PEDIGREA
Participatory Enhancement of Diversity of Genetic Resources in Asia

Training Curriculum for On-farm Conservation and Development of Indigenous Vegetable Crops

With Special Emphasis on Bitter Gourd, Angle Gourd, Wax Gourd, Pumpkin, and Sauropus

For Start-up of the FFS/PPB programmes in Indonesia and Cambodia
(First Draft March/03)

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1. Introduction

Background

Decades of vegetable crop improvement and conservation have not been able to prevent the loss of a significant proportion of the world's vegetable crop genetic diversity. Many traditional vegetable varieties, especially the more marginalized indigenous crops, are currently on the brink of extinction.

Genetic erosion is most noticeable in the rice-based farming systems of Southeast Asia. The number of local vegetable varieties has dwindled since the 1970s, replaced by high-yielding open pollinated and hybrid varieties. Indigenous vegetable crops lose out against a limited number of major marketed vegetable crops for which commercial seed has become readily available.

The PEDIGREA Programme

To counter this erosion process, a new project has been developed to strengthen traditional vegetable crop diversity in local communities in Indonesia (West Java), Cambodia (vicinity of Phnom Penh) and the Philippines (Mindanao). The PEDIGREA project (Participatory Enhancement of Diversity of Genetic Resources in Asia) makes use of the experiences obtained with Farmer Field Schools, and focuses on improving the diversity in traditional indigenous vegetables through participatory breeding methodologies. The project is linked with a similar program working on local rice varieties in the same communities.

A baseline study on vegetable crops was conducted in 2002 in four communities in Indonesia and Cambodia. Farmers made an inventory of the vegetable crops available in the community and prioritized the crops they most wished to improve. They also produced an overview of the strengths and weaknesses of the varieties grown, the local and city markets, and the desired traits for each crop. Based on this baseline survey two vegetable crops per community were selected for inclusion in the PEDIGREA breeding program:

Indonesia	FFS Indramayu:	Angular Gourd, Bitter Gourd
	FFS Sukabumi:	Bitter Gourd, Sauropus (katuk)
Cambodia	FFS Kandal:	Bitter Gourd, Pumpkin
	FFS Kampong Speu:	Pumpkin, Wax Gourd

Training Objectives

This curriculum has been developed to assist facilitators in the conduct of the vegetable participatory breeding program. The curriculum focuses on the four crops indicated above. All crops contribute significantly to the farmer's family income. Farmers highly favor these crops and have indicated that improvements are both possible and needed.

All vegetable crops belong to the Cucurbitacae family, except Sauropus (katuk). Even though Sauropus does not belong to the Cucurbits, the reproduction process is very similar as it is cross pollinating by nature and the flower expression is monocious (unisexual flower). This allows similar breeding techniques to apply.

Curriculum Outline

The field studies are the main focus in the curriculum. Farmer trainees learn best when they have tangible materials to focus their attention to. There are three field studies scheduled in this curriculum:

- Variety evaluation,
- Variety rehabilitation, and
- Cross breeding.

The conduct of variety rehabilitation field study depends on whether farmers consider their varieties to be 'deteriorated', if not, the curriculum will concentrate entirely on the other two studies.

The curriculum comprises of 14 weekly half day sessions. Each session involves field exercises, data collection, sharing of results and special topics. Experience from the rice curriculum learns that farmers are willing to invest this time. They are eager to learn new techniques in crop breeding and conservation.

Apart from the 14 weekly half day sessions, farmers need to dedicate time during the peak period, especially during planting, and from flowering to fruit maturity, when most of the cross breeding and selection activities take place.

The curriculum is meant as a facilitator guideline.

A tentative curriculum outline is presented below. Final curriculum should be developed prior to the season depending on the field studies included and the participants background and skills.

Vegetable Curriculum Outline FFS/PPB - 1st season (2003)

Weekly Schedule

The following schedule is for a 14 week program, not necessary continuous. Field studies: variety evaluation, cross breeding, and variety rehabilitation (if required). Weekly field exercises consist of observations on either agro-ecosystem or G x E interaction.

Pre-Season	Decide field studies and parent materials. Prepare seed to be ready in time for the first FFS session Meet with farmers in the FFS area to explain the FFS and to recruit participants Be sure to clarify all obligations of FFS participation. Arrange for a Study Field within easy reach of the FFS participants.
Week 1	(1 week before planting) Opening ceremony with introductions Pre-test expectations Discussion on layout of field studies by FFS participants and trainers
Week 2 (planting)	Planting of field studies: variety evaluation, rehabilitation, cross breeding Verification of the farmer/breeder selection objectives (baseline)
Week 3	Determine farmer's selection and selection criteria Decide on the type observations Discuss on how to collect the data
Week 4	Data collection / field exercise Study plant morphology and growth stages (2 crops)
Week 5	Data collection / field exercise Discuss deterioration of varieties
Week 6	Data collection / field exercise Study plant reproductive characteristics (2 crops)
Week 7	Data collection / field exercise Setting criteria for parent varieties in crossing, prepare cross table
Week 8	Data collection / field exercise Conduct cross breeding (1 crop)
Week 9	Data collection / field exercise Conduct cross breeding (other crop)
Week 10	Data collection / field exercise Farmer's breeding systems versus formal systems
Week 11	Data collection / field exercise Discuss crop selection methodologies
Week 12	Data collection / field exercise Cooking and eating quality evaluation
Week 13 (harvest)	Data collection/ field exercise Select varieties, harvest and preserve seed
Week 14	Summarize Post test Plan for follow up Field day

2. Start-up Session

Introduction

Prior to the planting season, trainers should organize a start-up session. The conduct of this session is essential for both farmers and facilitators and will contribute to the success of the PPB training. After a brief review of the baseline results, the pre-planning session will permit farmers to anticipate on the learning topics and what will happen during the season. Critical decisions must be made, activities outlined and responsibilities fixed.

Building Enthusiasm and Commitment

The curriculum activities thrive on the enthusiasm and commitment of the farmer participants. Participants should be carefully selected for their involvement and level of interest. On the other hand, the facilitators should make sure that farmer's data collection, results and initiatives are rewarded. This creates a sense of "ownership", which significantly contribute to the success of the program.

Time Frame

Unlike IPM which basically follows a one-season learning approach, PPB is per definition a multiple season activity. Training on on-farm crop improvement demands a high degree of commitment. A multiple season dedication of the participants is required for successful completion of the breeding and selection training program. After all, the first usable product from cross breeding i.e. a stable variety, can be produced only after 6-8 seasons of dedicated selection. Frequent fluctuations of participants in the community breeding activities may jeopardize the continuation and success of the program.

On the other hand, it may be difficult to expect farmers to commit themselves for a prolonged multiple - year period. At the start of the PPB program, one season commitment is probably the minimum they probably can oversee and the least one should expect in this stage. A firm commitment should be ensured.

Objectives of the Start-up session

The Start-up session aims at achieving the following outputs:

- ✓ To pre-select and register the participants for the training program
- ✓ To discuss with the farmers their time investment, kind and implications of their participation in the program
- ✓ To learn about the training program and the timeline of activities
- ✓ To draft a work-plan for the next season

Time Guide

The normal time to complete the pre-planning session is 2-3 three days, depending on the number of topics included.

Procedure

Pre-selection

Ask village leaders to organize a community meeting. During this meeting discuss the findings of the baseline survey and inform the community of the criteria for selecting participants. Explain that selecting participants does not mean that other interested farmers are not welcome to join. There will be a Farmers Field Day at the end of the season, where the selected participants will report back to the whole community the progress of their study. Also, the farmers are welcome to visit the field anytime and discuss with participants to see what the activity is all about.

The following criteria should be used to select the initial farmer participants:

- Farmers with a keen interest in the activity, preferably those with known experiences in plant selection and in on-farm crop experimentation.
- Full time farmers and not seasonal farm workers or government workers or employees
- Have farmland in the immediate village neighborhood and be or have been recently engaged in the cultivation of pearl millet and cowpea
- Farmers in good health, between 18 and 60 years old, preferably with some basic schooling
- Committed to attend the full duration of the season-long training and more
- If possible have followed an FFF training (i.e. IPM)
- More or less equal participation of male and female participants

Setting Expectations

As some farmers might be new to the concept, introduce the participants with the objectives and basic operations of the PPB curriculum. Discuss the time frame for the season's activities and raise expectations regarding the curriculum, objectives and outputs.

Raising expectation is mutual. A facilitator offers his skills in PPB to the participants but in return he/she expects the learner to know why he attends the training and be committed to this. Explain and discuss mutual expectations.

A facilitator is expected to:

- Making clear what participants can expect
- Motivating participants to ensure commitment if they should start losing interest in an activity or not take the activity seriously
- Providing participants with a goal (daily, weekly, season-wise) which can help them think through the learning activities and to provide inspiration directed towards meeting the demands of the program
- Providing participants with a basis for evaluation

A participant is expected to:

- know why he/she is participating in the activity
- know what is expected from him/her
- understand the nature of participation required for you to achieve this goal
- Providing the facilitator a basis for evaluation

Document the objective of the training and the mutual expectations and give each participant a copy of this. Explain that this is the Learning 'Agreement'; if they have questions about the methods or goals anytime during the training the expectations can be recalled. On the other hand the facilitators may bring to mind expectations on the commitment of the participants. Re-establish the expectations on a weekly basis. This will add to the group's involvement in the topics.

Final preparations

Ask participants to register by recording their name, age and details concerning farming experience, family household and education background.

Decide with the farmers where the field site for the field studies will be. See for criteria for the site selection in the next chapter.

Make sure that all material for the exercises is present in the classroom, and to set the expectations for each session. Such statements tell the participants what they can expect from the training activity

3. Season-long Field Studies

Why field studies?

Field studies are the key to the farmer learning processes. Farmers love to learn but employ various approaches to absorb abstract theoretical information. One of these approaches involves visual presentations to focus their attention, and tangible materials to observe and learn from. Since farmers' daily routine largely focuses on crop production and other agricultural and socio-economic activities, nothing can better motivate the farmer than involving him in learning processes to improve his management practices. Traditionally farmers tend to conduct small field experiments i.e. trying out new management practices, often together with new varieties. The field studies undertaken here merely extend this custom by presenting farmers with collaborative exercises throughout the cropping season. This may enable them to learn new techniques and building further on their knowledge.

Overview

The field studies described in this manual are intimately linked with each other; they lead farmers through a process of learning involving various stages in the plant breeding process. There are four types of field studies in the on-farm breeding process: variety evaluation, variety rehabilitation, cross breeding and line selection. For the season 2003, there will be no line selection study conducted, because there is purposely selected segregating material available.

The field studies described in this manual are designed specifically indigenous vegetable crops selected in the PEDIGREA program. For Indonesia these are: angle gourd, bitter gourd and sauropus (katuk), and for Cambodia: waxgourd, bittergourd and pumpkin. All of these vegetable crops, except sauropus are monocious crops and therefore cross pollinating. For sauropus, which can be propagated through vegetative cuttings and seed, a separate guideline will be produced. In principle, all field studies can be undertaken independently during one season, but they should be regarded tools in the long-term breeding program.

Group Dynamics

For each field study undertaken by the FFF, a small group of farmers should be assigned to take care of, and monitor the field study for an entire season. This task group of approximately 5 farmers should lead the others to develop specialized skills on each of the topics involved i.e. variety evaluations, variety rehabilitation, cross breeding, and line selection. During the season, on a weekly basis or at critical plant stages, it is important that each task group in charge of a field study share its experiences with the bigger group. Through this process farmers will learn to think about their observations and gain better understand on how their studies are linked together. It will be the responsibility of the task groups to help other farmers gain the different skills learned.

Preparation

Most of the planning for the field studies should be done prior to or during the start-up session. During this session, farmers will decide what field studies to conduct, where these will be conducted, and who will be in charge of which field studies. It is also important to know how many farmers will be available for each activity because the training may be taking place during actual farming seasons, and the farmers may have other things to attend to. At this point also, it is vital to know "who does what" on various activities intended to be conducted - by gender distribution of labor, or by age within farm family units.

Farmers should also decide on which varieties and lines to include. Seed materials should then be arranged for planting. The management and lay-out of the field study should be thoroughly discussed by the task-groups and locations of the entries indicated by preparing a map and tools requirement. Other equipment needed in the course of the FFS, such as forceps, insect cages, writing and drawing materials should be arranged just prior to the exercise.

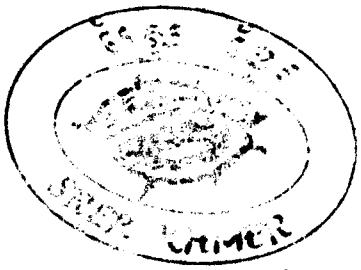
Site Selection

It is suggested that the studies all be set-up in one field, close to the classroom location, to facilitate weekly observations, experimentation and learning. Some field studies, like for pearl millet, require isolation and must be located elsewhere. To protect the study fields against grazing animals, they should be fenced.

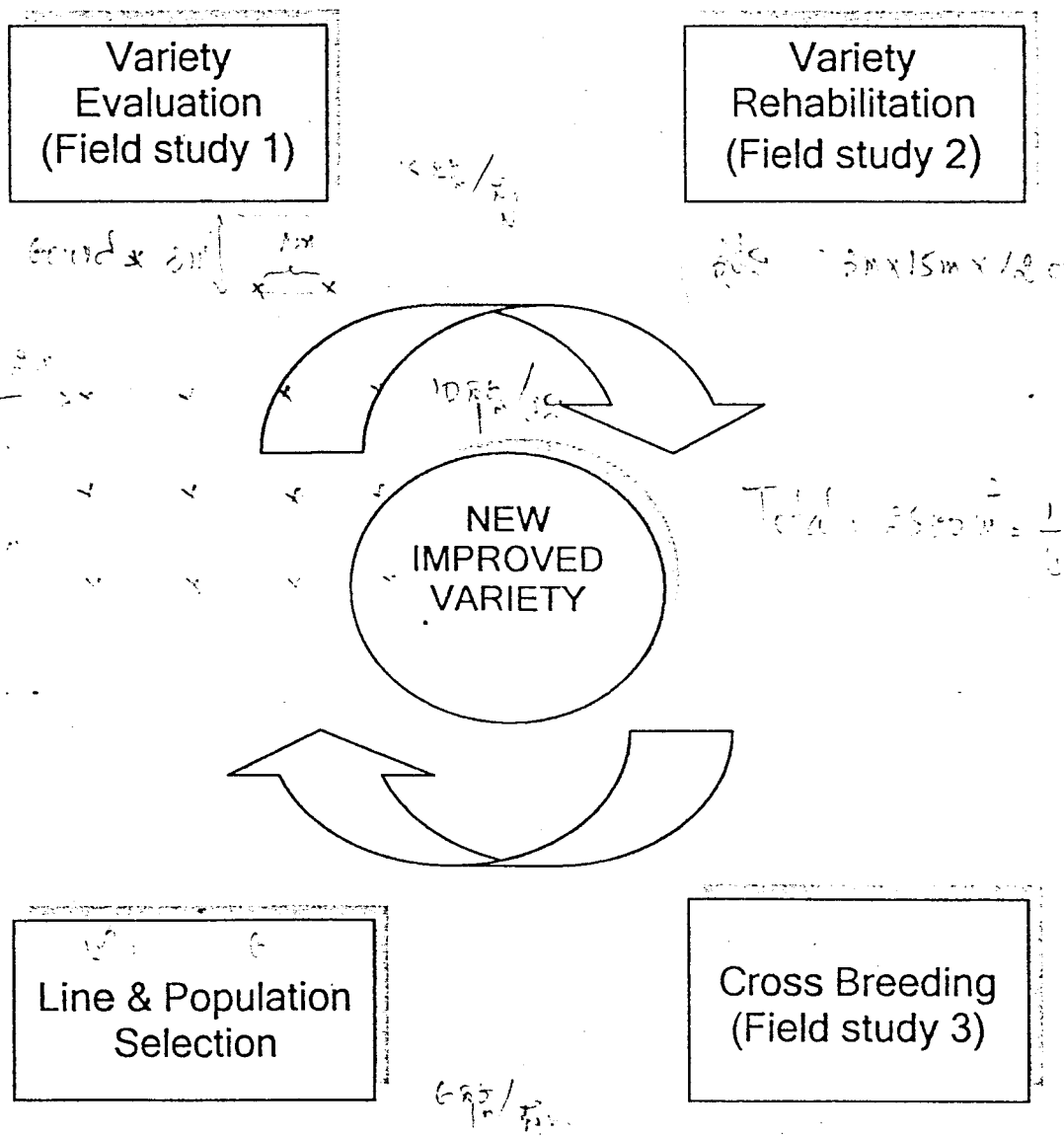
The field site can be a privately-owned land or communal owned land. Usually, some form of compensation may be required, either in cash or in kind, which may be provided by the community or project.

For site selection the following criteria are helpful:

- Leveled and homogenous land, representative of the local agro-ecosystem
- Away from houses and big trees
- Within walking distance from the classroom,
- Strategically located where other people can see the experiments



THE BREEDING PROCESS



3.1 Variety Evaluation

Introduction

One of the first steps in a plant breeding program involves the evaluation of existing genetic resources. The evaluation of varieties is a relatively simple process compared with the other breeding activities. In addition, farmers may find that it takes a relatively short time to obtain desired results and introduce a new variety that may meet their requirements.

In this study, farmers will evaluate the overall performance of a number of ~~pearl millet or cowpea~~ varieties based on preferred characteristics, and decide their suitability for local production, considering their local farming environment.

The field trial on variety evaluation is kept straightforward. It does not, for example, involve replications or multiple locations, to avoid unnecessary complicated analysis. The main purpose of this exercise is to allow farmers to enhance their skills in variety comparison.

Observations on environmental interactions at different crop development stages will be part of the evaluation process. Small exercises on agro-ecological topics critical to the particular plant stage will provide farmers with the skills for visual evaluations and interpretation, which will form the basis for decision making.

Learning Objective

- ✓ To enable farmers to test the performance of various local and improved varieties on their farms, using new skills.
- ✓ To involve farmers in comparing variety characteristics, and develop their skills in selecting varieties with preferred characteristics.
- ✓ To demonstrate together with the farmers the interactions that exists between varieties and the environment such as pests, diseases, weather, soil etc.

Varieties

The number of varieties will depend on what is available, and what is known by the farmers. Some of the varieties may be obtained from the village neighborhood; other varieties will be introduced. Farmers may decide to include exotic material from other regions and countries, recommended by extension officers or local breeders. Such varieties should be provided with the help of the facilitators and arranged from different breeding stations, genebanks and farmers in other regions.

A maximum of 10-15 varieties is suggested for the first season. This number will be sufficient and manageable to gain knowledge and skills. One of the varieties chosen by the farmers should serve as the 'standard' or control variety for comparison. This control variety should be the variety most promising or most commonly planted by farmers in the village.

Field Layout

Field Size

The size of the field depends on the crop and the number of varieties that farmers may wish to include in the study and the number of seeds available for planting. As a rule of thumb each single variety requires about 30 -50 plants per plot. No replicates are required. The study field should be protected by a fence to guard against grazing cattle.

Control variety

The control variety should be planted once in every five varieties. If 10 varieties are included in the evaluation, there should be three control plots: one in the middle, and two at both ends.

Planting

Recommended plant spacing or farmer's planting practices should be used for each crop. Prior to planting sticks or frames for guiding plants of bittergourd, pumpkin and waxgourd should be placed.

Identification
It is very important to label the fields with sticks and durable tags to know the location of the varieties planted. In addition, a map of the field will give indication of what variety is planted where.

Field Management

Soil tillage
Local soil tillage practices should be used. The kind of soil tillage to be used will be discussed with the farmer group during the pre-season discussion..

Fertilizer
Fertilizer levels will depend on farmer's practices and local recommendations. The level of fertilizer application should be determined for each site, in discussion with the farmer group. It is important to apply fertilizer in strictly uniform quantities as this may influence the variety performance and comparison.

Agro-chemicals
No pesticides will be used for comparison of resistance to insect pests and diseases, unless the infection threatens to destroy all plants and wipe out the field study.

Weeding
No herbicides should be used. The usual weeding practices should be applied.

Harvest
Each variety plot shall be harvested separately, dried and weighted to determine the yield. Farmers may test the seed further for other criteria such as storage, cooking, and taste, but will, except in the case of induced self-pollination, use it for re-planting, because of the high level of cross pollination and risk of deterioration.

Procedure

1. Well before the planting season, during the pre-planning session, ask farmers to make a selection of the varieties that they would like to include in the variety evaluation. It is expected that the participants have completed the baseline and pre-planning exercises on selection criteria and breeding objectives. Cross-check the varieties against the breeding objectives.

2. Ask farmers to select a variety evaluation task-group and assign a group leader. This group should be responsible to arrange the seed of the selected varieties prior to planting, and collect and compile the data in the variety evaluation field throughout the season. Agree upon an observation list and prepare a schedule indicating the timing and frequency of the observations.

3. On a weekly basis review and discuss the progress of the field trials in the bigger group. Explain and use the appropriate methodologies for comparison of varieties. After harvest, at the end of the season compile all the data and make a final evaluation.

Observations

Preparation
At the time that the first observations are conducted in the field, just after planting, conduct the exercise on "Farmers Selection Criteria" and "Farmers observations". This will lead farmers into discussing their own selection practices and observation skills. Subsequently ask the participants to review the selection criteria and decide on the type of observations needed. Agree on the timing and frequency, and indicate what observations to conduct:

- From planting to flowering stage

- From flowering stage to mature stage
- At the end of the season

Use the enclosed sample evaluation tables as reference, which will lead participants to think about the benefit of each observation. Prepare an overview of the agreed observations on paper for reference.

Note: It is not required to make a very detailed overview of observations for the whole season. It may be appropriate to split the observations into different crop growth stages. It should be clear to farmers that observations can be added if appropriate.

Genotype x Environment Analysis

Agro-ecosystem analyses will allow farmers to observe the different interactions between genotype and the environment. Sometimes, these concern simple observations on such issues as the rainfall pattern, soil type, pest and disease relations, etc. Farmers may be less familiar with methods for objective observation, for example on plant morphology, yield, pests and diseases; hence there is a need to discuss how these criteria's can be observed. Small exercises on topics critical to the particular plant stage serve to assist farmers in learning the skill of observation, comparison and interpretation.

It is important that these weekly exercises are tied up with questions that farmers come up with, or are linked up with points in time coinciding with decisions concerning field management. Group dynamics demand that the exercises are kept flexible. Each week there should be a new topic. Facilitators may find some guidelines in reading through the special topic on "G x E interaction".

Recording

The task-group on variety evaluation should keep a notebook for recording all data from the observations. Variety observations should be taken from a random sample of 10 plants per individual variety plot. Results of the genotype x environment (GxE) observations should be summarized on the ecosystem observation sheet. An example of an ecosystem observation sheet can be found at the end of this chapter.

The results of the variety observations will be summarized in matrices and graphs. There are several methods for comparison of varieties i.e. scoring card, pair-wise ranking, and index ranking. Conduct the exercise "Methods for Variety and Line Comparison" to acquaint farmers with these methodologies.

Discussion

On weekly basis, ask the task-group responsible for variety evaluations to present the results of their observations from the past week in the plenary session. This will lead farmers to discuss the various topics and compare these with their own observations.

Note: From time to time, a competition element may enhance group dynamics. The big group may be asked to conduct their own observations in the field using simple score tables, and compare these with the more detailed matrixes of the task-group.

Weekly

1. Describe the general condition of plant development for each variety. Do the different varieties develop in the same way? How did the weather conditions influence plant development? What fertilizer and other management practices were applied during the week? How did this affect crop development for each variety?
2. Compare the pest and disease situation to the previous week? Are there more insect pests and diseased plants? Why? Is the insect pest damage or disease infection more severe? Why? Is the development of insect pests and disease the same on all varieties? Are there some varieties that have few insect pests or little disease infection? Use graphical presentation for demonstration.
3. Compare growth development and performance of varieties. Select the best performing variety, based on observations and the weekly data gathered, and explain why this variety was selection:
    - Vegetative stage
    - Early flowering stage
    - Plant maturity stage

Arrange the varieties according to their overall levels of performance.

4. Based on the observations of other farmers (farmers aside from the varietal evaluation group), what varieties do they prefer? Are these the same varieties as selected by the variety evaluation group? Why? Are there any other important characteristics that were not included in the observations? Why are these characteristics important?

At flowering, ripening and harvesting stage

1. Is there any difference in the time of flowering between varieties?
2. Is there any difference in the time of grain maturation between varieties?
3. Do some varieties shatter easily compared to others?
4. What are the characteristics of the pods and panicle characteristics?
5. Do you see any difference in grain characteristics?

At the end of the season

1. After comparing the yields, do you see many differences?
2. Are the varieties with the least disease damage best yielding?
3. Do you observe any difference in the cooking qualities and taste of the varieties?
4. Note and discuss specific problems, advantages observed for each entry. Are there important observations that were missed out during the season's activities?
5. How can we improve the study for the next season?
6. Prepare a summary table of all the characteristics observed.

3.2. Variety Rehabilitation

Introduction

In this study farmers address the problem of variety deterioration. Farmers often complain that their variety has degraded from its original value by loosing one or more of its preferred characteristics, such as yield, shape and taste. In this study farmers will work through several seasons to bring back the preferred characteristic traits of their varieties, until they are close to their original state.

Why do varieties deteriorate? There are three main reasons for variety deterioration:

- Seed may get accidentally mixed in the field (left-over plants), after harvest (during threshing and drying), during storage or before planting. Such admixtures are often difficult to detect before planting and therefore visible only in the field.
- Varieties may be cross-pollinated by other locally grown varieties that are different in their genetic makeup, often through lack of adequate isolation distance. The incidence of such cross pollinations is much larger in open-pollinated crops like pearl millet than in self-pollinating crops like cowpea.
- Mutation may take place, which is a change in the genetic makeup of a single plant. Although mutation occurs at a very low rate, the effect can accumulate over time and may lead slowly to variety alteration.

Variety rehabilitation in cross pollinating crops like bittergourd, angular gourd and pumpkin cowpea is relatively easy compared to pearl millet. The fundamental difference is the genetic make-up of the two crops. While cowpea varieties consist of homogenous populations, pearl millet is largely heterogeneous, as a result of its open pollinated character. Different selection methods have been developed to resolve the issue of variety rehabilitation in self and cross pollinating crops, which will be examined during this study.

Learning Objective

- ✓ To explain why varieties deteriorate and the need to rehabilitate seeds from time to time
- ✓ To carry out seed rehabilitation activities on selected varieties to bring back their preferred original characteristics

Varieties

Farmers choose their varieties based on the extent of 'deterioration'. This should be carefully reviewed prior to the decision to carry out the field study. Mostly these consist of local 'deteriorated' varieties grown by the farming community, of which no better seed can be obtained. Usually, the field study will include one to three different varieties. On occasion, farmers may choose two different seed lots of the same variety.

Note: Sometimes traditional varieties may consist of 'composites' or 'clustered' genotypes. Selecting for one specific plant type in 'composite' variety may therefore not restore the original variety. Be sensitive to this point when farmers describe their varieties and when the selection methods are explained. Check for multiple selection goals.

Study Layout

Field size
The size of the field depends on the number of varieties that farmers may wish to include in the study. Each variety should be allotted at least 100 plants or about 100 m2, depending on the crop. No replications are needed.

Planting
2-3 seeds or seedlings should be planted per hill. After two weeks, plots should be thinned back to one plant per hill. Plant spacing should be appropriate and allow individual plants to be observed.

Isolation
Because of the open pollinated character of the selected vegetable crops, ensure at least 200 m isolation between the varieties. Make sure that there is no other variety of the same crop grown in the immediate vicinity of the variety plot.

Identification
Label the fields to know the location of the varieties planted. In addition, make a map of the field and indicate on the map what variety is planted where.

Field Management

Soil tillage and fertilizer management will depend on the farmer practice and local recommendations. The use of agrochemicals should be prevented or kept to a minimum. The field should be well fenced to protect against grazing animals.

Harvest
Depending on the method of variety rehabilitation, different harvest methods may be applied.

- Roughing will be done to remove the non-desired types (off-types). All remaining plants in the field will be bulk harvested, dried and stored until the next season. Make sure that a one meter border of the crop field is discarded during the harvest.
- Harvest each single marked plant separately; this method is used for the recurrent and ear-to-row selection methods. Seeds of each plant are harvested separately, dried, labeled and stored until the next season.

Procedures

1. At the start of the season, farmers should review the preferred characteristics of the varieties that they want to rehabilitate.
2. Explain the various methodologies used in variety rehabilitation and agree on one method. Discuss the exercise on "selection techniques"
3. Lead farmers to apply the agreed procedure for variety rehabilitation in the designated fields

Observations

Preparation
At the time that the first observations are conducted in the field, just after planting, discuss the selection criteria and observation schedule by using the exercises "farmer selection criteria" and "farmer observations". This will lead farmers into discussing their own selection practices and observation skills. Subsequently ask the participants to review the selection criteria and decide on the type of observations needed. Agree on the timing and frequency, and indicate what observations to conduct:

- From planting to flowering stage
- From flowering stage to plant maturation stage
- At the end of the season

Farmers may be less familiar with a particular kind of observation, such plant morphology, yield, pests and diseases; hence there is a need to discuss how these criteria's can be observed. Use the enclosed sample evaluation tables as reference, which will lead participants to think about the benefit of each observation. Prepare an overview of the agreed observations on paper for reference.

Note: It is not required to make a very detailed overview of observations for the whole season. It may be appropriate to split the observations into different crop growth stages. It should be clear to farmers that observations can be added if appropriate.

Genotype x Environment Analysis

Agro-ecosystem analysis allows farmers to observe the different interactions between genotype and the environment. Sometimes, these concern simple observations on such issues as the rainfall pattern, soil type, pest and disease relations, etc. Through small exercises on topics critical to the particular plant stage, farmers will learn the skill of observation and interpretation. These practical exercises serve to provide options for the farmers and explain on how to observe, collect critical data and interpret the results. Each week there should be a new exiting topic. To help the facilitator in designing these small exercises, guidance is provided in exercise 6.4.

Note: It is important that these exercises are tied up with questions that farmers come up with, or are linked up with points in time coinciding with decisions concerning field management. Group dynamics demand that the exercises are kept flexible. Each week there should be a new exiting topic..

Critical Selection Stages

To allow for optimal conditions for observation during the selection, farmers should conduct several rounds of selection in the field. Recommended plant stages for selection are:

- From planting to tillering: suitable for observations on vegetative development such as germination vigor, leaf color, plant type, pest and disease resistance
- At flowering: most suitable for observations on plant type, height, and earliness
- At seed maturity just before harvest: suitable for observations on early maturity, yield, pod development, seed set.

Plants with preferred criteria should be marked with a colored tag for later recognition. If the mass selection method is followed, off-type plants must be removed before flowering.
After harvest the selections can be further screened on desired characteristics and off-types removed.

Recording

The task-group for variety rehabilitation should keep a notebook for recording all data from the observations. Plant observations should be taken from a random sample of 20 hills per plot.

Results of the agro-ecosystem observations should be summarized on the ecosystem observation sheet. An example of an ecosystem observation sheet can be found at the end of this chapter. Prepare and present tables and graphs on paper and keep adding information on the characteristics for each observation.

Ask farmers to make a note on the number of off-types and/or selected plant types recorded in the variety plots. Mark the off-types for discussion before rouging. Mark the selected plant types for discussion.

Discussion

Ask the farmers task-group responsible for seed rehabilitation to present the results of their observations on a regular basis by using drawings, tables and graphs. This will lead farmers to discuss the various topics and compare them with their own observations.

Weekly

1. Describe the general condition of plant development for each variety. How did the weather conditions influence plant development?
2. What fertilizer and other management practices were applied during the week? How did this affect crop development for each variety?

3. Compare the pest and disease situation to the previous week? Are there more insect pests and diseased plants? Why? Is the insect pest damage or diseases infection more severe? Is the development of insect pests and disease the same on all plants and varieties?
4. Compare growth development and performance of the varieties. Identify off-type plants during:
    - Vegetative stage
    - Early flowering stage
    - Plant maturation stage

   Note the number of off-types. Indicate what variety is more deteriorated?
5. Aside from the seed rehabilitation task-group, what plant types do other farmers prefer? Are these the same plant types as selected by the seed rehabilitation task-group? Why?
6. Are there any other important characteristics that were not included in the observations? Why are these characteristics important?

At flowering, ripening and harvesting stage

7. Compare the differences in flowering and ripening of the varieties with the criteria i.e. original characteristic traits
8. Do the selected plant types possess characteristics that are preferred by farmers? If not, why? What characteristics have not been discussed before?
9. One to two weeks before harvesting, discuss different selection methods for the next season based on comparisons of plants in the field study and farmer's fields.

At the end of the season

10. After harvesting, compare the yields. Do you see differences?
11. Do the traits of these varieties fit the criteria defined early in the season?
12. Is it possible to bring back the original preferred traits of the varieties? Did you find plants that meet all the preferred criteria?
13. Note and discuss specific problems observed for each variety.
14. How can we improve the study for the next season?

3.3. Cross Breeding

Introduction

Farmers generally do not apply controlled cross breeding. Variations in the field are normally caused by natural out-crossing, admixture or mutation. Some resourceful farmers have learned to improve the variability phenomenon by mixing varieties or planting preferred varieties in the proximity of their field. For farmers, this may already be advanced; for breeders controlled cross breeding is nearly always the starting point for crop improvement.

Farmers and institutional breeders both carry out crop improvement in their fields; yet, the difference between them is significant in terms of applied methodology and selection environment. Farmers usually do not apply controlled cross breeding. Genetic variations in the field are caused by natural out crossing, admixture or mutation. By adding controlled crossbreeding to their field of expertise, this yields farmers a new source of variation for improved selection.

While formal plant breeders rather conduct selection under 'generalized' conditions for wide adaptation; farmers can select their crops for narrow adaptation, tailored to their own environment. This is more useful to farmers as the resulting crop has been exposed extensively to local stresses: pests, diseases and other local environmental factors. In using these methodologies on-farm, they will be no longer dependent solely on breeding institutions to obtain improved and well adapted varieties.

Most vegetable gourds are monocious which means that most flowers are either male or female. Female flowers need to be cross pollinated with pollen from male flowers, which in nature is provided by visiting insects in search of nectar. Cross pollination can lead to self-fertilization (fertilization of flowers on the same plant) but also to cross-pollination with neighboring plants and plants in neighboring fields. Since the plants are monocious by nature, usually no emasculation is required. As flowers of pumpkin, ridge gourd and bitter gourd are both monocious and fairly big, the plants are excellent to learn the art of cross breeding.

In this field study, farmers learn the reproductive characteristics of gourds and to make controlled crossings between parent varieties.

Learning Objective

- ✓ To learn the principals of cross pollination in cowpea
- ✓ To produce F1 seeds (for the first season)
- ✓ To observe, record, and file data on plant breeding activities

Parent Varieties

The number of parent varieties will depend on the breeding objectives determined by the farmers and the available materials. Some varieties may already be available in the farming community; others may have to be introduced from other region, or obtained from breeding stations, national and international genebanks.

A maximum of 10 varieties (to produce 5 crosses) is suggested for the first season. This number will be sufficient and manageable to gain knowledge and skills. It is suggested that farmers use a modern variety and a local variety as parents in plant breeding to increase production and conserve genetic resources from traditional varieties.

Study Layout

Field Size
For each parent variety it is sufficient to plant a 3-5 meter row. The total area for the study depends primarily on the number of parent varieties and the available material.

Planting
1-2 seeds shall be planted per hill; after 2 weeks this need to be thinned to one plant. Recommended plant spacing or farmer's planting practices should be used for each crop.
No replications are needed. Repeated planting for flowering synchronization may be necessary in case farmers wish to cross early flowering varieties with late flowering varieties.

Labeling
It is very important to label the rows with sticks and durable tags to know the location of the parent varieties planted. In addition, a map of the field will give indication of what variety is planted where.

Materials
For crossing: scissors, forceps, glassine bags (kind of waxy paper bags), magnifying glass, tags, labels, and markers.

Field Management

The field should be free from left-over crops. Soil tillage and fertilizer management will depend on the farmer practice and local recommendations. The use of agrochemicals should be prevented or kept to a minimum.

Procedures

1. Prior to planting, farmers should develop the criteria and define the preferred characteristics of the parent varieties that they want to use for the season
2. It is expected that the exercises "farmer selection criteria", and "parent varietal selection" have been carried out.
3. Prior to planting, seed of the parent varieties should be prepared and arranged for.
4. Sow seeds of the parent varieties in adjacent rows.
5. Prior to carrying out the crosses, the exercise on "reproductive characteristics" should be carried out. This exercise will allow farmers to practice making crosses.
6. Prepare a plan for the preferred crossings using a matrix (see below). Include reciprocal crosses to maximize the success rate.

Sample planning sheet for cross breeding

Male / Female	Variety 1	Variety 2	Variety 3	Variety 4	Variety 5	Total Plants
Variety 1		X	X			6
Variety 2	X			X		6
Variety 3	X			X		6
Variety 4		X	X		X	9
Variety 5				X		3
					Total	30

7. Arrange for 3 replications per planned cross or 6 replications including the reciprocal crosses. So, if farmer have planned for five parent crosses, this will result in 30 female flowers to cross eventually leading to 30 fruits if every cross is successful. Assume 50% success rate, so double the number of crosses should be made. (in the beginning it is even better to assume 1/3 success rate, so farmers need to make 18 reciprocal crosses per parent cross!).
8. Observe carefully and note when the plants start to flower.
9. Conduct the cross breeding activities as outlined in chapter 4.6.
10. After the crosses have been made, check the fruit development regularly to make sure that that the plants and fruits remain healthy, apply sufficient water, and monitor pest and diseases.
11. At maturity, harvest, dry and carefully store ripe fruits. Write the cross on the fruit with a marker pen or attach a label to the fruit. Extract the seeds and store each crossed seed separately in sturdy moisture proof bags and keep this in a safe storage environment, such as a closed tin or large plastic bottle, to protect against insects and birds.

Observations

Preparation

Ask the participants to review the type of observations, and agree on the timing and frequency, and indicate what observations to conduct in the field study:

- From planting to flowering stage
- From flowering stage to mature stage,
- At then end of the season

Use the enclosed sample evaluation tables as reference, which will lead participants to think about the benefit of each observation. Prepare an overview of the agreed observations on paper for reference.

Genotype x Environment Analysis

Through small exercises on topics critical to the particular plant stage, farmers will learn the skill of observation and interpretation. These practical exercises serve to provide options for the farmers and explain on how to observe and collect critical data and interpret the results. To help the facilitator in designing these small exercises, guidance is provided in the topic exercise on "GxE interaction".

Recording

The task-group for cross breeding should keep a notebook for recording all data from the observations. Observations regarding crossings should be noted down as detailed as possible. Results of the agro-ecosystem and GxE observations should be summarized on the ecosystem observation sheet (see example in annex). Prepare and present tables and graphs on paper and keep adding information on the characteristics for each observation.

Discussion

Request the task-group of farmers responsible for cross breeding to present the results of their observations on the field and crossings by using drawings, tables and graphs. Organize a special day to report on the success rate of the crossings.

Weekly

1. Describe the general condition of plant development for each variety. Indicate number of buds and flowers. How did the weather conditions influence plant development and flowering?
2. What fertilizer and other management practices were applied during the week? How did this affect crop and flower development for each variety?
3. Compare the pest and disease situation to the previous week? Are there more insect pests and diseased plants? Why? Is the insect pest damage or diseases infection more severe? Is the development of insect pests and disease the same on all plants and varieties?

During flowering and at the end of the season

4. What were the criteria of the selected parent varieties, and what do you expect will be the traits that develop in the off-spring of the cross between the parent varieties? Does this match with your selection criteria and breeding objectives?
5. Would you prefer other varieties to include for the next season?
6. Why is it important to approximate the time of flowering of each variety?
7. How would you set up a crossing if the farmers group decides to cross an early maturing variety with a late maturing variety?
8. How can we improve the study for the next season?

4. Special Topics and Field Exercises

Introduction

Every week farmers come together to observe and collect data in the field, conduct small experiments on their vegetable crops, and to share the results of their observations. In addition, the curriculum includes learning sessions, which are presented through exercises on special topics. Each exercise focuses on particular aspects related to plant breeding and selection or to specific characteristics of one of the vegetable crops included in the program: bitter gourd, angular gourd, pumpkin or wax gourd.

Some ten exercises on special topics are listed in this chapter. The exercises are designed to guide facilitators in the preparation and implementation of the weekly activities in the farmer field school. Although the exercises are discussed in fairly great detail, it is assumed that the facilitators utilize their own resources to adapt the activities to their own use, depending on the background of the farmer participants and the prevailing environment and questions of the participants.

4.1. Farmers' Selection Criteria

Introduction

Individual farmer selection approaches may appear simple and straightforward. When viewed from the farming community as a whole, they nevertheless can be fairly complex. Farmers consider many things before they select a plant or variety:

- Yield under favorable and unfavorable conditions
- Resistance to pests and diseases
- Drought resistance
- Early maturity
- Vegetative production for cattle grazing
- Type of grain, taste and color

To maintain and improve their varieties, farmers may apply different indigenous techniques, ranging from deliberate mixing of seeds and out-crossing with exotic varieties to hybrid recycling. Such approaches serve to conserve local germplasm and to retain or introduce genes within the local plant populations that are important for the community's survival.

In each community some farmers are recognized as 'the specialists'. They have developed certain techniques in the selection process which makes their varieties outstanding among others. This is where farmers come to replace their varieties, get seed of lost varieties or obtain seed of newly introduced varieties.

This topic will help farmers to discuss what is important when choosing a variety or line. Likewise the exercise will help farmers to understand how to use a set of criteria for varietal evaluation and match these with their breeding objectives.

Objectives

- ✓ To understand farmers' current selection methods in more detail
- ✓ To identify gender differences in selection and specialist involvement
- ✓ To identify single and multiple selection criteria

Materials

- Vegetable plants of different varieties.
- Tape, paper, marker pens, scissors

Time guide

It is highly recommended to focus this exercise on one crop at a time. The time guide presented is per crop.

Activity	Time	Most important contents
Introductory	20'	Discussion on farmer selection practices
Classroom exercise	30'	Social and gender involvement in the selection process
Group work	60'	Determine selection criteria and prioritize
Compilation	30'	Priority matrix, Identify single/multiple selection criteria
Final discussion	10'	Summarization
Total Time	2½	Hours

Procedure

1. Initiate a discussion on selection criteria by asking who is involved in the variety selection in their own field.
2. Ask whether there are any key farmers in the community that are recognized as 'seed' selection specialists. Verify whether these people already participate in the FFS. If they are not participating, if not, try to involve them in this topics session.

3. Present the 'selection diagram' and fixed it to the wall (see below). Show each participant a box with pieces of paper, each with different color: blue representing adult males, red representing adult females, and green representing other individuals within or outside the farming family.
4. Ask participants to indicate who is involved in the selection process and when he/she is involved by taking a piece of paper and stick it to the diagram close to the plant process stage.
5. Review and discuss the scores on male, female, and other people's involvement. Elaborate on the specific responsibilities of each group in the selection process.

6. Make four groups and ask them to focus on a different stage in the production process cycle.
7. Ask the groups to list the positive and negative criteria that they are looking for during the respective selection process. Prioritize the criteria in order of highest preference. Groups will present their findings.
8. Prepare a matrix and list all the positive traits with the highest score (top 5 or top 10) listed by the groups both horizontally and vertically. Then ask the participants to indicate pair-wise which of the given criteria they favor most. Discuss the results of the priority matrix.

Sample of priority matrix

Criteria (priority score)	Earliness (2)	Grain size (3)	Color (5)	Drought tolerance (1)	Storage suitability (4)
Earliness		Earliness	Earliness	Drought tolerance.	Earliness
Grain size			Grain size	Drought tolerance	Grain size
Color				Drought tolerance	Storage suitability
Drought tolerance					Drought tolerance
Storage suitability					

9. Observe how difficult it is to reach consensus on the priority criteria. Discuss the need for multiple criteria. If there is any indication for multiple criteria, take time to prepare a second (or third) priority list.
10. Compare the results of the priority criteria with the results of the breeding objectives prepared during the earlier sessions. Discuss relevant differences and agree on a final list of criteria for selection.

Notes for the Facilitator

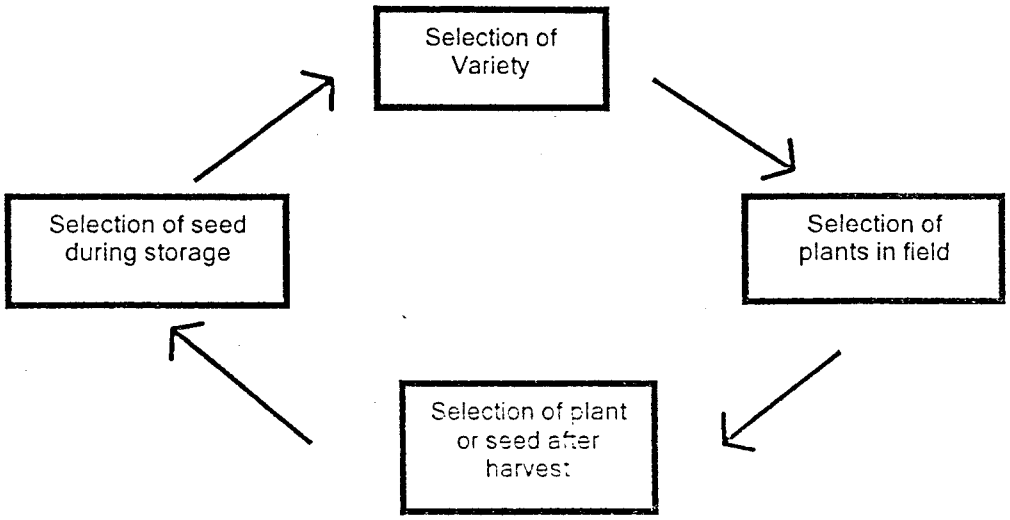
1. It is important to verify why farmers want to set multiple criteria. Farmers may use different varieties for different uses or different planting seasons. From vegetables like gourds not only the fruits are eaten, but also flowers, leaves and stem are delicatessen for the farmers.

Questions

1. Who decides what variety to plant on your farm? Where do you usually get your seed from?
2. When you acquire seeds from your neighbour or elsewhere, what kind of criteria do use? Are these the same criteria you use when you select from your own saved seed?

3. What selection criteria do you use on-farm? Are these similar to the selection criteria fixed during earlier sessions? How do they compare with the breeding objectives agreed upon in the FFF?
4. What important traits should be added? Why?

THE SELECTION PROCESS
WHO DECIDES AND WHEN?



SREK KHMER

4.2. Farmer's Observations

Introduction

Farmers usually are quite well able to test the performance of varieties in the field without elaborately collecting scores of data. They rely on their senses, indigenous know-how and experience in selecting the varieties and lines that they prefer. Some breeding objectives however, would benefit from a more scientific approach. Improved know-how, for example, may be needed in the observation of resistance for pest and disease. Similarly, converting yield data from small plots to field level are indispensable in institutional breeding and selection, but farmers undoubtedly have different methods of assessment.

Farmers quickly become de-motivated if they cannot comprehend and perceive the importance of the observations. They therefore need to participate in the decision process. This exercise is designed to involve farmers in the field studies and become owners of their collected data and selection process. Farmers will determine the kind of observations that are needed to achieve their previously set selection objectives, find out when the critical time to conduct these observations is, and finally what scoring or scale to apply for each observation.

Objectives

- ✓ To determine the type of observations during the season
- ✓ To identify the critical time for observations
- ✓ To agree on the score or scale of the observations

Materials

- Tape, marker pens, newsprint

Time guide

Activity	Time	Most important contents
Introduction	30'	Instructions and demonstration
Group Exercise	45'	Determining observation time and scoring
Group presentation	45'	Presentation of results, discussion and agreement
Plenary discussion	30	Comprehension
Total Time	2½	Hours

Procedure

1. Briefly introduce the purpose and tasks of the exercise.
2. Review with the participants the breeding objectives and selection criteria previously fixed for the particular crop. Hand out a form with an outline of the time table and different crop growth stages (see below).
3. Start with the most important criteria and demonstrate how to use the table. Ask farmers what type of observation would be needed to use this criterion and note this in the table. Then ask what the best time is to collect the observation data in the field. Point out that some observations such as pest resistance may need to be collected more than once.
4. Split into groups. Assign the remaining criteria to the groups and ask them to complete the observation table and timing.
5. Groups will present the results. Review and discuss each criterion in detail and the observations needed.
6. Once all observations are agreed upon, list the name and timing(s) in a table and fix this on the wall for viewing.
7. Ask participants to identify the scale for each observation. Note that all kinds of scores may be applied such as high/medium/low, + and -, and A,B, C. But preferably use numeric scales of 1-5 or 1-10. Avoid using 0 (zero) for computational reasons.

8. Ask the field study task groups to work out details of this schedule and to take their responsibilities in collecting the observations
9. Summarize the results of the day.

Notes for the Facilitator

1. It is not required to make a very detailed overview for the whole season. It may be appropriate to split the observation into different crop growth stages, and at least complete those observations that need immediate action. Refer farmers to the observation table when the time is needed to take action on the next set of observations.
2. Start with one field study, preferably variety evaluations, and continue with the other field studies one by one. Note that many observations are similar and that agreed scales can be copied.
3. A descriptor list for bitter gourd is annexed for reference on the type and scale of possible observations.

Questions

1. What is the purpose of collecting observations from the field?
2. Review breeding objectives. Are there any criteria that are difficult to observe in the field? Which ones? How can you resolve this?
3. Why is it better to assign a score of 1-5 in stead of A-E? When do we assign a score of 1-10? Why do we not use zero?
4. Observations can be scored by visual ranking and numeric ranking. What is the difference?
5. Why do we normally attempt to reduce the number of observations?
6. Do you agree with the following statement? The purpose of a field study task group is to manage the field studies, to collect and compile the observations and to share the results with the other FFF participants.

Sample Farmer's Observation Table

Field study:
Task group members:
Date:

No.	Criterion/Observation	Growth Stage(s)	Scale
	Plant height	Weekly	Cm, average of 10 random plants
	Pest resistance	Weekly	1-10
	Yield	At maturity	Kg
	Taste of fresh fruits	Fruiting stage	Scale 1-9, from 1=bad taste to 5 = medium, 7= good, 9=excellent

4.3. Agro-ecosystem & Genotype x Environment Interaction

Introduction

Many local and modern varieties may not survive if left alone in the wild. It is only by human interference, through specific farm management practices like fertilization, pest control and continuous selection, that these varieties are maintained and improved. This so-called agro-ecosystem, a compilation of a-biotic, biotic and human interferences, is very important in maintaining the characteristics of the local varieties. By default, local varieties thrive best in the agro-ecosystems in which they are used and re-produced.

Varieties respond differently to changes in the environment. Modern varieties are usually more responsive to fertilization than local varieties; on the other hand local varieties demonstrate better growth under stress conditions like drought. This is known as genotype x environment interaction (GxE interaction). In plant breeding it is important to determine whether differences between varieties or selection lines are the result of genetic differences or caused by the environment, as only genetic differences are sustainable (heritable).

Topics are elaborated in a series of small exercises, all related to either agro-ecosystem observation or GxE interaction. The sessions will lead participants through weekly sets of observations, questions, analysis, and illustrations, and are designed to improve the observation and decision making skills of the participants.

Objectives

- ✓ To better understand the local agro-ecosystem
- ✓ To identify genotype x environment interactions through field situational analysis
- ✓ To improve the decision making skills of the participants

Materials

- Various; always keep a stock of: notebook, newsprint, tape, marker pens, magnifying glass, scissors, plastic bags, meter sticks.

Time guide

These are small exercises, conducted usually at the beginning of a weekly class. Each exercise takes about 1-1½ hour to complete.

Procedure

Usually the activities will start with field observations for about 30 minutes, followed by a classroom reflection. They fit very well with the weekly FFF classes and can be used as energizer. The topics provide extensive links to further explorations and more in-depth teachings, if and when required.

Note for the Facilitator

Make a selection that suits best to the FFS situation. Be creative and flexible in applying the exercises. Ideally, the exercises should facilitate a selection or management decision i.e. fertilization, pest or disease management, critical stage for selection. Alternatively reflect to practical questions from the participants.

Learning Exercises

1. A-biotic factors

Field and Classroom exercises

1. Collect weekly rainfall figures and compile the data in a table or graphically (bar-chart). Discuss the plant's water requirement and the implications of flooding and drought.

2. After a sudden heavy rainfall, observe the plant's water stress. Draw the plants in the field ; dig up rooting systems. Experiment by drain off water and observe differences. Explain the importance of water for the plant's nutrients management and point to stages in the plant's development most sensitive to water stress.

3. In case of drought or flooding, study the field layout and observe carefully whether there are differences in stress patterns between various parts of the field. Carefully check whether these variations influence the comparison between varieties and lines.

4. Study the influence of sunlight on photosynthesis and plant growth. Experiment by applying various levels of shade using mesh netting (ranging from light shading to near darkness) at various plant stages and observe the plant's reactions on leaf development, stalk length, seed development etc. Explain the basics of photosynthesis in relation to the plant's physiology and growth.

5. Observe the plant competition for nutrients by experimenting with plant density. Experiment with a small plot having hills with single plants and hills having 3-5 plants per hill. Record plant developments between the hills on bi-weekly basis.

Some Questions for Conceptualization

1. What influence will rainfall have on growth of the plants?
2. What effect will in-equal distribution of rain and/irrigation have on plant growth?
3. How come some varieties are more drought or flood resistant, what is so specific about these varieties?
4. What relationship exists between root development and drought susceptibility?
5. How does the condition of the field compare with the previous week? Can you explain what happened last week?
6. What do you expect will happen next week, considering the weather and the plant growth stage?
7. How important is water in the plant's nutrient management? In what growth stage is the plant most sensitive to water stress?
8. Are damages on the plant caused by a-biotic stress or biotic stress factors (pests, virus, diseases)?
9. What types of plants are most effective in intercepting light for photosynthesis? Which ones are most effective in water stress environments? Can you identify varieties with such plant types? Knowing this, does this influence your plant breeding objectives?

2. Biotic Factors

General Agro-ecosystem observations

1. Ask the participants to go into the field and collect as many different types of organisms in the crops ecosystem. Include healthy plants, plants with disease, insects, spiders, rats, snakes, birds etc. Kill them with alcohol and separate the collected organisms by their function in the ecosystem. Place them on a table or piece of paper in levels with plants at the bottom, plant feeders at level 2, natural enemies at level 3, and predators / decomposers at level 4. Explain and discuss the functions and relationships between each level.

Insect - plant interaction

1. Groups should collect in the field as many insects as possible with a butterfly net and bring it to the classroom. Discuss with farmers on the harmfulness of insects and indicate what insects are harmless.

2. Monitor harmful insects by weekly recording the prevalence in the field during the most critical time in the plant's growth. Compile data graphically and discuss results.

3. Start an insect zoo for the most harmful insects by collecting eggs and raising the insects in a cage with potted plants, glass bottle or plastic bag. Weekly observe the developments from larvae to adult. Make a drawing of the insects in each phase. Explain and observe the insect lifecycle and insect feeding habits, natural enemies and potential crop damage.

4. Observe insect plant damage between different varieties by drawing the damaged leaves, pods, inflorescences, and seeds. Collect the variety score and discuss plant reactions. Explain the plant's physiology why some genotypes are resistant or tolerant to pests and others are not.

Disease-plant interactions

1. Ask participants to collect as many plants with symptoms of possible diseases. Explain differences between damages caused by a-biotic factors and biotic factors (diseases). Monitor the crop's harmful diseases on weekly or bi-weekly basis. Observe records of the most harmful diseases and discuss the disease cycle.

2. Observe disease resistance between different varieties by drawing the damaged leaves, pods, stalks and seeds, wherever applicable. Collect the score and discuss plant reactions. Explain the plant's physiology of resistance and tolerance and discuss why some genotypes are more resistant or tolerant to disease than others.

Natural enemies and predator

1. Ask a farmer to tell a story on how his crop got damaged by birds, rats or wild animals and what he did to prevent damage in the next season. Alternatively, facilitators may come up with stories about farmers who were effective in preventing damage by animal. Discuss how to apply their methodologies in the farmer's fields.

2. Observe varieties and identify morphological characters that (potentially) prevent bird or rat damage etc. Prepare drawings of the plant parts with these characters.

3. During or after an attack by natural predators, study the field layout and observe carefully the damage done to various parts of the field. Carefully check whether these disparities will influence the variety comparison results

Some Questions for Conceptualization

1. What organisms are at the bottom and which ones at the top of the ecosystem?
2. Where do the pests come from? What is the main pest?
3. Are there specific pests that we have to monitor more closely?
4. What sort of damage do the pests do at this stage?
5. Are they present in all the different plant groups or are they in one variety only?
6. What kinds of pests are present in the field?
7. How does the natural insect enemy population compare with the previous week?
8. What is the importance of natural enemies? Are birds natural enemies or pests? How can we make use of this?
9. Are the pests and diseases present in all the plants or are they concentrated on a certain plant or varieties? Which plant group is preferred by pests?
10. What sort of damage do pests do at this stage?
11. Is there any way that we can prevent harmful insects from increasing in numbers in the field?
12. If you decide to spray against pests, does spraying affect our observations concerning pest and disease resistance? When do we have to spray
13. Do the surrounding fields influence your field? How? What is the condition of the other surrounding fields?

14. How do diseases spread? What is the main disease in your fields?
15. Discuss how the different varieties or pedigree lines should be examined for diseases, what are the symptoms? How should this be recorded?
16. Are some leaves dying? Why? Is this natural? In which variety is this more pronounced or observed?
17. If you decide to spray against pests, does spraying affect our observations concerning pest and disease resistance? When do we have to spray?
18. Make drawings of the symptoms
19. Is there any disease in the field now
20. How can spreading of the disease be prevented?
21. Do diseases influence yield qualitatively or quantitatively?
22. Where do birds or rats come from? Are they always present in the locality?
23. Is there any way to prevent birds from doing damage to the field?
24. How can we control rodents?

4.4 Plant Morphology and Growth Stages

Introduction

Farmers generally know their vegetable crop very well. Indigenous knowledge accumulated over time has lead to particular varieties and crop cultivation techniques that are well adapted to the specific growth environment. They generally are eager to learn and improve their crop management practices.

Science has given a lot of information about specific interactions in the agro-ecosystem, such as plant growth, physiology, photosynthesis, and mechanisms on stress resistance, pest and disease resistance and optimal plant types. Supplementing indigenous knowledge and discussing about these topics will assist farmers in better understanding their crops and will provide them guidance in keenly observing characteristics for selection and improvement.

Farmers will easily recognize the aspects of plant morphology and growth stages discussed in this session. This will allow them to get a better understanding of the plant agro-ecosystem and to use this in their variety observations and comparisons.

Objectives

- ✓ To provide an overview of the morphology and growth stages of bitter gourd, angular gourd, and pumpkin
- ✓ To provide a general idea on changes that occur on these vegetable plants at various stages of growth and development

Materials

- Fields with different growth stages and varieties (vegetative phase, flowering phase, fruiting phase). For this exercise, use normal farmer fields or a separately planted plot. Do not use the field studies.
- Newsprint, markers, pens
- Field tools, magnifying glass, scissors, measuring stick

Time guide

Activity	Time	Main Points
Field exercise	15'	Collection of plants in different growth stages
Classroom exercise	60'	Plant observation and drawing
Learning exercise	30'	Explain morphological changes during growth stages
Group observations	60'	Dissect plants and detailed observation
Plenary discussion	15'	Comprehension
Total Time	3	Hours

Procedure

1. Split up in three groups and go to the field. Each group is assigned to a distinct crop growth stage.
2. Instruct to collect three specimens of each plant stage and each variety (including root system) by digging up the plants and bring it to the classroom.
3. Ask the groups to observe the plants carefully and note recognizable plant parts and differences between the plant stages and varieties. Prepare drawings of the plants on paper.
4. Groups will present their observations using the drawings. Arrange the drawings on the wall by growth stage and variety.

5. Using the drawings demonstrate the changes that take place in the vegetable plants from seed to maturity. Point out the three main growth phases: vegetative, flowering and fruiting stage, and the various morphological developments that take place in the plant phases.
6. Ask the groups to exchange plants so that each group has all plant stages in front of them. Assign farmers the task to dissect the plants and uncover the flowers and buds and to observe the seed development characteristics from initiation to maturity in the fruits.
7. Facilitate the discussion ensuring that farmers understand the changes in the plant parts, and relate this to cultural yield management and yield potential.

Note for the Facilitator

1. Facilitators can extend this exercise with observations on special topics of interest to the farmers. Small research topics may be worked out by the farmers and features observed and collected throughout the season. This may include such topics like plant density, fertilization, and other genotype x environmental interactions. See further the exercise on GxE interaction.
2. Pictures of the vegetable crops under study are presented in the annex. If needed, these pictures can be enlarged for illustration during the session exercise.

Questions

1. How long does it generally take from emergence to trifoliate leaf stage? And to beginning bloom?
2. How many flowers does a plant generally produce? How many fruits, seeds? Why do not all flowers produce fruits?
3. Can you observe differences between varieties in the number of leaves, root development and flowering?
4. How long or deep is the root system? Can you observe differences between varieties? Does this tell you something about plant growth, and about drought or flood resistance?
5. Is bitter gourd, angular gourd, and pumpkin a self-pollinating or an open pollinating crop? Why?
6. In what stage is the vegetable plant most sensitive to stress such as water shortage or high temperatures?
7. What pests do you commonly observe during the different growth stages?
8. What is the importance of knowing the morphology and growth stages of the cowpea plant?

4.5 Plant Reproductive Characteristics

Introduction

The plant reproduction stage is the most critical phase in the breeding process. It is in this stage that the best parent varieties and lines are selected and crossings are made.

Farmers need to understand how the plant manages to reproduce through female parts and male parts development; pollination, pod and seed set, and relate this new acquaintance to cross breeding and selection procedures.

In this session, farmers acquaint themselves with the reproductive characteristics of bitter gourd, angular gourd, wax gourd and pumpkin. This activity is an excellent exercise to prepare for cross breeding.

Objectives

- ✓ To discuss the characteristics of bitter gourd, angular gourd, pumpkin and wax gourd during the reproduction stage
- ✓ To study the respective flower morphology and pollination process

Materials

- Vegetable plants in flowering stage, at least 2 weeks after the plant has begun to flower.
- Knife, magnifying glass, forceps, tape, marker pens, counter, notebook, flag sticks, drawing paper

Time Guide

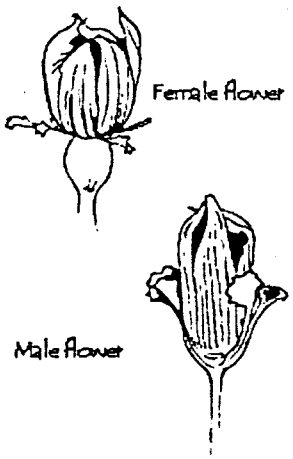
Activity	Time	Most important content
Introduction	10'	Instructions
Field Exercise 1	45'	Flower observation and counting
Field Exercise 2	60'	Insect pollination observation
Classroom exercises	45'	Flower development observation and drawing, insect observations
Group discussion	20'	Sharing of results
Topic explanation	15'	Explain reproduction process
Final discussion	15'	Comprehension
Total Time	2	Hours

Procedure

Flower Morphology

1. The first exercise aims at recognizing the different plant parts involved in the reproduction process.
2. Split up in small groups. Enter a field with a standing crops in flowering stage and ask farmers to observe the flowering stages of the different varieties; in case not all varieties flower, estimate how many days it will take for the varieties to reach the flowering stage, and to produce the first fresh fruit. Note the responses of the varieties down for later reflection.
3. Ask farmers to observe male flowers and female flowers. Note the differences between the flowers by pointing at the presence of stamens in the male flower and the presence of stigma in the female flower. Also point at the "baby pumpkin" (or baby gourd) below the female flower which is clearly lacking with the male flower.
4. Observe the number of stigma lobes (normally 5-6) and
5. Observe the still closed flower buds and ask the farmers whether they can determine which flower buds will open the next morning, and which one not. Mark the flowers with a tag, and

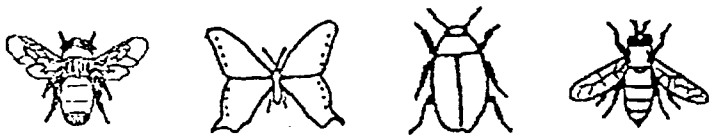
ask farmers to return the next morning and to note whether these flowers have opened. Results should be presented in the next FFS session.



6. Let the farmers randomly select five plants and count the number of female and male buds and flowers on each plant; calculate the female: male rate and the average number of flowers per plant. Ask how many fruits on average a plant will produce. Discuss the imbalance between female and male flowers, and the discrepancy between fruit and flower production.
7. Take a few samples of male and female buds and flowers and put these on water for detailed study in the classroom.
8. Back in the classroom dissect the flowers with forceps and knife, and ask farmer to draw a female and male flower. Using these drawings, explain the flower morphology and fruiting development.
9. Discuss the farmer's estimate on the flowering and fruiting forecasts of the various varieties.

Insect Pollinators

10. The next exercise is designed to observe the insects in the field and how they are acting as pollinators between female and male flowers of the same plant and in between plants.
11. Explain the farmers that each one of them is an "expert" on one specific insect.
12. Split up in groups of four farmers. Show the insect pictures and ask each group member to choose one insect. Thus there are four experts in the group, each for a different insect type.



13. Then ask each group to choose and mark a small area of the field in which to work. Using a meter stick, place four of the coloured stake flags in a 1 m by 1 m square plot.
14. Begin by recording environmental information on the data sheet. Be sure to include date, time, temperature and weather conditions. Once the preliminary environmental information is complete, farmers are ready to count their insects within the plot.
15. Each farmer in the group has the task to count the number of "his/her" insect landings on a flower in the delineated plot during a stretch period of 10 minutes. The procedure goes as follows:

    - The facilitator announces to start; the counting can begin.
    - Farmers observe carefully; every time "his/her" insect enters the plot and lands on a flower, pollinating it, the farmer make a tick in his notebook. If an insect pollinator leaves the plot and comes back, he will count it again.

6. How can you tell a flower has been pollinated or not? What are the differences between a successfully pollinated flower and one that is not?
7. What is the average number of flowers per plant? What is the average number of seeds per flower or fruit? Potentially how many seeds one plant can produce? Do you think this is realistic? Explain how and why seed set is reduced?
8. Do you think insects play a major role in the reproduction process? What factors will influence the role of insects in the pollination? How can we prevent or promote insect pollination? Does pesticide spraying influence the pollination process?
9. Why does wind not play a major role in the pollination process of these vegetable crops?
10. Considering the reproduction process, gourds are cross pollinating plants. Can you mention other plants with similar reproduction mechanisms? What makes gourds different from e.g. rice? Can you identify other plants that are self pollinating? Explain and discuss the implications?
11. Discuss the farmer's selection practices. Are there farmers who mix varieties on purpose in small quantities to improve their original variety? Is this process successful?
12. How can we improve the introduction of preferred characteristics in a local variety? Discuss the various options.

4.6 Cross Breeding Techniques

Introduction

This exercise will familiarize farmers with the different steps involved in controlled cross breeding vegetable gourds and pumpkin.

As a natural cross-pollinating crop, gourds and pumpkin readily cross without human intervention. Nature uses insects to make sure that pollination takes place. Since insects do not differentiate between flowers, and there are (usually) no barriers to prevent pollination of flowers on the same plant, also some degree of self-pollination occurs naturally. The rate of self pollination varies between 2-70% depending on the crop, the variety, and the environmental factors.

Artificial crossing aims to control these processes manually, thus allowing to selected parent varieties to cross with preferred qualities. Because of the monocious nature, and the large flowers, cross breeding in gourds and pumpkin is easy. In this exercise farmers learn to make crosses by using bags and hand pollination.

Objectives

- ✓ To observe demonstration of the procedures and techniques used in cross breeding
- ✓ To practice the cross pollination technique and manage the pollination processes

Materials

- Plants in flowering stage, at least 2 weeks after the first (male) flowers have emerged
- Knife, magnifying glass, forceps, tape, glassine bags, marker pens, drawing paper, labels

Time guide

This exercise should be split in three. When it is sure that there are enough female flowers to make crosses with, select the best day for making the crosses.

- The first exercise should be held during the late afternoon before the day the crosses are made
- The second exercise is to make the crosses and is held between 7 and 10 am (pumpkin, bitter gourd and wax gourd) or between 1-5 pm (angle gourd) on the next day.
- The third exercise takes place 3-4 days after the day when the crosses were made

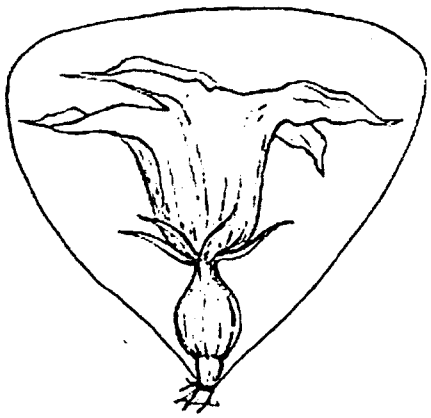
The cross breeding activities may stretch over a period of 1-2 weeks, depending on the number of suitable female flowers available.

Procedure

Late afternoon session (day before crossings)

1. Start the session by asking participants to review the reproductive process of gourds and pumpkin and to name the stages and flower parts involved. Ensure that farmers understand the reproduction process. A drawing should assist in the visualization (see annex). Previously the exercise on the reproductive characteristics should have been completed.
2. Go to the field and select a number of plots in flowering stage. Split the class into small groups of 4-5 participants.
3. Trainers present the participants with the following scenario: If farmers want to develop new varieties what qualities would they prefer? Ask the groups what varieties possess these qualities and what varieties would be good to combine to incorporate the preferred characteristics? Request them to identify in the field the two most preferred varieties for making a cross. Present the results to the plenary.

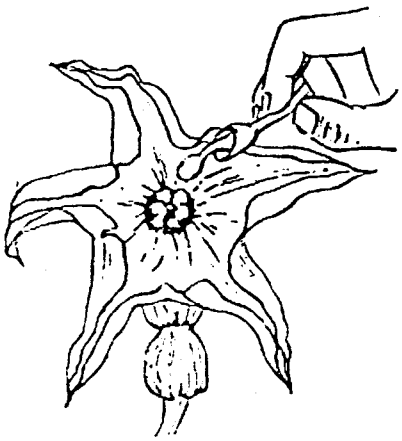
4. Alternatively, if farmers have already developed a crossing table (see 3.3 Cross breeding field study), which is highly preferred, recall and discuss this table. Note the number of female flowers of each variety that are needed to conduct the crosses.
5. Assign each group to one parent variety for the exercise.
6. Ask the groups to observe the female flower buds and to estimate which one of these flowers will open the next morning. Note that the petals should be still closed preventing insects to enter the flower.
7. Once the flowers have been identified, ask the farmers to cover the female flowers with a cellophane bag to protect it against insects. Tie the bag at the bottom carefully with a small thread to avoid insects from entering. Be sure not to damage the peduncle.



8. Finally, remove all the male flowers on the plant with the bagged flower. Count the number of bagged flowers and check if these are sufficient to complete the crossing.
9. This marks the end of the late afternoon exercise.

Early morning session (day of crossing)

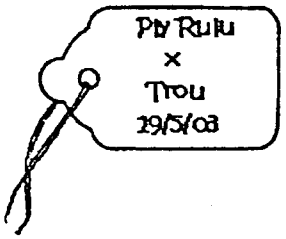
10. Enter the field and split up in groups. Assign each group to make one type of parent cross.
11. Ask farmers to inspect the bags on the female flowers and observe if the bags are still intact. When there is a small opening, allowing small insects to enter, the bag should be removed, and the flower rejected for making crosses.
12. Request farmer to write on the bag the name of the female parent variety with a marker pen.
13. Farmer groups will then proceed to the male parent variety plot, and pick open male flowers and collect these in a plastic bag. Mark the bag with the name of the male parent variety.
14. They will return with the male flowers to the female parent variety plot and carefully remove the bag. In the meantime the female flower has opened exposing the stigma.
15. Take one flower out, remove the anthers with forceps, and rub these gently into the exposed 5-6 lobes stigma. Alternatively, farmers can also use a fine brush to collect the pollen and rub it in the stigma. Be sure to touch all lobes of the stigma.



16. After pollination, again cover the female flower with the bag. Write the name of the parent variety on the bag, and the date of the cross. (e.g. PLYRULU x TROU, 19/5/03), as well as the name of the pollinator.
17. Crosses may be made reciprocal, meaning one parent variety can be used both as female as well as male parent.
18. Ask farmers to count all the successful crosses and to record this in their crossing table. Check if each group has completed their exercises satisfactory and summarize the learning topics.
19. This marks the end of the second exercise.

Post cross session (3-4 days after the day of the cross)

20. After 3-4 days, farmers will inspect the crosses. They must remove the bags and observe the flower. By this time the flower petals have dropped. Were pollination was successful; the ovary (the baby fruit) is clearly visible. Where it was not successful the flower altogether has wilted.
21. Instruct farmers to remove the bags and to fix a tag with the name of the parent varieties and the date when the cross was made. Attach the tag to the stem just below the flower that has been successfully pollinated, so that it is easily visible.



22. Ask farmers to calculate the percentage of successfully pollinated flowers. Compute the success rate as follows:

$$\% \text{ successful crosses} = \frac{\text{no. of flowers with baby fruit}}{\text{total no. of pollinated flowers}} \times 100$$

23. Note the successful crosses in the crossing table. Discuss the table in the plenary and review the rate of success.

Notes for the Facilitator

1. Farmers should keep on observing the developing fruits from the crosses until seeds have developed and the fruits have reached harvest maturity. Check whether fruits need support or protection.

2. Selfing of the plant is required in the simple recurrent selection method (see chapter 4.). In this case, the female parent flower should be pollinated with male flowers of the same plant. There is no need to mention the male parent on the bag and label. Replace the X with (X) which universally indicates selfing.
3. The first flowers on a plant are male; only after 1-2 weeks the first female flowers appear. There are between 20-40 times more male flowers than female flowers per plant.
4. Most problems with pollination relates to the timing the pollination takes place. While the stigma remain receptive for 24-36 hours after opening of the flower and exposure, pollen is only able to germinate for a couple of hours after anthers emerge in the early morning (afternoon for Angle gourd). For bitter gourd, for example, pollen germination decreases sharply after 11 am. Also, it is important to make sure that all 5-6 lobes of the stigma are fertilized.
5. In rare cases, plants may produce bi-sexual flowers (perfect flowers: stigma and anthers in one flower), which may depend on variety, environment, and time of flowering (last flowers appearing on the plant may becomes perfect). Be aware of this phenomenon. It is not likely that emasculation is required because there are usually sufficient imperfect flowers available on the plant.
6. Cross breeding in Sauropus (katuk) follow similar procedures, but bagging is a bit more difficult because the flowers are much smaller. In Sauropus, also perfect flowers develop.

Questions

1. Why is it necessary to understand the reproduction process for successful cross breeding?
2. Why do you need to monitor the flowering stages of the parent varieties?
3. Why is it good to prepare a cross table indicating the preferred parent varieties and the number of crosses that need to be made?
4. What is the reason to make reciprocal crosses?
5. Can you make controlled crosses without cellophane bags?
6. Consider this scenario: two parent varieties are planted in adjacent rows, while no other varieties are planted nearby. You decide not to apply bagging, because the plants will cross anyhow. Would you be successful in making the particular cross? What will happen? Why do we still prefer the bagging method?
7. What is the success rate of your crosses?
8. Did you make sufficient number of crosses?
9. What parts of this exercise did you find difficult? Do you have suggestions for improvements?

4.7 Breeding and Selection Techniques

Introduction

Vegetable gourds, pumpkin and Sauropus are all cross fertilizing crops. The selection techniques applied in cross-fertilizing crops are very different from self-fertilizing crops (like rice). The difference stems from the fact that cross fertilizing crops is by nature heterozygous and self-fertilizing crops homozygous.

Although crosses in self pollinating crops also produce heterozygous plants, continuous bulking and re-production automatically leads again to stable homozygous lines after 5-6 generations, from which a variety can be selected. In cross-pollinating crops this is not the case. In cross pollinating crops a large pool of genes is retained in heterozygote form simply because the open pollinating character of the crop provides for a constant re-mix of genes.
Selfing is possible, but may lead to inbreeding (retarded growth) because of reduced heterozygous plants.

Breeding in cross pollinating crops therefore is more complex than in self pollinating crops. This is because of the continuous risk of inbreeding and the requirement for isolation:

- Inbreeding; the selection techniques for cross pollinating crops are designed to reduce the risk of inbreeding by ensuring that at all times sufficient heterozygosis is retained in the population. To achieve this, the population is allowed to inter-cross as much as possible (bulk fertilization) after each cycle of plant selection or selfing. Also, the population size needs to be kept in check. Retaining too small populations (less than 50 plants) may lead to inbreeding (and loss of genes) which should be avoided.

- Isolation distance of at least 500 meter from other farmer plots or plots with different varieties is required to avoid mixing of unwanted genes. Careful planning of the bulk fertilization plots is needed. Also isolation in time can be applied by planting the different plots so that flowering is not synchronous (e.g. different months/seasons). Bagging of female flowers (or netting) creates the same effect of isolation, but requires considerable more effort and material and usually be applied only to small plots. .

Many selection methods have been developed by breeders for cross-pollinating crops. Here, two variants of the most common method: "Simple Recurrent Selection" are discussed. Farmers will be allowed to learn the selection methods step by step, choose the method they are most comfortable with and try it out in the field.

Objectives

- ✓ To introduce the selection procedures for cross pollinating crops
- ✓ To graphically present the methodologies and explain the strengths and weaknesses of each method
- ✓ To choose the most preferred selection method to apply in the current and next seasons

Materials

- Big size paper, markers, bowl
- 500 Pieces of colored paper, dyed seeds or stones. 10 different colors should be used to represent the segregating lines.

Time guide

Activity	Time	Aim
Introduction	20	Check know-how on reproductive process
Emasculation exercise	90'	Demonstration and practice of flower emasculation
Pollination exercise	90'	Demonstration and practice of flower pollination
Cross Management	20'	Explain management procedures
Final discussion	20'	Comprehension
Total Time	2	Hours

* Real cross breeding activities may take longer to complete

Procedure

1. Split the participants up into 2 groups.
2. Prepare two big pieces of blank newsprint and lay it on the floor for demonstration. Divide each paper into five sections by drawing four parallel lines. On the left side of each section write the year and the generation starting at the top with P1xP2, Year 1, year 2, year 3, year 4, year 5. Explain that year 1 is the offspring from the cross between parent 1 and parent 2 (F1), and that each section describes one generation (or season).
3. On each paper, deposit 10 pieces of paper (seed or stone) on the F1 section each with a different color. Tell farmers that each colored paper represents one plant, and that each plant produces five seeds. Explain that this is only for demonstration purpose and that the real F2 population in the field is definitely much larger (50 plants or more). Similarly the seed production per plant may be higher.

Simple Recurrent Selection Method 1

4. On the first newsprint write "Simple recurrent selection method 1" on top and demonstrate as follows: From the ten plants in the F1, select three plants and remove these from the paper. Explain that these plants have been roughed from the field.
5. Explain that all the other plants are then forced into self-pollination by bagging the female flower and pollinating it with male flowers from the same plant.
6. For each remaining plant, count five pieces of the same color representing the harvested seed from the plant after selfing.
7. Now lay the pieces in seven separate rows or lines of 5 plants in the year 2 (F2) section indicating the offspring planting. Explain that during the F2 growth season the lines are carefully observed and inspected. As a result of this inspection, two rows are rejected: remove the two rows.
8. The rest of the plants in the F2 are then bulked by allowing it to inter-cross and harvest together. Demonstrate this by mixing the remaining pieces in a bowl.
9. Lay the pieces on the year 3 (F3) sector to indicate the seed re-planting, and repeat the procedure as in F1. Continue the same procedure in the Year 3-6 (F4, F5 and F6).
10. Ask the first group to repeat the exercise. The other participants are watching to see if they perform the procedure correctly.

Simple Recurrent Selection Method 2

11. On the second newsprint write " Simple Recurrent Selection Method 2 (seed save method)" and demonstrate as follows:
12. From the ten plants in the F1, select three plants and remove these from the paper. Explain that these plants have been roughed from the field.
13. Explain that all the remaining plants are then forced into self-pollination by bagging the female flower and pollinating it with male flowers from the same plant.
14. For each remaining plant, count five pieces of the same color which represents the harvested seed from the plant.
15. Now lay the pieces in seven separate rows or lines of three plants in the F2 section indicating the offspring planting. Explain that not all the seed from the F2 is planted, half is planted, half is retained in store.
16. Demonstrate that the F2 growth season the lines are carefully observed and inspected for stress resistance and other criteria. The best plant rows or lines are written down. The plants are *not* harvested for re-planting.

17. The reserve seed from the F1 is taken out of store and those lines that performed well are replanted in the next season (year). Demonstrate this by taking the remaining 2 pieces and lay these on the year 3 sector to indicate the seed re-planting.
18. Repeat the procedure in F3 as in F1. Continue the same procedure in the F4, F5 and F6. .
19. Ask the first group to repeat the exercise. The other participants are watching to see if they perform the procedure correctly.

20. From the results of the above exercises, ask the groups to draw a diagram of the line selection method that they used in the demonstration.
21. Ask the groups to note down what they think are the strong and weak points of the line selection methods employed by them, and what method they would prefer to use in their vegetable breeding program. They should use the following table:

Selection Method	Advantage	Disadvantage	Preferred Yes/No
Simple recurrent selection			
Ear-to-row selection			

22. The groups present their diagrams and the list of strong and weak points and preferred selection method to the bigger group
23. Ensure that the participants understand the selection procedures and the advantages and disadvantages of each method. Discuss the topics thoroughly.
24. Make sure that farmers reach a consensus on the selection method.

Note for the Facilitator:

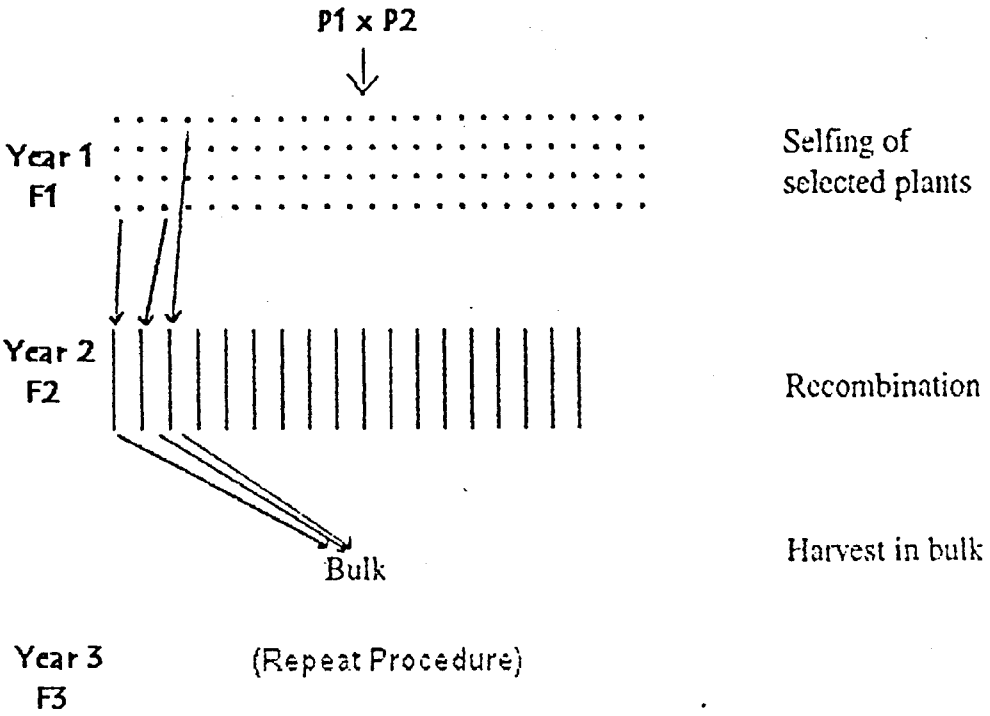
1. Selfing in the simple recurrent selection method 1 is used to allow testing the performance of each plant separately. If the characteristic is visible only after flowering (in most cases), bagging is always necessary. Only.in case the characteristics are visible before flowering (leave shape or color, seed vigor, some disease resistance), the breeder can rough off-types before flowering, avoiding contamination of the remaining preferred population, and bulk fertilize the plants using natural insect pollination. Make sure to apply proper isolation distance.

2. Discuss population size with the participants. As discussed, self-pollination leads to inbreeding. Retaining a too small population leads also to the same. To avoid in-breeding and genetic drift or inbreeding (in fact loss of genes), a plant population of less than 50 plants should be avoided.

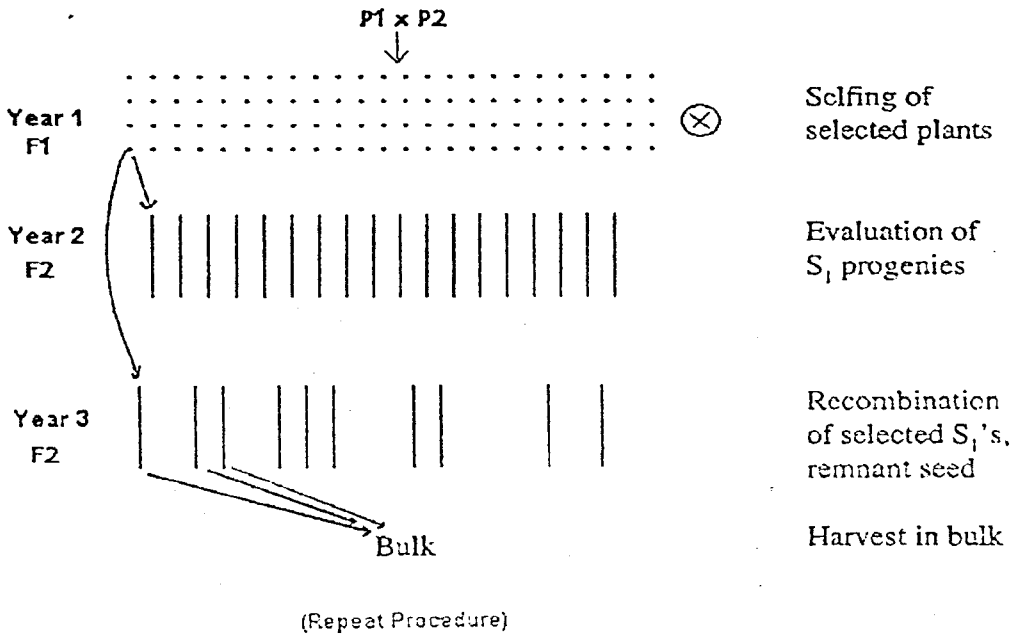
Questions

1. What method takes the longest to develop a variety? Why?
2. What selection method is easy to implement?
3. What is the main disadvantage of the simple recurrent selection method 1?
4. How many seasons does it take to produce a new variety after a cross is made?
5. What method do you prefer and why?
6. Would you be able to help other farmers to select lines from segregating populations? Why or why not?

Simple Recurrent Selection Method 1



Simple Recurrent Selection Method 2
(Seed Save Method)



Some advantages and disadvantages of selection methods in cross -pollinating crops

Selection Method	Advantages	Disadvantages
Simple Recurrent Selection Method 1	- For selection of characteristics visible before flowering (requiring no selfing) - New varieties can be selected in 4-5 seasons	- Line evaluation plots of different crosses cannot be planted in the same field because of isolation requirement
Simple Recurrent Selection Method 2	- Slightly easier to carry out - Line evaluation plots can be planted in the same field, no isolation required because only saved seed is used for replanting	- It takes a longer time (8-10 generations) to create a new variety - More storage space required

4.8 The Deterioration of Variety

Introduction

Most farmers lack easy access to new varieties. Though improved varieties may be available, they are seldom economically affordable or adapted to the specific subsistence environment. Farmers tend to rely therefore on on-farm saved seed and seed obtained from the community neighborhood. Occasionally, new varieties are introduced in the farming community, tested, and if performing well, multiplied for popular use.

Over time, farmers may notice that their variety loses 'its character' or in other words it has 'deteriorated. This usually means that the genetic makeup of the variety has changed in negative sense. The variety may have lost its capability to yield, has become disease susceptible, height has decreased, or it has lost taste, etc.

This session is designed to do three things: to help farmers understand what causes varietal deterioration, to assist participants comprehend the genotypic and phenotypic makeup of their varieties and to determine the selection criteria and method for variety rehabilitation in their field study.

Objectives

- ✓ To identify symptoms and explain the causes of varietal deterioration
- ✓ To discuss the need for variety rehabilitation
- ✓ To decide on the selection method for variety rehabilitation

Materials

- Fields with different growth stages and varieties (vegetative phase, panicle development phase, grain filling phase) of the pearl plant
- Newsprint, markers, pens
- Field tools, magnifying glass, scissors, measuring stick

Time guide

Activity	Time	Most important contents
Introduction	15'	Discussion on the validity of deterioration
Group discussion	45'	Determine positive, negative and desired traits
Field exercise	60'	Observe and measure critical traits
Compilation	45'	Discuss results and determine selection criteria /clusters
Classroom discussion	45'	Discuss variety deterioration causes and rehabilitation
Final plenary	30'	Review and decide on selection criteria and methods
Total Time	4	Hours

Procedure

1. Initiate a discussion on variety rehabilitation by asking why farmers choose the varieties included in the field study on variety rehabilitation. Verify whether farmers can get better seed in the community and to what degree the varieties are perceived to be deteriorated.
2. Split up in groups. Assign each group to work on one variety. Those farmers that are most familiar with the particular variety should join the group.
3. Ask each group to indicate the most positive and the most negative characteristics of the variety, and indicate what characteristics have been deteriorated. Use the table below:

Variety:			
Sl No.	Positive traits	Negative traits	Deteriorated traits
1			
2			
3			
4			

4. Groups will present the tables in the plenary. Then select one criterion per variety that is found important and can be measured easily in the field at this time in the season (such as plant height) and agree on the measurement scale.
5. Then go to the field and ask the groups to measure the selected criterion on 25 randomly selected plants in the variety rehabilitation plots. Also let farmers visually observe the differences (variability) of the other criteria. If possible, collect specimen of plants with key characteristics and bring these to the classroom.
6. Back in the classroom, ask the groups to summarize their data and prepare a frequency distribution of their measurements by making 3 -5 categories and present these in a column diagram (note: to obtain the categories subtract the highest score with the lowest score and divide this by 3 or 5).
7. Groups will present the diagrams and the results of their observations. Discuss the observed variability. Ask the participants what plants would be preferred, and which ones are perceived deteriorated and probably would be rejected.
8. Note the number of desired traits among farmers. Verify whether farmers can identify clusters of preferred characteristics.
9. Then agree on the selection goals to be used in the variety rehabilitation.

10. Ask participants what they think has caused the deterioration? Note down the responses including the traditional beliefs.
11. By referring to causes of deterioration, ask some farmers to come forward and tell the audience their own experiences regarding admixtures, mutation, spontaneous out-crossing etc.
12. Ask what farmers commonly do to prevent deterioration. Differentiate between the various vegetable crops. Some farmers will come forward and tell of their experiences and how effective their methodology was.
13. Explain and discuss the technical aspects of these causes and preventive measures wherever necessary.

14. Review the selection techniques. It is assumed that the exercise on selection techniques have been completed prior to this session.
15. Discuss the advantages and disadvantages of the different selection techniques for variety rehabilitation and agree on one technique to use in the field study.

Notes for the Facilitator

1. After the field exercise, it is recommended not to return immediately to the classroom, but to visit a number of fields planted with the same varieties by other farmers in the community. Ask farmers to observe the variability and varietal characteristics in these fields and verify whether these are different from their own fields, and whether they would classify these deteriorated. Discuss the term "deterioration". Ask why they cannot find better seed of their variety.

2. Even in vegetable crops, farmers often recycle hybrid varieties. It is likely that the discussion on variety deterioration focuses on former hybrid varieties. Be aware of this and ask farmers the origin of the variety. Explain that it is not possible to restore the characteristics of hybrid varieties.

3. Some traditional vegetable varieties may have become 'landraces', which is a mixture of various types with specific traits. Selecting for one specific plant type in a land race may not restore the original variety. Although it is less likely to find landraces in vegetable crops, be sensitive to this point when farmers describe their varieties and when the selection methods are explained. Check for multiple selection goals.

Questions

9. How can you tell if a variety is deteriorated? What are the symptoms of deterioration?
10. What varieties have deteriorated in your locality?
11. What do farmers say causes deterioration? Are these perceptions based on individual 'beliefs' or is this somehow proven fact in the community (experienced by everybody)?
12. What do farmers practice to prevent varieties from deteriorating? Is this common practice or only carried out by a few farmers in the community?
13. What can you do more to prevent varieties to deteriorate?
14. Which measures to prevent deterioration in cowpea varieties are different from pearl millet varieties and which ones aren't? Explain?
15. Is it possible to restore the characteristics of the original variety? How?
16. What kind of selection methods can be applied to rehabilitate a local variety? Which one do you prefer?
17. Did you ever plant hybrid varieties? Did you notice any deterioration when re-planting the seed harvested from a hybrid?
18. Is it possible to restore hybrid variety characteristics? Why not?

4.9 How to Harvest and Preserve Selected Seed?

Introduction

In plant breeding harvest time is the most critical period of the season. Prior to harvest the farmers will make their final selections and decide what plants will be carried on to the next planting season for further selection.

At harvest, the selected varieties, plants and lines must be carefully identified. Each fruit should be separately harvested, the seed extracted, dried, cleaned and stored. Fruits and seed lots must be identified with tags and labels and entered in bags to avoid admixtures. Clean storage rooms must be prepared to carry over the seed to the next season or to keep the grain for further post-harvest evaluations such as kernel size, color, and taste.

In this session farmers will focus on the specific activities prior to, during and after harvest time that are needed in the breeding program.

Objectives

- ✓ To understand the harvest procedures in a plant breeding process
- ✓ To explain requirements for seed storage and preservation
- ✓ To prepare a harvest working plan

Materials

- tape, marker pens, newsprint

Time guide

Activity	Time	Most important contents
Introduction	15'	Discuss harvest
Group exercise	45'	Discuss farmer's and breeder's harvest systems
Group exercise	60'	Elaborate work plan for harvest of field studies
Plenary-discussion	30'	Finalize work plans
Total time	2½ hours	

Procedure

1. Draw the participants into the topic discussion by asking around who has the most number of vegetable varieties standing in the field. Ask him to come forward and tell the class how he is harvesting his varieties, dry, store and planting, especially what he does to keep the crops and varieties separate.
2. Split up in groups. Ask each group to consider differences between the farmer's system of harvesting and the breeders' system of harvesting. Use the table below.

CRITERIA	FARMER'S HARVEST SYSTEM	BREEDER'S HARVEST SYSTEM
Selection before and during harvest		
Selection after harvest		
Labor requirement		
Kind of people involved		
Administration		
Threshing		
Drying		
Storage		

3. Groups will present their findings in the plenary.
4. Discuss the topic of seed harvesting by asking where farmers foresee problems in the harvest of the field studies: variety evaluation, variety rehabilitation, and cross breeding. Write the problems on note cards and discuss possible solutions.
5. Refer to the specific problems and starting from this, explain the procedures for separate harvesting of varieties and selection lines.

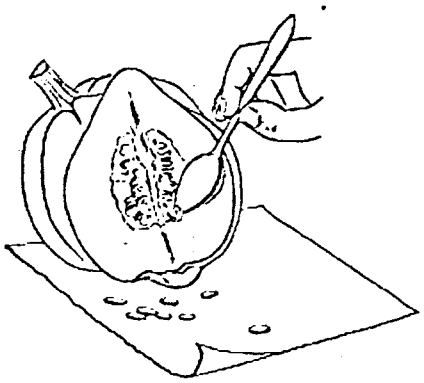
6. Split up in groups and ask the groups to prepare a work plan for the harvest of the field studies. Assign participants already responsible for specific field studies to the same group. Use the following table.

Format for planning activities for field study harvest

Field Study: _____
Date:_____

No.	Main Activity	Purpose	Detailed activity	Time	Participants involved	Main person responsible	Equipment needed
1							
2							
3							
4							
5							

7. Upon completion, groups will present the work plans.



8. Discuss each activity and ask whether all these activities are needed to carry out the harvest satisfactory. Delete or make additions if necessary. Observe whether the time scheduled for the harvest of the different field studies clashes with each other or with farmer's own harvest activities. Make corrections where necessary.

Notes for the Facilitator

1. Discuss the farmer's extraction and storage methods and verify whether this is sufficient to preserve the quality of the seed.

Questions

1. What is the main difference between the farmer's harvest system and the breeder's harvest system?
2. Do you have sufficient labels, bags, drying areas and storage space to handle the different varieties and lines?
3. What do you find difficult in this exercise and in the upcoming field study harvest? How can this be resolved?

4.10 Cooking and Eating Quality Evaluation

Introduction

To farmers the shape, color, processing qualities, texture and taste can be more important than the absolute yield. A vegetable crop is almost worthless if it doesn't have the right properties for the type of foods the family eats, or demanded by the market. Vegetable crops are largely grown for its nutrients and for its flavor. The Asian kitchen is very rich in using vegetable crops; often not only the fruit, but also the seed, the flower, leaf and stem are consumed.

It is therefore very important to evaluate the cooking and eating qualities of the varieties and selected lines. Only stable lines like varieties and lines from F6 up available in surplus quantities should be evaluated. Segregating lines at the early generations are not yet stable enough as they still change in character.

Objectives

- ✓ To evaluate the grain characteristics, processing and eating qualities of varieties and advanced selection lines
- ✓ To allow farmers to better understand their gastronomical preferences

Materials

- Kitchen, several grinding and cooking tools, plates
- Tags, newsprint, markers
- A panel of evaluators (including other villagers)

Time guide

This exercise can be part of a workshop celebrating the end of the season's training sessions (farmer field day). The evaluation may be followed with a presentation of the overall results and final evaluation.

Activity	Time	Most important contents
Criteria listing	30'	Designing the evaluation form
Food preparation	120'	Varieties or lines are processed into various dishes
Food testing	90'	Participants taste and score the entries
Score compilation	30'	Preparation of the summary table
Discussion	30'	Consolidation of test results
Total Time	5	Hours

Procedure

1. Split up in male and female groups.
2. In this activity the farmers will design the evaluation form. Ask the participants what type of foods and dishes they eat and what characteristics they prefer in the preparation and taste of these foods? What is a good vegetable crop to them? If more than one plant part is used, verify how important the taste, flavor or processing characteristics of the secondary plant parts (e.g. flower) are in relation to the primary plant parts (e.g. fruit).
3. Make a priority list of the dishes to be prepared per vegetable crop. Some may be fresh produce, others have to processed in the kitchen.
4. Ask the groups to list the criteria for each of the food dishes mentioned. Rank the criteria in order of importance.
5. Groups will present their list of criteria in the plenary. Discuss differences between male and female preferences.
6. Agree on the dishes that should be prepared, the list of criteria to be measured, and the measuring scale. On a scale of 1-5 use 5 as the highest preferred, and 1 as the least preferred. Do not use 0 for computational reasons.

7. Prepare the evaluation form for each dish. The form can be something like:

Crop: _____
Dish: _____
Date of evaluation: _____

VARIETY / CRITERIA	1	2	3	_	10
1: i.e. Aroma					
2. taste					
3. color etc.					

8. For each variety prepare the food that the farmers want to evaluate. Verify that the dishes are prepared under the same conditions, such as heat, water measurement, salt, etc. Preferably the dishes should be prepared by or under direct supervision of the facilitators.
9. Take care to keep the lines and varieties separate. Give each entry a number code. Note down the details with name and origin in a notebook. Do not give the farmers the names as this may influenced the preferences of the participants.
10. Place each dish on a plate and line it on a table with identification number. Alongside the dishes, facilitators can place the original grain and the milled grain. After two or three dishes farmers can place a glass of water for farmers to drink after tasting a couple of varieties or lines.
11. Give the farmers the evaluation form and ask them to form a line. Instruct the first farmer to taste the first entry and to fill out his form. This should be done without others observing it. He then moves on to the second plate and so on. After 3 plates, the second farmer can start tasting. When finished, ask the farmers to re-check their entries for each criterion and write their name on it.
12. After finishing the test run, prepare a big paper with the evaluation form and ask each farmer to enter his/her scores per variety or line. The score for each criterion will be totaled and the varieties ranked.
13. Finally reveal the variety names. Note the reactions and discuss the results.
14. Repeat the exercise with the other crop and dishes that farmers wish to test.
15. Document the evaluation results

Notes for the facilitator:

1. Farmers are usually very excited about this exercise. There will be surprises for both farmers and facilitators as the names of the varieties are hidden during the test.
2. Uncover potential differences in taste by grouping farmers by gender (male/female), by age (young/old), or by any other nature (ethnic, origin, education etc).
3. Participants should test a maximum of 2-3 dishes only per day. The taste receptors of the participants may falter if they taste more or eat too much, which can interact with the test results.

Questions

1. Do you find major differences in taste or appearance of the entries tested? Do you find entries that perform better than the control variety?
2. If you compare the gastronomical characteristics with the agronomic characteristics, do you see large differences?
3. Do you think you will be successful in selecting a better variety?
4. Are there any characteristics that have come up in this exercise that need to be more emphasized in the breeding program? Which are these?

4.11 Variety and Line Comparison

Introduction

The purpose of variety or line evaluation is to determine which one is the 'best', i.e. most suitable for cultivation, consumption, trade or any other purpose. Deciding on the value of a variety is a complex process which can be either subjective or objective. Farmers usually apply subjective perception in the evaluation of varieties. They base their decisions on observations using their senses: eyes (how it looks), mouth (how it tastes), hands, tongue or stomach (how it feels) and nose (how it smells). In addition, they may apply market criteria perception (how it earns).

Some field or farmer oriented breeders may do something comparable. But most breeders rely on field records and observations to compare and evaluate varieties. They determine criteria, time and measuring scales well ahead of the season and enter individual observations in complex comparison tables. Complicated field designs with replications have been introduced to statistically remove the effects of the environment and to decide more reliably on the value of the varieties included in the trial.

In variety evaluation it is not necessary to go through a complex process of data management if only a few varieties are compared. Especially if just a small number of criteria are considered important such as, for example, drought resistance or yield, selection of the best performing variety is not a complicated activity.

Farmers are generally not familiar with data management. Imposing scientific methods on them is therefore not effective, as they will quickly loose interest. It is important to leave the initiative with the farmers. This way, it keeps them involved and they will remain in charge of the selection process and enhances the use of the selected end- product.

Below some of the most basic methodologies for variety and line comparison are discussed. This allows farmers to understand the effectiveness of their own comparison methods, and adding new skills for use in their on-farm breeding program.

Objectives

- ✓ To demonstrate several variety and line comparison methods
- ✓ To understand the strength and weaknesses of the different comparison methods
- ✓ To practice the comparison methods using own field observations

Materials

- Large size paper, markers, scissors, notebook
- Field trial with a number of varieties or selection lines
- Records of field observation on important selection criteria

Time guide

This exercise is best scheduled somewhere between planting and maturity, preferably just before flowering. It is not necessary to demonstrate all methods in one session. Different methods may be used when new data become available.

Activity	Time	Important comments
Field exercise	60'	Collection of variety comparison data
Group Presentation	30'	Explain visual and pair-wise comparison method
Group exercise	60'	Explain score-card comparison
Group exercise	60'	Explain index ranking comparison
Plenary discussion	30	Comprehension
Total Time	4	Hours

Procedure

1. Ask farmers to go to the field, observe the different varieties plots and select which variety performs best. Each farmer should note down which variety performs best and why.
2. Split up into three groups. Ask one group to make pair-wise variety comparison with the control variety. Indicate which varieties perform better than the control and which do not perform better.

	Variety A	Variety B	Variety C	Variety D etc.
Control Variety				

3. Ask the other groups to make variety comparison in all kinds of combinations. Group 1 should take variety number 1-10, group 2 variety number 10 to 1 (more numbers should be added if more varieties are to be included). Using the table below, each group should indicate which one is the best performing among the two varieties compared, and indicate why.

	Variety A	Variety B	Variety C	Variety D
Variety A				
Variety B				
Variety C				
Variety D				

1. Visual comparison

4. Go back to the classroom and ask participants to collect the observation results of the first exercise and rank the varieties in order of highest frequency. Indicate the reasons given for choosing the variety.

Pair-wise comparison

5. The groups present the result of the pair-wise comparisons. Prepare a table that includes all varieties and count how many times a variety is selected as best performing.
6. The group then should present the control variety comparison. Make a ranking of the best performing variety.
7. Compare the results of the pair-wise ranking with the ranking results from the visual comparison exercise.

Scoring card comparison

8. For demonstration of the scoring card, observation data collected by one of the task groups should be used. Participants should indicate which of the criteria are the most important. Select the top five criteria for the exercise.
9. Demonstrate the scoring card by using one criterion and ask the groups to complete the matrix by filling in the records for the other criteria selected. For a sample table below.

VARIETY / CRITERIA	VARIETY A	VARIETY B	VARIETY C
Criteria 1 (plant height)	4	4	8
Criteria 2 (pest resistance)	3	8	2
Criteria 3 (early maturity)	6	3	1
Criteria 4 (yield)	4	3	7
Criteria 5 (etc_.)			

10. Then ask the groups to prepare a ranking with the best performing variety on top and the worst performing variety below.
11. Present and compare the results of the scoring card with the results of the pair-wise comparison.

Index ranking comparison

12. You may use the observed records of the five criteria collected by the task groups again for demonstration of the Index ranking method. Practicing with the same set of data facilitates comparison between the methodologies and stimulates the discussion.
13. Take the score card as basis and compute vertically the sum of the value per variety as well as horizontally the sum of the value per criteria. Note that it is difficult to compare the varieties when there are many criteria involved. Let farmers compare varieties first at the criterion with the highest ranking, then at the criterion with second highest ranking etc. Note that it is not possible to consider all criteria at once. Explain that the index method is developed to compute the measurement to enable variety comparison over all criteria.
14. Ask farmers to score the observed criteria in order of importance by giving each criteria a score 1-10 (1= low priority, 10 = high priority)
15. Then demonstrate the index ranking method by computing the Index for each single variety and criterion using the computation below. Start the procedure with one single observation:

$$\text{Index} = \frac{\text{Observation} - \text{Observation Average}}{\text{Observation Average}} \times 100 \times \text{Criteria Score}$$

16. Ask farmers to calculate the other indexes for the specific criterion, and then to calculate the indexes for the other varieties and criteria. Finally compute horizontally the sum of the index values per variety.

VARIETY / CRITERIA	VARIETY A	VARIETY B	VARIETY C
Criteria 1 (e.g. plant height)	Index a1		
Criteria 2 (pest resistance)	Index a2	Etc.	
Criteria 3 (early maturity)			
Criteria 4 (yield)			
Criteria 5 (etc_.)			Etc.
SUM OF INDEX	Sum index A	Sum index B	Sum index C

17. Examine the final scores for varieties in the bottom column and compare these. Indicate the best performing variety. Observe the relative scores in the table for each individual criterion and compare these with the scores in the scoring card. Note the differences.
18. Ensure that all farmers are involved in the comparisons and understand the methods.

Questions

1. Individual farmers may have different opinions on whether a variety performs better than the other. Why is it so important to find out which variety performs best? What do breeding objectives have to do with this?
2. What are the benefits of the visual and pair-wise comparisons? What are the weaknesses of these methods?

3. What type of information do you need to complete a score-card? Who should collect these data?
4. When do we use the score-card method? What are the limitations?
5. When you compare a few varieties, should you use the index method? Why?
6. Which method do you consider gives the best comparison? Which method is best for our farmer community? What method should we use in our breeding program?
7. What did you find difficult in these exercises? Can you recommend improvements?

Note for the facilitator

1. Facilitators should conduct these exercises at different times during the season. It is suggested to start with the simple methods i.e. visual comparison and pair-wise comparison; continue with score cards during the flowering stage, and schedule the index method at the end of the season when the number of observations becomes somewhat overwhelming for the farmers.

2. The pair-wise ranking method is a simple method that can be used in various situations. It is very suitable for farmer-based environments as it relies largely on visual interpretations. In addition, it serves to determine what criteria are found most important by the farmers. By discussing why they have chosen the varieties, farmers may sometimes disclose criteria which previously have not been identified. The method may also help to determine problems of preferences by individual community members. To reveal these differences, individual pair-wise scores should be noted and frequencies of preferences collected in a summary table for discussion. Despite these benefits, the pair-wise method remains a somewhat subjective tool and does not provide the detail that is sometimes required to select certain varieties and lines.

3. The scoring card method allows for a simple comparison between varieties for a range of criteria. In this score virtually any scale can be used, from 1-3 or 1-10, A-C, + and -, low/medium/high etc. The scoring card is very suitable for participatory ranking methods (i.e. using stones) to be used for illiterate farmers, although numeric scoring is highly preferred. It is best to schedule this exercise when the farmer task groups have collected some major observations, probably around flowering time. The scoring card is both a subjective and objective tool depending on what and how an observation is scored, and how many farmers are involved. It becomes truly objective when farmers agree on the scale to be used. If a numeric scale is used, do not include 0, always define 1 as least preferable and 5 or 10 as most preferable, to avoid confusion. The score card becomes less effective when a large number of varieties and criteria are used in the comparison. A possible technique to improve the score-card methodology is to make simple black and white comparison with the control variety (better/not better), or to rank varieties based on the average for the criterion (above/below average).

4. Farmers may get confused when too many criterions and varieties are compared, especially when some criterions are more important than others. The index ranking method provides a suitable solution in this situation, by providing an independent objective basis for comparison. It is nevertheless a rather abstract method that may not be applicable in all situations. Whether to use the index method or not depends completely on the farmers level of education and the number of varieties or lines and criteria used in the comparison. It may for example best be used when a large number of pedigree lines need to be selected. Alternatively, it may be used to make a final comparison of varieties at the end of the season.

5. Wrapping-Up the Season's Activities

Introduction

When all crops have been harvested and variety land line evaluations completed, it is time to wrap-up the season's training course. Preparations must be made for organizing a farmer's field day to report back to the whole community on the lessons learned and progress made.

The farmer's field day is a celebration. It is carried out to share the results of the studies to other farmers in the community, to relatives and officials. The farmer's day also serves as a platform for farmers to generate support for their activities to dignitaries and officials.

It is important to well prepare the farmer's field day. The days ahead of a field day are usually full of activities: evaluations are finalized, graphs and tables prepared, performances rehearsed and exhibition rooms arranged.

Apart from the preparations, ample time will be needed to evaluate the lessons learned, and to make a planning for the next season. This can be done either before or after the field day.

5.1 The Farmer's Field Day

Introduction

The field day is, par excellence, the occasion for the participants to show other people in the community what they have learned and to reveal the results of their achievements. The participants must plan for and implement the activity. They may send out invitations to farmers from the same or neighboring communities, and to relatives. In addition, the facilitators can send letters of invitation to local government executives and other officials with the view of orienting them on the program.

Objectives

- ✓ To determine the activities for the field day
- ✓ To implement the field day

Materials

- A "learning field" with fresh and mature fruits
- Exhibition room and materials
- Tape, newsprint, and markers

Time guide

Participants need to devote considerable time for the preparation and organization of the field day. Planning activities should start about three weeks ahead of the day. The couple of days before the field day are usually very busy, when they sent out invitations, prepare exhibition materials, and conduct rehearsals.

Procedure

1. Discuss with the farmer participants what is a field day? What are the reasons for holding a field day? What happens during a field day?
2. Write down the answers and use them as basis for planning the group's field day.
3. Plan the field day activities
4. Conduct the field day
5. Evaluate the field day activities and document this

Notes for the Facilitator

1. Field days can perfectly well coincide with the cooking and eating quality evaluations of varieties and advanced lines. Invited farmers and guests can participant in the testing and ranking of the different lines or varieties according to their preferences (see exercise 6.7). The whole activity can thus take on a cheerful character.
2. The field day is also an excellent time to hold a graduation ceremony for the farmers who have participated in the field studies and training session throughout the season.

Questions

1. Who should we invite for the field day? Why?
2. How do we ask for the involvement and commitment of local leaders in the community through the field day?
3. How do we share the knowledge and skills learned in the FFF to other farmers and local officials?

5.2 Suggestions for Field Days and Exhibitions

Activities in the field day should best reflect a normal farmer field forum activity, and can include the following:

Field Visit

Farmers present their studies and explain the methodologies used, allowing everyone to see the results of the studies and what they have learned..

Exhibits & Displays

Farmers can present the results of their evaluations and observations in graphs, live material, and drawings, diagrams and illustrations. Work on graphs and diagrams are spread over several days to allow for sufficient time for preparation. The evaluation data should be presented separately for: variety evaluation study, variety rehabilitation study, cross breeding study and line selection study.

For each study, the following materials can be considered for presentation:

- Overview tables on weekly agro-ecological observations
- Summary tables and graphs on the main criteria observed (height, tillering, taste etc.) between varieties and lines
- Graphs on crop cuts and yield component analysis for varietal evaluation, variety rehabilitation and evaluation of advanced lines
- Tables with an overview of the crossings made

Live material of cowpea and pearl millet, dried or in pots, may be shown from different varieties:

- Plants in pots
- Male and female flowers
- Fresh and mature Fruits
- Seeds

Diagrams and illustrations can be presented like:

- Field study layout
- Diagrams of the line selection methods
- Plant stages of cowpea and pearl millet
- Drawings and pictures of procedures in cross breeding of cowpea and pearl millet

Training Program

A summary report of information can be prepared on results of the training program for viewing on:

- The baseline survey
- The pre-season planning
- The number and background of the participants
- The field studies conducted
- Information exchange tours to other FFF and plant breeding stations
- Plans for the next season

General Issues

The field day can also provide a platform for Information to outsiders and officials to draw attention on on-farm conservation and crop improvement. A range of material may be prepared and activities planned by participants and facilitators focusing on advocacy like:

Activities:

- Speeches from farmers, guests and officials
- Exchanges of ideas between farmers and visitors

Information:

- Simple brochures on plant genetic resources
- Variety lists and catalogues Issued by plant breeding institutions and seed companies
- General information on conservation of plant genetic resources

5.3 Course Evaluation

At the end of the season, it is time to evaluate the training course. However, it is important to note that the evaluation of the season's training activities is not a one time activity, but rather an ongoing process. Evaluation has at least three steps:

- Weekly evaluation; each farmer field day will start with an elaboration on the day's expectations and learning targets and finish with an evaluation using a checklist or ballot box. This allows the participants to get the most out of the activities and the facilitators to learn and modify their approaches.

- Towards the end of the training season, it is time to evaluate the changes in know-how and field skills between the beginning and the end of the training. Those changes that are assumed to have taken place as a result of the training activities during the season's training course, should be taken. Evaluation may take place using several methods like T-cross, Piling up, and ballot box (see under).

- Finally, it is important to evaluate the overall training impact. Farmers may improve their basic skills and knowledge, but this may have little or no impact on their livelihood, and as such it will not be sustainable.

Impact evaluation is perhaps the most difficult factor to measure, since results of PPB training are not likely to produce tangible results in one or two training seasons. It is therefore perhaps not feasible to conduct this evaluation at the end of a first training course. Nevertheless keep it in mind as an overall goal of the training activities. To warrant a continual interest of the farmer community in PPB, the training activities should have an impact on at least one of three factors: 1) the farmer's benefit and income, 2) the environment, and the 3) community organization and self-funding activities.

Some group evaluation methods:

1. Ballot box is a method using multiple choice questionnaires and field situations to test the farmer's know-how and skills. Field situations or drawings are used. To evaluate the progress a ballot box should be conducted at the beginning and at the end of the day or season. Questions should be developed before the season or weekly session.

2. T-chart is an evaluation method using a T-shape drawn on a large piece of paper with two columns: for "good" and for "need to be improved". Farmers may produce cards with activities and stick it in one of the columns. The cards in the "need to be improved" column should be discussed with the aim of finding solutions.

3. In the Piling-up evaluation method farmer's are asked to make drawings on a large piece of paper that represent various aspects of the program (field study, group activities, field days etc). Give each person some seeds or coins and ask them to pile them on top of each drawing. Discuss the activities that have the least number piled-up with the aim to finding solutions for improvement

5.4 Developing Plans for the 2nd Season

On completion of the training course evaluations, participants and facilitators should discuss the following issues:

- What kind of field studies should we conduct in the next season?
- Who will be responsible for seed storage during the off-season?,
- When is the time to conduct a more detailed pre-season planning meeting?
- What will be the extra activities during the next season?
- Who is going to participate in the next seasons activities?

Try to make study design together and decide what should be observed.

Also discuss what the plans of the group are to help other farmers in the village understand more about on-farm crop improvement. Upon completion summarize the plans together and discuss what kind of support will be needed and how it can be obtained.

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ANNEX

Sample Genotype x Environment Analysis form

Farmer Observation Sheet

Week after sowing	
Weather condition	
Plant development stage	
General appearance	
Water level	
Other:	

Variety / Criteria	1	2	3	4	5	6	7	8	9	10
Plant development										
Pests										
Diseases										
Weeds										
..										
..										
..										
Etc.										

Remarks:

Date:_____

Group:_____

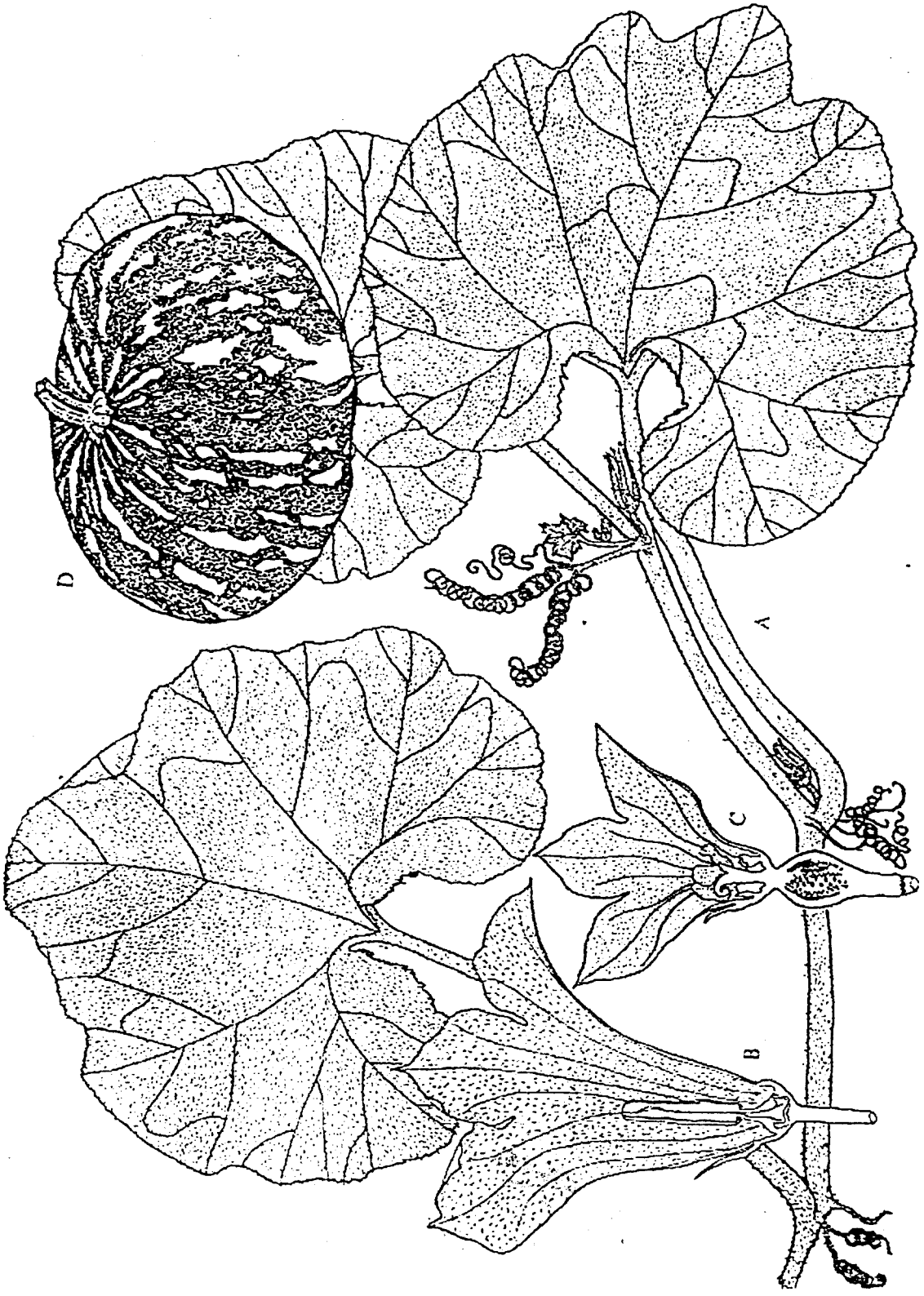
Sample evaluation table for gourds (especially bitter gourd)

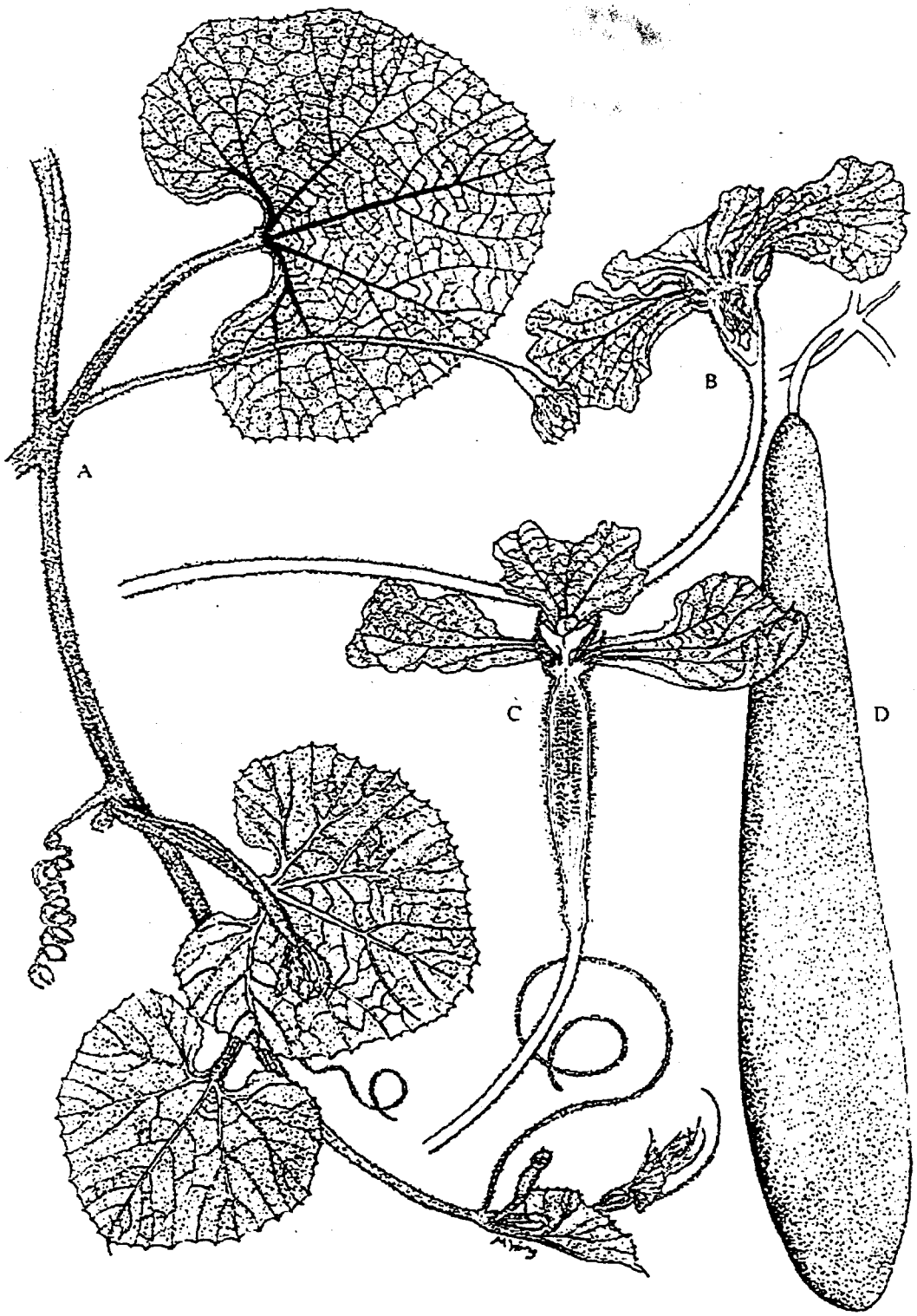
This table is used for facilitators to cross check with farmers whether important observation and criteria have been listed. This is only a selection. If farmer criteria or scores are not mentioned, let farmers develop their own evaluation method.

NO.	CRITERIA	GROWTH STAGE FOR MEASUREMENT	EVALUATION SCALE
2	Pests susceptibility	Weekly	Number of pests / unit sampled (e.g. m2), damage score 1-9 from 1= non, 3= low, 5= medium and 7=high
3	Disease susceptibility	Weekly	Number of pests / unit sampled (e.g. m2), damage score 1-9 from 1= non, 3= low, 5= medium and 7=high
4	Water or Drought susceptibility	Flowering stage	Scale 1-9 from 1= Low to 9= High
5	High temperature susceptibility	Flowering stage	Scale 1-9 from 1= Low to 9= High
6	Seed vigor	Emergence	Scale 1-5 from 1= Low to 5= High
7	Plant vigor	Flowering stage	Scale 1-5; 1= non-vigorous, 5 = Very vigorous
9	Growth pattern	Flowering stage	1. Climbing - vines 2. Self-staked
12	Leaf color	Flowering stage	Scale 1-7, from 3=pale green, 5=intermediate green to 7=dark green
15	Days to flowering-male flower	Weekly until flowering	Days from sowing to stage when first male flowers have begun to flower
16	Days to flowering - female flower	Weekly until flowering	Days from sowing to stage when first female flowers have begun to flower
17	Days to harvesting at commercial stage	Weekly, fruiting stage	Days from sowing to stage when first fruits can be harvested
18	Fruit color at fresh picking stage	Fruiting stage	1= light green, 3=green, 5 = dark green, 7=cream
19	Fruit weight at fresh picking stage	Fruiting stage	in grams, average of 5 fruits
	Fruit length at fresh picking stage	Fruiting stage	In cm
	Fruit width at fresh picking stage	Fruiting stage	In cm
	Fruit wall thickness	Fruiting stage	In mm, average of 5 fruits
	Fruit shape	Fruiting stage	1. Cylindrical 2. Elliptical 3. Fusiform 4. Ovate 5. Oblong 6. Spherical
	Warty patter on fruit	Fruiting stage	1. Weak 2. Intermediate 3. Warty 4. Very Warty
	Days to harvesting at physiological maturity stage	Weekly until maturity	Days from sowing to stage when first mature fruits can be harvested
	Fruit weight at mature stage	At harvest maturity	in grams, average of 5 fruits
	Taste	Picking and maturity stage	Scale 1-5, 1= bad taste, 5 = excellent taste, Depends on type of dish, fresh, processed etc.
	Number of seed per fruit	At extraction	Number
21	Seed shape	Post harvest stage	1. Elliptical 2. round 3. ovate 4. obovate
23	Seed weight	Post harvest stage	Weight of 1000 seeds in grams at 12% moisture

SREY KHMER

PUMPKIN





WAX GOURD