FACILITATORS' FIELD GUIDE FOR FARMER FIELD SCHOOLS ON PARTICIPATORY PLANT BREEDING (focused on maize, pearl millet, sorghum and groundnut)

This field guide is based on the guide originally produced by the staff of the Community Technology Development Trust (CTDT), Harare, Zimbabwe, with technical support of the Oxfam team for the Sowing Diversity = Harvesting Security (SD=HS) Programme

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FOREWORD

This *Facilitators' Field Guide for Farmer Field Schools on Participatory Plant Breeding* aims to assist facilitators in conducting Farmer Field School (FFS) sessions on participatory plant breeding (PPB) in their respective communities. In this context, participatory plant breeding should be understood in a broad sense: it includes participatory variety enhancement and participatory variety selection (both approaches working with established farmers' varieties and/or stable breeding lines), as well as participatory variety development, the full cycle breeding involving selection in heterogeneous populations and sometimes the making of crosses (hybridization).

An earlier version of this guide was developed by the Community Technology Development Trust in Zimbabwe in 2015, with the technical support of Oxfam Novib's Sowing Diversity = Harvesting Security (SD=HS) Programme. The current field guide is an attempt to provide a more generic version that can also be used in other countries and agro-ecosystems. Whereas it focuses on crops of major importance to Zimbabwe, it covers all topics and activities that need to be undertaken in a season-long FFS course on PPB. It is meant to function as the main reference for FFS facilitators, guiding them in FFS implementation. It also provides FFS facilitators with a framework for the regular documentation on breeding progress.

This field guide focuses on four major crops important in Zimbabwe: maize, pearl millet, sorghum and groundnut. In their sexual propagation and genetic development, these crops are representative of many other crops with similar properties, including major cereal and legume species. Being either cross- or self-pollinating, each of these crops exhibits a distinct reproductive biology requiring a distinctly different breeding methodology. This field guide concentrates on participatory variety selection and participatory variety enhancement – the two approaches identified as the main strategies of improving the diversity of plant genetic resources in the first FFS season(s). In addition, participatory variety development, involving more demanding selection in heterogeneous, segregating populations and even performing crosses is addressed as well.

This field guide, as its name suggests, is intended to be used by facilitators and trainers whilst conducting FFS activities in the field. It has been made as concise and practical as possible. It should be used in combination with the Training of Trainers Manual also published by Oxfam Novib and its SD=HS programme partners, which discusses topics that trainers or facilitators of Farmer Field Schools need to familiarize themselves with prior to commencing the FFS season, and possibly later through refresher courses.

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List of Abbreviations and Acronyms

AESA	Agro-Ecological Systems Analysis
FFD	Farmers' Field Day
FFS	Farmer Field School
FFS (on) PPB	Farmer Field School on Participatory Plant Breeding
HYVs	High Yielding Varieties
IPM	Integrated Pest Management
NGO	Non-government organization
NUS	Neglected and Underutilized Species
OPV	Open-Pollinated Variety
PAR	Participatory Action Research
PGR	Plant Genetic Resources
PGRFA	Plant Genetic Resources for Food and Agriculture
PPB	Participatory Plant Breeding
PVE	Participatory Varietal Enhancement
PVD	Participatory Varietal Development
PVS	Participatory Varietal Selection
SD=HS	Sowing Diversity = Harvesting Security programme
ToT	Training of Trainers

CONTENTS

1. INTRODUCTION

The Farmer Field School (FFS) approach is rooted in the idea that the strongest way to learn is through experiences. The FFS is therefore not about "teaching" farmers. It is about facilitating exercises and experiments with farmers in which they make their own observations and draw their own conclusions, and about assisting farmers by providing external plant breeding materials and technical capacity where needed, through the involvement of public breeding and extension services. In Farmer Field Schools, local knowledge and skills are respected as the strongest foundation on which to build new knowledge and skills. Most importantly, this new knowledge is developed in the FFS and owned by the farmers.

The FFS has the intention to be "holistic", in understanding that farmers are best motivated and will only remain committed to the FFS if it addresses issues that are closest to their livelihoods (the gut), that are intellectually interesting (the mind), and that are emotionally relevant (the heart). All participatory approaches need to address these motivational requirements.

These principles strongly contribute to the building of critical thinking and self-confidence, and to an increased capacity for experimentation and decision making. Farmers build their own knowledge by creating their own breeding populations, by learning effective selection techniques for faster genetic progress, and by learning how to design experimental plots to manage biases. Farmers also become more aware of the structures in their societies that keep them poor and that form a threat to the sustainability of their work in managing crop diversity. Ultimately, the aim of the FFS is to link the work on the conservation and utilization of crop diversity to the strengthening of farmers and their communities so that they can contribute to social change.

2. TIMELINE FOR THE FFS CURRICULUM

The following chapters describe the studies and provide a list of activities to be undertaken during the various crop growth stages in the farming season. A number of Special Topics have been included following the main body of this guide. These fit with particular phases of the FFS or pre-season preparation for the FFS and have been organized in two columns in the overview below: the left-hand column under Special Topics contains crucial topics directly bearing on the organization of the FFS, the right-hand column under Special Topics lists activities and issues that are of a technical nature or that deal with reflections on the social processes in an FFS. The topics in this right-hand column are more general and less closely linked to specific stages in the growing season.

Time	**Which activities?**		
	FFS Curriculum	**Special Topics**	
		Organizational	**Technical, social**
FFS Preparations	Chapter 3: Organizing a FFS on PPB		
Pre-season activities	Chapter 4: Pre-season diagnostic activities	10.1 Planning meeting for the first season 10.2 Start-up session 10.3 Developing the work plan	10.9 Concepts and terms 10.10 Use of PGR tools 10.1 Designing the FFS 10.15 Gender issues
Start of season (land preparation and sowing/planting)	Chapter 5: Establishment and management of FFS plots		10.13 Group dynamics exercises 10.15 Gender issues 10.11 Disaster Risk Management
Vegetative phase	Chapter 6: Activities in the FFS field	10.4 AESA and G x E interactions	10.9 Concepts and terms 10.13 Group dynamics exercises ToT Manual 11.2/3/4/6. Crop development
Reproductive phase	Chapter 7: Activities in the FFS field	10.4 AESA	(11. ToT Manual crossing and breeding topics) 10.13 Group dynamics exercises
Maturity phase (including harvesting)	Chapter 8: Activities in the FFS field	10.4 AESA 10.5 Farmers' Field Day 10.6 Final variety evaluation	10.12 Cooking and eating qualities (11. ToT Manual crossing and breeding topics) 10.13 Group dynamics exercises 10.15 Gender issues
Post-season (including planning next season)	Chapter 9: Reflections, lessons learned and planning for the next season	10.7 Curriculum evaluation 10.8 Developing plans for the next season	

3. ORGANISING A FARMER FIELD SCHOOL ON PARTICIPATORY PLANT BREEDING

3.1 Preceding steps

Before an FFS is formed, before the onset of the agricultural growing season, the FFS trainer comes together with interested members of the community to discuss the following topics discussed.
The trainer is expected to sketch a general picture of what the FFS on PPB will look like for the (potential) FFS participants and to explain how the FFS will be managed. In this context, the trainer also needs to describe the participatory and learning principles of the FFS .
Trainers are advised to carefully review the following sections on non-formal education methods used in FFS, and on the FFS described as a 'school without walls'.

Non-formal Education Methods Used in FFS

The following methods of informal education are used in FFS:

- Discovery-based learning techniques (including Agro-Ecosystem Analysis [AESA], Participatory Action Research [PAR], the collecting of genetic resources, the identification and functional classification of pathogenic insects, diseases and other abnormalities during plant growth);
- Experiential learning methods (including setting up of experiments, analysis of findings and sharing of experiences among participants, facilitators and technical resource persons);
- Participatory approaches (including group discussions, collective decision-making and team-building exercises).

These methods are applied jointly and coherently.

FFS as a 'School Without Walls'

The FFS involves education and training of adults within their own community and in their own fields. It does not necessarily make use of school buildings. In fact, much of the training takes place in the field. Hence the name 'school without walls.' The FFS includes the following activities:

- Observation and analysis of crop growth and other crop physiological properties, such as vigour, morphology and useful traits (these constitute the core of the FFS curriculum);
- Focus on developments in farmers' own fields;
- Season-long, hands-on experimentation and field studies in a 'learning field,' usually conducted in a group of 25 – 30 farmers, subdivided in smaller groups of 5 farmers approximately.

The trainer should announce and explain these activities at the start of the FFS. The FFS trainer also needs to discuss that in a school without walls, the FFS PPB plot and the plants on it are the sources of learning and education, and that the FFS will ensure that data is gathered and analyzed by small groups of farmers and reported to the FFS plenary once per week. The trainer should also explain that because plant growth is influenced by the environment (Genotype by Environment or G x E), an analysis of the agroecological system (AESA) is conducted once per week. The following characteristics define the FFS.

- Observation and analysis of crop growth and other crop physiological properties, such as vigour, morphology and useful traits (these constitute the core of the FFS curriculum);
- Focus on developments in farmers' own fields;
- Season-long, hands-on experimentation and field studies in a 'learning field,' usually conducted in a group of 25 – 30 farmers that is subdivided in smaller groups to guarantee active participation and contribution by all participants;
- The FFS participants meet once per week, from the moment the research plots are prepared for cultivation, to sowing and until harvest.

The following components will be part of all FFS on PPB:

- Agro-ecological Systems Analysis (AESA) or Gene x Environment Interaction studies and observation on crop growth and important traits will be done by small groups and reported in plenary: a season-long surveillance and analysis of plant health and plant disease; water, weed, soil and nutrient management; and a survey and collection of insect pests, predators and parasites (see Special Topic 10.4)
- Group dynamics will be addressed in plenary to maintain a spirit of liveliness and competition. Team building and leadership training form a major part of the FFS. Some group dynamics exercises are detailed in Special Topic 10.13 of the facilitators' field guide
- Special topics will feature in some weeks, e.g. morphology and growth stages at the vegetative stage, reproductive/flowering systems at the flowering stage of the crop, etc.
- Final evaluation of the FFS PPB plots will take place at the end of the season, first by the small subgroups, then at the plenary. Through reports and discussions all FFS participants will jointly come up with an evaluation of the PVS, PVE and/or PVD experiments.

Identification of sites

The implementing organization and its partners should identify and evaluate potential FFS sites, taking into consideration the cropping conditions (e.g. humid, semi-arid or arid) and the ownership status (e.g. communal or individual holdings) of the sites being considered. The selected sites should exhibit representative agro-ecological conditions. These sites should also be easily and safely accessible, near a road or a pathway, and within walking distance for all participants, especially women. The plots should also be familiar to women and be representative of their own plots; otherwise, results may only cater to men's interests and demotivate women's participation. Since tests of a particular single variety or line will be performed within a single plot and not per se be replicated elsewhere, sloping sites should be avoided as they may result in different water availability and may therefore complicate the analysis and interpretation of results. It is therefore necessary to conduct preliminary discussions with a greater number of villagers on the suitability of an identified FFS site. These discussions will further clarify the objectives of the FFS PGR and its potential usefulness to the farming community.

Selection of participants

Participant selection should be guided by clear and transparent criteria that are defined and agreed with the communities beforehand. Participants should be selected for their willingness to consistently participate in the season-long FFS and share the acquired knowledge with the other members in the community. Appreciation for gender equity and social inclusion is a major value that should be built into the FFS.
These preparatory meetings will give the villagers an idea of the tasks and responsibilities of the participants in the FFS. Finally, a short description of the research and development objectives of the

FFS (PVS, PVE and PVD) will help the villagers choose the crops appropriate for either PVS and PVE, or PVD.

Initial discussions

Initial discussions should be conducted to acquire insights into the crop portfolio available to the community, their food and nutritional status, as well as the biotic and abiotic stresses affecting the farming activities of the community. This is usually achieved by means of informal meetings with key community leaders and small (engendered) focus group discussions with farmers in the community.

FFS Rules and regulations

It is important to have rules to realize an efficient FFS PPB. These rules and regulations must be set by the participants themselves. They must own these rules and be responsible for enforcing them. It is undesirable and impossible for the FFS PPB trainers to "police" the FFS.

Small group formation

The participants should preferably be organized in five subgroups, each subgroup with a leader and a reporter, and each allocated its own plot in the larger FFS PPB site. At this stage, it should be decided whether or not to form women-only groups. This can be important in cases where women's crop and trait preferences may deviate from those of men. The role of reporter may rotate among the group members, so that each member can gain experience in the process of documentation.

Small subgroups of approximately 5 farmers are created to optimally involve all participants and to improve the functioning of the FFS. In particular, the following considerations are important.

- Farmers learn more and become stronger through collective action.
- Small groups are the key units for data gathering, analysis and reporting.
- Tasks and responsibilities are a collective responsibility within each small group.
- Team building, cohesion and a feeling of belonging can be established easier in small groups.
- New leaders and high-potential farmers emerge easier from small group activities, where more opportunity for participation exists.
- The small groups are responsible for documentation of all experiments, results and analysis.
- The small groups must have a team leader and record keeper.

Election of FFS PPB leader and record keeper

The plenary FFS elects a FFS PPB leader and record keeper for the entire FFS at the community level. The FFS PPB leader shall

- convene and initiate the FFS PPB
- encourage small group activities
- ensure that all participants are active and that all tasks and responsibilities of the FFS PPB are fulfilled
- encourage the discussion of problems occurring during the FFS and the identification of possible solutions.

3.2 Description of the once-per week/3 hours FFS activities

Each FFS meeting will start with a plenary and include a roll call and a discussion of the activities of the day (including any relevant special topics, if the facilitator and/or resource person has planned to address these).
The small groups will then visit their assigned plots in the FFS PPB research site to:

- observe plant growth and, if appropriate, gather morphological and agronomic data
- perform AESA: noting soil condition, moisture condition, frequency of pests and diseases and weeds, temperature and other relevant conditions that affect plant growth
- discuss the collected data and prepare for plenary reporting
- take care of management of their plots (e.g. weeding) and make decisions (e.g. need to re-sow, need to rogue, etc.).

The group reports will be presented in plenary. The plenary will make decisions and prepare plans for the next week and discuss any problems that arise and the solutions to them.

3.3 Short overview of the season-long FFS on PVS/PVE/PVD

Find below a hypothetical overview of weekly activities, showing the sequence of FFS activities during the season.

Weeks	**General Activities**	**Specific activities**
Week 1	Organization of the FFS	Review of FFS objectives Organization into small groups Setting the rules and regulations for the FFS
Week 2	Diagnostic exercises Setting breeding objectives Identifying plant materials	Timeline analysis, Diversity wheel for crops and varieties Ranking of traits Setting of breeding objectives Acquiring plant materials for the FFS (varieties, lines, populations, accessions, including local varieties)
Week 3	Site selection and preparation Acquiring/sourcing plant materials	Site selection and land preparation. Acquiring plant materials as in week 2
Week 4	Establishment and sowing of FFS plots	Seeds have been received or prepared earlier Review of FFS objectives Plots assigned per small group
Week 5	AESA Assessment of germination	Assess if re-sowing is needed Monitor if pests or diseases threaten seedling survival
Week 6	AESA Assessment of plant vigour	Special topic on morphology of the FFS crop and its growth stages Roguing in case of PVE Tagging selected plants in case of PVD
Week 7	AESA	Roguing in case of PVE

	Assessment of plant vigour Morphological measurements of selected plants	Tagging selected plants in case of PVD
Week 8	AESA Assessment of plant vigour Morphological measurements of selected plants	Roguing in case of PVE Tagging selected plants in case of PVD Special topic on the role of farmers in seed management and plant breeding
Week 9	AESA Assessment of plant vigour Morphological measurements of selected plants	Final roguing before flowering Tagging selected plants in case of PVE and PVD
Week 10	AESA	Final roguing before flowering Special topic on inheritance of traits / genes
Week 11	AESA	Special topic on different reproductive systems. Exercise in pollination control
Week 12	AESA Final evaluation of varieties Farmers Field Day	Special topic on final evaluation of varieties by farmers (PVS) Special topic on organizing a Farmers' Field Day.
Week 13	AESA Harvesting of study plots Review of the FFS season	Conduct AESA for maturity stage Gathering of data for analysis by breeders Harvesting of study plots and performing seed selection Special topic on Cooking and Eating quality evaluation Review of lessons learned.

3.4 Notes on various forms of AESA

The results of the field observations should be documented in tables and graphs. Several methods exist for the comparison of performance between varieties, lines and populations within PVS, PVE and PVD experiments, e.g. the scoring card method, pair-wise ranking, and index ranking. Here only pair-wise ranking and the scoring card method will be discussed and used. An exercise on these evaluation methods to acquaint farmers with the two alternative methodologies is recommended.

On a weekly basis, each small group is requested to present the results of their observations from the past week in plenary. This allows farmers to discuss the various issues related to these observations and to compare the reported with their own observations. The following questions should be answered:

- Describe the features of plant development for each observed variety, line or population. Do the different varieties (PVS) or individual plants in lines and populations (PVE and PVD) develop in the same way? How did the weather conditions influence plant development? Which fertilizer and other management practices were applied during the week? How did this affect crop development for each variety or family?

- Compare the frequency of occurrence of pests and diseases with that of the previous week. Do more pests and diseases occur in the field or in/on the plants occur? Is it possible to understand why? Is the development of pests and diseases similar on all varieties and/or families? Do some varieties or families have a lower frequency of insect pests or few symptoms of disease infection?

- Compare growth development and performance of the varieties or populations tested. Identify the best performing varieties (PVS), or individual plants in lines (PVE and PVD) or populations (PVD), based on observations and the weekly data gathered, and explain why these were selected and which stage was important for the selection:
    - vegetative stage
    - flowering stage
    - maturity stage

- Arrange the varieties (PVS), and mark individual plants in lines or populations (PVE and PVD) in order of their overall levels of performance.

- Compare with the observations of other subgroups (farmers who are not in the reporting subgroup): what varieties, and individual plants in lines or populations do they prefer? Are these the same? Why? Are there any other important characteristics mentioned by other small groups that were not included in the observations? Why are these characteristics important?

- At flowering, ripening and harvesting stage:
    - Is there any difference in the time of flowering between varieties, or between individual plants in lines or populations?
    - Is there any difference in the time of ripening between varieties, or between individual plants in lines or populations?
    - Do some varieties, lines or populations shatter more easily compared to others?
    - Do some elite plants occur within promising lines or populations (PVE or PVD)?
    - What are the characteristics of the pods, cobs and panicles?
    - Do you observe any differences in seed characteristics?

- At the end of the season:
    - After comparing the yields, do you see major differences?
    - Are the varieties, or the individual plants in lines or populations with the least disease damage also the highest yielding?
    - Do you observe any differences in the cooking quality and taste of the varieties or lines?
    - Note and discuss specific problems and advantages observed for each variety, line or population. Are there important observations that were missed during the season's activities?
    - How can the study be improved for the next season?
    - Prepare a summary table of all the characteristics observed.

4. PRE-SEASON DIAGNOSTIC ACTIVITIES

The activities and breeding objectives of a Farmer Field School season are based on a 'diagnostic stage', in which farmers perform a collective diagnosis of their situation and the problems and challenges they regularly encounter in growing their crops and varieties. The diagnostic stage is crucial to ensure that the FFS will address the primary needs and concerns of the farmers in the community. This is the only way to ensure the farmers' commitment to the FFS.

The results of the diagnostic stage form the starting point for a joint development of the FFS agenda, i.e., an agreed work plan for the upcoming growing season. It also functions as a benchmark against which the later outputs and impact of the project will be measured.

The information that the FFS group gathers during the diagnostic stage should be ordered by gender to distinguish and specifically address women's and men's positions and needs. This can be ensured by forming subgroups of women and men only (see below).

The diagnostic stage takes place prior to the sowing season and usually takes two sessions, both of approximately three hours. In the first session, the FFS group performs a Timeline Analysis. In the second session, the group continues with the Diversity Wheel exercise. These exercises help formulate the breeding objectives for the coming season(s).

How to organize the group in subgroups?

To make sure that breeding objectives answer the needs of all members of the FFS, it is important to divide the group of 25 to 30 farmers into subgroups of five. This enables 'segregation' (see below), and it helps participants to get to know each other better and feel more comfortable. It also helps all members of the small subgroups to play an active role.

Segregation
If possible, the subgroups should be women or men only (not mixed). Even if there are only two or three women or men in the entire group it is important to have the discussion with them separately. Likewise, it can be useful to segregate for other reasons. An example is to form groups of farmers that have more or lesser access to assets (tools, machinery, irrigation systems, animals), since the more equipped farmers tend to have different breeding preferences than farmers with less access to assets. The same can be done for different age groups. The forming of subgroups helps the facilitator in making sure all participants feel free to express their ideas and preferences.

Each subgroup independently conducts the exercises and writes down their results. The facilitator assigns a leader to each subgroup to lead the discussions. Since the leaders of the subgroups have little or no experience in guiding the exercises, the facilitator should take care to rotate among the subgroups to assist the group leaders.

Learning goals

Farmers use the Timeline Analysis and the Diversity Wheel tool to assess their own agricultural context (agro-ecosystem) and the status of crop diversity in their community. The exercises inform the choice of crops to work with and result in a list of breeding objectives to work towards. In using these tools, farmers practice skills of discussion, motivation and analysis.

Specific learning goals for farmers are to:

- Measure and analyze the level of diversity of selected crops in their own community.
- Understand the strengths and weaknesses of the current level of diversity in their community, especially the agronomic strengths and weaknesses of the varieties they currently cultivate.
- Understand the pattern of loss and introduction of cultivars in the community, and – if the trend is towards reduction of crop diversity – identify the causes for this erosion and how to address them.
- Gain insight in how to value different crops and crop varieties and for what reasons;
- Analyze the strengths and weaknesses of the varieties farmers are cultivating, as a basis for setting up their research, breeding and development objectives in the FFS.
- Analyze the strengths and weaknesses in the way farmers manage their crop diversity and understand how they can improve this diversity to meet challenges in food production.
- Identify knowledge farmers miss and the topics they want to learn more about (e.g., selection or cross-breeding techniques) to meet their breeding objectives.

4.1 Establishing a timeline

SESSION 1
(recommended duration: 2.5 - 3 hours)

The Timeline Analysis tool aims to create an understanding of how socio-economic and environmental conditions and developments influence agricultural systems and plant genetic diversity over time. These developments in politics, the economy, environment and/or infrastructure require continuing adaptations by smallholder farmers. More specifically, they mean that crop traits that were useful in the past may not anymore be useful today (ease of threshing, for example, may become less important with the availability of harvesting combines). Farmers adapt to these new circumstances by changing their preferences for crops and for traits in crop varieties. The Timeline Analysis provides insight into past and current circumstances and developments to help set realistic breeding objectives.

Step 1: Setting a timeline
In subgroups, draw a simple timeline on a large piece of paper. Ask the participants to discuss the number of years that best cover the changes that have affected the farming system, in particular crop diversity (e.g. the past 30 years), and that the group members still remember well. Indicate important historical events on the timeline, such as a droughts, elections, agricultural subsidies, the building of a road, etc.

Step 2: Reflecting on changes in context.
Ask each subgroup to reflect on the following changes. What do they mean for the community:

- changes in farming infrastructure
- changes in market access
- changes in socio-economic context
- changes in government policies and programs
- changes in climate

Step 3: Discussing the impact of changes on production systems and crop genetic diversity. Organizing the results in a table.

Subgroups discuss the past and present situation regarding infrastructure, market access, socio-economic context, government policies and programs, and climate. To the extent that the situation has changed during the period that is reflected in the timeline, the participants reflect on the impact of these changes on production systems (the way they produce crops) and on the availability and presence of plant genetic resources in the community.
The results of the subgroup discussions can be captured in (a copy of) **Form A**.
An example of what this looks like for a typical rice cropping system in the Mekong Delta in Vietnam is given in **Table 1**.

Form A: *Changes in production systems and crop diversity.*

Context and trends	**Past situation**	**Current situation**	**Impact on production systems**	**Impact on crop diversity**
Infrastructure				
Market access				
Socio-economic changes				
Government policies and programs				
Climate change				

Table 1: *Example of changes in rice cultivation in the Mekong Delta in Vietnam.*

Context and trends	**Past situation**	**Current situation**	**Impact on production systems**	**Impact on crop diversity**
Infrastructure	*Rainfed*	*Irrigated*	*Several cropping seasons per year from only one in the past*	*Photo-sensitive and long duration rice varieties replaced*
Market access	*Transport problems* *Weak urban demand*	*Better roads* *Urban export market*	*New crops* *Market standards and preferences* *Pressure for uniformity*	*Change in crop importance* *Traits of varieties defined by market* *Diverse varieties for home consumption replaced.*
Socio-economic changes	*Mainly subsistence system*	*Off-farm sources of income*	*Reduced labor available for the farm*	*Short duration traits preferred* *Buying seeds cheaper than harvesting and processing own seeds*
Government policies and programs	*Few policies with little impact*	*Support intensively mechanized systems,* *high yields, and*	*Mechanization*	*Government support defines which crops and varieties can be marketed*

		market response		
Climate change	*Sea level 'normal'*	*Sea level increasing Salt water intrusion in coastal parts of the Delta*	*Yields reduced or failed as a result of salinity*	*Salinity tolerance becoming an important crop trait*

Step 4: Discussing results of the analysis with the plenary group

Discuss the results of the analysis in plenary. Did subgroups come up with different developments or analyses? What are problems or challenges in the current situation? Can the plenary come up with potential solutions to challenges that they wish to investigate and address? Can the plenary think of types of crops they wish to grow more or improve that would better fit the current situation?

Step 5: Documenting the results of the discussion

The facilitator collects all papers or copies of **Form A**. Save the papers in the Facilitator Binder[1]. The results of the Timeline Analysis will be useful during future exercises and as 'benchmark' at the end of the FFS season.

4.2 Diversity Wheel exercise for crops

SESSION 2
(recommended duration: 1 hour)

The Diversity Wheel[2] for crops provides insight into the level of crop diversity in a community. It shows the value of each crop to farmers' livelihoods and helps investigate why the cultivation of some crop species is increasing or decreasing. The aim of this exercise is to identify the crop (or crops) that farmers are most interested in to improve, or solve problems with. This crop will be the focus of the work done in the FFS.

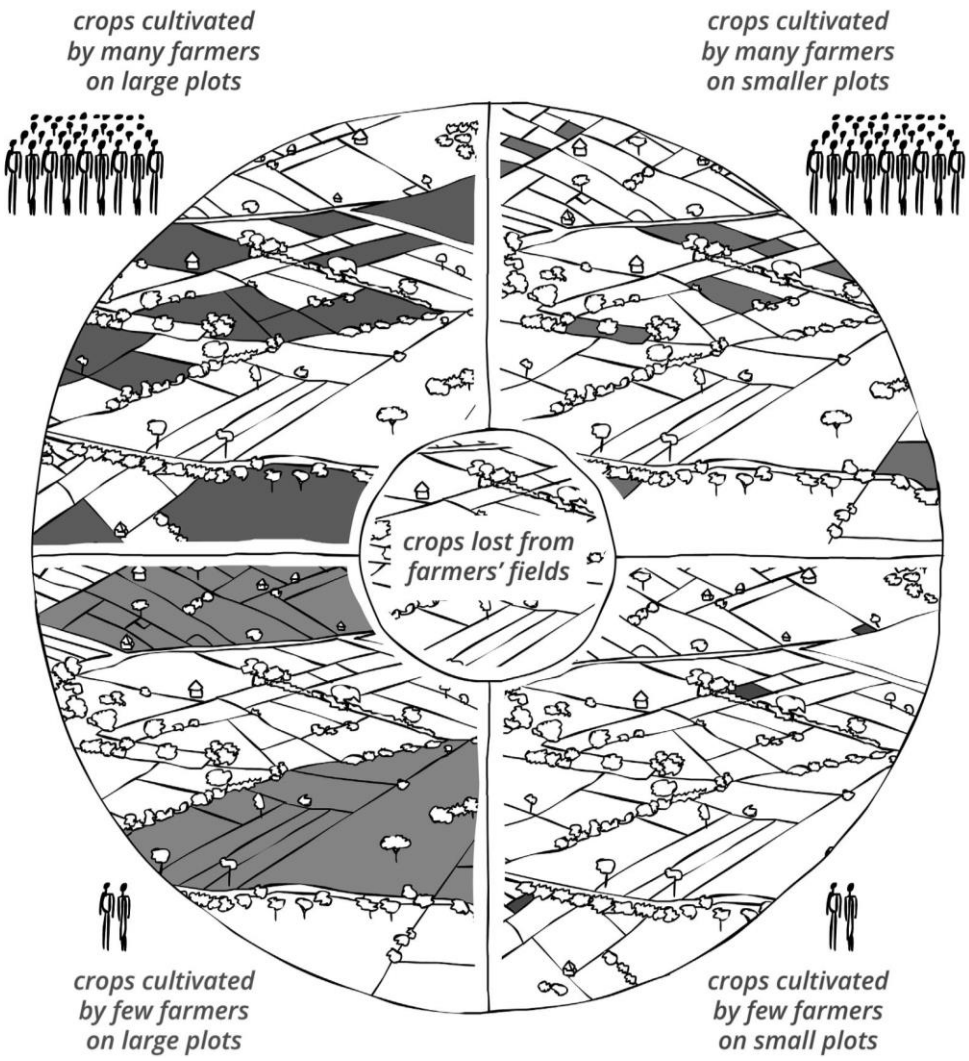
The Diversity Wheel is depicted as a circle divided into five segments (**Figure 1)**. Each segment corresponds with a category:

1. *Crops cultivated by many farmers on larger plots of their land.* These are staple crops that are most important in fulfilling farmers' food security needs.
2. *Crops cultivated by many farmers on smaller plots,* e.g. in home gardens. These are crops with specific uses that are not needed in very large quantities, but that might be important to (improve) diet and nutrition.
3. *Crops cultivated by few farmers on larger plots.* Often these are crops grown by better-off farmers for sale in commercial markets (e.g., under contract with a trader).
4. *Crops cultivated by few farmers on smaller plots.* These crops are at risk of being lost. They are maintained because of specific traits or uses that are of value to the people growing them. In some cases, these are also newly introduced crops that are being tested by farmers.

[1] FFS facilitators should receive a binder at the start of the FFS season or during their Training of Trainers course.
[2] The Diversity Wheel is based on the 'four cell analysis' tool originally developed by LI-BIRD and Bioversity International.

5. *Crops that are no longer cultivated by the villagers;* i.e. lost but known diversity. These are crops that are no longer useful to the community or that have been inadvertently lost due to weather conditions or other events, but that have remained in farmers' memories.

Figure 1: The Diversity Wheel



Step 1: Discussing the segments of the Diversity Wheel for crops

The facilitator guides a group discussion on the five segments of the Diversity Wheel. At the start of this session, the facilitator explains the objective and the steps that need to be taken.
Some guiding questions for group discussion:

- What is meant by 'larger' or 'smaller' plots? (The group should understand that this is not about absolute size [e.g. 0,5 hectares], but about relative size, i.e. the percentage of the family farm dedicated to specific crops.)
- What does the size of plots say about the crops grown on them? (The relative size of crop plots gives us an indication of how important these crops are to families and communities, although people must be aware that it is not the only indicator (the time spent on cultivating a crop and its contribution to people's diets, or the price the product fetches in the market are important as well).

- What characterizes crops that belong in any of the sections?
- What do we mean with 'lost crops'? (Explain that even if only one farmer in the community still grows a crop, or if there are seeds of crops stored in someone's house, these crops are not considered lost: people in the community still have access to them if they wish.)
- Ask the group to come up with an example of a crop for each of the five segments.

Step 2: Subgroups listing 8-10 important crops and crops that were lost

Each subgroup discusses the 8 to 10 crops that are most important in the community. These are the crops that take up most of a family's land and/or labour, or contribute substantially to diets or income. The subgroups write down their list on a piece of paper or a copy of **Form B**.

Each subgroup also discusses crops that were lost in the past 10-30 years. Why were the crops lost? Are they still of potential interest to community members? Would they again be grown if these were re-introduced or if certain traits were improved?

Form B: *Crops selected as most important crops in the community.*

Crop	**Production Volume**	**Contribution to food security**	**Contribution to nutrition security**	**Important for sales**	**Cultural values**	**Place in the Diversity Wheel**
1.						
2.						
3.						
…						
10.						

Step 3: Assigning the crops to segments of the Diversity Wheel

Each subgroup draws the Diversity Wheel on a piece of paper. For each crop, the participants discuss in which segment of the Diversity Wheel it belongs and write this down on the paper. If farmers are not able to read or write it can be useful to lay out the Diversity Wheel on the ground, for example with stones, and use samples of seeds to represent the different crops. If done in this way, make sure to ask the participants beforehand to bring seeds with them.

Step 4: Picking a focus crop

Each subgroup picks a crop they wish to further investigate. The crop can be from any of the sections of the Diversity Wheel and can be selected for various reasons. This is the first step in deciding on the crop(s) the FFS will work on over the coming season and years. For that reason it is important to prompt the farmers with questions about their crops so that the decision takes in as many considerations as possible. For example:

- Are specific crops deteriorating?
- Which crops are failing to cope with changing growing conditions?
- Which crops are being abandoned? Why?
- Would any of these crops be grown more often if they had specific improved traits, if seed was more readily available, if it was marketable, if it had better pest resistance, etc.?

Box 1: *Group decision on crops and learning priorities*

Generally it is best for a FFS in a community to focus on one crop only. The learning process is strongest that way, and more focused, and the capacity that is built during the first seasons can be applied in later years to work on other crops.
In some cases, however, FFS groups are not able to agree on one single crop for the first year and wish to focus on two: men, for example, might want to focus on maize, while women prefer to work on groundnut, which for them is easier to manage. Recognizing the limits of time and resources, it is possible for a FFS to work on two different crops. In that case, make sure that both groups are solid and strongly motivated. If one of the groups is small, they may be challenged to campaign for extra members to work on 'their' crop.

Step 5: Presenting the results to the plenary

The plenary discusses the results of all subgroups and tries to come to an agreement on the crops they wish to further investigate (usually 1-3). This is a second step towards deciding the crop(s) the FFS will work with in the future. The facilitator ensures that all subgroups' findings are heard and weighed in the group discussion.

Step 6: Document the results of the exercise

The facilitator collects all the papers (or forms) with the top 8-10 crops and the drawings of the diversity wheel with the crops assigned to the categories. Add the date, the location and the name of the FFS to all papers and collect them in the Facilitator Binder.

When the exercise is done with a wheel made of stones or seeds on the ground, the facilitator fills in the results in the last column of **Form B** (above) and adds it to the Facilitator Binder.

4.3 Diversity Wheel exercise for varieties

(recommended duration: 1 hour)

After doing the Diversity Wheel exercise at the crop level, the previously formed subgroups will now assess crop varieties of the 1 to 3 crops they selected as most interesting. Each subgroup will assess varieties of only one crop. To make sure all crops are covered, the plenary assigns crops to each of the subgroups. This second exercise shows the level of within-crop diversity and makes explicit which characteristics or traits farmers prefer in their crops.

The Diversity Wheel is depicted as a circle divided into five segments. Each segment corresponds with a category:

1. *Varieties cultivated by many farmers on larger plots of their land.* These can be varieties that are easily sold against a good price or have traits or characteristics that are widely appreciated by farmers, or varieties for which seeds are readily available.
2. *Varieties cultivated by many farmers on smaller plots.* These can be varieties with traits that are widely appreciated, and which have a specific cultural use or function, but that are needed in smaller quantities than the varieties grown on larger plots.
3. *Varieties cultivated by a few farmers on larger plots.* These varieties are often produced by better-off farmers for external commercial markets.
4. *Varieties cultivated by a few farmers on smaller plots.* These are varieties that run the risk of being lost, but which may fulfill specific functions in the household or community.
5. *Varieties that are no longer cultivated by the villagers.* These are varieties that have lost value or have been inadvertently lost due to bad weather conditions or other events, but that have remained in farmers' memories.

NB: at the start of the Diversity Wheel exercise on variety level, the facilitator explains the objective of the exercise and the steps that need to be taken.

Step 1: Discussing the segments of the Diversity Wheel for varieties
The facilitator guides a group discussion on the segments of the Diversity Wheel – see guiding questions on the Diversity Wheel for crops (p. 18, above). At this point it may be necessary to reemphasize that plot sizes are relative: if a crop has been selected that is grown on small plots by many farmers, the individual varieties of this crop can still be assigned to the segment 'few farmers, large area' in the diversity wheel, because they occupy more farm land relative to other varieties of that same crop.

Step 2: Listing the varieties used and the ones that were lost

In subgroups, farmers discuss and list all varieties of the crop (chosen during the Diversity Wheel exercise on crops) that are grown in or are available to the community, or that have been lost but were present in the past 10-30 years. It is important to dwell briefly on these lost varieties, as they serve to demonstrate that there are reasons (i.e. traits) that led farmers to stop cultivating them.
The subgroups write down their list on a piece of paper or a copy of **Form C**.

Form C: *Features of varieties of the crop selected for the FFS currently or recently grown in the community.*

Variety	Some favoured traits	Some negative traits	Trends in popularity over time	Place in the Diversity Wheel	Reasons for its loss (for lost varieties only)
1.					
2.					
3.					
…					
10.					

Step 3: Assigning the varieties to segments

In subgroups, farmers discuss and agree in which segment of the Diversity Wheel each variety belongs.

Step 4: Choosing one or two varieties

In subgroups, farmers discuss which varieties they wish to investigate further. These varieties can be from any of the segments of the Diversity Wheel. The main function of the varieties at this point is to serve as concrete examples that will be used by the participants to describe a list of traits that they find important. For example, varieties that are grown by many farmers will generally have more positive traits, while those grown only by few farmers often have more negative traits. Both are important. This step of translating farmers' preferences for varieties into positive and negative traits is the foundation for the setting of breeding objectives later on. These are some guiding questions:

- What are the most popular varieties in the community? Which traits make them so popular?
- Are specific varieties deteriorating? Which traits specifically?
- Are varieties failing to cope with changing growing conditions?
- Are varieties being abandoned? Why?
- Which varieties would be grown more often if they had specific (improved) traits?
- Are new varieties with other traits needed?

Step 5: Presenting the results to the plenary and group discussion on focus varieties

Each subgroup presents the results of their Diversity Wheel exercise to the plenary. The plenary discusses the results of all subgroups and agrees on the crop varieties they wish to use as a reference to identify the traits for their breeding objectives, during the next exercise.

Step 6: Documenting the results of the exercise

The facilitator should collect all the papers or forms with the lists of varieties and the drawings of the Diversity Wheel with the varieties assigned to the categories. Add the date and the name of the FFS to all papers and collect them in the Facilitator Binder.

When the exercise is done with stones on the Diversity Wheel that is laid out on the ground, the facilitator should take a picture and/or fill in (a copy of) **Form C** and adds it to the Facilitator Binder.

4.4 Setting breeding objectives and methods

(recommended duration: 1 hour)

Guided by the results of the Timeline Analysis and the Diversity Wheel exercises at crop and variety level, farmers are now able to set their breeding and selection objectives. Breeding and selection objectives are composed of the ideal crop traits that are desired by the community in the current context of environmental, economic, political and social conditions. The breeding and selection objectives determine the type of breeding and selection work that will be done in the FFS, and which varieties or populations will be used or requested from breeders or other sources as starting material. There are three different approaches that can be taken to achieve the breeding objectives (see box 2). This exercise should be done immediately following the Diversity Wheel exercise, in the same session. To set realistic breeding and selection objectives that address the needs of the community, simple scoring and ranking techniques are used to come to an agreement on the most preferred traits. With the list of these traits, the group discusses what breeding and selection methods are needed to achieve those traits.

NB: at the beginning of this exercise, the facilitator explains what breeding and selection objectives are, how they will inform the FFS work in the years to come and describes the different breeding and selection methods.

Step 1: Assigning crop varieties to the subgroups for discussion

The same subgroups that worked together in the Diversity Wheel exercise, will now focus on the crop varieties that were considered most important for further investigation during the Diversity Wheel exercise for varieties. If there is only one selected variety, all subgroups focus on this variety. If there are more, the facilitator assigns the different crop varieties to the subgroups. Subgroups start with a 10 minute discussion.

Guiding questions for subgroup discussions:

- Are the identified varieties cultivated a lot or only to a limited extent, or are they lost?
- What specific traits (positive or negative) make the identified varieties interesting?
- Do the identified varieties have traits that are important to food security, for economic reasons, to meet environmental conditions, etc.?
- Do the identified varieties possess negative traits that can be improved?

Step 2: Listing and scoring traits for selected varieties

In subgroups, farmers discuss and agree on the 8 to 10 most important traits, both positive and negative, of the variety assigned to them. These traits must be expressed in morphological and agronomic terms. For example, high yield (an agronomic term) is caused by several underlying morphological traits, like the number of tillers, panicle size or grain size. Also, the traits must be quantifiable: short duration should be expressed in the number of days to reach maturity from the day of sowing; and preferred height should be expressed in centimeters or inches. It is good to encourage farmers to describe traits that are important to them and to discuss the way they perceive a variety (for example, the ease of processing for sorghum varieties, or the position of the ears on a maize plant). Traits thus described by farmers may be quite different from those identified by agronomists or plant breeders.

To further deepen their understanding of the traits and determine the extent to which they are important in describing the variety, participants score each of the traits with a number from 1 to 5. The score describes how strongly a trait is present in a specific variety: the lower the score, the weaker the trait, the higher the score, the stronger the trait. For example, a variety that is fully resistant to a

certain pest may receive a score of 5 for that trait, whereas a variety that suffers some pest damage might receive a 2 or 3.

Step 3: Ranking the traits

Ranking is about making choices. For example, grain size and early maturity may have both received a score of 5 in the previous step, here farmers have to decide if one of the two traits is more important to them. In the subgroups, each farmer gets an equal amount of seeds (or stones), e.g., 20. They divide these seeds among the traits they find most important (more seeds means more important). Farmers can decide for themselves on how many traits they wish to rank. If they feel that many traits are important, they will divide their seeds among all those traits, if they wish to emphasize a few very important traits, they divide the seeds only among those. It is advisable always to make the vote anonymous, as power dynamics in communities will often influence the voting process (and it may be difficult for the facilitator to see). This can be done simply by asking participants to vote one by one, while the others turn their backs to the place where the voting takes place.

Step 4: Group discussion on breeding and selection objectives

Each subgroup reports the results to the plenary for discussion. The subgroup findings are compared to come to a top 5 of most desired traits that define the breeding and selection objectives. These discussions can be spirited and good facilitation is important. If not all farmers agree on the same breeding objectives they may choose to work with different subgroups over the course of the FFS season. The groups can work on the same crop and even variety (in the case of participatory variety enhancement), but with different breeding objectives, evaluating or selecting different traits. This adds diversity to the breeding process and creates an element of competition between the groups.
The facilitator should also ensure that breeding objectives are relevant and close to farmers' interests, and that they are realistic (remember that traits identified for breeding may be linked and that they can interfere with each other).

Step 5: Group discussion on breeding and selection methods

The facilitator gives a brief introduction to the different types of breeding and selection methods (see text box 2). The group discusses the breeding or selection method that is best fit to obtain varieties with traits that match the breeding objectives.

Regardless the breeding or selection method, the facilitator shares the list of preferred traits expressed in the breeding objectives with partnering breeding institutes, often through the partnering organization supporting the FFS. They can then determine which breeding lines (stable or segregating) may best be provided to a specific FFS group.

Box 2: *Different breeding or selection methods available to a FFS*

Participatory Variety Enhancement (PVE), sometimes also called variety restoration. It is performed to recreate an appreciated local variety that has deteriorated or is not anymore coping with changing growing conditions. Strong positive and negative selection over three growing seasons may result in much better seeds. For example, each season only the best 10% of the plants, panicles or seeds may be retained for the next season. PVE is not only used to recreate an old variety but also to increase the productive potential of a deteriorated variety or its ability to adapt to changing conditions. What makes PVE attractive, is that farmers do not need any material from outside. They can work with their own local variety with the aim to improve it.

Participatory Variety Selection (PVS). If the traits defined in the breeding objectives are not present in the varieties currently grown in the community, the FFS may look outside for new breeding material. Participatory variety selection is between a number of stable varieties or breeding lines, often provided by breeding institutes. 'Stable' means that all individuals in a sample variety or breeding line are identical or very similar. The traits of the different varieties or lines are compared over two to three growing seasons and the most preferred ones are retained. A favoured or most popular local variety is used as a control against which the performance of the new varieties is compared.

Participatory Variety Development (PVD) is more complex. Selection takes place within a single and large population of different individuals, called a segregating population. This population is obtained from crossings of two (or more) different varieties or breeding lines and consists of a very diverse and changing population of individual plants in which the characteristics of the parent plants are combined in different ways and to various degrees. Farmers may choose to cross their own varieties, with the aim of combining qualities of different varieties into a new one. They may also find an 'outside' variety they particularly like, whether from a breeding institute, the market, or a neighbouring community, and cross it with a local variety. The selection process following the crossing is more complicated than with PVE or PVS: usually, mass selection and bulking of preferred individuals is used in the first generations after a crossing (F1 to F4), whereas later pedigree selection may be preferred (see chapter XX for an explanation of different selection methods). It also takes longer: only after six to eight rounds of selection are the seeds sufficiently stable. By then a new variety has been created.

Step 6: Documenting the results of the exercise

The facilitator fills in a (copy of) Form D below. Add the date and the name of the FFS to all papers with notes and collect them in the Facilitator Binder.

Form D: *Breeding and selection strategy for selected crop(s)*

Breeding and selection goals	**Selected strategy**	**Advantages**	**Challenges**	**Seed needs**
1	PVE, PVS or PVD			
2				
3				
4				
5				

5. ESTABLISHMENT AND MANAGEMENT OF FFS PLOTS

This stage includes all activities from land preparation to sowing of the FFS study plots.

5.1 Site Design

This subchapter applies to PVS, PVE and PVD. The following sub-chapters will discuss each of these approaches specifically.

The site design and the location of each variety, line or population in separate plots within the site should minimize the risk of distortions of the experimental results. The following parameters (requirements) should be taken into account by trainers in selecting the FFS site and plot locations.

- Avoid distortion by factors such as slope and fertility gradient. Discuss with FFS participants why this is important.
- The plots should be representative of the farms in the ward. Discuss with FFS participants why this is important.
- The sites and plots should be safe from livestock.
- The location of the FFS sites should be easily accessible and easy-to-see for villagers who are not FFS participants.

The plot design and allocation of each line in the FFS field should minimize the risk of distortions by factors such as slope and fertility gradients, or other irregularities. The participants should preferably be organized in five subgroups, each subgroup with a leader and a reporter, and allocated their own sub-plot in the larger FFS site. At this stage, it should be decided whether or not to form women-only groups. This may be particularly relevant in cases where women's crop and trait preferences clearly deviate from those of men. The leader should ensure that all group members can voice their experiences and views and that proper analysis is made and conclusions are drawn. The role of reporter may rotate among the group members, so that each member can gain experience in the process of documentation and note-taking. All FFS members should participate in land preparation (an area of 1,000 m^2 at most), whether for PVS, PVE or PVD. Local soil tillage practices should be used in the FFS field. These practices can be identified and agreed upon with the farmer groups during the pre-season discussion, i.e. at the start of the FFS. In the course of the FFS, the Agro-Ecosystem Analysis (AESA) will form a key activity that will be carried out every week or every session, as the case may be. More details on how to design FFS studies and the various components of plant breeding and selection are presented in **Chapter 10.14**.

Planting density

The planting density depends on the crop species, and should be based on farmers' practice. Alternatively, the following densities are recommended for the following crops (these are crops that are of major importance in Zimbabwe):

- *For maize*, the planting density is one seed per hill, at a distance of 0.2m between hills x 0.9m between rows x 10m long rows, resulting in 278 plants per 50 sq. m., without thinning.
- *For pearl millet*, given that seeds are small, the planting density is three seeds per hill at a distance of 0.2m between hills x 0.9m between rows x 10m long rows, amounting to 834 plants per 50 sq. m. However, two seedlings per hill are thinned out one week after

emergence of the crop, thereby reducing the size of the plant population to 278 plants per 50 sq. m.

- *For sorghum*, given that seeds are relatively small, the planting density is 2 seeds per hill at a distance of 0.2m between hills x 0.9m between rows x 10m long rows, totaling 556 plants per 50 sq. m. However, one seedling per hill is thinned out one week after emergence of the crop, thereby reducing plant population to 278 plants per 50 sq. m.
- *For groundnut*, given that seeds are relatively bigger, the planting density is one seed per hill at a distance of 0.25m between hills x 0.5m between rows x 10m long rows, amounting to 400 plants per 50 sq. m; no thinning is required for this crop.

For cross-pollinating crops like maize and pearl millet, an isolation distance of 300m from the nearest stand of crops is advised, or an isolation by time where the FFS plot is sowed around 20 days before or after the sowing of the community farms. For self-pollinating crops, there is no need for isolation from other farmers in the community. In the case of PVS involving cross-pollinating crops, isolation is not essential for the purpose of the experiment, which is to compare the performance of stable varieties or lines. However, if farmers plan to save or use the seeds from plants compared in the PVS, then it is best to select plants in the centres of the plots, where the effects of cross-pollination will be smallest.

Avoid selecting seeds near plot borders (even of self-pollinating crops), as cross pollination, at a very low level, can still occur. Special care of avoiding the border in the case of sorghum is recommended as higher level of out-crossing can occur, especially under stressful conditions.

Suggestion. At this stage of site selection and plot design and planting, the following questions could be discussed with farmers. These questions are not to be presented as such but be used as a guide in the discussion with the participants.

- Should the FFS site have similar agro-ecological conditions as regular farmers' fields in the ward? Why?
- Should the FFS site be easily accessible or not? Why? Easily seen by non-participants or not? Why?
- How can the design of the site and the individual plots avoid distortion caused by factors such as slope and fertility gradient?
- How should the FFS site be subdivided in consideration of the number of small groups that have each been assigned their own sub-plots?
- What are the responsibilities of the small groups in the management of their plots, and in gathering data from each plot?
- What is the planting density (according to type of crops?)
- What is size of the total site and the plots within the site?
- Who shall be responsible in preparing the plots for planting and sowing the plots?

Plot design for Participatory Variety Selection (PVS)

Varieties or breeder lines

In PVS, stable varieties and breeding lines of various origins, including from breeding institutions, are studied and their performance is compared. One or two popular varieties (normally farmers' varieties) from within the community or other districts or provinces should be included as controls or standards for comparison. The control or standard variety should normally be the most popular, i.e., the variety/ies most commonly planted by farmers in the village.

It is recommended to sow a maximum of 8-10 lines (including the control variety/ies) during the first season. This number is both manageable and sufficient for farmers to gain the required knowledge and skills to successfully complete the FFS.

Field Size

Each single variety requires a field size of about 50-60 m^2. If a maximum of 10 varieties is included, the total area needed is about 500-600 m^2 per crop. Two separate sub-plots have to be allocated to the control varieties (see **Figures 1** and **2**). To increase the reliability of results and avoid uncertainties stemming from farmers' interpretation and analysis of data, replicate studies using the same lines may be conducted in other, often nearby villages that also undertake a FFS. The study field should preferably be surrounded by a fence in order to guard it against grazing cattle.

Plot identification

It is very important to properly label the individual sub-plots in the FFS field with durable sticks and tags in order to easily identify the location of the planted varieties. In addition, it is useful to make a map or layout of the field on paper and indicate on it where each variety is planted. The field layout may also indicate the slope and any variation in the field plots. If the site and its individual sub-plots are sloping, then the varieties should be arranged in parallel to the direction of the slope (see **Figure 1**). If the site is relatively homogeneous, then the varieties can be evenly distributed over the site (see **Figure 2**).

Figure 1: *Field layout of a PVS plot with slope*

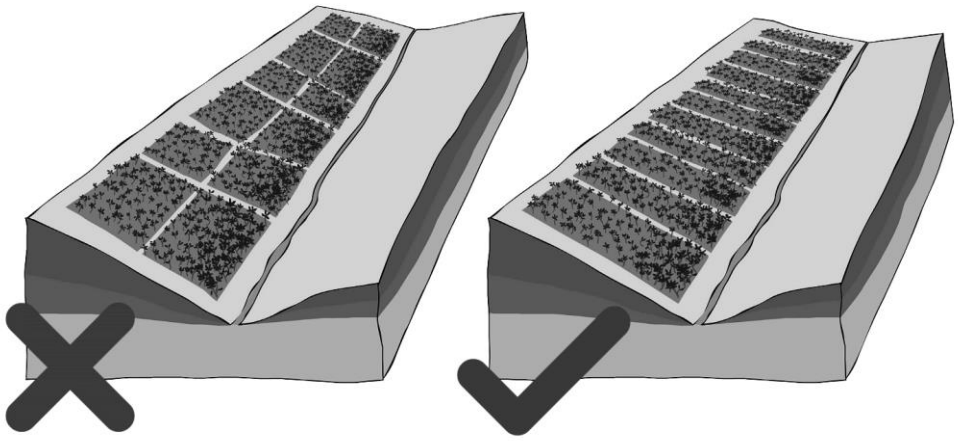
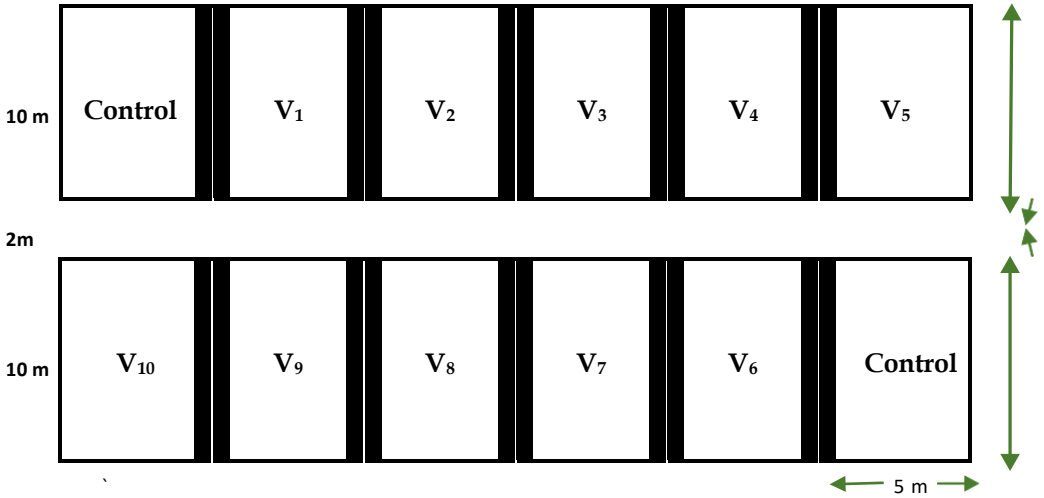


Figure 2: *Field layout of a homogeneous PVS plot*



Plot design for Participatory Variety Enhancement (PVE)

Identification of varieties

The selection of the variety or varieties to be improved (enhanced) is made during the diagnostic phase of the FFS. The selection concerns local 'deteriorated' varieties that are nevertheless popular in the farming community, but of which good quality seeds (homogeneous, well germinating, free of pests and diseases, with robust seedlings) can no longer be obtained. In those cases, seeds that are regularly available in the community may result in heterogeneous field stands, may be consistently infected by pathogens, or may have (partially) lost one or more of their valued traits. Farmers should choose one or more of such popular varieties. They should not only identify which specific traits they wish to improve, but also which negative traits (the traits associated with the perceived deterioration of the variety) they want to be reduced or eliminated. During the selection process farmers might also conclude that one or more traits of their variety would need to change in order for it to better adapt to new weather and climate conditions. Given that men and women may have different preferences in these regards, it is important to ensure that farmers of both genders participate in the exercise and that women's preferences are actively taken into account in the selection process. The analysis of desired characteristics should lead to the establishment of breeding and selection objectives jointly agreed upon by men and women farmers. If no consensus is reached, women's groups might work on another crop or variety than mixed or male groups (see also the section on "Setting breeding objectives and methods" in the previous chapter).

Field size

The size of the field plot needed for the PVE study depends on the number of farmer subgroups participating in the FFS. An individual variety should be allotted 300-500 m^2 in total, depending on the crop. The number of rows or sub-plots of the FFS field should be divisible by the number of farmer subgroups, so that each subgroup has an equal area and spends equal time on field observations. No further replications are needed.

Planting distance

Plant spacing for maize, pearl millet, sorghum and groundnut should be as per farmers' practice.

Alternatively, plants can be seeded as indicated above for PVS studies.

Isolation distance

While in PVS, seeds for the next season are generally obtained anew from breeding institutes, for PVE seeds are sourced from the FFS field plots in the community. Extra care must be taken to avoid cross-pollination from other varieties of the same crop. This is achieved by isolating the plots with PVE varieties from other plots either by distance or time of flowering:

- *For maize and pearl millet*, which are cross-pollinating species, ensure a distance of the FFS field of at least 300m from the next stand of the crop. Alternatively, realize isolation by staggering the planting time, with an interval of at least 20 days between planting from neighbouring farms (in order to be sure that varieties, even if planted at different times, do not flower at the same time, it is important to know the time to flowering of the different varieties). Make sure that no other maize or pearl millet is grown in the immediate vicinity of the PVE site. If there is only one local variety to be enhanced, then isolation needs to be practiced in relation to nearby farms. If there are two local varieties of the same crop to be enhanced, then the varieties can be planted in the same FFS site but they should be isolated by planting time. Alternatively, they can be planted in two different sites that are sufficiently isolated from each other.

- *For sorghum and groundnut,* which are mainly self-pollinating, ensure an isolation distance of at least 1 to 2 m between plots of different varieties. Be aware that, even though these crops are self-pollinating, hybridization might nevertheless occur. Depending on conditions, out-crossing levels may be as high as 15 percent (especially in the case of sorghum and under stress conditions). Therefore, selection of plants located at the edges of the PVE plot should preferably be avoided, since risk of cross-pollination (contamination) is highest here.

Identification

Label the fields in order to easily identify the location of the varieties planted. In addition, make a map of the field or a field layout on paper, indicating where each variety is planted (see **Figure 3a and Figure 3b)**.

Figure 3a: *Field layout of PVE plots for two 'deteriorated' farmers' varieties (cross-pollinating crops such as maize and pearl millet)*

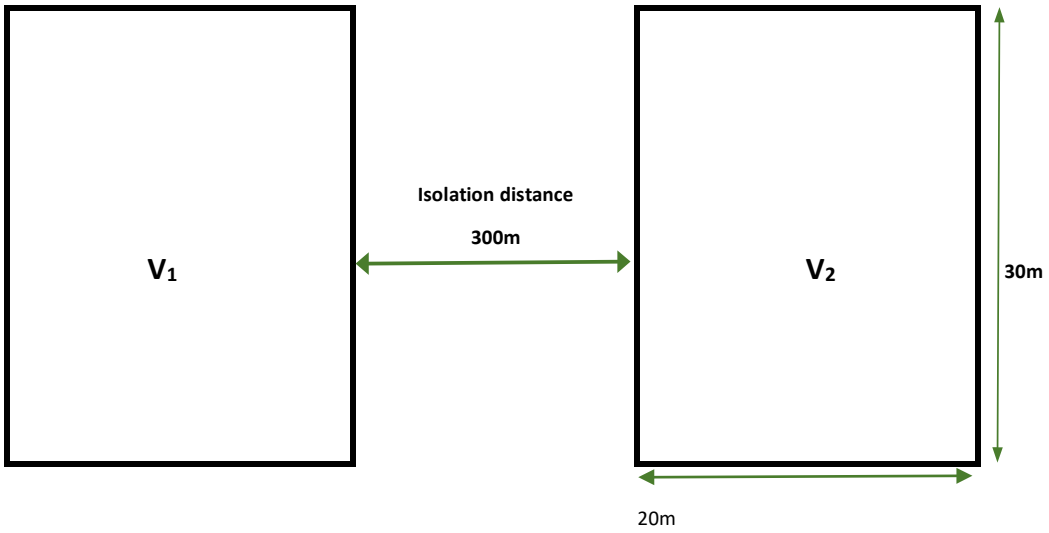
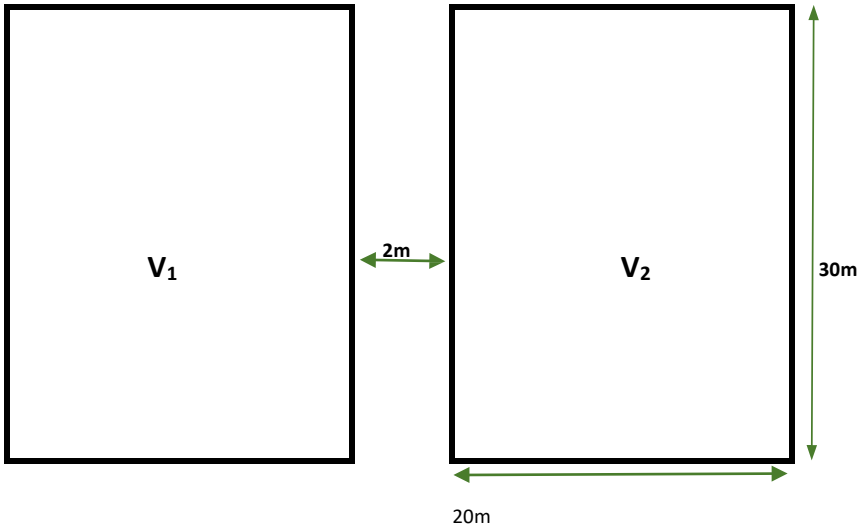


Figure 3b: *Field layout of PVE plots for two 'deteriorated' farmers' varieties (self-pollinating crops such as sorghum and groundnut)*



Plot design for Participatory Variety Development (PVD)

For PVD, different approaches may be followed. The most appropriate may be

- to select from a heterogeneous, or segregating, breeding population, created by breeders, for best adaptation to local conditions and preferences
- to create a composite population by allowing cross-fertilization between a number of collected varieties, lines or populations from various origins
- to cross two identified varieties in order to select for a new combination of traits in the offspring.

The same approach to plot design as for PVE can be followed when mass selection is applied. If in a later stage of the selection process ear-to-row (maize) or panicle-to-row is applied, a different plot lay-out is necessary. This lay-out is similar to the plot design for PVS, but now single lines of plants are established for all seed selected from single superior plants.

Seed provision

Irrespective of the breeding or selection method chosen, the seeds must be received and prepared a week before the estimated sowing time. If farmers are working under rain-fed conditions, sowing will be determined by the arrival of effective rainfall. The seeds must be properly stored given the possibility that rainfall and sowing may be delayed. When real chances exist that delayed rainfall or other weather events will cause a failure of seed germination, it is important to bulk or withhold a sufficient amount of seed to allow for a second round of sowing. In rare cases, such as during the El Niño of the 2015-16 growing season in Zimbabwe and again in 2017-18, three rounds of sowing were needed in some FFS sites. See also Chapter **10.11** on Disaster Risk Reduction.

5.2 Plot Management and Responsibilities

The varieties and lines to be evaluated by the farmers should be managed well to prevent mixtures, mislabeling and damage. In case of PVE, the seed of the identified variety to be enhanced is normally accessed locally. The FFS participants must identify the farmer-source of the seeds. The sowing period should be similar to that which is normally practiced in the village.

For PVS, the study field is divided into 10 plots (assuming 8 breeding lines and 2 control varieties), whereby two sub-plots are assigned to each farmer subgroup. Subgroups collectively share responsibility for the sub-plot(s) planted with the control variety/ies, which function(s) as a standard against which all newly introduced lines are compared.

For PVE, only one plot is established for each variety that will be enhanced. This study plot is then divided into five sub-plots and each section is assigned to a separate farmer subgroup. Subgroups will gather data from their own assigned sections on a weekly basis.

For PVD, either a single plot (for bulk selection in early generations), or a plot consisting of a number of sub-plots each consisting of a number of rows with the progeny of individual superior plants will be needed (in the case of more advanced generations).

Each subgroup is responsible for the sub-plots assigned to them. Although regular care should be practiced at all times, the host farmer who owns the FFS field site should ensure that they are protected from stray animals. The entire FFS group can assist in this task and work together to erect a fence around the study plot if needed.

The facilitator should regularly discuss the selection objectives with the participants in order to establish and reconfirm the type of data to be gathered, how often they will be gathered, and how they will be gathered at every stage of plant growth and development. It should be emphasized to the participants that data gathering, consolidation and interpretation are collective and collaborative activities of each subgroup and the FFS group as a whole, and that these activities are essential for the success of the FFS.

5.3 Critical Selection Stages in PVE and PVD

To optimize the quality of the observations during variety enhancement and bulk selection in PVD, farmers should conduct several rounds of positive and/or negative selection in the field. Recommended periods and plant stages for the purpose of selection are as follows:

For Maize and pearl millet

1. Observations

- From planting to tasseling/flowering period: most suitable for observations of germination rate, plant vigour, leaf colour, stem base colour, degree of tillering, early tasseling, and responses to pests and diseases;
- Silking/flowering period: most suitable for observations of early silking, silk/flower colour, plant height, and responses to pests and diseases;
- Period from flowering until maturity, just before harvest: suitable for observations regarding early maturity, plant height, ear/panicle size, cob cover and grain yield.

2. Critical selection stages

Maize and pearl millet are cross-pollinating species. Negative selection is very important as it ensures that no pollen from plants with inferior traits are able to pollinate the flowers of superior plants. Roguing plants with negative traits earlier identified as undesirable and causing low productivity should be conducted before the plants start to flower.

Selection and roguing can start from germination stage to late vegetative stage, or even at the booting phase of the plant (when the seed, ear or panicle begins to develop, but is still enveloped by the leaf stem). Each subgroup should constantly refer to their breeding objectives to guide their negative selection and roguing practice.

Only the better plants should be allowed to flower. After the flowering stage, plants with superior traits are identified and selected as sources of seed at harvest time.

In addition to roguing, a common method of negative selection for maize is detasseling: the removal of the pollen-producing male flowers (before they begin to produce pollen!) from the top of inferior plants. This will still allow the plants and ears to reach maturity and contribute to harvest, but no pollen carrying negative traits will spread to superior plants.

For sorghum

1. Observations

- From planting to flowering period: suitable for observations of germination rate, plant vigour, leaf colour, stem base colour, degree of tillering, and responses to pests and diseases;
- Flowering period: most suitable for observations of date of flowering, plant height, and responses to pests and diseases;
- Maturity period, just before harvest: suitable for observations regarding early maturity, number of productive tillers, panicle size, panicle exsertion and grain yield.

2. Critical selection stages

As this is a self-pollinating species, positive selection is more appropriate (there is less chance of out-crossing of negative traits from inferior plants). For greater genetic progress, it is advised to apply intense selection pressure. This will ensure that only the seeds of plants with superior traits are harvested for the next season. The number of superior plants can be as low as 5 to 10 percent of the established plants. Since sorghum is self-pollinating, there is no need for roguing during the vegetative phase and all plants can be allowed to flower. However, do keep in mind the earlier advice to avoid selecting plants from the edges of the plot.

For Groundnut

1. Observations

- Period from planting to flowering: suitable for observations of germination rate, plant vigour, leaf colour, early flowering, flower colour, and responses to pests and diseases;
- Pod development period: most suitable for observations of seed setting, growth habit, and responses to pests and diseases;
- Maturity period, just before harvest: suitable for observations regarding early maturity, number of pods, number of seeds per pod and total seed yield.

2. Critical selection stages

The same as for sorghum.

5.4 Selection methods in PVD

Farmers can undertake PVD by either making crosses between two preferred varieties themselves, or by working with segregating materials provided to them from crosses made by breeders or other farmers. In both cases the objective is to obtain progeny that better fits the needs of the community. Such crosses may, for example, involve a preferred local variety and a modern variety accessed from the market. PVD requires large investments in terms of land, time and expertise, especially when the creation of crosses is involved. Some background is provided below regarding this type of PVD.

In plant breeding, hybridization accounts for only 10 percent of the activity, while 90 percent involves selection. Hybridization is a special FFS topic that may be carried out during the reproductive stage of varieties in order to create entirely new genetic variability in crops. It is explained in more detail in the special topics on specific crops, towards the end of this document (see **Chapter 10.9**).

Important Advice

In order to carry out crossings and effective subsequent selection, breeding tools (i.e. hybridization kits, glycine bags, paper bags, threads, tags) and advice by breeders are needed. Technical experts of breeding institutions should schedule regular field visits to the FFS PVD sites and provide the necessary technical backstopping, particularly in the hybridization and subsequent early selection phases.

Selection from heterogeneous populations resulting from crossings

In most start-up FFS PVD experiments, farmer-generated or breeder-generated segregating materials are introduced for learning and development purposes. In this way novice farmer-breeders and more experienced farmer breeders can both benefit.

- During the FFS PVD participants will conduct up to four different selection rounds in the field: in the vegetative stage, the flowering stage, the ripening stage and at maturity. Selection criteria for each stage should be applied based on the breeding objectives, and field observations should be documented. Note measurements on traits such as germination, tillering, panicle length, early maturity, etc.
- During each selection round, walk through the plot and inspect each individual plant. Mark outstanding plants with a bamboo stick or ribbon. Assign different sticks, ribbons or colours per selection round to identify interesting individual plants. Differently coloured ribbons may also be used per breeding objective (e.g., green for height, blue for early flowering). Make drawings of outstanding plants.
- Perform the final selection round just prior to harvest. Select as many plants as possible for the next generation. Do not select less than 10% of the total population since preferred characteristics or special combinations of characteristics may not yet be visible and otherwise may be lost. In the 2nd generation (F2), the selected number of plants may be slightly more (20%) than in later generations. For example, when an F2 plot consists of 500 plants, select between 100 and 150 plants.
- After harvest, dry the panicles or cobs, or thresh the seed and place it in a bag. Panicles or seed may be bulked, depending on the selection technique used. Attach a label to identify the parent varieties in the cross and the generation.
- Dedicate some time to explain the breeding cycle of the crop, the cause and use of segregation, and the techniques involved in bulk selection. Let farmers practice by drawing the diagrams of breeding involved in bulk selection.
- Optionally, elaborate on the principles of pedigree selection and modified bulk selection. This may depend on the FFS situation.

- Further topics for discussion
    - What is the reason for the high amount of variation in the plots under study?
    - Are the plants in the segregating plot very different from the parent varieties?
    - How many generations are needed to select a new stable variety?

Selection methods in cross- and self-pollinating crops

Performing selection in a crop means influencing the frequency with which desirable genes and traits occur in a population of that crop. The aim is to increase their occurrence so that a gene becomes predominant and is stably expressed in a population, which may be released as a new variety if all major genes and traits have become stable and if the population is clearly different (distinct) from already existing varieties. The selection process is determined to a major extent by the way in which genes are normally transferred from one plant to another.

In *cross-pollinating plants*, many genes are exchanged between individual plants when the plants flower and their pollen is transferred to other plants by wind or insects. It is a process that is difficult to limit and control, and containing the natural flow of genes by forcing plants of cross-pollinating crops to

pollinate themselves instead of each other is a laborious task. Doing so for successive generations (as is practiced in the development of parents for hybrid varieties) also results in the deterioration of the population over time (i.e. plants may become shorter/smaller, malformed, etc.), something called inbreeding depression. This is why selection in cross-pollinating crops to create new open-pollinated varieties (OPVs) is focused on the improvement of populations rather than on the improvement of individual plants: a controlled group of selected superior plants that are allowed to cross-pollinate and so gain improved traits together, generation after generation, as a population. Such a population may be recognized and named as a variety for the stable presence and inheritance of a number of major traits and underlying genes, whereas the genome as a whole may be exposed to genetic changes over generations.

In *self-pollinating plants* the process of selection starts from individual plants. Self-pollinating plants do only transfer their pollen, and thus their genes and traits, to other individuals in the population at very low rates. In order for traits from different plants to be combined, crosses are performed through human intervention. Self-pollinating crops do not suffer from inbreeding depression. Their method of reproduction is very efficient: fixing genes and traits in individual plants and their offspring, effectively by passing on only their own genes with each cycle of reproduction while barring to a large extent the entrance of new genes from other plants. For the breeder this means it is possible to observe and follow the development of traits in single plants and their offspring very precisely, without having to worry about 'contamination' by genes from other plants. The selection methods described below mirror these differences in how plants reproduce.

A variety needs to be distinct (different from other varieties) and to a certain extent uniform and stable, but from the above it should be clear that the requirements and standards applied on self-pollinating plants can be stricter (less heterogeneity between individual plants in the variety) than in the case of cross-pollinating plants.

Bulk selection (self-pollinating crops)

In the bulk selection method, after making the initial cross, the segregating progenies (or offspring) are propagated till F4 or F6 without any applied selection. Field conditions are likely to cause spontaneous selection and farmers, even without conscious effort, will apply some measure of selection by choosing not to harvest the weakest, shortest or tallest, earliest or latest plants. Bulk selection may be applied by farmers, or by breeders at their premises respectively. Once a relatively high degree of homozygosity is reached (i.e. when major traits have become more defined and distinct), individual plant selection with progeny testing is applied. Each field is about the same size (2000-5000 hills). Plant or panicle (pedigree) selections are made from the F5 or the F6, and planted in rows for selection in the next generation. Preliminary yield tests are conducted in the F8. Finally, the best lines are multiplied and tested for adaptability starting from the F9 onwards.

There are some variations on this selection procedure, such as negative and positive bulk selection respectively. In this method only individuals with trait values greater or less than some threshold level are used for further selection. Either poor performing plants are eliminated through roguing (negative selection), or plants are selected that exceed a specified level (for example all plants above 100 cm). This modification of the bulk method slightly increases selection pressure. In the latter (positive) selection method, at least 30-40% of plants in the population should be selected to avoid a major loss of plant genotypes generated in the initial cross.

Pedigree selection (self-pollinating crops)

Following the pedigree selection method, a single plant is selected and the progeny of that single plant is tested, which allows for a much more precise and faster selection technique. After the initial cross, the progeny (F1) is monitored for sets of similar well-performing plants. These sets of similar plants are harvested, mixed and planted to create the next generation (F2).

Pedigree selection may then start in the F2: single well performing plants are selected and separately harvested. The seed is then grown in plant rows in the F3. Complete rows may be accepted or rejected. The number of selected plants should be quite high in order to retain sufficient genetic diversity for further selection. In the accepted rows well-performing plants are selected and again separately harvested for continued progeny testing in the F4 and F5. Plots in the F5 can be slightly larger to allow for preliminary observations for yield. In the F6 the rows have become fairly uniform, which allows for wider testing, including eating quality, in the F7 and F8. They are also called lines in this selection stage. This is a highly labour- and land-intensive method which is normally not advised for application in the FFS before the F4 or F5 generation.

In bulk selection many genes and traits passed on by the original parents are retained, but genetic progress is slow. Whereas genetic progress in pedigree selection is faster, it is more labour-intensive, and the risk of losing major genes and traits remains.

Modified pedigree/bulk selection (self-pollinating crops)

This is a combination of the above selection techniques. In this method bulk selection is applied from the F2 until the F4, which is followed by pedigree selection. The method combines the quicker genetic progress of pedigree selection in the later stages of variety development with the reduced demands on labour and land of bulk selection in the early stages.

Application of each of these methods depends on the situation, the available area and capacity of the farmers to manage the field studies, and the number of varietal crosses in which selection needs to take place.

The advantages of this approach are:

- Bulk selection until F4 is able to capture higher variation and its genetic potentials. Basically, bulk selection is equal to managing only one population. At these early and highly segregating stages, bulk selection does not lose high potential genes that may not have appeared to be important yet.
- Applying pedigree selection from F4 or F5 means that segregation is now significantly reduced. There can be 10 to 20 pedigree lines from an F4 or F5 bulk-selected population. It is easier to carry lines forward, or discard, as the traits in each pedigree line are relatively stable.

Mass selection (cross-pollinating crops)

The mass selection method is similar to the bulk selection method for self-pollinating crops (in the modified version of positive/negative bulk selection). Individual, well-performing plants are selected from a population, separately harvested, and bulked to produce the next generation, at which time the process is repeated. The selection method is based on the phenotypic appearances of the plants in the field. However, since the seed is bulked and hence a rather heterogeneous population is produced, no progeny testing at the plant level is carried out. The principle advantage of this method is its simplicity and the ease with which it can be carried out. Because of bulking of the population there is lesser risk of

inbreeding. However, selection progress is slow. If primary selection is for yield, a characteristic with an intrinsic low heritability, mass selection may not be very effective.

Mass selection is close to traditional farmers' practices that are applied in the field (for example, off-types in a population of maize are discarded as a form of negative selection). Farmers do understand that when they apply good mass selection, the resulting produce can be used and sold as seeds, not grains. This selection pressure (together with natural selection) is able to maintain the distinctness and stability of traditional OPVs of cross-pollinating crops, for example of maize in Meso-America.
For a variation on this method called **Stratified Mass Selection**, refer to the section on maize topics (Chapter 11.4)

Recurrent selection (cross-pollinating crops) The main benefit of recurrent selection is the type of progeny testing. From a segregating population superior plants are selected. Seed from each of the selected plants is planted in the next season in one or two rows per selected plant. The harvest is separated into two: part of the seed is withheld, the other part is used for further progeny testing, in which the progeny plot is planted only with the seeds of the selected plants . Since the female flowers developing into the ears will have been cross-pollinated, only one of the parents (the mother) is known, whereas the source of the pollen (father) is random and unknown. The constant factor in the progeny line is the female parent, whereas the genetic diversity originates from the male parent. Progeny testing is done to see whether the combination of genes in the selected plant with those of various other, male plants is generally favourable. Once tested positively, the retained seed of all selected superior lines is planted in the next generation and bulked. Bulking is required to prevent inbreeding. This selection procedure can be repeated, and continued until the population is stable enough for testing of yield and other traits and can be released as a new variety. Various modifications are used by breeders to improve the recurrent selection method, for example:

- If plant characteristics are visible before flowering (germination vigour, leaf shape), it is better to remove the poor performing plants from the field before flowering and bulk the remaining lines.
- If self-pollination is too laborious, farmers can harvest the selected plants (half-sibs) and sow the progeny in the next season for testing as above. In this method, however, selection progress is slower, since some degree of outcrossing occurs.
-

Creating a breeding population for cross-pollinating crops

A breeding population can be created by bulking and cross-breeding at least six or more parent lines to create a first generation composite population. Parent lines may be gathered from various sites, the greater the genetic distance between the initial lines that make up the composite population, the higher the potential for new promising varieties. To create a new open-pollinated variety from the composite population, either mass selection or recurrent selection can be applied as described above.

6. ACTIVITIES IN THE FFS FIELD DURING THE VEGETATIVE GROWTH STAGE

Each subgroup is expected to select a random sample of five plants within each tested variety or breeding line in their own subplot. These randomly selected plants should be marked with sticks or pegs and be used for collecting agronomic and morphological data on a weekly basis throughout the season (for PVE and PVD, as the growing season progresses, additional plants may be tagged as soon as positive traits begin to appear, for later recognition). In addition to the sample of five plants monitored by the subgroup, five additional plants should be randomly selected every week to monitor the incidence of pests and diseases (i.e. the percentage of infected plants, or the relative abundance of pests, pathogens and other natural enemies on plants). During the vegetative growth stage, the occurrence of drought and other abiotic stresses should be observed and qualitatively measured (i.e. the percentage of affected plants, the occurrence and length of drought spells). Special topics on 'morphology and growth stages' of pearl millet (chapter 11.5), maize (chapter 11.3), sorghum (chapter 11.4) and groundnut (chapter 11.7) can be addressed in the FFS weekly meetings at this stage.

Field Management

***Soil tillage*.** Local soil tillage practices for maize, pearl millet, sorghum and groundnut should be used. These practices can be identified and agreed upon with the farmer groups during the pre-season discussion, i.e. at the start of the FFS.

Fertilizer use. Fertilizer application levels should be as per normal farmers' practices, taking into account recommendations for maize, pearl millet, sorghum and groundnut under prevalent local conditions. These levels should be determined for each FFS field separately through consultation with the farmers' group. It is important to apply fertilizer (organic or inorganic) in strictly uniform quantities, as the volume of fertilizer used may considerably influence the performance of the planted varieties and thus the comparison of performance between varieties or lines.

Use of pesticides. In order to properly measure resistance to or tolerance for insect pests and diseases, preferably no pesticides should be used in the field study, unless the infection threatens to destroy all plants and, therefore, disrupt the field study. Alternatively, normal farmers' practices may also be applied.

***Weeding*.** No herbicides should be used. Usual weeding practices should be applied.

Agro-Ecosystem Analysis (AESA)

The agro-ecosystem analysis (AESA) is a thorough study of the different components of the agricultural environment and its ecology. It facilitates proper decision-making by helping participants consider the complexity of their farms and the factors influencing the growth of crops.

Each FFS is expected to perform an AESA on a weekly basis, as discussed in **Special Topic 10.4**. In order to track the growth and development of the crop during early in the growing season, observations should be recorded in the AESA Sheet for Vegetative Stage (see **Table 2)**. Any additional observations should also be recorded in the AESA sheet if found to be important during discussions in the FFS weekly meetings.

Roguing at the Vegetative Growth Stage

The FFS should include a discussion among the entire farmers' group, aiming to develop a set of selection criteria by means of which to identify preferred plants (in PVE and PVD) and varieties (in PVS). For the PVS plots, the selection criteria are used as the basis for selection of the most desired varieties, whereas for the PVE and PVD plots, the selection criteria are used to guide roguing. Roguing should be undertaken twice during the vegetative growth stage: the first roguing is performed two weeks after plantlet emergence and the second is done another two weeks after that. For cross-pollinating species like maize and pearl millet, roguing (or detasseling) of plants with inferior traits should be conducted at least before pollen initiation. This is to prevent pollen from inferior plants to pollinate the plants with superior traits.

No Roguing in PVS Plots

No roguing activity is needed in the PVS plots. Instead, the selection criteria developed by the participants should be used to select the most desired varieties from among the tested PVS varieties and lines. Unless strict care is taken to prevent pollen transfer from inferior plants (as is done with PVE and PVD), seeds from superior plants of cross-pollinating species such as maize and pearl millet in a PVS plot are not useful for next season sowing. These seeds will contain traits from nearby inferior plants resulting from cross-pollination.

Roguing in PVE and PVD Plots

In PVE and PVD roguing is a highly important and effective practice. Roguing should target plants showing inferior characteristics compared to the majority of plants within a plot. For example, less vigorous plants, tall plants, plants with fewer tillers, droopy leaf-type plants, suspected off-types (plants which deviate from the variety in one or more traits) or volunteer crops (plants that have grown by themselves and have not been deliberately planted), as well as diseased plants. Pollen from inferior plants with undesirable traits must be prevented from pollinating flowers of superior plants. Roguing or detasseling should be conducted before pollen initiation, or before emergence of the female flowers.

Organizing FFS discussions

On a weekly basis, each subgroup should be asked to present the results of their field observations from the past week in a plenary session. This encourages farmers to discuss various issues and to compare their observations with those of other subgroups. In this context, farmers should be asked to undertake the following:

- Describe the general plant development for each variety in the case of PVS. Do the different varieties develop in the same way? Can you observe differences between individual plants in a PVE or PVD field? How do 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 (in a PVS study) or for the variety under enhancement (for PVE) or population under selection (for PVD)?
- Compare the pest and disease situation with that of the previous week. Are there more insect pests and has disease pressure increased? Is it clear why? Is the development of insect pests and disease the same on all varieties (PVS) or plants (PVE and PVD)? Are there

some varieties (PVS) or plants (PVE and PVD) that show fewer insects or less disease infestation?

- Compare growth development and performance of varieties (in the case of PVS) or of individual plants (in the case of PVE and PVD). Identify the best performing variety in PVS based on observations and the weekly data gathered, and explain why this variety was selected. In PVE and PVD, rogue the weak plants, and select and clearly mark the best performing plants in order to monitor these throughout the entire cropping season.
- Rank the varieties studied in PVS according to their overall levels of performance.
- Reflect on the observations of other subgroups: what varieties do they prefer? Are these the same varieties as selected by the reporting subgroup? Why? Are there any other important characteristics that were not included in the observations? Why are these characteristics important to one or more of the other subgroups?

Extension support

If possible, regularly visits by extension staff should be arranged to FFS fields and sessions to monitor the quality and progress of the training. Extension staff can also serve as resource persons, including on group dynamics – a relevant theme for the participants at the time of field visits – given that most of the staff are well acquainted with the farmers in the community.

7. ACTIVITIES IN THE FFS FIELD AT REPRODUCTIVE GROWTH STAGE

Most of the selection activity is undertaken during this stage. In the PVE and PVD study plots, the final roguing is conducted before flowering. In PVS, the groups continue with further observations regarding the relative performance of the stable varieties and lines. The AESA is a very important ongoing activity at this stage, as most of the observations are relevant for selection. Activities related to the special topics included in this field guide can also be carried out at this stage (see Chapter 11.5 for pearl millet, Chapter 11.3 for maize, Chapter 11.4 for sorghum and Chapter 11.7 for ground nut).

Special Topics

When the plants enter the reproductive growth stage, a special topic on the *Reproductive Systems of Crops* should be addressed during the first weekly session after the onset of flowering (see **Chapter 11.4** for pearl millet, **Chapter 11.3** for maize, **Chapter 11.40.10** for sorghum and **Annex 10.11** for groundnut).
A special topic on *hybridization* (see **Special Topic 10.2** and **Annex 10.8** for pearl millet, **Annex 10.9** for maize, **Annex 10.10** for sorghum and **Annex 10.11** for groundnut) and *Inheritance of Traits* (see **Special Topic 10.10**) may then be addressed during the next weekly session held during this growth stage.
The topic of selection of segregating lines (see *Selection Techniques in Pearl Millet* in **Annex 10.8**) should be addressed as the last special topic in the case of PVD (performing crosses and selecting the progeny).

Agro-Ecosystem Analysis (AESA)

At the reproductive growth stage, farmers should continue conducting AESA and record on a weekly basis the progress of growth and development of the crop using the *AESA Sheet for Reproductive Stage* (see **Table 3**). Note in the AESA sheet other characteristics that should be observed, measured and discussed by the FFS farmers. In particular, the following characteristics should be documented:

- *For maize*: plant height, number of leaves, leaf angle, days to tasseling, days to silking, occurrence of pests and diseases.
- *For sorghum and pearl millet*: plant height, number of tillers, days to full bloom, occurrence of pest and diseases.
- *For groundnut*: number of branches, plant height, days to flowering, occurrence of pest and diseases.

Roguing at the Reproductive Stage

No Roguing in PVS Study Plots

In the PVS study plot, the selection criteria developed by the participants for major traits pertaining to this growth stage should be applied as the final basis for ranking of the desired variety or varieties. Off-type plants must be removed before flowering. No roguing activity should be undertaken in the PVS plots. Instead, the selection criteria developed by the participants should be used to select and rank the most desired varieties among the PVS entries.

Roguing in PVE and PVD Study Plots

At this stage, just before the plants are flowering, farmers should perform the last (third) round of negative selection, using the set of selection criteria developed for this purpose.
Roguing should target plants showing inferior characteristics compared to the majority of plants within a plot (e.g. less vigorous plants, tall plants, plants with fewer tillers, droopy leaf-type plants, suspected off-types or volunteer crops, and diseased plants). Remember that for cross-pollinating crops like maize and pearl millet, roguing or detasseling should be conducted just before flowering or before pollen migration. Positive selection is more effective for self-pollinating species. For cross-pollinating species, positive selection of the most superior plants is done later, during harvest time. Plants with inferior traits are discarded.

FFS Discussions

As during the vegetative growth stage, each subgroup should be asked to present the results of their observations from the past week at a weekly plenary session. This should encourage farmers to discuss various issues and compare the results of other subgroups with their own observations. The following questions and issues should be addressed:

- Describe the general condition of the plants. Do the different varieties (PVS) or plants (PVE and PVD) develop in the same way? Which variety (PVS) or plants (PVE and PVD) flowered first? Which variety has more tillers? How did the weather conditions influence plant development?
- Aside from roguing (in PVE and PVD only!), what other management practices were applied during the week? How did this affect crop development for each variety?
- Compare the pest and disease situation to that of the previous week. Are there more infested and diseased plants? How could this happen? Is the insect pest damage or disease infection more severe in its effects on plant health? Why? Is the development of insect pests and disease the same on all varieties (PVS) or plants (PVE and PVD)? Are there varieties (PVS) of plants (PVE and PVD) that have fewer insect pests or lesser disease damage?
- For PVS, compare growth development and performance of varieties. Rank the varieties according to their overall levels of performance. Select the best performing variety based on observations and the weekly data gathered, and explain why this variety was selected.
- Reflect on the observations of other subgroups: what varieties do they prefer? Are these varieties the same as those selected by the reporting subgroup or different? Why or why not? Does the selection of varieties (PVS) or plants (PVE and PVD) differ between men and women? Which characteristics are important to men and/or women and why? Are there any other important characteristics that were not included in the observations?

8. ACTIVITIES IN THE FFS FIELD AT MATURITY STAGE

The final evaluation of the tested varieties and lines against the breeding objectives should be undertaken during the maturity stage. Evaluation data for statistical analysis should be gathered at this stage. Plans should be made for the Farmers' Field Day (see **Chapter 10.5**) and regarding the selection and management of seeds from the PVS, PVE and PVD study plots. Related special topics should be addressed.

Individual plants with preferred traits (positive selection) should be marked with a coloured tag for later recognition. Plants with undesirable characteristics (negative selection) must be rogued or removed during observations. After harvest, the selected plants can still be further screened on desired characteristics and off-types can be removed. This is particularly relevant for the PVE and PVD studies.

Special Topics

A special topic on *Conducting a Farmers' Field Day* (see **Special Topic 10.5**) should be scheduled for discussion in the first weekly session during harvest time. A special topic on *Evaluation of Varieties by Farmers* (see **Special Topic 10.6**) should be discussed during the next weekly session. During the third and fourth weekly sessions, special topics on *Seed Production of High Quality OPV Seed for Maize (see Chapter 11.3) and Pearl Millet and Sorghum (*see Chapter 11.6) should be addressed.

Important Task: Data for Statistical Analysis of PVS Study Plots

Especially for PVS studies, breeding institutes may be interested to receive data on the performance of the breeding lines they have shared with the FFS. To this end, it is needed to coordinate with the partner breeding institutions in order to schedule visits of their technical staff to the FFS sessions. These visits provide the necessary technical backstopping for the gathering of data for statistical analysis and also enable the staff of the partner breeding institutions to identify possible breeding materials that could be useful in the next FFS season.
The final gathering of data for statistical analysis should be undertaken before harvesting. In the entire group, select 30 plants from each plot (i.e. for each variety or line in the PVS studies) for measuring agronomic data as explained below. The breeding institutions may use these data for statistical analysis.

Agro-Ecosystem Analysis (AESA)

Continue conducting AESA during the maturity stage until two weeks before harvest. Record on the *AESA Sheet for Maturity Stage* (see **Table 4**) the progress of growth and development of the crop at the time of observation. Note on the AESA sheet any other observations that have been identified as important during discussions with farmers in the course of the FFS. Some important characteristics to consider are:

- *For maize*: days to maturity, degree of lodging, number of ears, plant height, length and circumference of ears, occurrence of pests and diseases.
- *For sorghum and pearl millet*: days to maturity, degree of lodging, number of productive and non-productive tillers, plant height, length and circumference of panicle, panicle exertion, occurrence of pests and diseases.

- *For groundnut*: days to maturity, number of branches, plant height, number of pods, number of mature and immature seeds per pod, size and colour of seeds, occurrence of pests and diseases.
- At the end of the season, ensure that the following final data have been entered into the AESA Sheet for Maturity Stage:
    - Grain yield
    - Gross margin ($/ha)
    - Ranking of individual plants (for PVE or PVD) or of lines (PVS)

These data will ultimately become the most important yardsticks for selecting the best varieties (PVS) that farmers could use to add to or replace the varieties they currently grow.

Use the three sets of AESA evaluation sheets (for **vegetative stage** [Table 2], **reproductive stage** [Table 3] and **maturity stage** [Table 4]) to encourage FFS participants to think about the relevance of each of their observations. Prepare an overview of the agreed observations on a flip chart for reference.

Harvesting of PVS Study Plots

Each plot containing a different variety or breeding line should be harvested separately, and the seeds should also be dried and weighed per variety or line separately to determine the yield. After this stage, farmers may wish to test the seeds further using other criteria such as storage behaviour, cooking qualities and taste. If the crop is self-pollinating, like groundnut, farmers may carefully select seeds from varieties or lines they like and try it at small production scale in their own farms. However, if the crops are cross-pollinating, the seeds of the preferred high performing variety cannot be used for seeding, since pollen from plants that did not perform so well may have pollinated these varieties. The farmers should instead use the “remnant or reserve” seeds of the chosen varieties from the source of the varieties (usually the plant breeding institute) for their own seeding. Additional seed of the preferred varieties may be requested from the collaborating breeding institutions.

Special instructions for Groundnut

Harvest each variety separately only when 80 percent of all pods in a specific plot are physiologically mature. Physiological maturity of the pods can be determined by the presence of black layers at the base of the seeds inside the pods. To avoid cross-contamination, if seeds are collected for sowing the next season, make sure to harvest only the 8 inner rows of a 10-row plot, leaving one hill or plant at both ends of each row (these can still be harvested for consumption). Thus, approximately 304 plants per plot should be harvested (38 hills per 9.5-metre row x 8 rows per plot).

Harvesting of PVE and PVD Study Plots

Whereas harvesting of seeds for sowing is optional in PVS, it is always required for PVE and PVD. When doing PVE and PVD, a FFS uses its own seeds to build on the selection work of previous years. Both negative and positive selection techniques are employed. Depending on the type of variety enhancement (PVE) or progeny selection (PVD), different harvesting methods may be applied.

- It must be remembered that positive selection is most appropriate for self-pollinating species, e.g., groundnut and sorghum. The plants with superior or desired traits can be selected as seeds for the next season.

- Positive selection can also be used for cross-pollinating crops. However, this selection is applied only to the plants that remain after the plants with negative traits have been rogued.
- Do not select plants from the edges of a plot, not only because rates of cross-breeding are higher there, but also because factors that affect growth but are not related to genotype (more sunlight, nutrients) may be stronger there.

Positive bulk or mass selection

In positive mass selection, plants with desirable traits are selected from the population and mixed together to be used as parents of the next generation.

- Harvest all marked 'superior' plants, which may then be dried, labeled, and stored together until the next season. Harvest a total of 10 percent of the seeds of 'superior' plants (hills). Mix the 'superior' seeds of all selected plants.
    - *For maize*: Prepare around 1,000 'superior' seeds for next-season planting in 1,000 hills (e.g. one seed per hill without thinning) in a plot size of 10m x 50m = 500 m^2 (i.e. 0.9m between rows x 0.2m between hills x 10m rows).
    - *For pearl millet*: Prepare 3,000 'superior' seeds for next-season planting in 1,000 hills (e.g. three seeds per hill to be thinned to one seedling per hill one week after germination) in a plot size of 10m x 50m = 500 m^2 (i.e. 0.9m between rows x 0.2m between hills x 10m rows).
    - *For sorghum*: Prepare 2,000 'superior' seeds for next-season planting in 1,000 hills (e.g. two seeds per hill to be thinned to one seedling per hill one week after seed germination) in a plot size of 10m x 50m = 500 m^2 (i.e. 0.9m between rows x 0.2m between hills x 10m rows).
    - *For groundnut*: Prepare 4,000 'superior' seeds for next-season planting in 4,000 hills (e.g. one seed per hill without thinning) in a plot size of 10m x 50m = 500 m^2 (i.e. 0.5m between rows x 0.25m between hills x 10m rows).

Pedigree selection and recurrent selection

In pedigree selection, seeds of superior plants are not mixed, but kept and sown separately, while keeping a record of their ancestry (pedigree). Breeding progress is generally quicker using this method, but requires greater management from farmers.

- When applying **pedigree selection**, harvest each 'superior' plant separately. Seeds of each 'superior' plant should then be dried, labeled and stored separately for ear-to-row or panicle-to-row sowing in the next season. Harvest 56 superior plants of maize, pearl millet or sorghum and up to 300 superior plants of groundnut. For **recurrent selection** in cross-pollinating species, it also requires the withholding of part of the seeds from each seed stock (ears, panicles): if the seeds from a particular ear or panicle produce a row of superior plants, it will be possible to go back to these 'reserve' seeds in the next season, knowing that they will produce the same superior plants. It is not possible to do this with the seeds produced by the plants in the superior row, as these will have been cross-pollinated with pollen from inferior plants.

- Prepare around 56 seed stocks (ears, panicles) from the marked 'superior' maize, pearl millet or sorghum plants for ear- or head-to-row planting in the next season. Prepare 300 seed stocks from marked 'superior' groundnut plants for plant-to-row planting in the next season. After the completion of seed preparation, unused or remnant seeds should be stored as a reserve and/or for succeeding planting seasons.

    - *For maize*: Prepare around 56 'superior' seed stocks (ears) for next-season planting in 56 rows (i.e. one seed per hill without thinning) in a plot size of 10m x 50m or 500 m^2 (i.e. 0.9 m between rows x 0.2 m between hills x 10m rows).
    - *For pearl millet*: Prepare 56 'superior' seed stocks (heads) for next-season planting in 56 separate rows (i.e. one seed stock pocket per row of three seeds per hill, to be thinned to one seedling per hill one week after germination) in a plot size of 10m x 50m = 500 m^2 (i.e. 0.9m between rows x 0.2m between hills x 10m rows).
    - *For sorghum*: Prepare 56 'superior' seed stock (heads) for next-season planting in 56 separate rows (i.e. one seed stock pocket per row of two seeds per hill, to be thinned to one seedling per hill one week after germination) in a plot size of 10m x 50m = 500 m^2 (i.e. 0.9m between rows x 0.2m between hills x 10m rows).
    - *For groundnut*: Prepare 300 'superior' seed stock (plants) for next-season planting in 300 separate rows (i.e. one seed stock pocket per row of one seed per hill without thinning) in a plot size of 10m x 50m or 500 m^2 (i.e. 0.5m between rows x 0.25m between hills x 10m rows).

Evaluation of Varieties by Farmers

In the final activity, the facilitator should guide the farmers on how to perform an overall evaluation of the varieties and lines (PVS) or plants (PVE and PVD) included in the FFS field studies. Three methodologies can be used and compared to evaluate the varieties or lines in a PVS study, namely: (a) visual observations, (b) pair-wise ranking, and (c) score card evaluation. These methods are discussed in **Chapter 10.6**. It is important that the data collected is ordered by gender.

9. REFLECTIONS, LESSONS LEARNED, AND PLANNING FOR THE NEXT SEASON

This stage involves final reflections on what has been accomplished during the first FFS season. A review of the lessons learned should be undertaken with both facilitators and project staff present to reveal 'what went well' in the first season and 'what needs improvement' for the next season's activities. A simple course evaluation may also be undertaken to determine which areas to improve and how to improve them (see **Chapter 10.7**). The lessons learned will be the basis for improvement of the following FFS elements:

- This field guide;
- Technical processes (breeding and selection);
- Participatory processes (e.g. group organization);
- Partnership with breeding institutions and other partners (e.g. extension service, government organizations);
- Gender and social inclusion aspects.

The review will also provide a basis for the identification of advanced or model farmers in different FFS sites for the purpose of training them as future FFS facilitators. Special attention may be needed to identify and support women FFS facilitators in order to enable the FFS to reach out to and address the training needs of women farmers in the same measure as those of men.

A special topic on the evaluation of cooking and eating qualities of tested varieties may also be undertaken if the farmers so desire. The approach for this activity is elaborated under **Chapter 10.12**.

Once farmers have grasped and reviewed all of the above information, they should be ready to develop plans for the next season with guidance from the facilitator. The methodology for this activity is detailed in **Chapter 10.8**.

10. SPECIAL TOPICS

The special topics regard organizational matters (10.1 – 10.8), technical topics (10.9 – 10.12) and issues regarding the underlying FFS processes and approaches (10.13 – 10.15).

10.1 Planning Meeting for the First Season

Introduction

Prior to the planting season, facilitators should organize a session with all interested farmers and community leaders to launch the FFS PPB activities. This pre-season session will allow farmers to anticipate the learning topics and develop mutual expectations. It will also allow the facilitators to make some critical decisions regarding field studies, prospective participants, required training materials and responsibilities. The pre-season activities should build enthusiasm and commitment from prospective participants and the community as a whole.

Objectives

The pre-season session aims to achieve the following objectives:

- To help farmers understand what FFS PPB is all about and establish mutual expectations with the community regarding the goals and results of the FFS PPB training programme;
- To identify prospective participants among the community farmers and field study plots for season-long FFS PPB activities;
- To conduct an assessment of available Plant Genetic Resources (PGR) through the Diversity Wheel exercise (page 17);
- To organize small groups, ensuring gender and social inclusion, prepare training materials and draft a work plan for the planting season.

Timing of the pre-season session

In the course of pre-season planning and commencement of groundwork activities, facilitators should establish protocols with village officials and community leaders. It may be useful to allow for a short time gap between the PGR assessment and the identification of prospective participants. This allows farmers to share findings of the PGR assessment with others in their community and thus generate enthusiasm among a larger group of farmers, especially those who were not present during the assessment. This also gives the facilitators enough time to compile the PGR assessment data, prepare training materials and decide whether the data provide sufficient basis for successful FFS implementation.

10.2 Start-Up Session

Introduction

A multi-season FFS PPB training requires a fair degree of commitment. Frequent fluctuation of participants' attendance in the weekly small-group activities jeopardizes the continuation and success of the programme. However, it may be difficult to expect farmers to commit themselves to a prolonged multiple-season undertaking. Thus, a commitment for one season is the maximum that farmers should be asked to pledge and the minimum that one should expect from them at this early stage. Women may face hindrances to their participation due to inter-related reasons, such as prejudices that do not recognize women as farmers, household responsibilities conflicting with the FFS timing, constrained mobility to participate in training at more distant locations, or a lack of self-confidence to participate in the FFS. It is therefore important to jointly discuss hindrances to women's participation and collectively seek solutions to address these.

Objectives

- To ensure enthusiasm and commitment from the participants
- To inform farmers about the training programme and the timeline of activities (see chapter x above)
- To discuss with the farmers their investment in terms of time and effort, and implications and expectations of their participation in the FFS
- To understand and address hindrances to women's participation

Procedure

Pre-selection

Village leaders should be asked to organize a community meeting. During this meeting, the findings of the baseline survey should be discussed and the community should be informed of the criteria for the selection of participants (see below). It should be clarified that selection does not mean that other interested farmers are not welcome to join the activities. There will be a Farmers' Field Day at the end of the season, where the selected participants will report to the whole community on the progress of their study. In addition, all farmers should be welcome to visit the field studies at any time and discuss with the participants the nature and objectives of the FFS. Farmer participants should be selected using the following criteria, well communicated within the entire community:

- Farmers with a keen interest in the activity, preferably those with known experience in plant selection and on-farm crop experimentation;
- Full-time farmers, rather than seasonal farm workers, or government workers or employees;
- Farmers who have farmland in the immediate village neighbourhood and who are or have been recently engaged in the cultivation of the crops the FFS is likely to focus on;
- Farmers in good health, between 18 and 60 years old, preferably with some basic education;
- Farmers who are committed to attend the full duration of the season-long training and possibly more.
- Farmers who attended an FFS training on another topic (e.g., integrated pest

management [IPM]);
- More or less equal participation of women and men farmers.

Setting Expectations

As farmers may be new to the FFS concept, introduce the participants to the objectives and basic operations of the FFS PPB curriculum. Discuss the timeframe for the season's activities and raise realistic expectations regarding the curriculum, objectives and outputs. It should be explained that expectations are mutual: a facilitator offers his/her skills in PPB to the participants, but in return expects the latter to know why they attend the training and must be committed to it. Discuss mutual expectations.

A facilitator is expected to:

- Facilitate agreement on mutual expectations;
- Motivate participants to ensure commitment and re-establish it whenever a participant starts losing interest in an activity or does not take an activity seriously;
- Provide participants with a goal (daily, weekly, season-wise) which can help them to think ahead during the learning activities and inspire them to meet the weekly demands of the programme;
- Address hindrances to women's participation;
- Provide participants with a basis for evaluation of their activities and the results of the FFS.

A participant is expected to:

- Know why he/she is participating in the activity (what is attracting and motivating him/her);
- Know what is expected from him/her;
- Understand the nature of participation required to achieve the goals of the training;
- Jointly commit to promote effective women's participation;
- Provide the facilitator with a basis for evaluation of the results of the FFS, which should be a joint activity coordinated by the evaluator.

Document the objectives of the training and the mutual expectations in short and clear wording. Give each participant a copy of this document and also reproduce it on a flip chart for display in the room. Explain that this is the 'Learning Agreement.' If participants have questions about the methods or goals at any time during the training, the expectations can be recalled. At the same time, the facilitator may remind the participants about the expectations regarding their commitment to the training. Reconfirm the expectations on a weekly basis to strengthen the group's involvement in the topics.

Final preparations

Qualified participants should be asked to record their name, age and gender, and details concerning their farming experience, family household and educational background. Subsequently, discuss the criteria for site selection and decide with the farmers which site is most suitable for the field studies.

10.3 Developing the Work Plan

Introduction

In the first FFS session farmers should only decide on the study activities and responsibilities for the coming planting season. However, FFS PPB activities usually span several seasons. Although it is suggested that the farmers make plans only for the commencing season, they must be reminded not to lose sight of their long-term objectives.

Objectives

- To decide on the crops, varieties and type of field studies for the first FFS study season;
- To consider the number, source, and type of crops and the varieties, breeding lines and/or populations involved, to be planted and used for PVS, PVE and, possibly, cross pollination and line selection (PVD);
- To draft a work plan for the coming season, ensuring that the plan is realistic and feasible and that it includes women's interests and objectives.

Materials

- Tape, small pieces of paper, marker pens, paper

Time Guide: 2 hours

Procedure

Farmers' Field Studies

- Briefly review the components of the breeding process and the proposed field studies with the participants. For the first season, farmers may opt to work mainly or exclusively on PVS and PVE, and to work on cross-breeding and line selection (PVD) only to a limited extent, if at all. However, for the second season, they may try to work on all components of the plant breeding agenda.
- Explain to participants the implications and time requirements of the field studies involved and the need to limit the number of studies for the first FFS season in order to set realistic goals.
- Discuss crops and varieties involved: as major staples (in Zimbabwe), maize, pearl millet, sorghum and groundnut are logical choices. Elaborate on the options for PVS, PVE and, possibly, cross-breeding and progeny selection. Note that for the first season, the selection of varieties will depend on the availability of varieties, cultivars and breeding lines from collaborating breeders and farmers.
- Make a final decision on the exact field studies to be included in the coming cropping season: will the FFS focus on PVS, PVE or PVD?

Crop Materials for Field Studies

- Ask the farmers to split up into small groups. Review the breeding objectives established during the Diversity Wheel exercise.

- Discuss the number of new varieties, local cultivars and breeding lines that are needed for each field study. Ask the farmer groups to determine which type of varieties they would like to include in the field studies.
- Small groups will present their findings. Note the possibility to obtain additional varieties from breeding institutions. Discuss the findings in the plenary and seek consensus.

Organization and Responsibilities

- Divide the farmers again into small subgroups and ask them to consider the activities that they intend to carry out during the next two seasons (e.g. PVS, PVE, cross-breeding, progeny selection) and decide on the priorities and plans for the first immediate season.
- Ask them to write down the activities on a flip chart using the format shown in **Table 5**.

Table 5: *Format for planning FFS PPB activities for the coming two seasons*

No.	Main activity	Timing & Duration	Responsible people	Equipment needed
1				
2				
3				
4				
5				

- Ask each subgroup to present their work plan.
- Ask participants which preparations are needed for the implementation of the planned activities.
- Finally discuss how the group members will undertake weekly observations and data gathering for each activity.

Questions *(make sure to be consciously sensitive to women's participation and needs)*

- What field study will demand most of your time and work?
- Do participants have sufficient land to conduct the selected field studies?
- What is better: to do a lot of activities superficially or to do a few activities well?
- Do you think you have all the necessary materials to conduct the field studies?
- Considering the plant breeding objectives, which kind of varieties, cultivars and advanced lines would be best to include in the FFS? Are women's needs and preferences addressed?
- If participants will perform cross-breeding, which varieties have favourable characteristics that they wish to cross with and integrate into their own varieties?
- If farmers wish to undertake line selection from a heterogeneous populations to be obtained from a breeding institution, is access to such a population ensured?
- Which kinds of activities should be undertaken between this planning session and planting time?
- Are there activities that may not be amenable to women's participation? How can these hindrances be overcome?
- Who is responsible for supervising the activities?

10.4 Agro-ecosystem Analysis (AESA) and G x E interaction

Introduction

AESA stands for a thorough analysis of the agricultural environment and its ecology. For the FFS participants, AESA provides a way of considering complex, interlinked factors for proper decision making. Every week during the season, the participants will study the various components of the crop agro-ecosystem. They will study climate developments and weather conditions, plant morphology and agronomy, the incidence of herbivores and natural enemies of herbivores. They will also investigate diseases, and their natural enemies, as well as their interactions in the cropping ecosystem, and they will use this information for their agro-ecosystem analysis and decision making.

Many local and modern crop varieties may not survive if left alone in the field. 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. The so-called agro-ecosystem in which this takes place – the result of abiotic, biotic and human interferences – is very important in bringing out the characteristics of the local varieties. Local varieties thrive best in the agro-ecosystems in which they have developed, and are used and reproduced. Droughts, floods, pests, diseases and other hazards all interact with crops and hence with farmers' crop production.

Varieties respond differently to the environment. For example, modern varieties are usually more responsive to fertilization than local varieties. However, local varieties normally demonstrate better growth under stress conditions such as drought. These responses are known as genotype x environment interactions (G x E interaction). In the FFS, it is important to determine whether the differences between varieties and advanced breeding lines are only the result of genetic differences or also caused by the interactions between the genotype and the environment.

These observed differences are discussed and elaborated in weekly exercises, all related to agro-ecosystem observations, in particular G x E interactions. These sessions will lead participants through weekly sets of observations, questions, analyses and illustrations, which are designed to improve the observation and decision-making skills of the participants.

The AESA methodology allows farmers to observe the various interactions between the genotype and the environment. Sometimes, these will be simple observations on aspects such as rainfall patterns, soil type, agronomic characteristics of the crop, and pest and disease occurrences, among others. Farmers may be less familiar with methods of objective and quantitative observation (for example, on plant morphology, yield, and pest and disease incidences); hence, there is a need to discuss on how these observations can best be made and used. Small exercises on topics critical to the particular plant stage serve to assist farmers in learning the skills of observation, comparison and interpretation.

It is important to tie these weekly exercises to questions raised by farmers, or link them with moments at which decisions concerning field management are made. Group dynamics demand that the exercises are kept flexible. Each week a new topic should be addressed. Facilitators may find some guidelines in reading through this special topic on 'Agro-ecosystem analysis and G x E interaction'.

Recording

Each subgroup in the FFS should keep a notebook for recording all data from their observations.

Variety observations should be taken from a random sample of five plants per individual variety sub-plot (plus another five for the monitoring of pests and diseases). Results of the genotype x environment (G x E) observations should be summarized on the agro-ecosystem observation sheets. Examples of ecosystem observation sheets are provided in **Tables 2, 3 and 4.**

Objectives

- To allow farmers to better understand the local agro-ecosystem;
- To help farmers identify and analyze relationships in their agro-ecosystem and determine genotype x environment interactions through analysis in the field;
- To allow participants to improve their decision-making skills.

Materials

- Always keep a stock of notebooks, papers, tape, marker pens, magnifying glass, scissors, plastic bags and meter sticks.

Procedure

The AESA activities should normally start with field observations by each subgroup separately for about 30 minutes, followed by a classroom reflection. These activities fit very well with the weekly FFS sessions and can be used as group dynamics exercises. The topics provide major links with further activities in the course of the FFS, including in-depth learning activities, if and when required. Field observations are recorded on a weekly basis in the AESA sheets (**see Tables 2, 3 and 4**), and thus at various crop stages (e.g. vegetative, reproductive, and maturity).
Ideally, the weekly AESA exercises should facilitate a variety selection process or a crop management decision, e.g. fertilization, pest or disease management. In addition, the exercises should reflect on practical questions raised by the participants.

Learning Exercises

Abiotic factors

- If feasible, collect weekly rainfall figures and compile the data graphically. Discuss the crop's water requirement and – if occurring - the implications of flooding and drought.
- Observe the plants' responses if a sudden heat wave occurs, or if rains are delayed and a drought sets in. Explain the importance of water for the crop's nutrient management and indicate stages in the crop development that are most sensitive to water stress.
- In case of drought, study the field layout and observe carefully whether there are differences in drought stress between various parts of the field. Carefully check whether these variations influence the comparison between the varieties and breeding lines that are studied in the FFS PPB.
- Study the influence of sunlight on photosynthesis and plant growth. Explain the basics of photosynthesis in relation to the plant's physiology and growth.
- Study crop morphology by observing varieties with different plant types (PVS) or different plants within a variety (PVE). Discuss plant types in relation to their effectiveness of light interception.
- Observe plant competition for nutrients as affected by plant density. On a weekly basis,

record plant development as affected by plant density.

Some Questions for Conceptualization

- Which influence will the rainfall have on the growth of plants?
- Which effects will unequal distribution of rain and/or irrigation have on plant growth?
- Why are some varieties more drought tolerant? What is so specific about these varieties?
- Which relationship exists between root development and drought susceptibility?
- How does the condition of the field compare with the previous week? Can you explain what happened since the last meeting?
- What do you expect will happen next week, considering the weather forecast and the plant growth stage?
- How important is water in the plant's nutrient management? In what growth stage is the plant most sensitive to water stress?
- Are damages on the plants caused by abiotic stress or biotic factors (pests and diseases)?
- What types of plants are most effective in intercepting light for photosynthesis? Which ones are most effective in environments experiencing water stress? Can you identify varieties with such characteristics? Does this information influence your plant breeding objectives?

Biotic Factors

Ask the participants to go into the field and observe and collect as many different types of living organisms in the crop ecosystem as possible. They should collect in each sub-plot in which a variety or breeding line is being evaluated. Include healthy plants, diseased plants, insects, spiders, and list the occurrence of rats, snakes, birds and other animals. Classify the collected or listed organisms by their function in the ecosystem. Explain and discuss the functions and relationships between each organism and the crop and between the collected or listed organisms.

Insect-plant interactions

- Groups should observe and, if possible, collect various insects in the field using an insect net, then bring them to the classroom. Explain to farmers which insects are harmful and which ones are not.
- Monitor harmful insects by recording their prevalence in the field on a weekly basis, particularly during the most critical period in the plants' growth. Compile the results graphically and discuss.
- If necessary, create an insect 'zoo' by collecting some of the most harmful insects and placing them in a cage made from a glass bottle or a plastic bag and containing some potted plants or plant parts. Observe if and how the insects damage the plants or plant parts. Make a drawing of each stage in the insects' development at the time of observation. Explain whether the insects are pests or rather natural enemies of pests, and discuss the potential crop damage they can cause.
- Record the damage caused by insects to different varieties by drawing the damaged leaves, pods, inflorescences and seeds. Score each variety and discuss the plant's reactions. Explain the plant's physiology, i.e. why some genotypes are resistant or tolerant to pests and others are not.

Disease-plant interactions

- For each variety being evaluated, ask the participants to find and collect a number of plants with symptoms of possible diseases. Explain the differences between damages caused by abiotic factors and biotic factors (i.e. diseases). Monitor harmful crop diseases on a weekly or bi-weekly basis. Observe and record the progress of the most harmful diseases, and discuss the disease cycle.
- Record disease resistance levels of different varieties by drawing the damaged leaves, pods, stalks and seeds, wherever applicable. Score and discuss plant reactions. Explain each plant's physiology of resistance and tolerance, and discuss why some genotypes are more resistant or tolerant to disease than others.

Natural enemies and predators

- Ask a farmer to tell a story about how his crop was damaged and what he did to prevent damage in the next season. Alternatively, facilitators may recount stories about farmers who successfully prevented damage by using natural predators. Discuss how FFS participants could apply this method in their fields.
- Observe varieties and identify morphological characteristics that potentially prevent bird damage (e.g. awn length, seed colour, etc.) and rat damage, among others. Prepare drawings of the plant parts with these characteristics.
- During or after an attack by natural predators, study the field layout and observe carefully the damage done to various parts of the field. Determine whether these disparities might influence the results of variety comparison.

Some Questions for Conceptualization

- Which organisms are at the bottom and which ones at the top of the ecosystem's food chain (who eats who)?
- Which are the main pests and where do they come from?
- Are there specific pests that farmers should monitor more closely? What sort of damage do these pests cause and mainly at what stage of growth?
- List the various types of pests present in the field. Are they present in all plant groups or do they occur in some varieties or plant types only?
- If a decision is taken to spray against pests, would it affect observations concerning pest resistance? Is there a moment for spraying that would minimize the impact on the field experiments?
- How does the population of natural insect enemies compare with that of the previous week? What is the importance of natural enemies? Are birds considered natural enemies or pests? How can farmers make use of this?
- Are pests and diseases present in all plants, or are they concentrated on certain plants or varieties? Which varieties or plant types are preferred by pests?
- What sort of damage do pests cause at this stage? Is there any way that harmful insects present in the field could be prevented from increasing in numbers?
- Do the surrounding fields influence your field? How? What is the condition of the other fields?
- How do diseases spread? What is the main disease in your field? Is there any disease in the field now?

- Discuss how the different varieties or lines should be examined for diseases based on the symptoms. How should this be recorded?
- Are some leaves dying? Why? Is this natural? In which variety is this more pronounced or observed? Make drawings of the symptoms.
- If a decision is taken to spray against diseases, would spraying affect observations concerning disease resistance? Is there a moment for spraying that would minimize the impact on the field experiments?
- How can spreading of the disease be prevented? Do diseases influence yield qualitatively or quantitatively?
- Where do birds come from? Are they always present in the locality? Is there any way to prevent birds from doing damage to the field?
- How can farmers control rodents?

The results of the variety observations above as entered into the AESA sheets should later be summarized in matrices and graphs. There are several methods for comparison of varieties, e.g. the scoring card, pair-wise ranking and index ranking. In this field guide, only pair-wise ranking and the scoring card will be discussed and used (see Chapter 10.6). Conduct an exercise on evaluation methods in order to acquaint farmers with these methodologies.

TABLE 2: AGRO-ECOSYSTEM ANALYSIS (AESA) SHEET AT VEGETATIVE STAGE

AESA NO.			**GROUP**		**DATE**		**SOIL TYPE**		**BREEDING OBJECTIVES**		
CROP			**VARIETY/LINE**		**CROP AGE**				**1.**		
DATE PLANTED			**% SEED GERMINATION**		**STAND ESTABLISHMENT**				**2.**		
WEATHER CONDITION (Sunny: 1, Cloudy: 2, Rainy: 3, Other)	**Week 1**	**WK 2**	**WK 3**	**WK 4**		**Week 1**	**WK 2**	**WK 3**	**WK 4**	**3.**	
					CROP CONDITION (Poor, Fair, Good)					**4.**	
					COMMENTS on crop condition (If not good)					**5.**	
SOIL CONDITION (Dry, Moist, Other)					**WEED TYPE (Annual or Perennial; Grasses, Sedges, or Broadleaves)**						

SORGHUM/ PEARL MILLET	**Date of Emergence**	**Leaf Colour**	**Plant Height (cm)**	**No. of Tillers (Before Flowering)**	**Pest and/or Disease Name & Intensity (1: Low, 2: Medium, 3: High)**	**Natural Enemies Name & Intensity (1: Low, 2: Medium, 3: High)**	**Breeding objective A**	**Breeding objective B**
MAIZE	**Date of Emergence**	**Leaf Colour**	**Plant Height (cm)**		**Pest and/or Disease Name & Intensity (1: Low, 2: Medium, 3: High)**	**Natural Enemies Name & Intensity (1: Low, 2: Medium, 3: High)**	**Breeding objective A**	**Breeding objective B**

Sample number										
1	**Week**	1								
		2								
		3								
		4								
2	**Week**	1								
		2								
		3								
		4								
3	**Week**	1								
		2								
		3								
		4								
4	**Week**	1								
		2								
		3								
		4								
5	**Week**	1								
		2								
		3								
		4								
Average				in WK 4					in WK 4	in WK 4

Decicions based on traditional weather interpretations and other local knowledge		**Key decisions on crop management, including pest & disease management**	

TABLE 3: AGRO-ECOSYSTEM ANALYSIS (AESA) SHEET AT REPRODUCTIVE STAGE																
AESA NO.				GROUP				DATE						DAYS TO 50% FLOWERING		
CROP				VARIETY/LINE				CROP AGE								
WEATHER CONDITION (Sunny: 1, Cloudy: 2, Rainy: 3, Other)	Week 1	WK 2	WK 3	WK 4	CROP CONDITION (Poor, Fair, Good)				Week 1	WK 2			WK 3		WK 4	
					COMMENTS on crop condition (If not good)											
SOIL CONDITION (Dry, Moist, Other)					WEED TYPE (Annual or Perennial; Grasses, Sedges, or Broadleaves)											
SORGHUM/ PEARL MILLET	Plant Height (cm)	Days to full bloom		Pest and/or Disease Name & Intensity (1: Low, 2: Medium, 3: High)				Natural Enemies Name & Intensity (1: Low, 2: Medium, 3: High)				Breeding objective A		Breeding objective B		
MAIZE	Plant Height (cm)	Days to tasseling	Days to silking	Pest and/or Disease Name & Intensity (1: Low, 2: Medium, 3: High)				Natural Enemies Name & Intensity (1: Low, 2: Medium, 3: High)				Breeding objective A		Breeding objective B		
Sample number																
1	Week	1														
		2														
		3														
		4														
2	Week	1														
		2														
		3														
		4														
3	Week	1														
		2														
		3														
		4														
4	Week	1														
		2														
		3														
		4														
5	Week	1														
		2														
		3														
		4														
Average	in WK 4											in WK 4		in WK 4		
Decicions based on traditional weather interpretations and other local knowledge					Key decisions on crop management, including pest & disease management											

TABLE 4: AGRO-ECOSYSTEM ANALYSIS (AESA) SHEET AT MATURITY STAGE

AESA NO.		**GROUP**		**DATE**		**Degree of Lodging %**	
CROP		**VARIETY/ LINE**		**CROP AGE**		**Grain Yield (kg/ha; estimate)**	
WEATHER CONDITION (Sunny: 1, Cloudy: 2, Rainy: 3, Other)				**CROP CONDITION (Poor, Fair, Good)**		**Yield (kg/ha)**	
				COMMENTS on crop condition (If not good)		**Gross Margin ($/ha)**	
SOIL CONDITION (Dry, Moist, Other)				**WEED TYPE (Annual or Perennial; Grasses, Sedges, or Broadleaves)**		**Ranking (in PVS)**	

SORGHUM/ PEARL MILLET	**Days to Maturity**	**Plant Height (cm)**	**TILLERS**		**PANICLE**			**Grain Pests/Diseases (1: Low, 2: Medium, 3: High)**		**Breeding objective A**	**Breeding objective B**	**Breeding objective C**	**Ranking (in PVE, PVD)**
			Productive	**Unproductive**	**Excertion (Partial, Full)**	**Length (cm)**	**Circumference (cm)**						
MAIZE	**Days to Maturity**	**Plant Height (cm)**	**No. of cobs per plant**	**Husk cover (Good, Fair, Bad)**	**COB**			**Grain Pests/Diseases (1: Low, 2: Medium, 3: High)**	**Ear rot (Absent/ Present)**	**Breeding objective A**	**Breeding objective B**	**Breeding objective C**	**Ranking (in PVE, PVD)**
					No. of grain rows on cob	**Length (cm)**	**Circumference (cm)**						
Sample number 1													
2													
3													
4													
5													
Average													

Decicions based on traditional weather interpretations and other local knowledge		**General reflections on the season: Average, dry, wet, short, long, exceptional pests or weather events, type of yields, etc?**	

Source: adapted from FAO (2013)

Discussions

On a weekly basis, ask each subgroup to present the results of their observations from the past week in the plenary session. This will encourage farmers to discuss various related topics and compare observations of other groups with their own.

Weekly

- 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?
- Compare the pest and disease situation to that observed 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 fewer insect pests or little disease infection?
- Compare growth development and performance of varieties. Select the best performing variety (PVS) or superior plants (PVE), based on observations and the weekly data gathered, and explain why this variety or these superior plants were ranked highest and/or selected, and at which stage:
    - Vegetative stage
    - Early flowering stage
    - Plant maturity stage
- Rank the varieties or lines in PVS according to their overall levels of performance.
- What varieties do other subgroups prefer? Are these the same varieties as selected by the reporting subgroup? Why? Are there any important characteristics that were not included in the observations? Why are these characteristics important?

At flowering, ripening and harvesting stage of cereals and pulses

- Is there any difference in the time of flowering between varieties (PVS) or plants (PVE)?
- Is there any difference in the time of maturation between varieties (PVS) or plants (PVE)?
- Do some varieties shatter easily compared to others?
- What are the characteristics of the pods and panicles?
- Do you see any difference in grain characteristics?

At the end of the season

- After comparing the yields, do you see many differences?
- Are the varieties (PVS) or superior plants (PVE) with the least disease damage best yielding?
- Do you observe any difference in the cooking qualities and taste of the varieties?
- Note and discuss specific problems and advantages observed for each tested variety or breeding line. Are there important observations that were missed during the season's activities?
- How can we improve the study for the next season?
- Prepare a summary table of all the characteristics observed.

10.5 Farmers' Field Day

Introduction

When all crops are about to be harvested (i.e. when the standing crop shows at its best) and once field evaluations of varieties or segregating populations have been completed, it is time to conclude the season's FFS activities. The Farmers' Field Day (FFD) is the culminating activity of the FFS PPB season-long sessions, organized in order to report back to the whole community on the lessons learned and the progress made. The best time to have an FFD is when the crops in the 'learning field' are still standing and nearing maturity – unless there is an emergency situation and there is no choice but to harvest the crops before the FFD can take place.

The FFD is an activity that brings the farmer participants and other members of the community together. It is an occasion for the farmers and the facilitators to show the community and other stakeholders (e.g. elders, local authorities and officials) what they have learned and what have been the results of their research activities. It also highlights what a group of farmers can do when working together as a team to solve their problems. Thus, the FFD also serves as a platform for farmers to generate support for their follow-up activities among dignitaries, authorities and officials, and other prospective stakeholders.
The FFD may include such activities as a field tour, an exhibition, and/or a formal programme in which local officials deliver speeches. The participants and the community also jointly prepare food dishes as part of the event. The FFD is a genuinely festive occasion, with a festival-like atmosphere. Folk media activities (songs, dances and other common cultural activities in which the knowledge that has been gained can be expressed) prepared by farmers complete the celebrations.
It is important to prepare well for the FFD. The preceding days are usually full of activities: field evaluations are finalized, graphs and tables prepared, performances rehearsed and exhibition rooms arranged. The FFD is the FFS participants' affair, meaning that they must plan and implement it themselves. The farmer participants may choose to invite fellow farmers from the same or neighbouring villages. The facilitators may opt to invite their local chief executives or direct supervisors with the aim of informing them about the results of the FFS programme.

Apart from the preparations for the FFD, ample time will be needed to evaluate the lessons learned in the FFS group and to plan for the next season. This can be done either before or after the FFD.

Implementing an FFD

Objectives

- To help farmers decide on activities for the FFD
- To organize the FFD
- To show the results of the season-long FFS studies

Materials

- A 'learning field' in maturity stage
- Exhibition area and materials
- Tape, paper and markers

Time guide

Participants should devote considerable time to the preparation and organization of the FFD. Planning activities should start about three weeks ahead of the day. The last few days before the FFD, when farmers send out invitations, prepare exhibition materials and conduct rehearsals, are usually very busy.

Procedure

- Discuss with the farmer participants what makes a FFD successful. What are the reasons for holding an FFD? What might happen during the FFD?
- Write down the answers and use them as a basis for planning the group's FFD.
- Plan the FFD activities.
- Conduct the FFD.
- Evaluate and document the FFD activities.

Notes

- The FFD can be perfectly combined with the cooking and eating quality evaluations of varieties and advanced lines. The invited farmers and guests can participate in the testing and ranking of the food items prepared from the different lines and varieties according to their preferences. The whole activity can thus take on a cheerful character.
- The FFD is also an excellent time to hold a graduation ceremony for the farmers who have participated in the field studies and FFS sessions throughout the season.

Guiding Questions

- Who should be invited for the FFD? Why?
- How should participants approach local leaders to ensure the latter's involvement in and commitment to the FFD?
- How should the knowledge and skills learned in the FFS be shared with other farmers and local officials?

10.6 Final Evaluation of Varieties by Farmers

Participatory Variety Selection

In PVS, the performance of a set of varieties and breeding lines is compared; as such it is a straightforward process that well fits the first year of a FFS in a particular community, or with a new group. Considering that only a small number of traits and hence selection criteria are perceived as important (such as drought resistance, early maturity, resistance to pests and diseases, or grain yield), selection of the best performing variety is an activity that can be performed well by any FFS under nearly all circumstances.

It is essential to leave the initiative in the PVS experiment with the farmers. It will keep them involved, put them in charge of the selection process and enhance the probability that they will make further use of their selected options. Most farmers are not familiar with statistical analysis. Burdening them with statistical methods is not needed and would in fact be counterproductive, as they might quickly lose interest.

Some of the most basic methodologies for variety and stable line selection are discussed below. They will enable farmers to understand the effectiveness of their own comparison methods and add new skills for further use in their FFS programme.

Procedure for variety evaluation

Visual examination

- Ask the farmer subgroups to go to the field for the last time to inspect the different variety plots and select the best performing variety or varieties. Each subgroup should note down which variety performs best in their opinion and why.
- Ask each subgroup to make pair-wise variety comparisons with the control or standard variety (normally the farmers' most popular variety). Indicate which varieties perform better than the control or standard and which do not perform well enough (use the format of Table 6).

Table 6: *Pair-wise variety comparison with the farmers' popular (control) variety*

	1	2	3	4	5	6	7	8	9	10
Control Variety										

All-pair-wise combinations

- Ask subsequently to make variety comparison in all kinds of combinations. Ask them to take variety numbers 1-11 (including the control or the farmers' most popularly grown variety). Using Table 7 below, each group should indicate which one of the two varieties being compared is the best performing of the two and to explain why.

Table 7: *Pair-wise variety comparison in all kinds of combinations*

	Control Variety	Variety 1	Variety 2	Variety 3	Variety 4	Variety 5	Variety 6	Variety 7	Variety 8	Variety 9	Variety 10
Control Variety											
Variety 1											
Variety 2											
Variety 3											
Variety 4											
Variety 5											
Variety 6											
Variety 7											
Variety 8											
Variety 9											
Variety 10											

- Return to the classroom and ask subgroup participants to summarize the results of their observations in the first exercise, comparing the tested varieties with the control or standard, and ranking the varieties in the order of highest preference. Ask them to indicate the reasons given for choosing a particular variety.
- Ask all subgroups to present the result of their all-pair-wise comparisons. With assistance from the facilitator, prepare a table that includes all varieties and count how many times a variety is selected as the best performing.
- Compare the results of the pair-wise ranking with the ranking results from the visual comparison exercise in which each of the varieties and/or lines was compared with the control or standard.
- Select the first five varieties that rank highest for the scoring card comparison.

Scoring card comparison

- For the scoring card comparison, ask each subgroup to present the collected observation data and indicate which of the criteria were the most important in making the comparison.
- With assistance from the facilitator, recall the top 10 traits that were ranked during the exercise on breeding objectives.
- Ask the entire group to complete Tables 8a, 8b and 8c (see below) by recording the information for the selected top 10 criteria.
- Then ask the group to prepare a ranking with the best performing variety on top and the worst performing variety at the bottom.
- Present and compare the results of the scoring cards with the results of the pair-wise comparisons.
- 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.

- Ensure that all farmers are involved in the comparisons and understand the methods.

Questions

- Individual farmers may have different opinions on whether a variety performs better than another one. Why is it important to find out which variety performs best? How do breeding objectives relate with this performance exercise? Are there differences in men and women's preferences?
- What are the strengths of the visual and pair-wise comparisons? What are the weaknesses of these methods?
- What type of information do the farmers need in order to complete a score-card? Who should collect these data?
- When do we use the score-card method? What are the limitations?

Table 8a: *Sample Scoring Card Comparison for Maize*

VARIETY / CRITERIA	Variety Rank No. 1	Variety Rank No. 2	Variety Rank No. 3	Variety Rank No. 4	Variety Rank No. 5
1. Early maturity					
2. Plant height					
3. Lodging					
4. Drought tolerance					
5. Length of ears					
6. Circumference of ears					
7. Leaf angle (erect)					
8. Resistance to pests & diseases					
9. Grain yield					
10. Gross margin					

Table 8b: *Sample Scoring Card Comparison for Pearl Millet and Sorghum*

VARIETY / CRITERIA	Variety Rank No. 1	Variety Rank No. 2	Variety Rank No. 3	Variety Rank No. 4	Variety Rank No. 5
1. Early maturity					
2. Plant height					
3. Lodging					
4. Drought tolerance					
5. Number of productive tillers					
6. Length of panicle or head					
7. Panicle exsertion (fully excerted)					
8. Resistance to pests & diseases					
9. Grain yield					
10. Gross margin					

Table 8c: *Sample Scoring Card Comparison for Groundnut*

VARIETY / CRITERIA	Variety Rank No. 1	Variety Rank No. 2	Variety Rank No. 3	Variety Rank No. 4	Variety Rank No. 5
1. Early maturity					
2. Growing habit (spreading)					
3. Number of pods					
4. Number of seeds per pod					
5. Size of seeds					
6. Colour of seeds					
7. Resistance to pests					
8. Resistance to diseases					
9. Grain yield					
10. Gross margin					

10.7 Curriculum Evaluation

It is important to note that evaluation of the season's training is not a one-time activity, but rather an ongoing process. However, the end of the season is an important moment to evaluate the season-long FFS PPB activities. The evaluation consists of at least three components:

- Each farmers' field day should start with a review of farmers' expectations concerning the day's learning targets and finish with an evaluation using a checklist or the Ballot Box method (see below). This allows the participants to get the most out of the activities and the facilitators to learn and adapt their approaches.
- Slightly later, at the end of the FFS season, immediate effects of various kinds assumed to have been caused by the training activities should be evaluated. This includes the changes in know-how, field skills and confidence of the participants that have developed between the beginning and the end of the training. Evaluation may be based on several methods, including T-Cross, Piling Up and Ballot Box methods (see below).
- Finally, it is important to evaluate the wider impact of the FFS. Farmers may have improved their knowledge, skills and attitudes (e.g. cooperation, confidence, and gender and social inclusion), but this may not resolve their major problems. Impact is perhaps the most difficult factor to measure, also since the FFS on PPB is not likely to produce tangible results in one or two training seasons. Thus, an evaluation on impact at the end of the first FFS season might only be preliminary. However, it is important to keep impact in mind as the overall goal of the training activities. To warrant a continued interest of the farmers' community in the FFS PPB, the season's FFS activities should have an impact on one or more of the following three aspects: the farmer's food security and income, the agro-ecosystem environment, and community organization.

Some Group Evaluation Methods

- The ***Ballot Box*** is a method that uses multiple choice questions and field situations to test farmer's know-how and skills at the beginning and at the end of the season. The Ballot Box can also be used to test farmers' know-how and skills at the beginning and the end of a single day. Questions should be developed before the start of the season, and therefore requires timely planning.
- The ***T-Chart*** is an evaluation method whereby a T-shape drawn on a large piece of paper forms two columns, one for activities deemed to be 'good' and one for activities that 'need to be improved.' All farmers write the names of activities on cards, which are then stuck to either one of the columns as appropriate. The activities that 'need to be improved' should be discussed with the aim of finding solutions to the identified weaknesses.
- In the ***Piling-Up*** evaluation method, the farmers are asked to make drawings on a large piece of paper to represent various aspects of the programme (e.g. field studies, group activities, FFD, etc.). Subsequently, each participant is given some seeds or coins and asked to score each activity by piling the seeds/coins on top of the drawing that represents it. Discuss the activities with the lowest scores with the aim of finding solutions for improvement of such activities, or alternatively, for their replacement by others.

10.8 Developing Plans for the Next Season

After completion of the FFS evaluation, participants and facilitators should discuss the following issues:

- What kind of field studies should be conducted in the next season?
- Who will be responsible for seed storage during the off-season?
- What will be the need for new seeds from outside sources in the next season?
- When is the best time to conduct a more detailed pre-season planning meeting?
- Which new activities should be introduced in the next season?
- Who is going to participate in the next season's activities?

Based on the answers, design a study plan together with the farmers and decide which activities should be carried out in the next season. Also, discuss the group's plans to help other farmers in the village to understand more about PPB. Upon completion, consolidate the field research plan and discuss what kind of support will be needed to carry it out and how and from whom this support can be obtained.

10.9 Some concepts and terms explained

What are Plant Genetic Resources for Food and Agriculture?

Plant genetic resources for food and agriculture (PGRFA) refer to plants that are used by farmers and breeders and are maintained by genebanks and other collection holders. PGRFA may be cultivated, semi-cultivated or semi-wild, wild or gathered plants. PGRFA are valuable for supporting humankind with food, feed, medicines and other products. Generally, the value of these resources depends on the extent of diversity that they carry and the information available about their traits. A rich genetic diversity is invaluable for food production under conditions of climate change; it is a necessary basis for conventional plant improvement programmes in the public and private sectors, as well as for participatory approaches involving farmers.

In most countries, PGRFA encompass cultivated and semi-cultivated crops, in particular cereals, legumes, root and tuber crops, as well as vegetables. The most important among these are often cereal and legume crops such as maize, pearl millet, sorghum and groundnut in Zimbabwe, potato and other tuber crops, amaranth and quinoa in Peru, and rice, soy bean and pepper in Laos. Together, these crops provide calories, and many additional nutrients, the latter in particular in the form of vegetables.

Where do the seeds that farmers use come from?

The seeds that farmers use come from informal as well as formal sources. Informal seed sources include farmer-saved seeds directly used or exchanged and traded in local markets. Formal seed sources include seeds from private companies and public institutions, including multi-national companies and international agricultural research centres (see **Table 9**). Seeds may also be obtained from relief organizations and local seed businesses, and these often have a mixed origin. Informal sources may provide both farmers' varieties (i.e. local varieties) and formally registered varieties developed by the public and private sectors.

How are plant genetic resources maintained on-farm?

Plant genetic resources for food and agriculture (PGRFA) do change over time. They evolve through the combined effects of natural processes and human selection. The role of farmers and their practices (including management and storage, as well as sharing mechanisms) influence the fate of their PGR. The farmers' portfolio of PGR results from these practices, which include the informal flow of genetic materials through farmers' own social networks. These practices make a major contribution towards the creation of on-farm diversity.

In addition to the on-farm management, PGRFA are also conserved in collections maintained by breeding institutes and genebanks (a practice known as *ex situ* conservation), whereas many wild relatives of our cultivated plants survive in nature (*in situ* conservation).

Table 9: *Seed sources of farmers in Zimbabwe*

Farm-saved/ Community-based	Relief Aid	Local Seed Business	National Companies (private & public)	Multi-national Companies
▪ Mainly crops for household consumption ▪ Maize, millets, sorghum, banana, cassava, beans, cowpea, pigeon pea, green grams, groundnut, Bambara nut, potato ▪ Farmers' varieties & formal varieties (public and private sector) ▪ Locally produced seed ▪ For household use, exchange and local markets ▪ Seed normally not certified	▪ Crops creating food security (subsistence) Beans, maize, cassava ▪ Mainly formally released varieties ▪ Free distribution, based on voucher schemes ▪ Seed may be certified	▪ All crops ▪ Beans, rice, maize, sorghum, potato ▪ Mainly formally released varieties Seed normally certified ▪ Distribution through local markets	▪ All crops ▪ Maize (hybrid & open-pollinated variety [OPV]), sunflower, sorghum, wheat, rice ▪ Formally released varieties ▪ Seed certified ▪ Marketing through national and local markets, or through input schemes	▪ All major crops, including export crops ▪ Maize (hybrids), exotic vegetables ▪ Formally released varieties ▪ Seed certified ▪ Marketing through national and local markets
Informal Sources	**Intermediary Sources**		**Formal Sources**	

Small-scale farmers in developing countries, especially women, are key in maintaining PGR diversity on-farm and managing the associated processes. Together, they maintain a high diversity of varieties of many crops, and exchange their varieties with other members in their community and beyond. They introduce and exchange new varieties from various sources (see Table 1), and maintain the knowledge on their own local varieties.

What are the major threats to PGRFA conservation?

Genetic erosion is the decrease in the diversity of species and, more distinctly, the decrease in the numbers of varieties within our crops. Over the course of history, humanity consumed products from more than 2,000 plant species, whereas today 86 percent of our food is derived from only 32 species. Genetic erosion is caused by socio-economic and political changes, including globalization, market pressure, the development of monoculture, government policies, centralized plant breeding, and the loss of farmers' role in breeding and seed production.

In Zimbabwe, consumer preference for local crop varieties (e.g. in millets, sorghum, cowpea and groundnut) has decreased due to urbanization and prejudices in lower-income classes (which used to consume these grains, but now tend to favour the diet of higher-income classes).
Cheap, subsidized conventional grains distributed through non-government organizations (NGOs), public distribution systems and food-for-work programmes has further depressed the demand for local varieties.
Low prices and lack of procurement support for local varieties reduce incentives for farmers to grow them for local and national markets. The allocation of better lands for HYVs, which respond best to external inputs, tends to leave only marginal lands for local varieties. Consequently, farmers tend to grow local varieties in plots that cannot be used for alternatives that provide better yields and income.

How did domestication of crops result in current crop diversity?

Crops have not evolved randomly across the globe: rather, their evolution has taken place within specific regions. These regions provided the right conditions for the emergence of agriculture because of the presence of wild cereals and legumes, as well as animals that could be adapted to support local agriculture, and have been called centres of origin.
The centre of origin is a geographical area where a group of organisms, first wild and then domesticated, developed their distinctive properties. Centres of origin are also referred to as centres of diversity, given that areas of domestication contain a wide genetic diversity of the concerned domesticated species. Some crops and farm animals developed new traits after migrating to certain new areas, which may therefore also be called (secondary) centres of diversity.

Many small-scale farmers across the world maintain their own locally adapted diversity of crops that may have once been introduced from other parts of the world. Thus, Sub-Saharan Africa – which is home to cultivated sorghum, pearl and finger millet, cowpea and groundnut, as well as cattle – can also be considered a secondary centre of diversity for maize and cassava, which originated in the Americas. In particular, the diversity of maize in Southern and Eastern Africa's small farming systems provides a good example of a second centre of diversity that is situated far away from the region where the crop was originally domesticated (i.e. southern Mexico).

Locating the origin of crop plants is important for plant breeding. This allows one to locate wild relatives and, therefore, new useful genes these relatives may contain that can be incorporated into the related domesticated species by means of crossing. Knowledge of the origins of crop plants is also important because it identifies areas that should be conserved in order to avoid genetic erosion and the loss of genetic diversity due to the loss of ecotypes and landraces, the loss of habitat (such as rainforests), as well as pollution and increased urbanization.

How about drivers of diversity and the role of diversity?

The evolution of PGR diversity is driven by natural selection, the movement of seeds between different regions of the world, and conscious selection by farmers and professional breeders. This process, which began in ancient times, still continues today. PGR diversity is essential for resilience in agriculture. It allows adaptation to biotic stresses (e.g. pests and diseases) and abiotic stresses (e.g. drought and iron toxicity), other diverse agro-ecological conditions and climate change.

What is the role of farmers in PGRFA management?

The role that farmers have traditionally played in PGRFA management regards the on-site (*in situ*) selection, improvement and maintenance of local crop varieties (including by positive or negative mass selection sometimes complemented by pedigree selection of favoured plant types). As mentioned earlier, diversity is the cornerstone for breeding, and hence for adaptation to climate change and for global food security. The conservation and development of diversity requires the contribution by small-scale farming systems, and given the threats to these systems these need to be strengthened through participatory plant breeding (PPB). The *in situ* management of crop diversity performed by farmers is better known as on-farm management.

In Zimbabwe, the majority of farmers are women. Aside from their role in agricultural production, women's knowledge and skills are important in seed management (see also Chapter 11.15).

Therefore, special attention is needed to ensure women's participation in the Farmer Field Schools (FFS).

Given changing realities, farmers' seed systems need to be strengthened in order to secure their role in maintaining crop diversity in the field. Many farmers have adopted components of intensive production systems and major segments of agricultural production have become market-driven. As a result, the management of diversity has dwindled. To promote the ongoing maintenance of PGR in functioning small-scale systems, support for diversity conservation has to go hand-in-hand with strategies promoting sustainable agriculture and improved livelihoods for farmers. Such support should come from facilitating government policies, including seed policies. Relevant seed laws affecting PGR management by farmers have been analysed in a recent SD=HS study.

Differences Between Genotype and Phenotype

Whether full-time breeder or farmer, observation is an essential activity in achieving the desired breeding and selection goals. For successful selection, it is important to take a close look at the plant performance and to observe the various characteristics during plant growth, harvest and storage.

Some characteristics are 'heritable,' which means that they are transferred with the seed and re-appear in the next season, regardless of the season or the agro-environment. Other characteristics only appear when the plant is grown in a particular environment and may still be heritable to a large degree or, alternatively, largely be determined by the environment with only a small genetic contribution/component. The level of heritability is an important factor in plant breeding as it determines the success of selection. The question is, how do we know whether and to which extent a characteristic is heritable or not?

Breeders therefore distinguish between genotype and phenotype. Plants, just as other organisms, are made up of ten thousands of genes, which in isolation and together determine the plant's growth and development. A genotype is the genetic skeleton of a plant; it is a fundamental part of a plant's life form but not exclusively responsible for the plant's appearance. A phenotype is the plant's physical characteristic that farmers see in the field. Each plant's appearance is determined by a genotype, the expression of which may be modelled, 'disturbed' or modified by the environment in varying proportions to form the phenotype. Phenotype literally means 'the form that is shown'; it is the outward physical appearance of the combination of traits that make up the plant in a certain environment.

In this first topic on basic genetics, the participants will focus on variation in the field and differences between genotype and phenotype. In the course of the training programme, they will learn how to apply these principles in their selection practices.

Illustration

The difference between genotype and phenotype can be best illustrated by Mendel's *Laws of Inheritance* (see **Figure 10**). These include the *Law of Dominance* and the *Law of Segregation*.

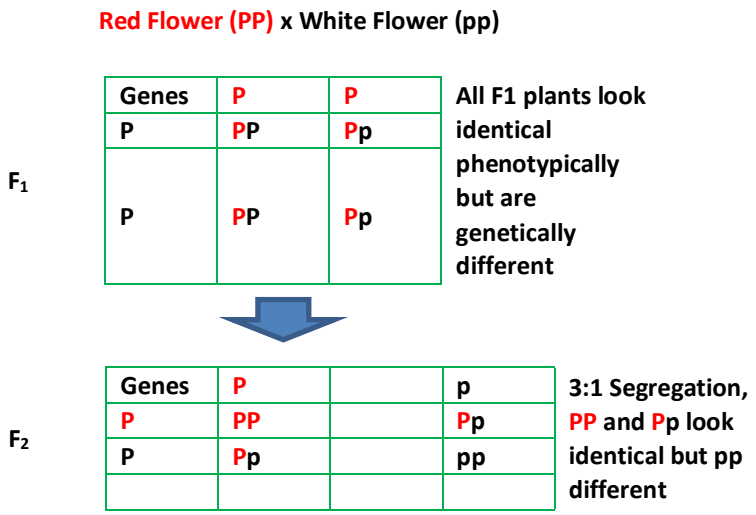
The *Law of Dominance* requires an understanding of the following genetic terms:

- DNA is the primary carrier of heritable information, and represents the genome (composed of thousands of genes).
- A gene is a piece of DNA that contains the actual heritable information for a particular trait (often in combination with many other genes).

- Alleles are different versions of the same gene (which may be one or two dominant [AA for homozygous dominance and Aa for heterozygous dominance] or two recessive [aa for homozygous recessive]), where 'A' determines the outcome/phenotype, and 'a' does not get expressed in a heterozygous (Aa) allele, but only in a homozygous recessive state.
- A qualitative trait is expressed *qualitatively*, which means that the phenotype falls into different *categories*. The pattern of inheritance for a qualitative trait can be *monogenetic*, which means that the trait is influenced by a *single gene.*
- A quantitative trait shows *continued variation along a gliding scale*. If *several gene* effects are present, the phenotypes within a population will typically have a *normal distribution.*
- The gene alleles make up the genotype and affect the phenotype of plants. Thus, phenotype is the visual appearance of the plant (P = Gene + Environment) and genotype is the genetic make-up of the plant.

The *Law of Inheritance* can be demonstrated subsequently, as in **Figure 10** below, highly relevant for the understanding of how to develop a hybrid variety:

Figure 10: An illustration of Mendel's Law of Inheritance



More background on plant breeding

This subject is best done at crop flowering stage. The following topics are discussed.

- What are morphological and agronomic traits within a selected crop?
- How are traits inherited?

<u>Morphological and agronomic traits</u>

- Discuss which morphological traits are expressed at harvest time (the traits that can be seen like plant height, leaf shape and orientation, root system, panicle size, seed color, etc.), and let farmers identify the morphological traits that they like, especially related to stable and/or high yield.
- Then discuss the morphological traits that appear at two additional growth stages, i.e. at

seedling stage and at flowering stage.
- Discuss similarly which agronomic traits are important, such as disease resistance, drought tolerance, taste, nutrient content, etc., and when these are expressed and/or most important.

Traits and how these are inherited

- Discuss how genes are the carriers of traits inherited to the next generation. Give simple examples: a gene for grain color, a gene for plant height, a gene for aroma, etc.
- Discuss how these genes are inherited to the next generation (the principle of sexual reproduction, e.g. male and female flowers, as well as asexual, clonal propagation, through vegetative parts such as cuttings, tubers, shoots, etc.). This step prepares for the next topic.

Two main reproductive systems

- Discuss how flowers enable the exchange of genes by pollen fertilising the female flower parts.
- Discuss how a self-pollinating crops ensures that its female flowers are pollinated by its own pollen and not by pollen from another plant.
- Discuss how a cross-pollinating crop exchanges pollen with other plants and by which mechanisms a cross-pollinating species ensures that its female flowers are pollinated by pollen from another plant and not by the pollen of the same plant.
- Use living materials, drawings or pictures of a cross pollinating flower and a self-pollinating flower to illustrate the divergent pollination processes.
- Furthermore, discuss how the type of pollination affects how we can manage PVS, PVE and PVD experiments. For example:

    - In a PVS where 10 maize (cross-pollinating) lines are evaluated and farmers like two lines, can the seeds from the FFS PPB plot be used for the next season or not? Why or why not?
    - Under PVE for a cross-pollinating crop, how can superior plants be selected so that they will not carry traits from inferior plants? Why is this?
    - In a first selection cycle of PVD, 25-35 maize families are evaluated, the elite plants from the superior families are selected, afterwards in a second selection cycle cobs from the superior plants will be sowed following the cob-row method. Subsequently, in a third selection cycle, cobs from the superior plants are mixed to create a composite population. In order to reach a stable variety, the superior plants from the composite population will be selected during the next (fourth and fifth selection cycles). If you want to obtain new varieties, should on encourage cross pollination?

Selection

- What is negative selection: to eliminate the inferior plants showing negative traits. Why is it important and when is it applied?
- What is positive selection: to select superior plants with strong positive traits to be used for the next planting/generation. Why and when?
- Under PVS for cross-pollinating crops, can the seeds of the “best lines” be used as seeds for the next season? If not, explain why. Explain where seeds for the “best lines” will come from.

- Under PVD (composite selection method) for cross-pollinating crops, can the seeds of the superior plants be used as seeds for the next season? Why?
- For negative selection under PVE, at what stage of the plant does negative selection no longer works Why?
- For PVE on self-pollinating crops, how is positive selection conducted? How strong should selection be?

10.10 Disaster Risk Reduction in Farmer Field Schools on PPB

Background

Disaster Risk Reduction (DRR) seeks to protect livelihoods from shocks, and aims to make food production better capable of absorbing the impacts of and recovering from disruptive events.

This module will focus on ways by which the management of crop diversity can facilitate DRR. More especially, within the context of this FFS curriculum, it will address the way farmers can manage their plant genetic resources under the conditions of biotic and abiotic stresses caused by the unreliable weather patterns they increasingly experience.

The DRR module is of paramount importance for Zimbabwe as the country is prone to droughts, which have become more and more disruptive as a result of climate change. The country contains five agricultural zones . Zones 3 to 5 are the drier zones where the country's most smallholder farmers live. Even zone 2b, which is classified as a higher rainfall zone, does not escape from drought stress as rain patterns change and wet seasons have become shorter.

In addition, farmers of Zimbabwe face political instability and challenges in governance, coupled with a serious economic downturn. (As of October 2017 inflation is again rising and hard cash is barely available.)

Elements of the DRR addressing the role of PGR

The following elements are included in the DRR module on PGR:

- Building Resilience
- Safeguarding diversity
- Preparing to respond and to rebuild

Interventions aim at the following levels:

- Household level
- Community Level
- Institutional level

Causes of Disasters

Disasters caused by nature

- Drought characterized by lack of rainfall, high temperature and shortened rainy periods
    - After sowing, seeds may fail to germinate and may require re-sowing
    - Heat stress may severely reduce yields
    - Long-duration and medium-duration crops and varieties may fail as growing season become shorter

- Floods caused by heavy rainfall and denuded forest cover, uneven rainfall distribution over the season, water-logged soils

    - Planted seeds and young seedlings may be damaged
    - Water-logged soils may result in plant stress, reducing harvests
    - Short-duration varieties may not have enough time to recover from drought periods

- Massive pests and disease outbreaks, sometimes due to climate change and sometimes due to trans-boundary movement of seeds, plants and produce that allow migration of pests and pathogens with few natural enemies

    - Massive crop damage reducing harvest or even causing total crop failure
    - Loss of seeds for the next season

- Wild fires

Disasters caused by human beings and their institutions

- Civil disturbances / violence that disrupts agricultural activities
- Economic crises that may disrupt flow of agricultural inputs, reduce prices of farmers' produce or lead to a collapse of markets

Potential Impacts on farmers

- Severely reduced harvests and even total crop failure
- Lack of food causing malnutrition
- Negative impact on farmers' livelihood systems
- Disruption of farmers' seed systems
- Insufficient resources, including of crops and varieties, which may not be sufficient to rebuild their farming systems after a disaster

Elements of a DRR Intervention

Building Resilience
Objective: Protecting livelihoods from shocks, rendering food production more resilient and capable of absorbing disaster impact and the capacity to recover. Understanding the specific role of PGR management in building resilience

Potential areas to build resilience using PGR and a few related farming measures:

- Increasing the number of crops, in particular more drought tolerant species (e.g. dryland legumes, small grain cereals such as sorghum and pearl millet and different food crops)
- Enhancing the role of women's crops and their home gardens where stresses can be better managed (e.g., through irrigation)
- Increasing the number of varieties, especially of short duration and drought tolerant

varieties, and/or water-logging tolerant varieties
- Undertaking plant selection and breeding initiatives which address stresses caused by disaster conditions (through PVE, PVS and PVD)
- Increasing (doubling to tripling) the amount of seeds (this is not difficult for small grains cereals and maybe not be too difficult for home garden seeds) for potential repeated sowing,
- Mapping and ranking of seed sources, and quantifying the amount of seed required for (re)planting. Include the potential role of community seed banks, if relevant.
- Adjusting the cropping calendar which usually requires the use of shorter-duration varieties
- Using of integrated pest and production management (IPPM)
- Involving research and breeding institutions in sourcing better adapted crops and varieties

Safeguarding diversity ("watch" to prepare)
Objective: To foresee possible upcoming disasters, to adjust livelihood and farming strategies, and to prepare to respond

Potential aspects to watch and prepare for:

- Long-term weather forecasts for the entire growing season (e.g. El Niño, La Niña or Neutral year) and predictions of severity (resulting in adjustments of crops, varieties and/or cropping calendars)
- Short-term weather forecasts within an ongoing season predicting rain patterns on a weekly basis (allowing adjustments of sowing dates, weeding dates, fertilizer applications, etc.)
- Pests and diseases trends in adjacent provinces, other parts of the country and adjacent countries
- Economic and political trends and their potential impacts on agricultural production and consumer behavior

Preparing to respond and to rebuild
Objective: To minimize the negative impact of disasters, and to rebuild livelihoods and especially food production with stronger resilient elements

Potential approaches to respond to disaster, and options for rebuilding:

- Accessing and using neglected and underutilized species (including wild food plants) and increasing the use of home gardens
- Accessing food aid when necessary
- Accessing and ensuring access to seeds of appropriate varieties for the next cropping season
- Ensuring that information and views from farmers, especially women, are received by community-based and other aid organizations

FFS exercises and activities towards disaster risk management
Assessing disaster experiences and their impacts, assessing evidence and potential sources of resilience

The aims of this exercise are:
- to facilitate the use of farmers' assessment of the impacts of disasters as a basis for

addressing the problems
- to identify the areas of vulnerability in their agro-ecosystems and especially in their crops and varieties
- to evaluate the potential resilience of particular crops and varieties
- to evaluate options of home gardens and "women's crops" to contribute to more resilience
- to appreciate further options for farmers to adapt to disaster situations

Potential outputs:
- Increased appreciation of the crop diversity and varietal diversity (e.g. reliability of dryland legumes, the resilience of many short duration pearl millet and sorghum varieties, etc.) as a mechanism to cope with disaster conditions
- Increased appreciation of home gardens and "women's crops" as a contribution to increased resilience and to nutrition security
- Appreciation of options for adaptation or adjustments to respond to the crisis (e.g. repeated re-sowing, adjustment of cropping calendar)

Initial Tools:
- Comparative assessment of the performance of major and minor crops under El Niño and La Niña conditions, as well as their performance under major biotic stresses directly caused by disaster situations (e.g. fall army worm outbreaks during La Niña)
- Comparative assessment of the performance of varieties of major crops under El Niño and La Niña conditions, as well as their performance under major biotic stresses directly caused by disaster situations (e.g. heavy rain spells and army worm outbreaks during La Nina)
- Listing main adaptation strategies that have been used during disaster conditions and collectively ranking their effectiveness (e.g. late sowing, repeated sowing, use of short duration varieties)

Assessing preparedness and "watchfulness" approaches

Seasonal hazard risk calendar
By questioning "When do hazards usually occur?", and "How long?", we can prepare a seasonal hazard risk calendar.

The aim of this exercise is to assess how farmers in the FFS are able to prepare for disasters

Potential outputs:
- Plan to maximize access to information and forecasts of potential disasters and to understand reasons for failures to adequately prepare
- Identified important concerns regarding the availability of seeds of important crops and varieties, such as adequate numbers of seeds for possibly required repeated sowing, the bulking (multiplication) of seeds of better adapted drought tolerant crops and varieties, etc.
- Expansion of plots for drought tolerant crops and increased attention for home gardens

Initial tools
- Assessment of how families and the community as a whole have appreciated and made use of the forecasts of potential disasters and of the result of the actions taken (e.g. multiplication of seeds of appropriate crops and varieties)
- Assessment comparing a 12-month cropping calendar with the seasonal risk hazard calendar, identifying which major crops are most risk-prone, and which other crops could

potentially play a role in food security in the months that risk of food scarcity is highest.
- Listing the reasons for strong and weak preparations of families and communities to cope with disaster conditions

Responding to and building from disasters

The aim of this exercise is to assist farmers in assessing the results of their actions during and after the crisis, and in ensuring that the rebuilding process will aim at increased resilience of the farming system

Potential outputs

- Plans to improve food and nutrition security and to minimize food shortages and malnutrition
- Plans to improve and systematize the management of neglected and underutilized species (including wild food plants) as a contribution to increased food and nutrition security under disaster conditions
- Crop diversification and increased number of varieties
- Increased and systematized interactions with development institutions to help ensure that the recovery and increased resilience agenda can include crop diversification, participatory selection and breeding of more appropriate varieties, etc.

Initial tools

- Assessing the contribution of neglected and underutilized species during and after disaster conditions (list of available species and potential usefulness);
- Listing initiatives towards rebuilding that utilise crop diversification and an increased use of varieties, as opposed to initiatives that did not result in building resilience (conditions remained “the same” or not)
- Assessing potential community action to facilitate rebuilding strategies

10.11 Cooking and Eating Quality Evaluation

Introduction

To farmers, the characteristics of grain, such as shape, colour, processing qualities, texture and taste, are as important as the yield levels. A grain is almost worthless if it does not have the right properties for the type of food the family likes to eat. This is particularly so in semi-arid regions of Africa, where most villagers are subsistence farmers. After harvesting their maize, pearl millet, sorghum or groundnut crop, farmers bring it to their home-yard, where the grain is ground or boiled for use in one of their favourite dishes.

It is therefore very important to evaluate the processing, cooking and eating qualities of the varieties and selected lines. Only stable varieties and advanced segregating lines available in surplus quantities should be evaluated. The early generations of segregating lines are not stable enough, as they continue to change in character, and the available quantities are usually too small.

Objectives

- To let farmers (and invited guests) evaluate grain characteristics and processing, cooking and eating qualities of varieties and stable advanced lines
- To evaluate and understand farmers' gastronomical preferences

Materials

- Kitchen, several grinding and cooking tools, plates
- Tags, paper, markers
- A panel of evaluators (including other villagers who are not participants of the FFS)

Time guide: 5 hours per crop

This exercise can be part of a workshop celebrating the end of the season's training sessions. The evaluation of dishes may be followed by a presentation of the overall results and the final evaluation. Conduct the evaluation of dishes made of maize, pearl millet, sorghum and groundnut separately. Note that a similar exercise is instrumental in promoting and evaluating the use of neglected and underutilized species (NUS).

Procedure (preparations)

- Split up the participants into one group of men and one group of women.
- The first activity is to design the evaluation form. Ask the participants how they prepare their maize, pearl millet, sorghum and groundnut dishes, and what characteristics they prefer in the preparation and taste of their food. What is a good grain to them?
- Ask the groups to list the criteria by which each of the food dishes mentioned is evaluated. Rank the criteria in order of importance.
- Groups should present their list of criteria in the plenary session. Discuss the differences between the preferences of women and men.
- Agree on the dishes that should be prepared, the criteria that should be measured, and the measuring scale. On a scale of 1 to 5, use '5' to indicate the most preferred and '1' to indicate the least preferred. For computational reasons, do not use '0.'

- Prepare the evaluation form for each dish (Table 12 offers an example).

Table 12: Evaluation form for cooking and eating qualities of crop varieties

CROP: _____ **DISH: _____** **DATE OF EVALUATION: _____**						
VARIETY / CRITERIA	**1**	**2**	**3**	**4**	**5**	**6**
1. Aroma						
2. Cooking ability						
3. Starch content*						
4. Taste						
5. Colour, others						

* Starch content may be important to farmers because it determines how long the food stays in the stomach. Farmers may prefer food that stays longer in the stomach so that they do not experience hunger too often.

Procedure (preparing and evaluating the dish)

- For each available variety, prepare the dish that farmers wish to evaluate. Note that all dishes should be prepared under the same conditions in terms of heat, water content, etc. Do not use (too much) salt or sauce for this test. It is strongly advised that the dishes be prepared by or under the supervision of the facilitators.
- Take care to keep the lines and varieties separate. Give each entry a number code. Note down the names and the origins of the grains used for the dishes in a notebook. Do not reveal this information to the farmers, as they may be influenced by their preferences.
- Place each dish on a plate and line up all dishes on a table along with their identification numbers. Place a glass of water after every dish so that the food tester could rinse his/her mouth before tasting the next dish.
- Give the farmers the evaluation form and ask them to stand in a line. Instruct the first farmer to taste the first entry and to fill his form without others observing it. He should then proceed to the second plate and so on. After the first farmer has tasted three entries, the second farmer can start tasting. Once finished, ask the farmers to re-check their entries for each criterion and write their names on their evaluation sheets.
- Prepare a big sheet paper with the evaluation form and ask each farmer to enter his/her scores per variety or line. The scores for each criterion should be added up, and per dish the varieties may then be ranked.
- Finally reveal the variety names. Note the reactions and discuss the results.
- Repeat the exercise with the other crops and dishes that farmers wish to test.
- Document the evaluation results.

Notes:

- Farmers usually find this exercise very exciting. Since the names of the varieties are hidden, there may be surprises for both farmers and facilitators. Cover the testers' eyes and ask for silence if they try to guess the varieties used before or during the test.
- Uncover potential differences in taste by grouping farmers by gender (men/women), age

(young/old), or by any other nature (ethnic origin, education, etc.).

- Participants should taste a maximum of 3-4 dishes only per day. The taste receptors of the participants may falter if they taste too many varieties and dishes at once, which would affect the test results.

Questions

- Did you find major differences in taste or appearance of the entries tested? Did you find entries that performed better than the entry prepared from control variety?
- If you compare the gastronomical characteristics with the agronomic characteristics, do you see large similarities or differences in popularity and ranking?
- Do you think you will be successful in selecting a new variety as source for a dish with better cooking and tasting characteristics?
- Do any characteristics that have come up in this exercise need to be emphasized more in the breeding programme? Which are these?

10.12 Group Dynamics Exercises

Introduction

Group dynamics refer to the interactions between members of a group at any given time, which actively influence the functioning of each group individual, and the group as a whole (Ortigas, 1994). Group dynamics reflect interactions that influence the attitude and behaviour of people when they work in a group together. These interactions may be perceived as either accommodating, accepting or threatening. In all situations, tensions can grow within a group and between its individual members. The more rigid a person's position is towards what he or she perceives as threatening, the more tense he or she becomes. In more extreme situations, tensions can reach an explosive level and result in aggressive behaviour. A person who responds less rigidly to pressures from his or her environment is less tense and, therefore, more apt to manifest accepting behaviour.

The concepts of emotional value and tension play a significant role in the study of group dynamics. To a participant, for instance, group acceptance can be a positive emotional value and group disapproval a negative one. If a group shows characteristics attractive to a participant, the group will elicit an approaching behaviour from him or her. If the group behaves threateningly, avoidance behavior may well result on the part of the participant.

Group dynamics exercises are meant to detect, discuss and help counter negative attitudes and perceptions resulting from group interactions between participants and facilitators during the learning process. Group dynamics activities are either games, trust exercises or initiatives that are more often used as group exercises by facilitators in the conduct of FFS sessions. According to the Philippine National IPM Program (1993) such group dynamics exercises are included in order to:

- Develop the participants into a closer knit FFS team;
- Establish a learning climate that is enjoyable as well as fruitful;
- Help participants experience and be able to identify such aspects of teamwork as mutual support, the importance of individual roles to a team's success, and behaviours that can build or hinder teamwork; and
- Help participants to experience what can be accomplished by working together.

FFS Facilitators should be experienced in these group dynamics activities and make use of those activities that they feel are most appropriate in a given situation. Some examples of group dynamics exercises (Callo Jr. *et al*., 1999) are provided below.

Group Dynamics Exercise No. 1: Drawing without Lifting of Pen

Purpose

- To develop cohesion and cooperation among group members.

Materials

- Chalkboard and chalks, or newsprint and marker pens

Procedure

Divide the group of 25-30 participants into five smaller subgroups. Give each subgroup five minutes to make a group drawing of a farmer without lifting a pen. Give each participant in a subgroup one minute to contribute his/her share in the joint drawing activity. Then, give the next set of directions. This time, give each subgroup five minutes to plan together on how to come up with an illustration of a farmer in which each subgroup member would have a part in completing the drawing. Then, give each subgroup five minutes more to work on their drawings as planned. Evaluate each subgroup's drawings after five minutes. Ask the following questions:

- How did the first drawing look? How does your drawing look this second time? Why was this different?
- How did you come up with your second drawing? What attitudes or behaviours did each member exhibit? Are you happy with the result of your first drawing? Your second drawing?

The purpose of this exercise is to demonstrate that a higher quality of results can be achieved when a group thinks ahead and works together. While each group can work without a clear plan and direction, the result of their work may not be ideal. However, when each group plans cooperatively how the activity should be undertaken and each member is given a specific assignment to perform and guidelines to follow, the result is likely to be much better if not perfect.

When this exercise is most appropriate

This game is appropriate for a group of 25-30 participants. Use this as a group dynamics exercise, an icebreaker, or a starter for sessions on planning, problem solving, leadership, community organizing or group work at any time in the FFS season.

Group Dynamics Exercise No. 2: Block of Ice

Purpose

- To illustrate how people change when participating in a development process.

Materials

- Chalkboard and chalk, or newsprint and marking pens

Procedure

Draw on the board a block of ice measuring 8 cubic feet or 2' x 2' x 2' (approximately 50cm x 50cm x 50cm). Divide a group of 25-30 participants into five smaller subgroups and give each subgroup the following instructions:

- Imagine that you are given a block of ice with the above-mentioned dimensions.
- Alter the shape of the block of ice to one measuring 2' x 1' x 4'.
- Plan together how the group should go about it.
- List down the steps that the group should follow in altering the shape of the ice block.

When this exercise is most appropriate

This activity is most appropriate when linked with discussions on how people react to various situations in a development process. People participating in any development activity or programme are like a block of ice: to change, they need to be opened up, 'liquefied,' moved to a new situation and made to stay in that situation of change.

Group Dynamics Exercise No. 3: Nine-Dot Game

Purpose

- To be aware of the concepts, objectives and approaches of the FFS programme in reference to the problems and issues of farmers in the local community. Compare with past training experiences.

Materials

- Paper, tape and pens

Procedure

Draw nine dots on a flip chart, as shown below:

Ask the participants to join all of the nine dots with only four straight lines and without lifting the pen from the paper. Then ask them to share their results. The solution should look something like this:

In this game, farmers have to look outside the square (out of the box) to find the solution. Ask the farmers: Why was it difficult to find a way to do this at first? How did you overcome the problem? Discuss how this experience relates to solving other problems (e.g. very often, before we are able solve a problem, we need to look beyond the things that we think are the problem in order to identify the real causes).

Tell the farmers that the nine dots can represent the nine most important problems of farmers in this community. All of the problems may begin with 'P.' Ask them to help you list them. Adapt the identified problems so that they fit into the nine categories beginning with 'P,' as shown below:

- Plant genetic resources (loss of diversity)
- Pests (including diseases)
- Poverty (profits are low)

- Pesticides (poisoning)
- Programmes (that are no good)
- Politicians (who do not help us)
- Public health
- Pollution
- Provision of water
- Protection of environment

Link each of the nine problems to an explanation of some of the central concepts and approaches of participatory plant breeding. Below are some of the ideas that could be discussed:

- In the FFS PPB project, we explore ways to solve the problems of loss of diversity of our PGR, pests and diseases, low profits, pesticide resistance and pesticide poisoning. The project is based on what farmers need and want to learn; farmers decide what they will do in the FFS.
- The FFS is based in the farmers' fields and so looks at the real problems that are happening now. We learn by exploring these problems together as a group. By working together, we can discover how to solve problems that are too big for one person: a group can do much more than one. By becoming a strong group, we shall be able to get more support and attention from the local governments or other organizations that we may want to influence.
- The fields are a part of the local environment and the community, so we also look at the effects our actions have on things that are outside our fields.

The facilitator guides a participatory discussion on how the FFS PPB project differs from the farmers' current experiences and ideas of PGR diversity.

When the exercise is most appropriate

Use the activity as a starter for a session on 'Concepts, Principles, Objectives and Approaches of the FFS PPB Project.' It should assist farmers to compare their past experiences with the FFS PPB concepts, objectives and approaches in addressing problems and issues in their own fields.

Group Dynamics Exercise No. 4: The Longest Line

Purpose

- To develop an attitude of sharing and cooperation among participants.

Materials

- Items carried by the participants on their person (e.g. the contents of their pockets, etc.).

Procedure

Divide a group of 25-30 participants into five subgroups. Give the following instructions:

- Within five minutes, make a single line out of the items found on the person of each of the group members.
- After completing the line, stand in a straight line and clap hands three times to announce

that the subgroup has completed the task. The group with the longest line of items wins.

When the game ends, analyze the activity. Ask the following questions:

- What happened during the activity?
- How did each group come up with their line?
- What behaviours or attitudes did the group members show?

Explain to the team members that they can achieve successful programme or activity results when they work cooperatively, voluntarily share their efforts, resources, ideas and talents, and actively participate in all stages of the undertaking.

When the method is most appropriate

Use it as a starter for a session on 'FFS PPB Planning' in order to demonstrate to the farmers how to go about group activities and carry out objectives successfully.

Group Dynamics Exercise No. 5: Battle of Sports

Purpose

- To demonstrate the value of planning and coordination as part of successful teamwork.

Materials

- Warm bodies of the participants

Procedure

Divide the group of 25-30 participants into five subgroups. Assign a different sport activity or action to each subgroup, for example:

- BASKETBALL, SHOOT
- BASEBALL, BAT
- VOLLEYBALL, TOSS
- FOOTBALL, KICK

Point to any subgroup to start the game. The subgroup should say its own assigned sport and its corresponding action thrice, before calling out the sport and the corresponding action of another subgroup it has chosen that should respond to their calling. In turn, the second, selected subgroup should says its own sport and its corresponding action thrice, before calling out the sport and the corresponding action of yet another, third group.

For example, the basketball group may say, 'BASKETBALL SHOOT, BASKETBALL SHOOT, BASKETBALL SHOOT TO FOOTBALL KICK.' The football group should answer, 'FOOTBALL KICK, FOOTBALL KICK, FOOTBALL KICK TO VOLLEYBALL TOSS,' and so on.

Eliminate any group that makes a mistake in calling out or doing the actions of the sport assigned to it.

The group that is not eliminated automatically wins. Ask the winning group why they think they won over the rest (expect different answers). Ask the following questions:

- Why did your group not make any mistakes?
- How did you choose which group you were going to call out next?
- Did you have a leader?
- Did you make a plan?

Accepting all answers will encourage participants to share in the discussion as well as give them the feeling of respect. Emphasize the value of planning and coordination for successful teamwork.

When the exercise is most appropriate

Use this as an initiating exercise in the morning or before the start of the afternoon sessions. However, use it at any time of the day when the group experiences a dip in its energy level and needs a perk-up exercise.

10.13 Designing Farmer Field School Studies

Introduction

This exercise will allow participants to learn about and get familiar with the various components of the breeding and selection cycle. It will enable them to understand the underlying importance of variability for plant breeding and selection.

Farmers are continuously seeking to improve the qualities of their field crops. While they may appear to hold on to their traditional varieties, at the same time they keep on improving these varieties using indigenous knowledge and traditional selection techniques. Given the opportunity, farmers are very likely to regularly introduce and test new varieties from neighbouring communities, national breeding programmes or markets. In the process, genes may be passed on to traditional varieties through natural out-crossing, so that these become part of the existing farmers' cultivars. Even in self-pollinating crops, a certain level of outcrossing and variability always occurs.

Farmers may learn from their trained facilitators to better monitor and control the existing variability, and to introduce new variability through variety selection, variety enhancement, cross breeding and line selection. Initially, better selection methods may be established and applied to enhance existing varieties and for the purpose of variety selection. These breeding methodologies are part of the 'breeding processes,' which are repeated every season with the aim to obtain better crop varieties in line with the breeding and selection objectives. Later, making crosses and/or selection from segregating populations may be undertaken as well.

PPB is a collaboration between farmers and scientists to co-define and execute a joint breeding and selection agenda. The PPB strategy aims to improve the portfolio of local crops and varieties by enhancing local variability, relying on traditional and improved farmers' selection techniques, and allowing farmers to compare and select between local and newly introduced varieties and breeding lines. In the process, techniques and practices of modern breeding are shared with farmers, thus strengthening the latter's ability to control and direct the development of the local plant genetic resources or cropping system.

Objectives

- To enable men and women farmers to identify their own sources of existing and new crops and varieties, i.e. variability.
- To make farmers familiar with various methods that can be applied in farmer-led breeding efforts.

Materials

- Tape, marker pens, paper, flip-over chart

Time Guide: 1 ½ hour

Procedure

- Organize farmers into subgroups and ask whether they have acquired seed of new varieties during the last three years. List the names of the new varieties in Table 13 (see below).

Discuss new varieties of maize, pearl millet, sorghum and cowpea in sequence or for each of these crops in separate parallel groups.

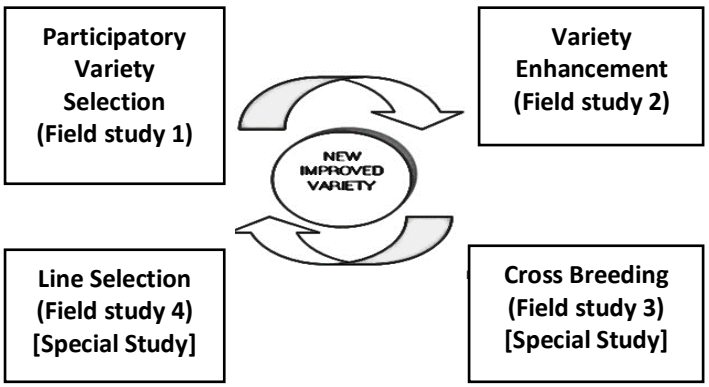
- Request farmers to indicate where they obtained the seed and whether they have retained the variety for production or rejected it. Is access different for men and women? How? Specify as much as possible.

Table 13: *Farmers' sources of new variability*

NO.	VARIETY	YEAR TESTED	OBTAINED WHERE?	SELECTED OR REJECTED?
1.				
2.				
3.				
4.				

- Each subgroup should present their findings in plenary. Discuss findings.
- Ask the participants which measures can be taken to further increase variability in their crops and, if appropriate, discuss differences in access for men and women.
- Explain the various components of the breeding process: variety evaluation and selection, variety enhancement, cross breeding, and line selection. Explain the role of each component in the breeding process, what it does and the way it contributes to variability and creates opportunities for selection. Refer to **Figure 5** for a diagram of the FFS selection and breeding processes.
- Remind participants about the previous exercises aimed to identify the positive and negative traits of their local varieties and the breeding targets. Focus on the fact that to start up a breeding and selection process, the selection of a portfolio of starting materials should be major part of the planning process.
- Explain that the components in the breeding process will be further studied in the course of the FFS through field studies and exercises. However, for the first season, it is suggested to set up PVS (Study 1) and PVE (Study 2) for weekly observations. Only set up PVD, involving cross breeding (Study 3) and line selection (Study 4) in the second season or depending upon participants' priorities and the availability of segregating materials from breeding institutions.

Figure 5: *A farmer-led plant breeding cycle*



- Verify whether the participants understand the breeding process by asking in which components they have already been engaged and which components are totally new to them.
- Based on the above discussions, design with farmers the field studies that they wish to carry out in the coming season.

Notes

- Recall the option of positively selecting off-types and mutants from variety populations and multiplying these to obtain a new variety. Farmers practice this a lot, but often fail to mention it during discussions. Remind them that it is an important exercise in plant breeding, which they regularly undertake spontaneously and even unconsciously.
- This exercise is meant as an introduction to the field studies. It is essential to conduct this exercise during the planning session, as it allows farmers to understand the implications of the various field studies and decide which field studies are most relevant for them and should be included in the FFS sessions.

Questions for discussion

- What is variability? How can the use of variability contribute to crop and variety improvement?
- Which measures can be taken to increase variability?
- What is the difference between natural (spontaneous) crosses and artificial (deliberate) crosses?
- What are the basic differences in the breeding processes for maize, pearl millet, sorghum and groundnut?
- Which methods described in the breeding process are already familiar to the participants? Which methods are entirely new to the participants?
- Which methods described in the breeding process would participants like to know more about? Disaggregate by gender.
- Considering the crops and varieties grown in the community, which field studies would participants prefer to conduct in the coming season? Disaggregate by gender.

10.14 Gender Equity in Seed Diversity Management

Session Guide

This session examines the respective roles and contributions of women and men in agriculture, particularly in the conservation, development and management of on-farm crop diversity. It analyses some prevailing practices and their underlying assumptions bearing on equity and sustainable seed management. It offers a perspective through which values and attitudes may be affirmed or modified, and practices changed. The session could best be performed during seed maturation and crop harvesting growth stages. Whereas gender forms a major basis for unequal positions and different roles in the community, other variables might result in similar inequalities, including age, marital status and income. A gender analysis might also extend to such parameters.

Why focus on women?

- Men's roles, responsibilities and contributions are often recognized by the community and the authorities as a standard, whereas this is not the case for women.
- Policies, institutions and societal structures are mostly supportive towards the roles of men.
- At the same time, women often remain systematically excluded.
- For women's empowerment, existing power relations caused by gender differences need to be transformed.
- For inclusion, existing multiple exclusions need to be identified, addressed and corrected.

Objectives

At the end of the session, participants should be able to:

- Raise awareness of perceived and prescribed roles of women and men and analyse the values underlying those roles;
- Discuss why gender equity is an imperative to sustainable seed management;
- Examine one's personal perspective on gender equity;
- Discuss lessons and action plans to support women's agendas and their participation in the FFS.

Learning aids and materials

- Papers
- Marking pens
- Cards
- Visual aids for presentation (PowerPoint or flip charts or other appropriate materials)

Duration: 4 hours

Procedure

Activity 1: Sharing personal experience as a man/woman (30 minutes); exchange of short stories

- Divide the participants into 2 or 3 groups (around 10 participants per group).
- Ask the individual participants to reflect on their own individual experiences, in particular on

any incident that made each participant realize that she/he is a man or a woman.

- Facilitate the sharing of experiences within the group. Be respectful of the fact that not everyone may be open to sharing personal reflections.
- Ask volunteers to share one experience per subgroup in the plenary, ensuring that both men and women are represented.
- In the plenary, let the selected participants share their experiences and lead a discussion by asking the following questions:

    - What made him/her feel that she/he is a woman/man?
    - Why did she/he feel that way?

- Moderate discussions to highlight the economic, social and cultural attributes and opportunities associated with being a woman or a man.
- Lead the discussion on basic gender concepts (see 10.15.1).

Note: The experiences will reveal some of the **socially constructed ways** of being women and men.

Activity 2: Old and new stereotypes (30 minutes)

- Distribute cards with gender-related proverbs (see 10.15.2) to the participants.
- Ask the participants to read their cards; then ask if they know of other similar proverbs.
- Discuss with the participants the implications of such proverbs on men and women, their roles and behaviour.
- Ask the participants to relate the proverbs to the experiences shared earlier among them.

Note: Lead the discussion on common stereotypes of men and women farmers, and on what the experiences and proverbs say about how norms, rules, practices and social expectations are different for men and women. Explain how these form an unconscious part of our perceptions, which in turn influence our behaviour (see 10.15.2 for some important points to highlight in the discussion).

Activity 3: Gender-specific activity clock and calendar (1 hour)

- Divide the participants into two groups: one men-only group and one women-only group. If time is limited, each group can further divide into two so that they can do the activity clock and the activity calendar simultaneously.
- Ask the subgroups to prepare the activity clock (see **10.15.3**) and activity calendar (see **10.15.4**).
- Ask each group to present their individual outputs in the plenary.
- Lead the discussion by asking the following questions:

    - Which major differences do you notice in the way men and women farmers spend their day and year?
    - How are tasks and responsibilities (both in the household and in the farm) divided between male and female household members?
    - What are the implications of these differences for the farm and the family?
    - What are some of the consequences of these differences to men and women?

- What are some of the consequences of these differences to society?

Activity 4: Access and control (1 hour)

- Divide the participants into two groups (one group of men and one group of women).
- Ask each group to fill in the ***Access and Control Profile*** (see **Table 16**).
- Ask each group to present their outputs in the plenary.
- Discuss the information generated from this activity in relation to:

Access and control over resources

- Who owns the agricultural resources, i.e. land, farm equipment, etc.?
- Who has better access to cash?
- Who has better access to land, seeds and other inputs?

Note: Where women cannot own land, their chances of getting credit are nil. Without credit, whatever capital there is may not be augmented. Similarly, the hiring of labour and acquisition of tools and equipment are severely limited.

- Does the national or local culture equally support girls and boys going to school? If there are schools, are they situated close enough to settlements so as not to endanger girls on their way to and from school?
- Are extension services available? If they are, do they include women officers? Are extension workers approaching women too? How does the community respond to this? Are training programmes designed with women farmers in mind? Are they offered in venues and at times accessible to women?

Note: Training programmes fail when the above concerns are overlooked. Note in particular that the capability to harness material resources, assuming they are available, is greatly enhanced through education and training.

Decision-making in the farmers' family

- How are decisions in the farmers' family made?
- Who has a say on what crops/varieties to plant, where to source the seeds and what to do with other assets (e.g. fertilizers)?
- Who decides on the use of proceeds from the sale of farm produce?

Note: Participation in all aspects and levels of activity (more importantly, decision making) in the household and in the community by all members ensures equity. It guarantees that labour is shared according to each one's capability, and that resources are allocated according to each one's needs. Likewise, it ensures that education and training are availed of equitably and that decision making is a co-responsibility.

- When the *who*, the *what*, and the *how* questions have been answered, lead the discussion on to the critique level by asking why for every major practice. Give particular attention to stereotypical comments, such as: "*The women do not know which varieties are good and where to source the seeds*," or "*It's insulting to men when women speak up in mixed company*."
- Summarize the comments and present to the group for validation.

Activity 5: Synthesis

- Distribute three colours of cards. **Green** represents conditions that can be changed by the individual himself/herself. It can be implemented in the individual's own household. **Yellow** represents conditions that can be changed but would take time: consultation and consensus with community needed. **Red** represents conditions that cannot or should not change according to the farmers' views.
- Ask each participant to write down an item on a card of the appropriate colour and post it on the designated board or wall. Place the green, yellow and red cards in separate columns.
- Determine whether there are common items under the green and yellow cards. Elicit opinions and insights on the *why* of each item. Reaffirm the green entries and give a strong signal that the yellow entries depend on the position of each individual.
- Document and present inputs on potential positive changes using a PowerPoint presentation or other visual medium (see *6. Social Inclusion* for some important points to highlight).

Activity 6: Lessons and actions to support women's participation in FFS

- Divide the group into two men and women subgroups.
- Ask each group what they have learned about gender roles in the sessions:

    - Why is it important to be aware of gender and social inclusion?
    - What is the role of women in farming and seed management?
    - What are the obstacles to women's participation in the FFS?
    - What would women do differently in the FFS?

Plenary Discussions and Synthesis

- Ask each group to report and facilitate common reflections.
- Search for a consensus on how to support women's participation in the FFS.
- Ask the plenary do develop an action plan.
- Ask how and when they plan to monitor and assess action plans.

10.14.1 Basic Concepts on Gender

Key definitions

Gender - refers to the economic, social and cultural attributes and opportunities associated with being women or men. It describes the **socially constructed ways** of being women and men, rather than the biological differences. It changes according to culture, class, time and place.

Gender Relations - refers to **relations of power** between women and men which are revealed in ideas and behaviour, differences in roles, the division of labour, access to and control over resources, and in ascribing different expectations, abilities, desires and aspirations to women and men.

Gender and Social Inclusion Analysis - Identifies the differences between women and men of different ethnicities regarding their:

- Specific roles and activities;

- Access to and control over resources;
- Access to benefits and roles in decision making;
- Social practices which cause discrimination and violence against women.

Gender and Ethnic Equality - to strive for gender and ethnic equality does not mean to ignore the biological differences between the two sexes, nor to ignore the differences between what it means to be a man and what it means to be a woman, or what it means to belong to an ethnic minority.

The process of achieving gender and ethnic equality - while respecting these differences - refers to changing norms, values, attitudes and perceptions in order to attain equal status between men and women, as well as between advantaged and excluded social groups.

Gender and Ethnic Equity - this refers to fairness in women's and men's roles and positions, or in those of advantaged and disadvantaged social/ethnic groups. In particular, it refers to fairness in access to socio-economic resources. Discrimination results from inequitable access to socio-economic resources due to being a man or being a woman, or being a member of a disadvantaged group or ethnic minority.

Empowerment - empowerment is the enhancement of assets and capabilities of diverse individuals and groups to function and to engage, influence and hold accountable the institutions that affect them (World Bank definition). The definition applies directly to the options for women and disadvantaged groups.

Two Dimensions of Empowerment

***Livelihood Empowerment (access to assets and services) includes*:**

- An increase in access by women, or the poor and excluded, to assets and services that are needed to sustain at least a minimum level of livelihood security;
- The creation of systems and mechanisms for upward mobility of women, the poor and excluded.

Note: Assets may be natural, physical, financial, social and human. Livelihood empowerment can be initiated by outsiders (government, donors, NGOs, etc.).

Mobilization empowerment (voice, influence and advocacy) includes an enhanced:

- Ability of women, the poor and excluded to engage in a debate with, influence and hold accountable the institutions that affect them;
- Understanding of the systemic causes of poverty and social exclusion concerning women, the poor and excluded;
- Capacity of women, the poor and excluded to aspire and act on their aspirations, and overcome the sense of powerlessness.

Social exclusion?

Social exclusion occurs when formal laws and government policies and/or informal social practices, values, norms and beliefs:

- Result in the conscious or unconscious ignorance and disregard of the interests of specific

groups of people, in particular women or ethnic minorities, or groups belonging to a certain class or age;

- Prevent members of certain social groups from getting equal access to:

    - Economic assets and opportunities;
    - Public goods, services and rights;
    - Political voice and influence.

10.14.2 Gender-related proverbs and stereotypes

"*Sons are sticks for old age"*

"Bringing up a daughter is like manuring and watering a plant for someone else's courtyard"

"An unmarried girl must obey her father, a married woman her husband, and a widow her children"

Old and new stereotypes of men and women farmers

- Men cultivate cash crops, while women cultivate food crops in small plots only for family subsistence.
- Women can best be reached by agricultural services and resources (e.g. extension, training, credit) indirectly through their husbands.
- Women are overburdened with work and therefore cannot participate effectively in development activities.
- Women farmers are generally poor and can only manage subsistence farming.

What do the proverbs and our experiences say?

- Rules, practices, the division of labour, social expectations, and vulnerability and mobility conditions are different for women and men as a result of religious and cultural traditions, societal values and beliefs.
- These ideas have been in existence for many years in communities and societies. As a result, they form an unconscious part of our perceptions, which in turn influence our behaviour.
- These ideas become part of our lives so much that even if we are doing gender work, we unconsciously remain influenced by these perceptions and beliefs.

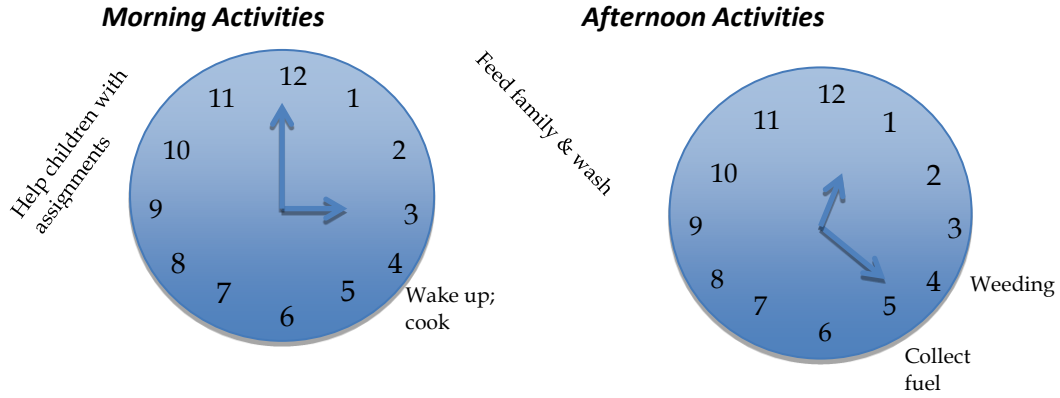
Table 14: *Basic gender analysis questions*

Who does what?	How?	Where?	When?	Why? (Labour)
Who uses what?	How?	Where?	When?	Why? (Access)
Who controls what?	How?	Where?	When?	Why? (Decision making and control = power)
Who knows what?	How?	Where?	When?	Why? (Information = power)
Who benefits from what?	How?	Where?	When?	Why? (Benefit-sharing)
Who is included in what?	How?	Where?	When?	Why? (Participation)

10.14.3 Guide on preparing the Activity Clock

Draw two large circles on two separate papers and slice both circles (one representing morning and the other representing afternoon) into portions to show the amount of time spent doing a particular activity in a typical 24-hour period by a typical woman/man farmer, e.g. feed family and animals, collect fuel, washing, help children with assignments, weeding, washing, going to market, etc.

Figure 6: *Sample activity clocks*



Guide on preparing the Activity Calendar

- Prepare a matrix (see sample in Table 15 below).
- Ask the participants to identify all the activities/tasks that they do on-farm, off-farm and within the household.
- Give some examples if needed.

Table 15: *Sample Gender-Specific Activity Calendar*

	J	F	M	A	M	J	J	A	S	O	N	D
CROPS												
Ploughing												
Planting												
Seed Selection												
ANIMALS												
Herding												
Watering												

Milking												
HOUSEWORK												
Cooking												
Collecting Firewood												
Feeding the Baby												
OFF-FARM												
Selling Crops												
Other Activities												

10.14.4 Access and Control Profile

Table 16: *Access and Control Profile*

Resources	Access		Control	
	Women	Men	Women	Men
Land Seeds Labour Cash Other				
Benefits				
Outside income Asset ownership (e.g. land) Basic needs (e.g. nutritional diet) Education Political power (community decision-making) Other				

10.14.5 Social Inclusion (Rules of the Game)

Development of action plans contributes to:

- Removal of institutional barriers in order to increase the access of women, the poor and the excluded to development opportunities.
- Changes in informal practices and behavior, as well as in formal law and policy, in favour of women and the poor and excluded.

- Structural changes in opportunities within which women and the poor and excluded effectively seek to develop and exercise their advocacy capacities.

What are the domains of change that we can support?

- Improving access to assets and services for women, the poor and excluded farmers
- Increasing their voice and influence
- Supporting changes in the "rules of the game" that have traditionally favoured the elite/advantaged

Figure 7: *Rules of the Game*