

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SEED DORMANCY: A period in the seed life history where development is temporarily suspended.

SEED DRILL: An agricultural implement that makes furrows into which it drops seeds.

SEED VIABILITY: The capacity of a seed to germinate.

TIME ISOLATION: Separation of varieties / species / contaminants by adjusting the sowing date in such a way that both crops do not come to flowering at the same time. The crossing is prevented and genetic purity is maintained.

UNISEXUAL: Flowers having either stamens (Androecium) or stigma (gynoecium) are said to be unisexual. If they have only the androecium, they are male flowers. If the flowers have only the gynoecium, they are said to be female flowers. Eg. Cucurbit, Castor.

VARIETAL PURITY: Maintenance of true to type nature of the plant / seed. The plant / seed resembles it's mother in all features (i.e.) from seed to plant to seed.

VOLUNTEER PLANTS: Unwanted plants growing from the seeds that remain in the field from a previous crop.

WINNOWING: A method by which the chaff is wafted away from the seeds after tossing into the air. By this method the calyxes, stems, old petals, husks and dead reproductive organs of the flowers and fruits etc. could be separated from the seeds.

7 Annex

7.2 Sources

The documents listed in this section have been referred to during the preparation of the manual. Recommended readings are also added. This list is by no means exhaustive.

7 Annex

7.2.1 Bibliography (Sorted by topic and title)

(For detailed references see 7.2.2)

1 - Introduction

A Trainer's Guide for Participatory Learning and Action (Pretty, Jules. N., Guijit, Irene et al.)

Agricultural Extension. Guidelines for Extension Workers in Rural Areas (Bolliger, E., Reinhard, P. et al., 1994)

Directorio Instituciones Capacitation Agroecologica (MAELA, International Federation of Organic Agriculture Movements IFOAM, 1997)

Directory of Training and Education Opportunities for Tropical Organic Agriculture (van Beuningen, Coen and Witte, Rob, 1996)

Modules for Discussing Participatory Development of Agricultural Innovations on Farmers Fields (Scheuermeier, Ueli; Zellweger, Tonino, 1999)

Proposed Basic IFOAM Organic Agriculture Curriculum for Africa (KIOF, Kenya Institute of Organic Farming, 1999)

2 – Need and Methods to Conserve Biodiversity

First World Conference on Organic Seed: Challenges and Opportunities for Organic Agriculture and the Seed Industry (FAO, Food and Agriculture Organization of the United Nations, 2004)

Nature's Harvest: Rejuvenating Biodiversity in Doon Valley (Vandana Shiva, Vinod Kumar Bhatt et al., 2002)

Organic Agriculture and Biodiversity (Sue Stolton, 2002)

The Role of the Private Sector and Trade (Rice, T., 2004)

The Violence of the Green Revolution. Third World Agriculture, Ecology and Politics (Vandana Shiva, 1991)

3 - Community Based Seed Conservation

Crops of Truth. Farmers' Perception of Agrobiodiversity in the Deccan region of South India (Satheesh, P.V. et al.,)

Cultivating Diversity (Shiva, V. et al., 1993)

In situ Conservation of Agricultural Biodiversity and Establishment of Community Seed Banks (Research Foundation for Science, Technology and Ecology and Navdanya, 1997)

The Seed Keepers (Shiva, V. et al., 1995)

4 – Seed Multiplication for Utilization

In situ Conservation of Agricultural Biodiversity and Establishment of Community Seed Banks (Regassa Feyissa, 1997)

On-farm Conservation of Seeds Diversity – A Guide to Conserving Agricultural Diversity (Genetic Resource, Ecology, Energy and Nutrition Foundation GREEN, 1998)

Trainer's Training Manual for Sustainable Agriculture and Biodiversity Conservation (Basu, P., 2000)

5 – Seed Multiplication Techniques for Specific Crops

Advances in Seed Science and Technology. Recent Trends in Seed Technology and Management-1 (Vanangamudi, K., Natarajan, N. et al., 2006)

Indigenous Rice Varieties-1 (Arumugasamy, S., Jayashankar, M. et al., 2001)

Local Seed Systems for Genetic Conservation and Sustainable Agriculture (Fernandez, P., 2001)

Principles of Seed Production and Quality Control (Bhaskaran. M., Vanangamudi.K. et al., 2002)

The Seed Saver's Handbook for Australia and New Zealand (Michel and Fanton, J., 1993)

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6 – On-Farm Conservation – Examples from the Field

Home Gardens: A Cultural Responsibility (Emily Oakley, 2004)

Participatory Conservation. Paradigm Shifts in International Policy (International Union for Conservation of Nature and Natural Resources IUCN, 2004)

Seeds of Plenty Seeds of Hope (Vijayalakshmi, K., Balasubramanian, A.V., 2004)

Seed Quest. A Journey Through Space and Time (Genetic Resource, Ecology, Energy and Nutrition Foundation GREEN, 2004)

Using Diversity. Enhancing and Maintaining Genetic Resources On-farm (Louise Sperling, Michael Loevinsohn., 1995)

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7.2.2 Bibliography (Sorted by author/editor)

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Bhaskaran, M., Vanagamudi, K., et al. (2002). Principles of Seed Production and Quality Control. Tamil Nadu Agricultural University, Coimbatore. 365p.

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Michel and Fanton, J. (1993). The Seed Savers Handbook for Australia and New Zealand. The Seed Savers Network, Australia. 174p.

Pretty, Jules, N., Guijit, Irene et al., Eds. A Trainer's Guide for Participatory Learning and Action. London, IIED, http://www.iied.org/bookshop.

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Shiva, V., et al. (1993). Cultivating Diversity. Research Foundation for Science Technology and Ecology (RFSTE), Dehradun, India.130p.

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Vandana Shiva (1991). The Violence of the Green Revolution. Third World Agriculture, Ecology and Politics. Research Foundation for Science, Technology and Ecology, New Delhi, India. 263p.

Vandana Shiva, Vinod Kumar Bhatt et al. (2002). Nature's Harvest: Rejuvenating Biodiversity in Doon Valley. Navdanya, Dehradun, India.105p.

Vijayalakshmi, K., Balasubramanian, A.V. (2004). Seeds of Plenty Seeds of Hope. Centre for Indian Knowledge Systems, Chennai.135p.

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7.2.3 Web sites with educational material on seed saving

Convention on Biological Diversity (CBD)
www.biodiv.org

The Community Biodiversity Development and Conservation Program
www.cbdcprogram.org

Genetic Resource Ecology Energy Nutrition Foundation (GREEN)
www.greenconserve.com

International Plant Genetic Resource Institute (IPGRI)
www.ipgri.cgiar.com

International Seed Saving Institute (ISSI)
www.seedsave.org

International Federation of Organic Agriculture Movements (IFOAM)
www.ifoam.org

Navdanya
www.navdanya.org

Virtual Seeds – Home Garden Seeds & Décor
www.virtualseeds.com

Seed Savers Exchange (SSE)
www.seedsavers.org

Options for supporting On-Farm Conservation in Eastern and South Africa
www.africanfarmdiversity.net

Samuha
www.samuha.org