Africa Rice Center (WARDA)

Curriculum for Participatory Learning and Action Research (PLAR)

for

Integrated Rice Management (IRM) in Inland Valleys of Sub-Saharan Africa

Facilitator's Manual

Toon Defoer, Marco C.S. Wopereis, Philip Idinoba, Tom K.L. Kadisha, Salif Diack and Moustapha Gaye

Africa Rice Center (WARDA)

The Africa Rice Center is an autonomous intergovernmental agricultural research association of African member states and one of the 15 international agricultural research centers supported by the Consultative Group on International Agricultural Research (CGIAR).

Its mission is "to contribute to poverty alleviation and food security in Africa, through research, development and partnership activities aimed at increasing the productivity and profitability of the rice sector in ways that ensure the sustainability of the farming environment."

The modus operandi of the Africa Rice Center is partnership at all levels. The Africa Rice Center's research and development activities are conducted in collaboration with various stakeholders—primarily the national agricultural research systems (NARS), academic institutions, advanced research institutions, farmers' organizations, non-governmental organizations (NGOs) and donors—for the benefit of African farmers, mostly small-scale producers, as well as the millions of African families for whom rice means food.

The development of the 'New Rice(s) for Africa,' or NERICA(s), for which WARDA was conferred the CGIAR King Baudouin Award, is bringing hope to millions of poor people in Africa. This scientific breakthrough of crossing African with Asian rice species has helped to shape the Center's future direction, extending its horizon beyond West and Central Africa into Eastern and Southern Africa. The creation of NERICA rice and its expected contribution to food security and income generation in Sub-Saharan Africa are in harmony with the spirit and sustainable-development aspirations of the World Summit on Sustainable Development (WSSD), the Tokyo International Conference on Africa's Development (TICAD), the Millennium Development Goals (MDGs), and the New Partnership for Africa's Development (NEPAD).

The Africa Rice Center hosts four networks and consortia—the African Rice Initiative (ARI), the Inland Valley Consortium (IVC), the International Network for Genetic Evaluation of Rice in Africa (INGER-Africa), and the West and Central Africa Rice Research and Development Network (ROCARIZ)—all charged with ensuring the widespread and rapid dissemination, adoption and diffusion of new rice cultivars across the various rice ecologies found in Africa.

The Africa Rice Center has its headquarters in Côte d'Ivoire and four regional research stations—one covering the Sahel and located near St-Louis, Senegal, one at the International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria, the third at Dar-es-Salaam, Tanzania, and in Cotonou, Benin, where the center also has its temporary headquarters.

For more information, please visit www.warda.org

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IFAD–International Fund for Agricultural Development

IFAD

IFAD, a specialized agency of the United Nations, was established as an international financial institution in 1977 as one of the major outcomes of the 1974 World Food Conference. The main objective of the Fund is to directly give funds and mobilize additional resources for programmes facilitating economic promotion of the rural poor particularly by increasing the productivity of agricultural and extra-agricultural activities.

CBF–Inland Valley Consortium

IVC / CBF
Inland Valley Consortium
Consortium bas-fonds

IVC was founded in 1993 to promote sustainable development of inland valleys in Sub-Saharan Africa. The Consortium groups national and international agricultural research institutes and development agencies. Since April 1999, the Consortium is part of WARDA and works with 10 West African countries (Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Ghana, Guinea, Mali, Nigeria, Sierra Leone, Togo) and 8 international institutions (WARDA, IITA, ILRI, FAO, WECARD/CORAF, WUR, CIRAD, IWMI). Each of the member states has a National Coordination Unit (NCU) that brings together—under the direction of a national coordinator—the representatives of the institutions involved in the development of inland valleys. Donors of the IVC are mainly The Netherlands (DGIS), France (Ministry of Foreign Affairs), the Common Fund for Commodities (CFC) and the European Union.

AGA KHAN FOUNDATION

Founded by His Highness the Aga Khan in 1967, the Aga Khan Foundation (AKF) has been experimenting with, and implementing, innovative solutions to development challenges for over 40 years. In every undertaking, the overriding goal is to assist in the struggle against hunger, disease, illiteracy, ignorance and social exclusion. Central to all these efforts have been inclusive, community-based development approaches, in which local organisations identify, prioritise and implement projects with the Foundation's assistance. Within this ethos, AKF focuses on five major areas: rural development, health, education, civil society and the environment. For more information, please see www.akdn.org/.

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Contents

Foreword

The inland valleys of Sub-Saharan Africa are a major asset for the region's food security and they are particularly well adapted for rice growing. However, these land resources (an estimated 85,000,000 ha) have often not been developed because of their extreme diversity and because of the difficulties related to water management in such systems.

Nonetheless, sustainable intensification of inland valleys seems to be a very promising way to close the increasing gap between rice production and rice consumption on the continent, and also to help stabilize the use of the fragile upland soils.

The idea of this manual, and the associated *Technical Manual*, stems from the observation that West Africa's inland valleys are very complex and that there is a chronic lack of communication among farmers, extension services and researchers. It is a product of several years of fieldwork coordinated by WARDA in close collaboration with ANADER (*Agence nationale d'appui au développement rural*, Côte d'Ivoire), and agricultural research and development services, including NGOs, in Benin, Côte d'Ivoire, The Gambia, Ghana, Guinea, Mali, Nigeria and Togo.

This *Facilitators' Manual* is targeted at fieldworkers of research and extension services (both government and non-governmental), to help them stimulate field-based discussions about rice cropping in inland valleys. This manual deals with all aspects of rice cropping, from land preparation up to the end-of-season evaluation after harvest, using an integrated rice management approach.

We hope that later issues will offer a more complete curriculum on the integrated management of all the natural resources in inland valleys. Some modules already deal with such topics. Furthermore, we would like to encourage you to adapt these modules to your own working conditions and to add further material as you see fit.

We wish to thank the staff of WARDA and all the agricultural research and development services in Benin, Côte d'Ivoire, The Gambia, Ghana, Guinea, Mali, Nigeria and Togo, who have contributed to this important work.

Dr Papa A. Seck
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1 Introduction

1.1 Why this manual?

Inland valleys are of great importance to the development and intensification of agricultural production in Sub-Saharan Africa. Their total surface area is estimated at 85 million hectares or 7% of total arable land, of which only 10–15% is used for agriculture. Most inland valleys are concentrated in the inter-tropical zone where rainfall is more than 700 mm per year.

'Inland valleys' always refer to wetlands, but not all wetlands are inland valleys. In particular, the term excludes coastal wetlands (deltas, estuaries and tidal flats), lagoons and mangroves, floodplains, inland deltas, and lakes. The term 'inland valley' refers to the relatively shallow valleys that occur in the undulating plains and plateaus of Sub-Saharan Africa. They are known as '*dambos*' in eastern and central Africa, '*fadamas*' in northern Nigeria and Chad, '*bas-fonds*' or '*marigots*' in francophone African countries, and 'inland-valley swamps' in Sierra Leone.

The inland valleys are characterized by their upstream position in a drainage network. The catchment area of an inland valley includes water movement from the hillcrest (upland area) through the hydromorphic zone (with shallow groundwater table) to the inland-valley bottom.

The objective of this *Facilitator's Manual* and the accompanying *Technical Manual* is to address the food-security challenge in Sub-Saharan Africa through increased and sustainable use of this tremendous resource.

This manual focuses on integrated rice management in inland-valley lowlands. Water accumulates here during the rainy season because of rainfall, runoff and subsurface flow, leading to a recharge of the water table. Valley bottoms are often used for rice and may retain enough residual moisture to permit a second vegetable or legume crop in the dry season. The hydromorphic fringes and upland slopes and crests offer potentials for other food and cash crops, and for trees and livestock. Next to their agricultural potential, inland valleys have other important social and ecological service functions, such as water storage, drainage and maintenance of biodiversity. Thus, inland valleys constitute an extremely important agricultural and hydrological asset at local and national level.

The diversity and dynamics of growing conditions in inland valleys of Sub-Saharan Africa make it impossible to formulate standard crop management recommendations for use by farmers. Given this complexity, a bottom-up, social learning process is critical, leading to change in behavior and innovation as the outcomes of communication and social interaction. A participatory learning and action research approach among inland-valley development stakeholders (farmers, change agents, extension, research) will enable farmers to become experts in managing their inland valleys, emphasizing adaptive responses to context-specific problems and making the best use of available resources, local knowledge and decision-making, as well as research-based understanding and analysis of underlying processes.

This *Facilitator's Manual* seeks to contribute to this process, stimulating discussion within farmer communities, and with other actors in agriculture such as extension agents and fieldworkers, and building bridges between indigenous and external knowledge. The manual includes a learning curriculum for inland-valley farmers in Sub-Saharan Africa. This curriculum contains a set of modules for a team of facilitators or field agents (for instance, from a national extension service, research or NGO), modules that will help them to play their role as animators or facilitators among groups of farmers. The curriculum is based on the Participatory Learning and Action Research (PLAR) approach and addresses all the important aspects of the rice cropping calendar; it will facilitate individual and collective learning in the field or in the 'classroom.' The curriculum is the outcome of collaborative work with farmer groups in inland valleys with good and with poor water control. However, the authors do not pretend to have delivered a finished product. On the contrary, future PLAR teams that will implement some or all of the modules in this curriculum are invited and encouraged to adapt the modules to their specific local conditions and to add other modules as necessary.

The accompanying *Technical Manual* offers additional information and a range of technical options for improving rice production in inland valleys in Sub-Saharan Africa, summarized in a series of technical references.

Sustainable management of inland valleys depends on many factors. One has to consider the impact of interventions on the entire catchment area and hydrologic network. Cutting trees in the upland areas may have severe consequences for lowland rice farmers and on water-users further downstream. This manual concentrates on improved and integrated rice management in the inland-valley lowlands and is, therefore, only an entry-point to improved and integrated management of natural resources in general in inland valleys. It is expected that, in the future, new modules and references will be added on aspects that have not been addressed to date, such as options for diversification, fish-farming and maintenance of biodiversity.

1.2 Basic principles of integrated rice management (IRM)

Inland valleys are highly diverse in terms of bio-physical and socio-economic settings. Farmers have adapted to these conditions, leading to great variation in rice management practices. For this reason, it is not possible to develop technological packages that are adapted to each and every situation. Farmers are, therefore, not served with 'blanket' recommendations, that supposedly work under a wide range of environmental conditions. They rather need advice, and lots of ideas or options for improving rice production. The validity of these ideas or options has to be tested under their own specific farming conditions and farmers will possibly have to adapt them before integrating them into their own farming systems.

In the past, introduction of new technologies has had limited impact, because attention was focused on only one aspect of the cropping calendar of the farmer (e.g. fertilizer management or varietal improvement). Much better results are obtained if a more holistic approach is used, where a new technological option is not so much introduced but rather integrated into the prevailing production system, taking into account interactions with other production factors and management practices. In this way, the technology will be adapted to its new environment. For example, a new soil-fertility management strategy may require new options for weed management. Gradually, other technological options may be integrated, eventually leading to a range of technological options that encompass the entire growth cycle, from the initial planning phase to the harvest and post-harvest stages. This process is called integrated crop management, indicating the step-wise integration of new technological options into production systems with full farmer participation, thereby raising production levels in a sustainable way. For rice, this approach has been called 'integrated rice management' (IRM).

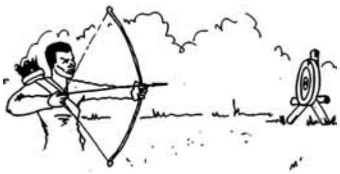
The process described above ultimately results in baskets of integrated rice management options for different types of inland-valley and irrigated systems occurring in major rice-growing areas in Sub-Saharan Africa. As these systems are dynamic, baskets of options will be developed over time.

For this reason, the technical options need to be developed in a farming environment with the active and strong involvement of farmers in the adaptation process, particularly in low-precision systems. The technologies of major interest—which help the farmers to face their major constraints—should be integrated first. It is important to point out that IRM not only includes agronomic technologies, but also socio-economic options, e.g. improved planning of crop calendars and access to resources such as credit. IRM is based on local knowledge and practices and on farmers' decision-making, while integrating exogenous knowledge and techniques, and the scientific understanding of the underlying processes.

The *Technical Manual* sets out the different IRM options for inland-valley rice, from preparation for the growing season up to harvest and post-harvest practices, and the financial balance sheet of the growing season. IRM focuses mainly on the inland-valley lowlands. However, IRM is expected to gradually develop into improved and integrated natural-resources management (INRM) of the inland-valley system as a whole.

2 Participatory Learning and Action Research (PLAR) curriculum

2.1 Principles and objectives of the PLAR approach

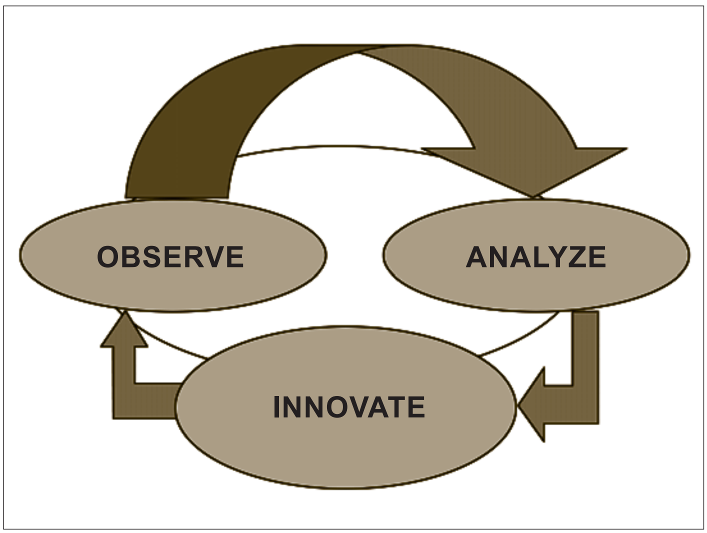


Participatory learning and action research (PLAR) is a farmer education approach, based on adult learning in groups of 20 to 25 farmers, making use of the experiences of the group members. The PLAR curriculum covers the whole cropping season, and the activities follow the development stages of the rice crop and the agricultural cropping calendar. Farmers analyze their own practices, discover problems and seek solutions to solve them. Instead of diffusing or transferring the technologies coming from research or extension services, the facilitators encourage farmers to find solutions themselves and help them to become better rice-crop managers. PLAR does not seek to find the best solutions from a scientific point of view, but those which are the most practical, applicable and adapted to specific local situations.

In the PLAR approach, farmers are not considered as potential 'recipients' or 'adopters' of new technologies; the idea is rather to create a process which will stimulate the farmers into discovering and innovating themselves. The underlying assumption is that in a given context, the learning, discovering and innovating process prompts change and sustainable improvement of the production system. This learning process is facilitated by a team of facilitators, the PLAR-IRM team, often coming from extension services, research or NGOs.

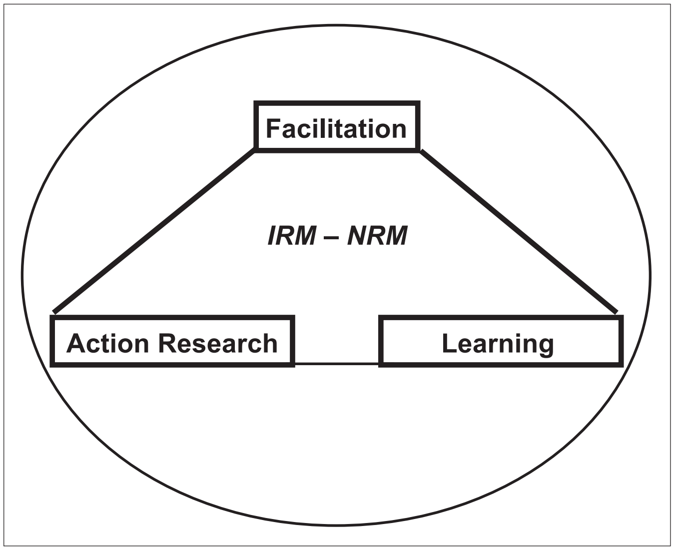
The objectives of the PLAR approach are:

- To develop and improve the farmers' capacities to observe and analyze their working environment (field, inland valley) in order to identify the major constraints and to test, adapt and introduce possible improvements to achieve integrated rice management. This process includes the following steps:
  – Exchanging knowledge, attitudes, experiences and practices;
  – Observing, recording;
  – Comparing, interpreting, analyzing, understanding the causes and factors behind what is observed;
  – Finding potential solutions;



- Reasoning through the decisions to make before taking action, experimenting (trying out) new ideas, learning by doing, and understanding that experimenting also means planning, observing, comparing and interpreting;
- Organizing (individually or at group or community level) for the implementation of activities;
- Creating functional networks with other farmers, extension services, research and any other support service.

- To facilitate learning to make sure that farmers are capable of taking well-thought-out decisions, resulting in more productive and sustainable IRM. The facilitation team uses different learning tools, they are part of the modules and together they form the curriculum. The modules are implemented during facilitation sessions run by the facilitation team. With their enhanced capacity to observe, record, analyze and interpret, the farmers will be better equipped to appropriate further knowledge; this will stimulate them to implement this knowledge, innovate and to learn by doing. The facilitator encourages the exchange of experiences among farmers, and listens rather than dictates to farmers.



The facilitator plays a very important role. He (or she) assists farmers—apprentice groups—in taking the best possible decisions, resulting in more productive and sustainable rice management. Some important roles for facilitators are:

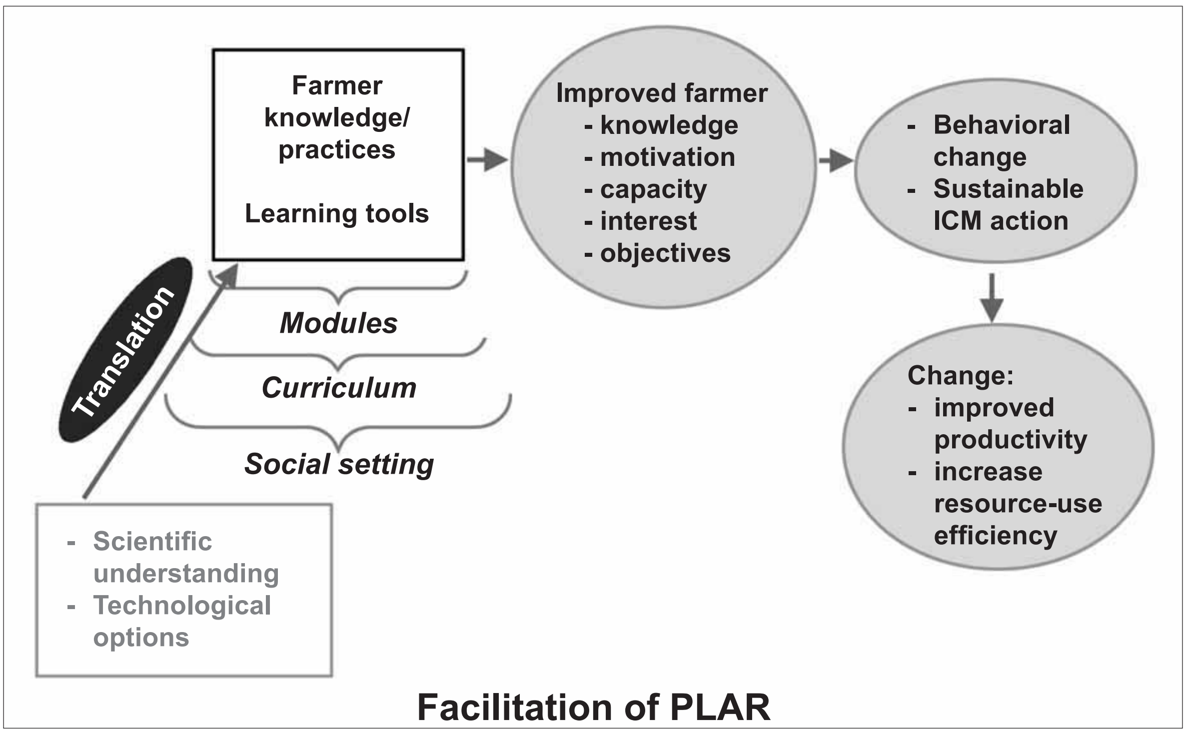
- To understand that learning is based on farmers' experiences and farmer training needs.
- To create situations favoring the exchange of experiences and practical knowledge.
- To ask questions—using simple, direct and open questions; questions that encourage discussion and reflection, that insist on the 'how' and 'why' of practices, etc., to make the farmers think about the variability and differences in space and time.
- To use visual tools that are robust and flexible.
- To encourage discussions in sub-groups, but present results and observations in plenary sessions.
- To stimulate field visits to observe, compare and discuss.
- To translate scientific principles and knowledge into words and illustrations that farmers can understand. Link new external ideas to existing knowledge and practices.
- To urge farmers to implement what they have learnt, innovate and to test new ideas on their own farms.

2.2 Key elements of the PLAR-IRM approach

The modules are the basic components of the PLAR-IRM curriculum and the basic tools used in the facilitation sessions. In principle, each module takes as a starting point the farmers' existing knowledge and practices. The learning tools are the key elements of the PLAR-IRM modules and are intended to bring new and relevant information to farmers in an easily-digestible form, so that the new information can be captured by the farmers and thereby become internalized knowledge. The information captured in the learning tools relates to scientific insights and principles, and possible technological options for improvement. But this scientific information is generally too complicated to be understood by the farmers and thus needs to be 'translated.' Each module aims at improving farmers' knowledge, motivation, capacity and interest to innovate and thereby to change behavior in a sustainable way vis-à-vis Integrated Rice Management. This will ultimately lead to improved resource utilization and rice productivity in the inland valleys.

The three key elements of the PLAR-IRM approach are explained in detail:

- The learning dimensions and tools.
- The modules.
- The facilitation sessions.



2.2.1 Learning dimensions and tools

Learning dimensions

Four major learning dimensions can be distinguished: concrete experience, abstract conceptualization, active experimentation, and reflective observation.

Beyond these, two ways to learn may be distinguished: individual learning, and communicative or social learning. The four learning dimensions (*see* 'Notes on learning dimensions,' page 21) mostly stimulate individual learning. Social learning supposes that individuals can learn through communication and reflection in groups. Groups prompt individuals to learn (e.g. school). When comparing group and individual analyses of a situation, groups usually obtain a more complete image out of the facts, arguments and relations between causes and effects; they also recognize false arguments more easily. The group can influence values, beliefs and feelings. The feeling of belonging to a learning group can stimulate members to go beyond their own individual capacities. But a lot depends on the facilitator animating the discussion, and stimulating open reflection and criticism using tools such as calendars, drawings, maps, etc.

Learning tools

PLAR-IRM is based on a set of learning tools with the aim of helping farmers to express themselves and exchange their knowledge and experiences, to observe, to stimulate farmers to give careful consideration, to analyze, conceptualize, innovate and implement new ideas, etc. Many tools are based on the visualization of phenomena which help farmers to discover and 'see' things that were previously 'invisible' to them. The learning tools used by PLAR-IRM to date are:

- The cropping calendar.
- The inland-valley and catchment area map.
- The transect walk.
- The plenary session to exchange experiences.
- The introduction of new concepts by the PLAR team.
- Field observation in sub-groups.
- Summary and presentation of field observations.
- The IRM field.
- Testing/experimentation.
- The recording form.
- Evaluation of the PLAR session.

Some of the tools are directly linked to a specific module (e.g. the inland-valley map or transect walk), while others are used in several modules (e.g. the cropping calendar, observations in sub-groups, experimentation, the IRM field) and a third group of tools are used in all the modules (e.g. the plenary session to exchange experiences, evaluation of acquired knowledge). Most tools aim at stimulating individual as well as social learning.

The cropping calendar allows farmers to obtain an overview of the stages of rice-plant development in order to improve the planning of good crop-management practices. The rice cycle and the cropping calendar are visualized by the farmers themselves. They use small figurines which they place on a cotton cloth. The cropping calendar will be the basis for the individual planning of the activities which (s)he will visualize on his/her recording form (Annex 1).

The inland-valley and catchment area map. Inland-valley and watershed maps represent the key elements related to the form/morphology, hydrology, soil, vegetation and land use of the inland valley. Such a map allows farmers to have an overall picture of the inland valley, beyond the field level. This overall picture helps them to analyze the functioning, constraints and possibilities of the inland valley in order to take action for improvement, which often requires consensus-building and concerted efforts.

The transect walk. A transect consists of walking along longitudinal and transverse lines, covering the different units of the catchment area of the inland valley. The group doing the transect walk stops at each unit identified by the farmers and discusses the type and characteristics of the soil, the hydrology and the relations between catchment area, soil and hydrology. The dominant vegetation, crops, practices, constraints and possibilities are also discussed. Thus, this transect walk completes the inland-valley and catchment area map.

The plenary session to exchange experiences. PLAR is based on farmers' knowledge and practices. Hence, each module begins with an exchange of experiences among farmers. This session allows the facilitators to understand the elements that the farmers do not control so that they can adapt the contents of the module in order to improve farmers' knowledge.

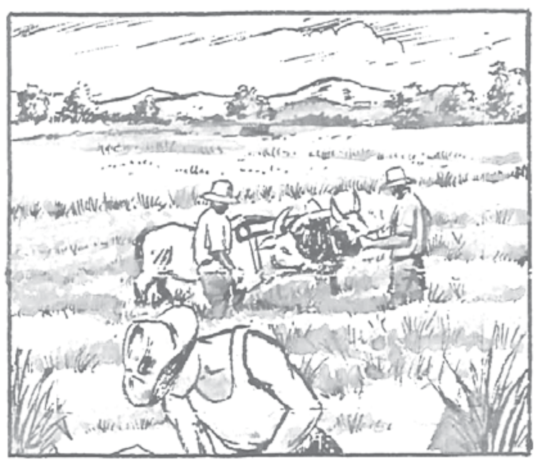
The introduction of new concepts by the PLAR-IRM team. Each module addresses one or more concepts that most of the participants do not control and which require explanation. The contents of these interventions are determined by the initial knowledge level of the farmers, identified during the plenary session of exchange of experiences. The PLAR-IRM team avoids giving long explanations, but will introduce new concepts in the form of question-and-answer sessions, making links with existing knowledge and practices.

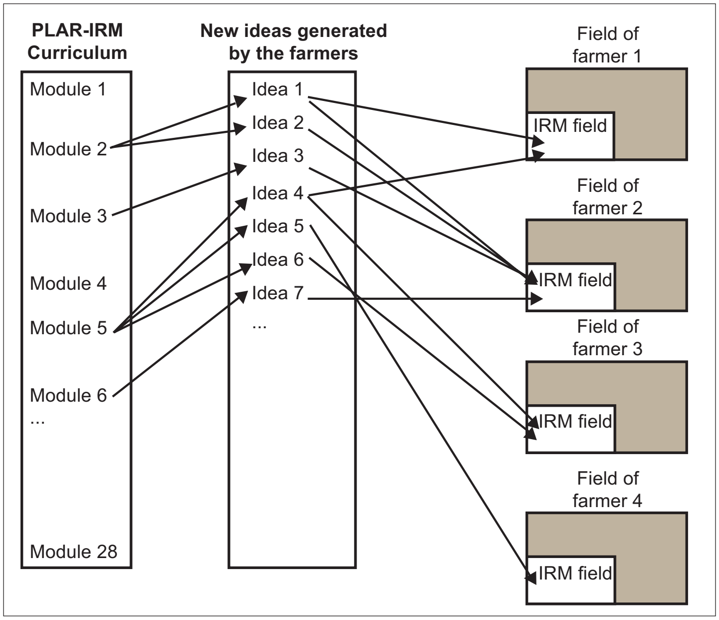
Field observations in sub-groups. Making observations in the field is the leading principle of the PLAR approach. In order to be efficient, field observations are generally done in sub-groups of four to six farmers. Each sub-group designates a farmer-facilitator and a farmer-rapporteur. The type of observations to be made is normally discussed during the plenary session; they are called 'observation indicators.' It is important to take enough time to discuss and agree upon the meaning of 'observation indicators' (Module 11, page 2) and to find the translation into the local language. The field observations are made at different stages of rice development, but they also concern experiments, problems with weeds, insect damage, etc.

Summary and presentation of field observations. After the field observations, the farmers come back together into a plenary session and present a summary of what they have observed. Usually, by turns, the farmer-rapporteurs of the sub-groups present the results, while the other farmers provide additional information. All the information is synthesized in the form of a table. During this session, the observations are analyzed in detail. To analyze is to understand the underlying causes or factors of what has been observed, e.g. if we see that a field is poorly leveled (an observation indicator), asking questions about why it happened is analyzing the problem.

During field observations, the farmers will often take samples that they will further analyze during the summary session. For instance, during the session on insect observation, the farmers collect insect-infested plants to identify the causes of the damage, and this will enable construction of the life-cycle of the insect.

The IRM field. The participating farmers are encouraged to implement any new idea—picked up during the PLAR sessions—in a part of their field. In practice, they identify and mark the limit of a field where they will install any new technique learnt, that field is called the 'IRM field'; some options will be difficult to implement on only part of the field, e.g. improved land leveling or water management. At the end of each session, the facilitator asks what new ideas they want to implement (*see* 'Evaluation of the PLAR session' below) and during the next session, the facilitator asks which new ideas they actually applied on their IRM field. Farmers are advised not to use all their fields to apply the new practices, because it is often easier to test and adapt new techniques on a small scale before applying them on a larger scale; it also enables comparison with the farmer's usual practices. This is totally consistent with the philosophy of the PLAR-IRM approach, i.e. the farmers discover and learn by doing and, if necessary, adapt the technique according to local conditions. After this phase, the farmers will probably apply the technique over wider areas (often after some adaptation of the technique) and integrate that technique into their production system. The sub-groups visit these IRM fields regularly for observation during the field-observation sessions.





In principle, any module can generate new ideas that farmers can apply in their IRM fields. Each individual farmer decides which idea(s) (s)he wants to put into practise. It is clear that the type and number of new practices applied in the IRM field will differ among farmers[1].

Testing/experimentation. Farmers are encouraged to decide which new ideas they want to test. Farmers' experiments are a way of systematically testing a set of options while comparing them to their conventional techniques. It is important to notice that experimenting/testing requires a significant investment from the farmers. For this reason, it is preferable to limit the number of 'test' farmers to those who really want to be involved and are ready to invest considerable time and energy in doing an experiment. The group of test farmers can meet regularly and discuss all the aspects of the tests, giving this core group an important role in the presentation and exchange of the results achieved during the regular PLAR-IRM learning sessions.

In order to ensure the efficiency of the tests, it is necessary to operate in a systematic way and to follow a set of conventions that allow valid conclusions to be drawn. Farmers' tests have different aspects: conceptualization, implementation, monitoring, observation visits, data analysis and presentation of results. The test farmers and the other farmers that are involved in the PLAR-IRM approach present the results together. The experiments play an important role in the adaptation of the new technologies to local conditions.

[1]A questionnaire has been developed to record the new practices put in place by the farmers on their IRM fields (Annex 5). In principle, a PLAR team member should visit each farmer's IRM field each month to record the information.

The recording form. Monitoring and evaluation of new technologies are necessary to analyze the efficiency of the IRM techniques and possibly improve these and the PLAR-IRM approach as a whole. Monitoring and evaluating requires proper recording of information on the activities and observations done in the IRM field. The recording form includes many visual aspects, allowing illiterate farmers to keep track of observations and practices implemented. A model of the recording form is given in Annex 1. It consists of:

- General information on the participating farmer and his/her farm.
- A sketch of the IRM field.
- A calendar of the activities planned, followed by the activities actually implemented.
- Field observations relating to field preparation, nursery, transplanting, and the different development and growth stages.
- Data on management practices.

Evaluation of the PLAR session. At the end of each module, an evaluation is done. This evaluation consists of three elements:

- Appreciation: what did the participants appreciate most and least?
- Learning: what do the participants know now that they did not know before?
- Benefit of the new knowledge: did the module generate new ideas which the farmers want to apply, e.g. on their IRM field?

2.2.2 Modules

The modules are the basic elements of the PLAR-IRM curriculum and the key tools used for running the facilitation sessions.

Structure of the modules

Each module starts with a short introduction, followed by the following sections:

- Learning objectives 
- Procedure 
- Time required 
- Materials required 

The introduction presents the problem and explains why this particular module is part of the PLAR-IRM curriculum. Normally, it is because farmers have expressed a need for information or it results from previous diagnoses.

<u>Learning objectives</u>

The learning objectives mostly aim at increasing farmers' capacities and skills, e.g. how to analyze a situation, observe, compare, interpret, look for and find solutions, take decisions, plan activities or experiments to implement, test new ideas, compare different techniques, evaluate the performance of new techniques, define how to meet a goal. There may also be some learning objectives for the PLAR-IRM team.

To make it possible to check later if the learning objectives have been met, they have to be formulated as simply and clearly as possible. For example, "by the end of the session, farmers will be able to diagnose signs of nutrient deficiency in rice."

<u>Procedure</u>

Most of the modules contain the following elements:

- Greetings.
- Review of the previous module, review of new techniques implemented in the IRM fields.
- Presentation of objectives.
- Exchange of farmers' experiences.
- Introduction of new concepts.
- Field visit or use of a visual tool, e.g. crop calendar.
- Restitution and summary.
- Evaluation of PLAR session.

<u>Time required</u>

The time required to run a facilitation session should not exceed 3 hours, in order to keep the attention of the farmers. If a module takes too long, it is better to suspend the session and to continue the module during the next session.

<u>Materials required</u>

For a session, sometimes the material has to be prepared in advance.

Modules

Currently, the PLAR-IRM curriculum consists of 28 modules. It is not necessary to use all the modules during the facilitation sessions. The choice of modules to be used will depend on the training needs of the farmers expressed during the first session. It is possible that there is no module on a particular subject judged important by farmers, in this case an additional module will have to be developed. The following table gives an overview of the existing modules.

Closing PLAR-IRM

- Closure session of the PLAR-IRM curriculum (M28)

After the growing season

- Evaluating the PLAR-IRM curriculum (M27)
- Evaluating the results of the cropping season (M26)
- Harvesting and post-harvest activities (M25)

During the growing season

- Managing experiments, making observations and recording information during the maturity phase (M24)
- Making field observations: Reproductive phase (M23)
- Integrated pest management: Rice stem borer (M22)
- Integrated pest management: African rice gall midge (M21)
- Insects in rice cultivation (M20)
- Managing experiments, making observations and recording information during the vegetative phase (M19)
- Making field observations: Vegetative phase (M18)
- Using herbicides efficiently in inland-valley rice production (M17)
- Integrated weed management (M16)
- Recognizing weeds (M15)
- Making field observations: Transplanting and beginning of the vegetative phase (M14)
- Assessing farmers' knowledge and evaluating implementation of IRM practices (M13)
- Transplanting and establishing experimental plots (M12)
- Making field observations: Preparing the field and establishing the nursery (M11)
- Maintaining soil quality (M10)
- Planning land preparation, nursery establishment and transplanting (M9)
- Establishing a nursery (M8)
- Preparing the rice field (M7)

Before the growing season

- Planning good crop-management practices (M6)
- Using good seed and rice varieties (M5)
- Maintaining inland-valley lowland infrastructures for better water management (M4)
- Making a transect walk in the inland-valley lowlands and the catchment area (M3)
- Mapping an inland-valley catchment area (M2)

Introduction to PLAR-IRM

- Starting the PLAR-IRM curriculum (M1)
- Site selection

2.2.3 *The facilitation sessions*

Facilitation sessions take place in the fields and at the PLAR-IRM Center. The location of the PLAR-IRM Center is chosen by the farmers. It can be somewhere under a tree, or a small room in the village or any other place not too far from the inland valley.

A facilitator is more than a trainer. He (or she) plays the role of an experienced farmer or of an advisor (for the practical part), of an animator (asking questions), of an organizer and coordinator. The roles and responsibilities of the facilitator are:

- To prospect potential sites for the implementation of PLAR-IRM (Section 4.2 and Reference 1).
- To make observations and prompt farmers to make observations.
- To ask simple questions so as to encourage farmers to exchange their knowledge and experiences, and to seek advice from other farmers; to ask other questions to encourage farmers to try to understand why things are like they are, and why they do this or that.
- To attract the attention of the farmers, try to understand their current knowledge, their attitudes, their practices and their underlying reasons for doing what they do. To give particular attention to the differences among farmers (diversity) and motivate the farmers to recognize and understand that diversity.
- To animate discussions and encourage farmers to analyze and take decisions to try out (test) what they have learnt.
- To train farmers to improve their way of testing new ideas, favoring the adaptation and adoption of new techniques and stimulating farmers to develop news ideas.
- To make the farmers respect some rules of behavior: if someone talks, the others listen and follow attentively. The facilitator makes sure that all the farmers participate and that the discussions are not monopolized by one or a few participants.
- To prepare the materials required for the sessions.
- To make a report of each facilitation session.
- To analyze the results of the farmers' tests and compare the IRM fields with the rest of the farmers' fields.

To be effective, the facilitator should:

- Be motivated to improve rice production and livelihood conditions of farmers.
- Avoid giving answers to questions, but encourage farmers to find the answers themselves, from their own experiences.
- Start with a few, cheap, simple activities for farmers to implement (basing choices on local knowledge and practices), which are most likely to give visible and significant results in a short time; this will help motivate the farmers.
- Avoid using artificial incentives.

- Be systematic and follow the procedure of the modules as described in the manual. To be systematic means: progress from simple things to more complicated things, and from what is known to what is not known, in order to explain something new to the PLAR-IRM participants.

The facilitator's attitude can stop the learning process, e.g. when the facilitator:

- Seems little interested in, or incapable of, focusing the farmers' attention, or is impatient with the farmers.
- Does not stimulate the exchange of knowledge and experiences among farmers.
- Offers standard recommendations without analyzing problems with participants.
- Does not ask further questions, but only gives his or her own opinion.

The PLAR-IRM modules have been developed to help the facilitator in his/her work. *However, the modules should* ***not*** *be considered as unique and rigid tools.* On the contrary, facilitators are encouraged to adapt and modify the modules to make them appropriate and useful to the conditions in which they are working. In that sense, it is important to evaluate the efficiency of the modules. At the end of each module, the facilitator should ask the farmers to what extent they appreciated the module, what they learnt and what they will implement or test. If the results of the evaluation are not satisfactory, it is clear that improvements have to be made. In addition to the farmers' evaluation, it is also important that the facilitation team evaluates each session. A sheet has been prepared to allow the recording of the evaluation results (Annex 2).

3 Plan, prepare and implement PLAR-IRM

3.1 The PLAR-IRM team

Ideally, a team of two or three agents who have followed the PLAR-IRM training for trainers carries out the facilitation sessions. These facilitators can be extension or NGO agents, or scientists having a good knowledge of the field. The sessions take place once a week over about 30 weeks, which means that the facilitators have to be available at least one and a half days per week: half a day to prepare the session, half a day for the session itself and another half day to evaluate and record the results (Annex 2). In addition, the facilitator can be asked to assist farmers in recording information on the IRM fields (Annex 5).

The institutes and organizations interested in the PLAR-IRM approach should consider whether they can effectively implement such a time-consuming process. Several African research and development services do not have the necessary human and financial resources to carry out activities focusing on 'learning.' For this reason, the PLAR-IRM activities should begin on a small scale, i.e. as pilot activities. This will allow the team and the partner organizations to acquire the experience required and to gain confidence in the efficiency of the approach before extending the process on a larger scale. It is advisable to begin pilot activities with a small team. Given the exploratory nature of the team, it should be composed of scientists, development workers, extension agents or NGO personnel.

In any case, a long-term commitment of the team members is required; they should be willing to be involved in the field activities for at least a few years. This is not always easy because staff are often reassigned—this risks disturbing the continuity of the team. Scientists and extension agents who are already involved in numerous activities should not be selected as members of the PLAR-IRM team. What is needed is a PLAR-IRM team with experience in participatory research methods and skills for group-work and interaction with farmers, scientists and development workers. The PLAR-IRM requires regular critical review and adaptation of its approach, according to the area/site and time. The PLAR-IRM approach requires flexibility from the team members and their institutions; it requires good communication skills among team members and their institutional superiors, and it requires resources.

3.2 Site selection

The choice of the site is very important, because the site determines not only the results, but also the opportunities for the extension of these results to other inland valleys or areas. In Reference 1 of the Technical Manual, a set of selection criteria is presented. It is clear that the farmers' request for assistance is one of the major criteria for starting PLAR. Farmers can formulate this kind of request during the participatory diagnostic phase or during development-workers' interventions. However, the message should be clear from the beginning: as a principle, it is an assistance to train/educate the farmers so that, later, they will themselves take control over the PLAR. The request can also be the result of an open field day organized by an already running PLAR-IRM Center.

Before selecting the priority areas, the sites and the number of PLAR-IRM Centers to install, the research and development organizations should take into consideration all the agro-ecological areas and inland-valley rice production systems. Since PLAR-IRM requires a long-term commitment, the number of centers will necessarily be limited. However, in order to play a key role in farmer-to-farmer training, the PLAR-IRM Center should be committed to its role. That is to say: after 1 or 2 years, some of the PLAR-IRM farmers should become farmers-facilitators in the neighboring inland valleys. Therefore, the original site selection should also consider the distance to neighboring inland valleys. A center isolated from other inland valleys is not a good choice, as the extension of knowledge to the farmers of other inland valleys will be difficult.

The ultimate goal of PLAR is to become an approach used by all the extension services in all the regions were inland-valley rice production is important. To reach this target, a significant commitment is required from the research and development services involved in inland-valley rice systems. For this reason, the number and density of PLAR-IRM Centers that an extension service can manage should be considered and, furthermore, the number of centers able to support the extension of the objectives to other inland valleys through exchange and farmer-to-farmer learning should also be considered.

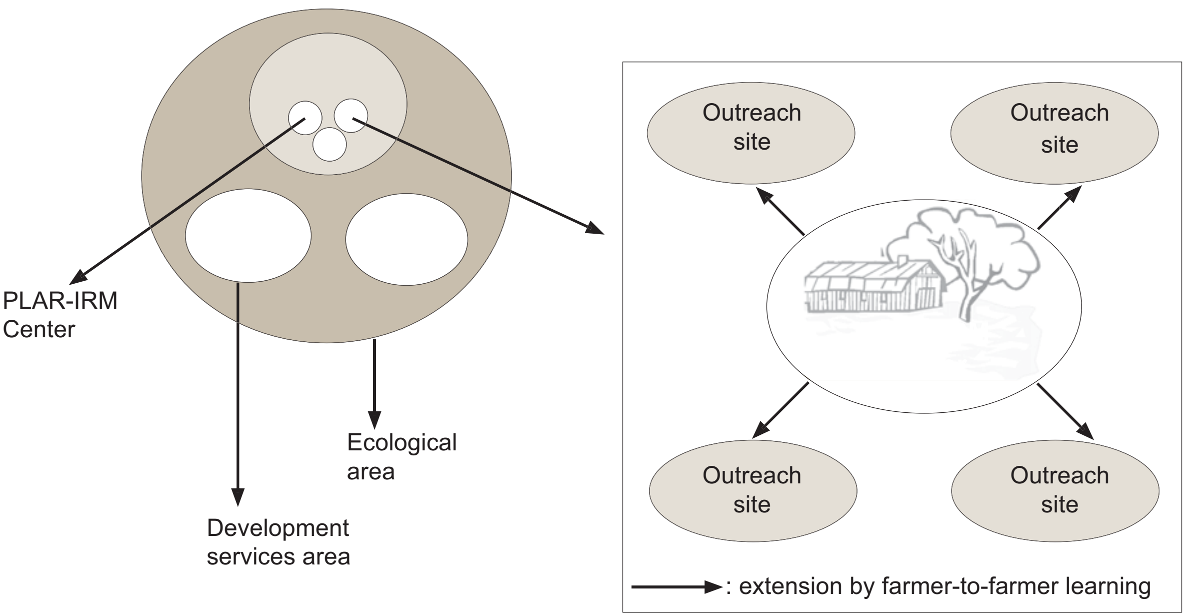
In order to make PLAR really function in the neighboring sites, the farmer-facilitators should be rewarded for the assistance they give. To make the system sustainable, the farmers receiving assistance should contribute for receiving training. At Bamoro and Lokakpli near Bouaké in Côte d'Ivoire, where the first PLAR-IRM Center was installed, a system of 'learning coupons' is being tested.

The farmers of the PLAR-IRM Center Bamoro–Lokakpli extended the PLAR-IRM results and tools to the farmers of neighboring inland valleys, through farmer-to-farmer learning. An outreach campaign was organized in the neighboring villages to inform people of the existence and skills of the PLAR-IRM Center. As a result, four requests for training were received. Now, there are four farmer-facilitators running PLAR-IRM sessions in the neighboring villages in response to their peers' demand. Professional facilitators, members of the PLAR-IRM team, assist these farmer-facilitators in the preparation of the training sessions and, if needed, give to-the-point explanations during the sessions. It is clear that not all the modules of the curriculum will be addressed in the outreach villages, especially in the first year.

Indeed, modules and tools are selected on the basis of the priority problems of major interest to the PLAR-IRM Center farmers combined with the demands formulated by the farmers of the outreach sites.

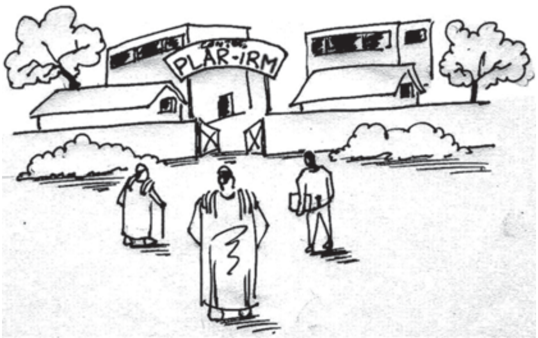
In partnership with WARDA, the Ivorian extension service ANADER sells tickets to farmer groups in the outreach sites at 2000 FCFA per ticket (about $US 3) for one training session. At the time of the training session, the farmer group gives a ticket to the farmer-facilitator who claims the money from ANADER–WARDA. The first 30 training sessions are subsidized by WARDA, but each additional session is paid by the group at the full rate (100 FCFA per farmer per session for a group of 20 farmers). The system works successfully in the four outreach sites.

In principle, success is guaranteed if the PLAR-IRM Center is limited to a village. In a village, there is normally a certain social cohesion facilitating the organization of farmers around a PLAR-IRM Center, where farmers meet regularly and follow the sessions, where knowledge is exchanged and working in groups is encouraged. By the same logic, it is preferable to work with farmers who are already organized into farmer organizations and who have some experience of working together. Annex 3 presents a form to record basic information on the inland-valley site.



Local authorities and extension agents or NGOs who know the environment well can help to identify potential sites. The PLAR-IRM team will visit these sites to see the provisional choice first-hand. Afterwards, one or more meetings will be organized with the villagers in order to explain their interests and expectations to the PLAR-IRM team.

3.3 Farmer selection



To be efficient, the number of participants should not exceed 30. Bigger groups are difficult to manage and with smaller groups discussions and knowledge exchange tend to be limited. The preliminary meetings in the village and the first module can be followed by all interested farmers. In principle, adherence to the group takes place during the first session on a voluntary basis. If women produce rice, they should be encouraged to participate in the PLAR-IRM Center. The selection should *never* be done by the field agent, nor the local village chiefs. The PLAR-IRM candidates should:

- Be rice producers in the selected inland valley.
- Be interested in learning new rice management techniques and practices.
- Commit themselves to participate regularly in the PLAR-IRM sessions during the 30 weeks.
- Accept to share their acquired knowledge with peer-farmers from their own and other villages.

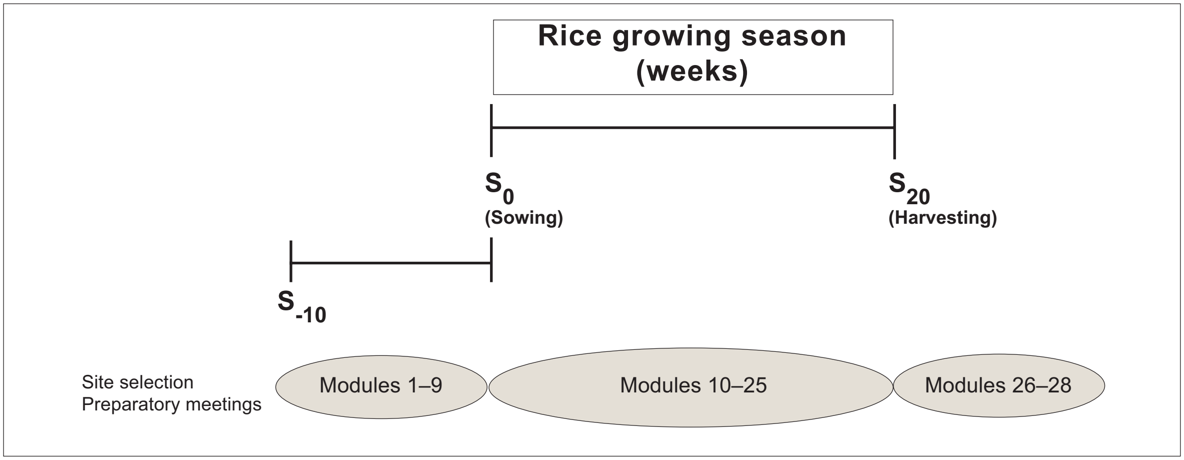
It is important to know the socio-economic characteristics of the participating farmers to compare them with those of non-participating farmers. This information can be used in a database to analyze the impact of PLAR-IRM. Annex 4 presents a form for recording basic socio-economic information about the farmers participating in PLAR-IRM and of a sample of farmers who are not participating.

3.4 Planning of sessions

It is important that the PLAR-IRM sessions match the local rice cropping calendar. In practice, it is necessary to start the modules two months before the beginning of the campaign, when the farmers begin to clear the land. Therefore, with a frequency of one or two sessions a week, Module 9, addressing farmers' planning of the campaign, will coincide with the beginning of the campaign.

The correct implementation of the PLAR-IRM curriculum requires good planning, especially in the initial phase. It is far easier to carry out modules when they coincide with the implementation of the corresponding activity in the farmers' cropping calendar. Practising of the acquired knowledge, especially at the IRM-field level, is then possible. It is important that the PLAR-IRM team starts its activities on time. The planning of the activities should take into account the rice cropping calendar that does not normally cover more than 20 weeks.

In practice, Modules 1 to 9 address items related to the preparation for the campaign and, for this reason, they have to take place before rice seeding. If, for instance, in a particular PLAR-IRM site, farmers normally start seeding in early August, it is useful to start the PLAR-IRM sessions 10 weeks earlier, i.e. at the end of May. If this is not possible, increasing the number of sessions per week, two



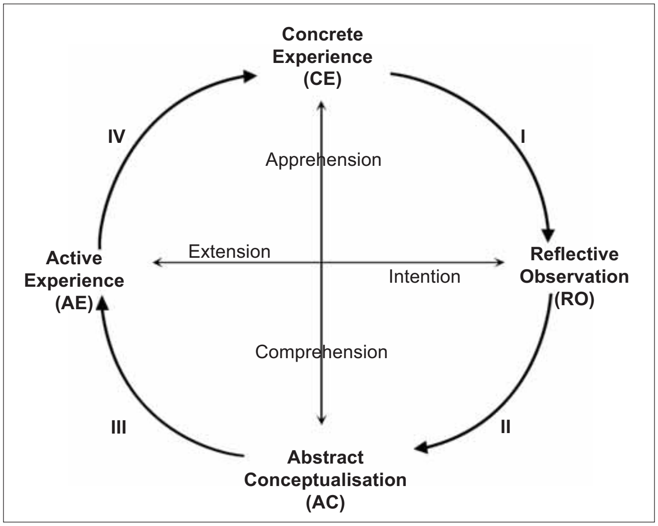
instead of one for instance, may be tried. Modules 10 to 25 are related to the agricultural campaign and should take place during the rice cropping (cycle) calendar. Modules 26, 27 and 28 can be carried out well after harvest. Module 27 needs data from the IRM field and to collect, treat and organize them takes time.

The planning illustrated in the figure (above) could help, but each team has to adapt it to its own local conditions. In addition, this planning should be flexible, as it should be possible to adjust it if necessary according to what happens during the campaign.

Notes on learning dimensions

Four major learning styles can be distinguished: concrete experience, abstract conceptualization, active experimentation, and reflective observation. When someone observes, listens or gets some significant information, (s)he has a 'concrete experience,' called 'apprehension.' Apprehension involves one's subjective sense of what is important and how one thinks and feels about something—thus, one's attitude. To a large extent, attitude influences one's behavior. 'Behaviorists' suppose that learning starts with the experience of particular needs, therefore need is seen as an incentive or stimulus for learning. One responds to that need by behaving in different ways. Any behavior that more or less fulfils that need reinforces that particular behavior. Reinforcement will probably lead to the repetition of that successful behavior: concrete experience takes place. It will be clear that one's individual needs strongly influence one's attitude and behavior and thus the way to acquire concrete experience.

The 'abstract conceptualization' dimension of Kolb's[2] learning process involves understanding or 'comprehending,' and is based on one's ability to analyze a situation and relies on interpretation and cognition (leading to knowledge). Comprehending relates to the theory of 'cognitivism' that, as opposed to behaviorism, sees learning not as a change in behavior, but as improving particular mental processes, like observation, memory, or fact-linking. Abstract conceptualization happens in the mind. When using maps and models, structure is given to the contents and abstract conceptualization takes place.



Apprehending and comprehending are two poles of the learning process and knowledge results from the alternation between these two poles: (1) exploring situations and perceiving meaning (concrete experience) and (2) designing or modifying personal representations (constructs) for these situations (abstract conceptualization). The vertical line in Kolb's model of the learning process shows that learning can be seen as a flow between concrete experience in existing situations (apprehension) and abstract conceptualization (comprehension) of these experiences (*see* Diagram).

The other two dimensions of Kolb's model of the learning process deal with intention and concrete action. 'Active experimentation' happens when personal constructs previously developed through abstract conceptualization are put into practise and then used to change a situation. As such, one's understanding of a situation is tested and extended through active experimentation. At the other pole of the horizontal line, 'reflective observation' appears as the fourth dimension of learning. Reflective observation takes place when one does not take action, but prefers to take time for verifying whether the beliefs, values and newly perceived wisdom (concrete experience) are accurate and will hold true. During reflective observation, the concrete experience is compared to alternative views and earlier experimentation, thanks to an increased perceptiveness. Reflective observation may be transformed into active experimentation after consultation and thinking, and when one feels comfortable extending intentions and thus transforming ideas into concrete action.

Kolb has integrated the four learning dimensions into a cyclic learning process. Learning alternates between apprehending and comprehending a new situation (the vertical line) and transforming the new perceptions into reflection about the insights or actively experimenting with the new elements (the horizontal line). The cyclic learning process thus integrates activities people carry out when they learn. With concrete experiences of real problem situations, the active learner reflects on the value of his/her ideas by comparing them with other ways of looking at the problem (*see* segment I of the cycle). With the broader picture in mind, the active learner then conceptualizes the ideas and formulates theories and models of understanding (*see* segment II of the cycle). Subsequently, the models are tested (*see* segment III of the cycle) resulting in concrete experience (*see* segment IV of the cycle). Although each individual has a specific way of learning, it is possible to monitor people's learning process by distinguishing the four segments of the cycle. Some people will have a distinct ability to learn by experimenting, while others will gain better insights by conceptualization. Kolb distinguishes four learning styles, corresponding to the four segments of his model (*see* segments I, II, II and IV of the cycle).

[2] Kolb, D.A., 1984. *Experiential Learning: Experiences as a Source of Learning and Development*. Prentice-Hall, Englewood Cliffs, USA.

Starting the PLAR-IRM curriculum

After identifying the site for the planned intervention, i.e. the inland-valley lowland (Reference 1), the first contact is made with the farmers who work at the chosen site in order to set a date and time for an introductory meeting. This introductory meeting is very important, because Participatory Learning and Action Research for Integrated Rice Management (PLAR-IRM) can only be effective if farmers fully and actively take part in the PLAR-IRM sessions that will take place during the entire rice-growing season. For most participants, PLAR-IRM is a new approach and farmers are generally not experienced in this type of approach to learning. To demonstrate the importance of this first session, it is critical that the PLAR-IRM team leaders participate.

Before presenting the principles and objectives of the curriculum, it is useful to examine, as a joint exercise, what farmers perceive as good rice-management practices and what conditions are required to be able to follow these practices. The first session will also enable discussion on what areas of rice management practices farmers intend to learn.

❶ List good rice-management practices and factors enabling good management.

❷ Identify differences in rice management practices between farmers and changes that have taken place over time.

❸ List farmers' training needs.

❹ Introduce PLAR-IRM.

❺ Write down the names of the farmers who wish to participate.

❻ Ask farmers to choose a group leader, and identify a meeting place and time for the PLAR-IRM sessions.

Learning objectives

At the end of this module, farmers will be able to:

- Identify 'good' management practices and rank these according to their importance.
- Identify the conditions required to put these 'good' management practices in place.
- Acknowledge that there are various forms of rice management and that these can change over time.
- List their training needs.
- Explain the principles and objectives of the PLAR-IRM approach.
- Express their interest in participating in PLAR-IRM and register to take part in the PLAR-IRM sessions.
- Agree on the PLAR-IRM curriculum outline and agenda.

Procedure

1. Farmers who work at the potential PLAR-IRM site should agree on the date and place of the first session. Note that this first step is taken well before the session itself and that it is important to confirm this agreement at least once before the session takes place.

2. Village officials, farmers and the PLAR-IRM team members introduce themselves to each other.
3. One of the team members explains the objectives of the meeting and gives an outline for the session.
4. A large sheet of strong packing paper is spread out and divided into two columns with the headings: (1) 'good rice-management practices,' and (2) 'factors that enable or prevent the use of good rice-management practices.'
5. After some discussion, farmers are invited to list 'good' management practices and then list the factors that allow or prevent good management.[1] A field visit is highly recommended to stimulate the debate. The facilitator or a literate farmer records the main points cited, on the paper.

6. The facilitator invites farmers to list the various rice management practices they undertake and stimulates the debate on the 'whys' and 'wherefores' of differences between farmers.
7. Then, the debate focuses on changes and improvements that have taken place over time, and what farmers think about future developments.
8. A second large sheet of strong packing paper is displayed with the heading, 'What we want to learn.'
9. Farmers are invited to state what they want to learn and all suggestions are written down.

1. If the group of farmers is large, it would be convenient to form subgroups and then to combine the results of discussions during the plenary sessions.

10. The facilitator introduces the PLAR-IRM principles, objectives and approach, and explains what farmers can expect from the curriculum.
11. The facilitator asks questions to find out if farmers have grasped the principles of participatory learning and if they are ready to take an active part in the sessions during the whole rice-growing season.
12. The facilitator then discusses the PLAR-IRM curriculum with the farmers, and the PLAR-IRM team and facilitators agree on an agenda for the growing season and the frequency of meetings during the rice season (it is better to agree on a weekly meeting program or every other week and set the day and time of meetings in advance). The facilitator makes sure that the scheduling of the PLAR-IRM sessions will not conflict with that of other meetings.
13. The names of volunteer farmers willing to participate in the PLAR-IRM curriculum during the rice-growing season are written down.
14. Farmers are expected to choose a group leader and an assistant leader who will be made known during the subsequent session. The facilitator explains that the leader will receive a notebook to write down the names of the participating farmers and take attendance at the various PLAR-IRM sessions. The facilitator also explains that farmers will get a certificate at the end of the PLAR-IRM program if they attend most of the sessions.
15. The facilitator asks farmers to give a name to the group and identify a meeting place. This can be a classroom, an unused store or in the shade of a tree, etc. This meeting and learning place could be called the 'PLAR-IRM Center.'
16. The facilitator ends the session with a summary of the substance of the module.

Time required

- Three hours

Materials required

- Two large sheets of strong packing paper.
- Markers.
- Adhesive (Scotch) tape.

Box 1

A field visit with farmers was conducted before starting the PLAR-IRM curriculum in order to appraise farmer practices. The farmers from Lokakpli and the PLAR team visited three rice fields.

The first field was at about two weeks from harvest (maturity phase). The rice crop (variety Bouaké 189) was doing very well and had a completely closed canopy cover. We estimated yield at 6–7 t/ha. There was still water in the field. The discussion focused on the most appropriate time to drain the field before harvesting, and timing of fertilizer application. Farmers had difficulties in converting a per-hectare dose of fertilizer to a per-field dose. Most of them seemed unaware of the importance of the main plant nutrients (nitrogen, N; phosphorus, P; potassium, K) and the composition of the main mineral fertilizers used in terms of N, P and K.

The second field was also close to harvest, but it did not look as good as the first field. Rice tillering in the vegetative phase had been poor and we saw a lot of empty spaces between rice hills. The canopy cover was, therefore, far from closed. At the field edges, we noted spots of iron toxicity. A lively discussion followed on the causes of the poor plant stand. Farmers identified the following factors: disease pressure, poor soil quality, poor drainage conditions, late transplanting, use of old seedlings at transplanting, and problems with land-leveling. In the end, farmers more or less agreed that this field had two major problems: iron toxicity, which originates from the upland areas surrounding the lowlands, and a soil texture that was thought to be too sandy. Farmers seemed to be well aware of differences in soil texture. They said that land-leveling works during the construction of the irrigation scheme had caused a lot of damage to soil quality.

In the third field, rice seedlings had just been transplanted. The soil was sandy, but contained a lot of organic matter. Rice straw had been incorporated using a power tiller. Farmers said that owners of power-tillers do not like to rent out their machines for straw incorporation. One of the farmers found a solution to this problem: he is decomposing the straw before incorporating it. The farmer showed us that he produces his compost near his threshing area.

Following the field visit, farmers discussed factors determining yield formation: they mentioned land-leveling and land preparation in general, soil quality, time of transplanting, age of seedlings at transplanting, weed pressure, problems with pests and diseases, and high costs of mineral fertilizers. After a lively discussion, farmers agreed that to raise rice productivity in a sustainable manner, an integrated rice management approach is needed that embraces all aspects of the rice cropping calendar from land preparation to harvest and post-harvest practices.

Mapping an inland-valley catchment area

The inland-valley bottom or lowland is the lowest part of an inland-valley catchment area, which includes from top to bottom: the hillcrest, the upland slopes (upper and lower slopes), the hydromorphic zone and the actual valley bottom (Reference 2). The catchment area is the entire land area in a valley depression that forms the hydrographic (water-channel) network, which conveys water to the valley bottom. Among others, this network determines the inflow (irrigation) and outflow (drainage) of water in the inland-valley lowland. The shape of the catchment area, the soil types and their depth, the vegetation, the rainfall regime and other factors also influence the functioning of the inland valley and determine its potential and limitations for agricultural use. To understand the functioning of the valley bottom, it is necessary to have an overview of the entire catchment area and its hydrological system. In many cases, farmers do not have a global view and clear understanding of the inland-valley catchment area and hydrological system.

Learning objectives

At the end of this module, farmers will be able to:

- Draw a map of the inland-valley catchment area they cultivate, while indicating key land sub-units as well as their relative dimensions, shape/morphology, hydrology, pedology (soil characteristics), vegetation and land use.
- Understand the importance of having an overview beyond the field level.
- Analyze the functioning of the inland valley, and identify its limitations and potentials for agricultural use.
- Reflect on activities to improve the functioning of the inland valley and realize that these activities often require collective action.

❶ Place a sheet of strong packing paper on the ground, preferably in the direction of the valley, and let the farmers decide among themselves who will draw the map.

❷ Visualize the inland-valley features, including the irrigation–drainage systems.

Introduce the concept of catchment area, lateral and longitudinal water movement and groundwater (groundwater table).

❸ Identify and visualize the upland slopes, hydromorphic zone and valley bottom.

❹ Visualize areas of excessive seasonal flooding and seasonal drought, and identify the possible causes.

❺ Determine and indicate the main soil types on the map, including areas influenced by iron toxicity.

❻ Identify the natural vegetation and the main crops grown, and visualize spots with high weed-infestation.

Procedure

1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator reviews the main issues discussed in the previous module and invites farmers to comment.

2. The facilitator reviews the list of participants and asks if a group leader and a deputy have been appointed. He (or she) checks whether someone will keep track of attendance during the sessions. The facilitator also asks if farmers have agreed on a name for the group and if they have agreed on a day, time and place for the PLAR-IRM sessions.

3. One of the PLAR-IRM team members explains the objectives of the meeting, the learning objectives and the procedure of the current session.

4. A large sheet of strong packing paper is displayed on the floor and markers are made available to farmers. The facilitator explains the idea of mapping the inland-valley system, and the need to use symbols for physical elements, such as irrigation canals and bridges. Farmers need to agree themselves on what symbols to use for each element.

5. The facilitator invites farmers to position the sheet of paper in the length-wise (longitudinal) direction of the valley bottom and to pinpoint the highest and the lowest points of the valley on the map.

6. Farmers are then asked to choose a person who will take the lead in drawing the map. However, farmers should agree with the principle that elements or landmarks are only put on paper if a consensus is reached. All farmers will, therefore, feel ownership of the final map, and agree that this is an adequate representation of their valley. All farmers are invited to gather around the paper and to contribute to the mapping process.

(The valley bottom)

7. Farmers first identify places where water enters the valley (upstream), then lakes, bridges, roads, dams and other landmarks. Farmers decide on the choice of colors and symbols to represent the various landmarks. The main irrigation and drainage canals are drawn from the upper to the lower part of the part of the valley, representing the natural river course in the valley bottom.

8. Next, farmers try to locate and draw their own fields, respecting as much as possible the relative dimensions of each field, again working from the upper to the lower part of the valley. They also draw the secondary irrigation and drainage canals.

(Catchment area)

9. The facilitator introduces the concept of a catchment area, and lateral and longitudinal surface water flow. Farmers indicate the highest point of the hillcrest and its relative distance from the valley bottom, i.e. the area covered by the upland slopes on both sides of the valley bottom.

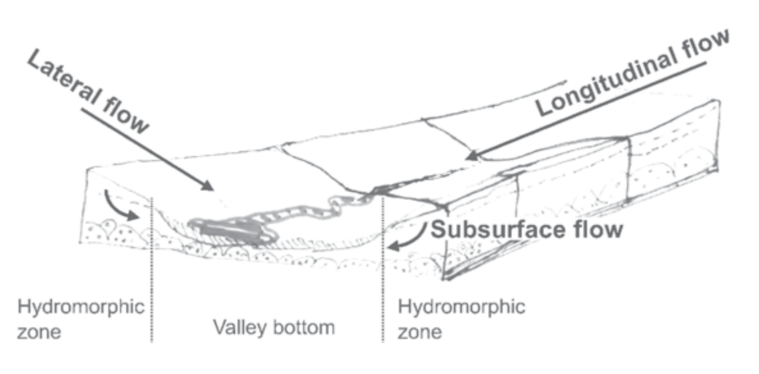
10. The facilitator introduces the concept of a hydromorphic zone. Farmers generally recognize this zone as the area suitable for vegetable growing. Farmers try to demarcate—with dots on the map—the area where vegetable growing is possible, relative to the crest and the valley bottom. Next, a solid line is drawn linking the dots. This line represents the border between the hydromorphic zone and the rainfed upland slopes.

11. The facilitator introduces the concept of the groundwater table. Farmers are asked to compare the depth of groundwater in the upland slopes, the hydromorphic zone and the actual valley bottom. The facilitator explains that water flows from the upland slopes to the hydromorphic zone and the valley bottom.

12. Farmers discuss the size of the area occupied by the upland slopes, the hydromorphic zone and the valley bottom at different locations in the inland valley (i.e. starting upstream and moving downstream). The facilitator explains the effect of a long and gentle slope on water supply in the valley and the risk of erosion and reduced groundwater recharge on a steep slope.

How to introduce the concept of a hydrographic system

The facilitator identifies a spot in the meeting place where the ground is undulating with a well-defined slope. He indicates the longitudinal direction of the lowest portion and the lateral slopes (borders) on both sides. With a big bucket, some quantity of water is first poured out at the upper part so that the water runs downward to the lowest depression. This is to show the longitudinal direction of water flow. Then, from a position on the lateral side (diagonal to the longitudinal direction) some quantity of water is poured to represent rainfall on the hillside, which partly seeps through the soil and partly runs-off towards the lowest depression (representing the valley bottom). Next, some water is poured on a shorter and steeper lateral section to show what is happening with water seepage and runoff. Finally, the concept of ‘crest’ is explained by pouring water on the highest lateral side: part of the water flows down one side towards the valley bottom, while the rest of the water flows down the other side, into another valley.



(Hydrology and water management)

13. Farmers indicate areas of water stagnation and areas affected by seasonal drought. They discuss the importance, periods and duration of these phenomena. The facilitator encourages farmers to identify the causes of water shortages or stagnation (e.g. soil texture, topography). Farmers are also asked to indicate areas susceptible to erosion.

(Soil and subsoil)

14. Farmers identify the main soil types, preferably as a function of the toposequence in the catchment area (Reference 3). The facilitator thus encourages farmers to list various soil types identified on the upland slopes, in the hydromorphic zone and in the valley bottom. Farmers indicate the distinguishing criteria and specific features of the various land types.
15. Next, farmers indicate the spatial variability of the various soil types on the map for the upland slopes, the hydromorphic zone and the valley bottom.
16. Farmers also give an indication about the natural fertility of soils, and their water-holding capacity. The facilitator stimulates a discussion on the link between land sub-units and their characteristics, such as texture, color, soil fertility and permeability.
17. Areas prone to iron toxicity are also indicated on the map. The facilitator encourages farmers to discuss the link between iron toxicity, soil type and groundwater depth (Reference 4).

(Vegetation and crops)

18. Farmers list the crops, natural vegetation and main weeds predominant in the upland areas, the hydromorphic zone and the valley bottom.
19. For the valley bottom, farmers indicate which areas are especially infested with weeds. They briefly discuss weed species and their importance to rice growth.
20. Evaluation: the facilitator asks to what extent farmers:
    - Have appreciated Module 2—what did they appreciate most and what did they appreciate least?
    - Have learnt—what do they know now that they did not know before drawing the map?
    - Will put their newly gained knowledge into practise—what can be done with the new knowledge obtained?
21. The facilitator concludes the session, informs farmers about the topic of the next session and invites them to that session.

Time required

- At least two sessions of 2–4 hours.
- Depending on farmers' interest, the map can be more or less complete; however, it is always possible to go back to the map later and conduct a second or third session.

Materials required

- Large sheet of strong packing paper, markers, adhesive (Scotch) tape.
- An attendance book.
- A bucket.
- Water.

Box 2

About 30 farmers and the PLAR-IRM team met in Lokakpli. We provided farmers with a large sheet of strong packing paper and marker pens. To start with, farmers found it difficult to draw a map of their valley. After about an hour, farmers were not satisfied with the result and decided to start all over again. The aim of the exercise was not yet clear for a number of the farmers. Gradually, more farmers became involved and finally many among them expressed their points of view.

The map that was eventually drawn proved to be an important means of communication. It was obvious that fields are generally located between the peripheral irrigation canal and the central drainage canal. The map also indicated a large blank area, corresponding to fields of farmers who were not represented. Some farmers present said that the farmers in this blank area were not very cooperative. During the discussion it also became obvious that farmers working downstream do not often go to the fields upstream and vice-versa.

About 25 farmers and the PLAR-IRM team met in Bamaro. Bamaro farmers were much more at ease in mapping their inland-valley system than the Lokakpli farmers were. This may be due to the fact that the land outside the valley bottom and hydromorphic zone does not belong to the Lokakpli village. Lokakpli farmers had, therefore, much less detailed knowledge of the entire catchment area than did Bamaro farmers. In fact, at the start, Lokakpli farmers did not really see the point of discussing about land outside their irrigation system. We also observed that not all farmers understood the principle of groundwater movement.

We asked farmers to identify the various soil types encountered in Bamoro and they came up with three major categories: upland soils, hydromorphic-zone soils and valley-bottom soils. After a lot of discussion, farmers agreed on the following categorization (this took about 45 minutes):

Upland soils:

Type:	Fertility level
Black / white sand	Less fertile
Black / red gravelly	Fertile
Red / black sandy-clay	Very fertile

Hydromorphic soils:

Type:	Fertility level
Black / white sandy-clay	Fertile
Black / white / red sand	Fertile
Black / white sand, gravelly	Fertile
White clay	Less fertile

Lowland soils:

Type:	Fertility level
Clay with black clay-loam below	Very fertile
White sand	Less fertile
Black loam	Fertile

Crops do not perform well in hydromorphic zones on white clay soils, as these dry very quickly. We asked questions about the land-use history of the Bamoro valley. A lot of (sometimes heated) discussion (especially between the younger and more senior farmers) followed. Eventually, it seems that rice was cultivated in the valley of Bamoro before Ivorian independence, probably at least 70 years ago. In the beginning, rice and raffia were the main crops. After independence, the Prefect asked the village farmers to remove the raffia and to use the whole valley bottom for rice. Rice production has become more intensive over the last 10 years.

Farmers made a inventory of crops, natural vegetation and trees:

Upland: teak (tree), bamboo, cashew (tree), mango (tree), coconut, palm, monkey-bread tree, acacia, orange tree, cacao, yam, cassava, maize*, imperata*, millet.

Hydromorphic zone: sugar cane, okra, tomato, cucumber, sweet potato, taro, pineapple, banana, raffia, millet.

Valley bottom: rice, and several weeds with Baoulé names.

Making a transect walk in the inland-valley lowlands and the catchment area

Making a transect consists of walking through a pre-determined pathway that goes through the major land sub-units of the catchment area of the inland-valley lowland as indicated on the map (Module 2). The purpose is to gain a better understanding of the catchment area and to describe the drainage system, hydrology, vegetation, soil types, and other biophysical features of the lowland. The transect walk will thus preferably be carried out in two ways: *laterally from the upland area to the valley bottom*, covering the major land sub-units of the toposequence, and *longitudinally along the valley bottom*. Farmers will bring along with them the map they produced during the previous session (Module 2).

❶ Visualize the direction of the transect lines on the inland-valley catchment-area map produced during the previous session (Module 2).

❷ Walk from the upland area towards the valley bottom and then downstream or upstream along the valley bottom.

❸ Describe the upland area and slopes, the hydromorphic zone and the valley bottom in terms of soil type, vegetation, etc.

❹ Sample and describe the various soil and vegetation types.

Learning objectives

At the end of this session farmers will be able to:

- Have an overview of the catchment area, which comprises the upland area and slopes, the hydromorphic zone and the actual valley bottom.
- Analyze the functioning of the valley, identify constraints and potentials and, more particularly, understand the main effects of (a) soil type, field position and water supply, on (b) discharge, vegetation, management practices, soil fertility, yield, and problems related to crop production.
- Check and complete the information already visualized on the valley catchment-area map with the additional information observed during the transect walk.
- Reflect on activities to improve the functioning of the inland valley and realize that these activities often require collective effort.

Procedure

1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator briefly reviews the previous module and invites farmers' feedback.

2. One of the PLAR-IRM team members explains the learning objectives and procedures for the current module.

3. A transect line is visualized on the inland-valley catchment-area map, taking into account the diversity of the landscape and the need to ensure good coverage:
   - The lateral section from top to bottom: upland area and slopes, hydromorphic zone and lowlands.
   - The longitudinal section: moving from the upstream to the downstream section and taking into account:
     – Various soil types;
     – Water inlets;
     – Areas that experience seasonal flooding or drought;
     – Various types of vegetation and weeds;
     – Management practices;
     – The width of the valley bottom and the slope of the hydromorphic zone.
4. Farmers and the PLAR-IRM team then proceed to the field—to one end of the first transect line, normally the highest part (the upland area) so as to have an overview of the overall catchment area. The group then moves downward along the slope towards the hydromorphic zone and the valley bottom.
5. When the group arrives at the valley bottom, the facilitator invites farmers to list any features that allow them to distinguish between upland area and slopes, the hydromorphic zone and the valley bottom. The group proceeds to the boundary between the lower slope and the hydromorphic zone, and then to that between the hydromorphic zone and the valley bottom. The facilitator stimulates a debate on the differences between these zones in terms of topography, vegetation, cropping practices, hydrology (depth to groundwater) and soil types.
6. With a soil auger, a shovel or a knife, soil samples are taken in the hydromorphic zone, close to the valley bottom.
   - The facilitator invites farmers to describe the soil in terms of color and texture.
   - Afterwards, he/she shows how soil texture can be determined in the field and reviews with farmers the links between the soil's natural fertility, color and texture (Reference 3).
   - Samples are taken at various depths with the soil auger or shovel. The facilitator encourages farmers to observe differences in color and texture. At some point, the groundwater table will be reached in the auger hole. The facilitator explains that it is in fact the same water as that in the valley bottom and that there is a groundwater movement towards the valley bottom.
   - If there are red stains or red concretions in the soil, the facilitator asks farmers if they recognize these. He/she stimulates a discussion to improve farmers' understanding of iron toxicity. He/she explains the relation between water movement (infiltration) and the iron content in the water and the iron concentration in the soil at places where the groundwater table comes to the soil surface, i.e. between the hydromorphic zone and the valley bottom. The facilitator stimulates a discussion on the effects of iron toxicity on plant development and yield (Reference 4).

How to determine soil texture

- Take a soil sample large enough to fill about a quarter of the palm of a hand.
- Remove extraneous pieces (roots, seeds, etc.) and any material over 2 mm (gravel).
- Add some water to the sample and mix it to form a paste. The soil must be evenly moist without aggregates.
- First rub the paste between the thumb and the index and then form a ball or a cylinder, by moving the paste from the palm of the hand towards the fingers and back towards the wrist; this will allow you to determine whether the soil is mainly:
  - *Sandy*: grits are felt between the fingers and the soil does not stick to the fingers; there is no consistency and the ball breaks easily when squeezed between the fingers; the cylinder is not shaped easily;
  - *Loamy*: the paste sticks partly to the fingers; a ball can be made, that does not break easily when squeezed between the fingers; a cylinder can be shaped; when the cylinder is bent into a U, it cracks;
  - *Clayey*: the paste is very elastic and sticks to the fingers; it is very easy to make a ball of paste and push a hole inside or mold it; it is easy to shape a cylinder that does not crack when bent into a U-shape.

7. The group then moves on to the valley bottom and stops at any place where farmers identify a specific soil type. For each soil type:
   - The facilitator invites farmers to describe the soil, including its color and texture.
   - The facilitator stimulates a discussion on the difference between this and other soil types encountered and on their differences in terms of natural soil fertility, vegetation, management practices, hydrology, opportunities and specific constraints.
8. After all major soil units have been visited, the group returns to the PLAR-IRM Center to assess the module. Farmers are invited to draw up a summary of the observations made and the main lessons learnt.
9. Evaluation: the facilitator asks what the farmers appreciated (or did not appreciate), what they learnt, and what they intend to do with their newly obtained knowledge.
10. The facilitator asks a volunteer farmer to conclude the session, and then invites all the farmers to the next session.

Time required

- Two to four hours

Materials required

- Soil auger, shovel or bush knife.
- Sheets of strong packing paper and markers.
- Plastic bags.
- Bottle filled with water.

Box 3

A group of about 20 farmers attended Module 3 in Bamoro. The group first came down from the upland area towards the valley bottom, crossing the hydromorphic zone. There, farmers explained how they distinguish the upland slopes (hillside) from the so-called vegetable-growing (hydromorphic) zone and the actual valley bottom. After a few minutes, everyone agreed on the extent of the hydromorphic zone, which is between the two other zones. Farmers discussed differences between the three zones (upland, hydromorphic, valley bottom). Farmers mentioned that there is a difference in slope between the zones: the uplands (hillside) have a steeper slope than the hydromorphic zone and the valley bottom. The distinction between hydromorphic zone and valley bottom is the presence of abundant stagnant water in the valley bottom. Next, farmers discussed differences in soil type. In the upland areas, soils are rather sandy-gravel-like, while they are more sandy-loam in the hydromorphic zone. Soils are loamy-clayey in the valley bottom. Farmers discussed the various weed species and the natural vegetation found in the upland area, hydromorphic zone and valley bottom.

A soil sample was taken from the hydromorphic zone. The soil was sandy-loamy and black. We demonstrated how to determine the soil texture (wet and then try to make a ball or a 'cigarette'—if it works and if it sticks then it is clay, otherwise it is sand or loam; loam is a texture between sand and clay).

The group then proceeded to the valley bottom. Farmers first located the valley bottom on the map and the exact place where they were. Farmers took a sample with the soil auger. The soil was sandy-clayey, black with reddish spots. By rolling the soil between the hand and the fingers, farmers experimented and rolled a ball or a rod; which showed that it was clay. When we tried to fold the 'cigarette,' it broke, which showed that it was not pure clay but contained a good amount of loam. We then explained that the red spots are like rust on a hand-hoe and these same spots make the water become red. Iron is a problem for rice production. One farmer said that red water is hot. Another farmer said that the iron comes from the uplands. Farmers gave several mechanisms through which rice is affected by iron. One young farmer said that iron does not allow roots to develop properly. We likened this to a situation where the rice plant 'drinks' the red water—it is like drinking poison.* One old farmer said that it was possible to remove the iron through drainage. We also talked about the possibility of testing rice cultivars resistant to iron toxicity. It was decided that we should discuss all aspects of iron toxicity during a later session. Farmers explained that the problem of iron toxicity is particularly severe in the parts of the valley bottom bordering the hydromorphic zone, i.e. towards the periphery of the valley bottom.

Next, we discussed spatial variability of the various soil types in the lowland. Some farmers explained that sandy soils are mainly located towards the valley periphery and that clayey soils are more present towards the center of the valley bottom, near the drainage canal. Some farmers were able to explain that this was due to the fact that the water moves soil particles from upland slopes (upper slopes and hillcrest) towards the lower slopes or bottom (valley lowland); the gravely and heavier sand particles are deposited at the periphery of the valley, whereas the finer and lighter clay particles that are suspended in water are deposited at the valley bottom through sedimentation. One old farmer explained that this phenomenon has been occurring for a very long time.

We then continued along the valley bottom, on the west side. We saw a field of courgettes (hardly emerged) on mounds in the hydromorphic zone. Mounds were made in the direction of the slope. The farmer said that this allowed the water to move better. His colleagues said that it is better to make mounds across the slope so as to avoid erosion. We introduced the concept of the groundwater table to the farmers and showed the depth of the water table close to the valley bottom and further up towards the uplands. To demonstrate this, we dug a hole with the soil auger. The water table was 1.3 m deep. The soil that came out from the soil auger had very high iron content. This allowed us to discuss about the movement of iron from the upland to the lowland. Finally, farmers understood the principle of water movement through the soil by surface runoff, sub-surface lateral flow and capillary rise ('sponge' effect of the soil).

We also took soil samples from the bunds. Farmers make these bunds every year by accumulating farm debris (cleared grasses, weeds, etc.) on top of the old bunds. We observed that this soil had a high organic-matter content and a good structure. Before taking the sample, one of the farmers said that the soil was too poor to allow crops on the bunds. Sampling revealed that the soil is actually very rich in organic matter because of decomposition of the accumulated weeds. We suggested that farmers could use these bunds for okra, maize or even perennial shrubs. We showed farmers a leguminous plant (*Sesbania*) and explained its fertilizing effect. Farmers said they consider the presence of *Sesbania* as a sign of soil fertility; there are many around the irrigation canal where the soil is richer and where the water arrives early in the season inducing the germination of *Sesbania* seeds.

* In fact, the toxic effect is due to the concentration of reduced iron in the soil solution (Reference 4).

Maintaining inland-valley lowland infrastructures for better water management

Maintenance of irrigation and drainage infrastructure is often lacking in inland-valley lowlands. This can cause serious problems with water management.[1] Depending on the dynamics of the inland valley, inadequate maintenance of irrigation and drainage facilities in the lowlands can result in water shortage, while elsewhere it may lead to excess flooding and difficulties in draining some plots. Without irrigation or drainage facilities or when water cannot be retained long enough on the field (which is often the case with plots that are far from the irrigation canal), water control can be problematic. However, in small rainfed lowlands, excess water rather than water shortage is often the major problem, because a drainage system is lacking or ineffective, or because the bunds are not well made. The main river course in the lowland usually brings water to the lowland and is also used as the central drainage canal; if it is not well maintained, water is not easily drained, resulting in uncontrollable floods.

It is not possible to solve all the problems related to water management in a single module. The idea of this module is to show that farmers can improve or maintain the water-management structures in lowlands in a step-wise manner. In this module, the focus is on managing excess water, using farmers' past experience as a starting point. The purpose is to achieve better water management through concerted and collective action. This module thus tackles the technical (Reference 5) and organizational aspects of water management.

❶ Discuss issues related to water management in the lowland.

❷ Investigate farmers' interest in collective action to improve water management.

❸ Assess the reality of the problem with farmers through field observation and discussions on the condition and functionality of the water-control facilities (canals and bunds).

❹ Demonstrate the construction of canals, bunds and plot irrigation–drainage techniques.

❺ Discuss practical implications.

Learning objectives

At the end of this module, farmers will:

- Be aware of the importance of working together to maintain irrigation and drainage infrastructures to improve water management.
- Be able to develop and maintain simple low-cost water-management facilities.

Procedure

1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator briefly reviews the previous module and invites farmers' feedback.

1. This module is especially useful for undeveloped lowlands, where water management is a serious concern to farmers.

2. One of the PLAR-IRM team members explains the learning objectives and procedures for the current module.

3. Brief summary of water-management issues:
    - Consequences of excess water or water shortage: late transplanting, inefficient fertilizer use, etc.
    - Possibilities for achieving better water control.
    - Past experiences.
    - Role of an efficient drainage canal and bunds in successful water control.

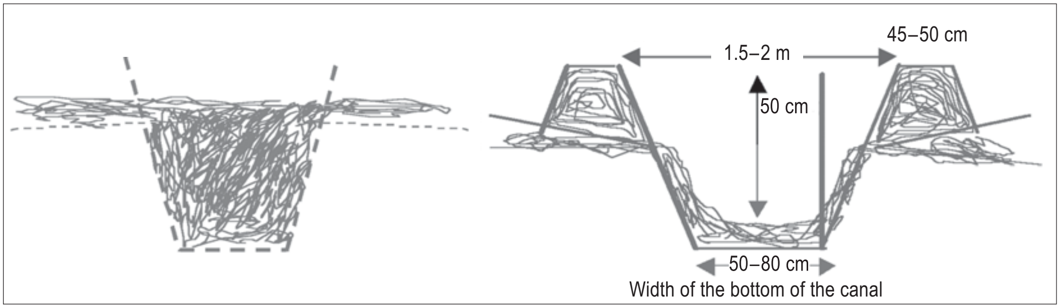
4. Discussion on farmers' experience in water management and more particularly on the construction and maintenance of water-control facilities, as well as the management of possible conflicts between farmers' interest in water rights.

5. The facilitator asks farmers to clearly express their interest (or possibly their lack of interest) in collectively engaging in activities to improve water management.
    - Farmers must be encouraged to express their possible concerns associated with developing the lowland. The facilitator must explain that the final purpose is that everyone finds it profitable; however, any change may need compromises from everyone.

6. Farmers and the facilitator go to the field, to the most upstream place where the drainage canal starts.

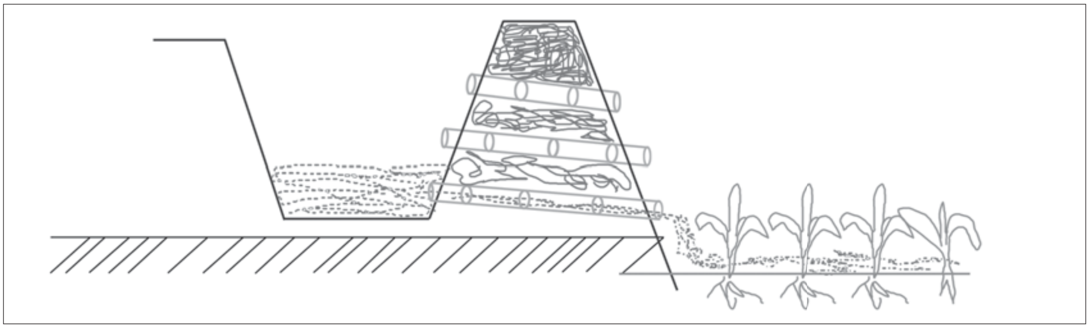
7. Observation and discussion on the condition and functionality of the drainage canal.
    - After arriving at the canal, farmers are asked to indicate the whole natural river course, water movement and seasonal channels; does the current width, depth and shape of the canal permit efficient inflow and outflow of water?
    - What are the main constraints in water control? Where does water accumulate during the periods of flooding and in which places is dryness easily noticeable during shortfalls?
    - The facilitator explains the principles of canal construction: the ideal shape, width and depth as determined by the flooding regime and valley width. For instance, a canal may need to be 2-m wide and 50-cm deep. The facilitator cuts wooden sticks of 0.5 m and 2 m length (in this example) to demonstrate canal construction.


8. Demonstrating the canal construction.[2]
    - The estimated width of the canal (e.g. 2 m) and height of bunds (e.g. 0.5 m) is pegged out on a 5-meter length piece of land.
    - With the hoe or shovel, the canal is excavated. The angles between the floor (base) of the canal and the sides are tilted at 45°. The excavated soil is deposited beside the canal, between the (already laid-out) pegs to form the bunds.
    - The digging is continued until a depth of 0.5 m to 1 m is reached in the middle of the canal, depending upon the size of the canal and soil type. The height of the bunds beside the canal may also reach between 0.5 m and 1 m, making the canal able to withstand 1–2 m flood heights.



9. Demonstrating the field's irrigation and drainage technique.
    - At the bund, a 20 cm slit is dug to create a connection between the canal and the field adjacent to the bund.
    - If available, a big bamboo 0.1 m in diameter and 1.50 m long is cut. This bamboo is put in the slit and the slit is closed with some soil.
    - The bamboo can be put at different levels to thus irrigate or drain the plot. To avoid water runoff, it is also possible to close the slit with soil.

2. The size can be different based on the lowland length, width and slope.



10. Farmers and the facilitator continue moving along the existing canal.
    - At places characterized by flooding, the facilitator introduces a discussion, raising the following topics:
      – What observations did you make?
      – What are the causes?
      – Were there any attempts to solve the problem? How?
      – How can the issue be solved in a more sustainable way?
    - According to the need, pegging is done at places where the canal must be widened and deepened and where bunds are to be reinforced. If a canal has never been constructed in the lowland, it will be the choice of the farmers whether they would like to embark on the construction of a one.
11. Back at the PLAR-IRM Center: farmers and the facilitator discuss the practical aspects of activities to be conducted.
    - One or several teams are to be formed.
    - Farmers agree on a date and time to start the activities.
12. Evaluation: the facilitator asks what the farmers appreciated (or did not appreciate), what they learnt, and what they intend to do with their newly obtained knowledge.
13. The facilitator concludes and invites farmers to the next session.

Time required

- Three hours

Materials required

- Shovels or hoes.
- Bush cutlasses.
- Pegs and ropes.
- Rammer.
- Large bamboo stick.

Box 4

After arriving at the Bamoro lowland, we went upstream where we started discussing the hydrological network of the lowland, the natural water course and the principles of canal construction (dimensions, effectiveness). We cut a 2-m stick to measure the canal width. Using a hoe, the canal was excavated with its edges tilted at about 45° on both sides, being 1-m wide at the bottom of the canal. The canal was made 0.5-m deep upstream and 0.7-m deep downstream to enable downward flow. The soil was removed from the canal and used to build up the bunds and the soil was well consolidated as excavation progressed. Afterwards, we demonstrated how to construct irrigation inlets from the side of the canal. A big 1.5-m long bamboo was first cut. A slit was made in the bund at the water level and the bamboo was placed in the slit and then the slit was closed again. The bamboo can be closed if necessary with soil and opened if necessary; the bamboo can also be tilted to allow water in or out of the plot. The same system is applied to allow water movement between plots. If there is no bamboo, water can simply be let through the slit.

After the demonstration, we covered the whole downstream section of the lowland. We stopped at several places and discussed "what we see" (the problems), "their causes" and "the way they can be solved." Afterwards, we put stakes at all these locations to indicate where and how to widen the canal and make bunds. At certain locations, there were incoming lateral canals where T-shaped stakes were placed. At other locations, lateral canals are to be connected to the central canal with a bamboo. The closer we got to the downstream area, the deeper the canal will have to be made. Farmers listed all farmers involved, i.e. those along the canal and those who will be in charge of developing the canal at that particular section. After covering the length of the lowland and indicating places to be developed in the lowland, the PLAR-IRM team and farmers rested under the trees in the forest. Here we conducted the evaluation of the module. Farmers were asked to start the practical phase of activities. A team was immediately created to supervise the activities, composed of:

- Chairman: BROU Kouakou Maurice
- Assistant Chairman: KOUAME Yao "Dembélé"
- Second Assistant: SANOGO Adama

During the assessment session, farmers said they were delighted to find out that lowland-development activities can be achieved with ease through cooperation and team-work. Around 1:30 p.m., the team took leave of their hosts.

Using good seed and rice varieties

A good start to the rice-production season begins with the selection of the rice cultivar to grow and the seed source. The varietal choice depends on the farmer's objectives and on field constraints—for example, yield characteristics, plant height, field flooding regime, iron-toxicity occurrence, and the degree of water control. Seed production and conservation practices will determine seed purity and germination capacity (Reference 9).

1. Identify farmer seed production practices.
2. Identify farmer seed conservation practices.
3. Present basic seed production and conservation techniques.
4. Discuss the characteristics of good-quality seeds.
5. Conduct a demonstration of a seed germination test.
6. Identify varieties cultivated by farmers and the changes over time and why these changes have occurred.
7. Introduce new varieties that correspond to site-specific objectives and constraints.
8. Introduce farmer experiments (with a sub-group of volunteer farmers).

Learning objectives

At the end of this session farmers will:

- Have a good knowledge of the diversity of rice seed production, supply and conservation techniques that exist within their community.
- Be aware of ways to improve rice seed production and conservation.
- Be familiar with a number of rice cultivars that respond to certain production objectives and specific constraints.
- Select cultivars for evaluation, as a function of site-specific problems or needs identified.

Procedure

1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator briefly reviews the previous module and invites farmers' feedback.

2. One of the PLAR-IRM team members explains the learning objectives and procedures for the current module.

3. Discussion of farmer rice seed production practices. The facilitator stimulates a debate on the following topics and pays attention to *differences in practices* among farmers:
   - What is seed?
   - What is the difference between rice seed and paddy?
   - How do farmers obtain their seed? What is the relative importance of seeds produced on-farm and other sources of supply? What are the other sources?
   - How do farmers produce their seeds?

- How often do farmers renew their seed? What are the reasons for changing seed and what are the sources of good seed?
- Are there farmers who specialize in rice seed production? What techniques do they use? What quantities are produced and what are they used for?
- What are major constraints related to rice seed production and distribution?

4. Discussion of farmers' rice seed conservation practices. The facilitator stimulates the debate by addressing the following topics:
   - How is seed harvested and threshed?
   - What are the conservation and storage techniques?
   - What are the major constraints to seed conservation?
5. The facilitator introduces a discussion on techniques of rice seed production and conservation (Reference 9):
   - Observation of the plot:
     - Identify areas within the field with vigorous, homogeneous plants that correspond to the desired variety characteristics;
     - Remove abnormal plants;
     - Remove weeds and diseased plants.
   - Activities during harvesting: harvest separately plants that represent the characteristics of the variety in terms of size and color and that are disease-free.
   - Dry the rice.
   - Thresh the rice.
   - Winnow the rice.
   - Conserve the rice.



6. Farmers discuss the characteristics of good-quality seed and pay particular attention to seed purity, odd grain type and extraneous objects, and homogeneous shape and color.

7. The facilitator stresses the importance of conducting a germination test before sowing and demonstrates how to conduct the test: put a cotton towel in a plate, wet the towel, put 100 seeds on the towel, cover the seeds with another towel, put the plate in the shade and add water if necessary (Reference 9).

8. Discussion about rice varieties grown by farmers. The facilitator stimulates the debate by addressing the following topics:
   - What are the varieties that farmers currently grow?
   - For how long have these varieties been cultivated?
   - Are there specific varieties grown for commercial purposes and others for home consumption?
   - How are varieties chosen and who chooses them?
   - Do cropping practices differ by variety? If so, how?
   - What varieties were cultivated in the past? Why are they no longer cultivated?
   - What are the most important characteristics of the major rice varieties?

9. The facilitator proposes a set of new varieties, which meet farmers' major production constraints and needs (Reference 10):
   - If iron toxicity is often a major constraint, varieties tolerant to iron toxicity will be proposed.
   - If there is poor water control, varieties more resistant to flooding may be proposed.
   - With good water control, high-yielding varieties may be proposed.
   - Where rice is cultivated mainly for home consumption, varieties generally appreciated for their good taste may be tested.

10. The facilitator leads a discussion on the principles of farmer experimentation (Reference 17).[1]
   - He/she explains the importance of reflecting thoroughly on the 'reasons' for conducting an experiment; i.e. what does the farmer intend to find out through experimentation? What is the objective and what are the hypotheses?
   - He/she elaborates on the treatments involved, i.e. the various new varieties to test and the need to include the local variety or practice for comparison.

1. This is a first introduction to farmer experimentation. This topic will be addressed again in Module 12 when dealing with the layout of experimental plots. As a rule, the whole group of farmers can take part in the experiments, but in practice it is better to have a smaller group of farmers, e.g. some 10 farmers, who are actually interested in the experiment and agree to spend some of their time on that as well as to share information with other farmers (Reference 17).

- He/she stimulates the discussion on the conditions for experiment: the place, seed quantities, farmer management practices, etc.
- He/she gives first ideas about monitoring of experiments and the role of the group of farmers that will conduct the experiments, he/she also elaborates on the need to organize regular field visits and to share information during the experimentation.
- Farmers will choose the specific type of experiment they want to conduct. As a rule, a farmer will not register for more than one type of experiment. If he/she is interested in several types of experiment, the facilitator will help them to make a priority choice.

11. Evaluation: the facilitator asks what the farmers appreciated (or did not appreciate), what they learnt, and what they intend to do with their newly obtained knowledge.

12. The facilitator asks volunteer farmers to conclude the session, and then invites farmers to the next session.

Time required

- Two to three hours

Materials required

- Strong packing paper and markers.
- Seed samples.
- Plate and cotton towel for germination test.

Box 5

The discussion on varieties and seeds in Bamoro is summed up as follows:

- Most farmers said they select part of their rice field that will be used for seed production to be used the following season. To select this part, they mainly rely on plant size: they normally prefer plants of a 'good height.'
- Other farmers (a minority) do not do that but they harvest all the paddy without distinction and keep part of the paddy, which will be used as seed the next season.
- The quantities kept as seed vary from 10 to 50 kg; whatever is not sowed will be consumed or sold.

Farmers explained that they normally do not renew their seed. Farmers change varieties when there is a higher demand for a new variety, i.e. the 'market' pays a better price for a certain variety. All farmers currently use Bouaké 189; some have been using this variety for 18 years, others for 3 years only; some farmers also buy seed when they consider that it is no longer of good quality or if conservation has not been adequate.

The discussion continued on seed conservation practices. The following techniques were mentioned for seed conservation: jars well covered and inside the house, bags hanging in the house, bags in the granary. Because of devastation caused by rats, sacks or jars are closed tightly. It is important to adequately dry the seeds before storing them, otherwise there is risk of mold and germination will be poor. Conservation in sacks is not considered good practice, because the risk of mold is too high; also, the rice at the bottom of the sack can heat up when seed is not properly dried.

- The question was asked as to whether farmers produce seed for others. Farmers said it could be a good idea to provide seed to farmers who failed to produce their own seed. However, farmers do not think of ordering seeds beforehand (the idea of a seed purchase arrangement with a seed producer did not attract them and purchase is clearly a last resort when personal seed production has failed).
- Presently, Bouaké 189 in particular, is cultivated. There are a few farmers who tried or who still cultivate small quantities of WITA 1, 3, 7, 8, 9 and 12 and Tox 31. The 'old' varieties that were cultivated before, such as IR5, Omaroso, Malodjan, Djouknin and Gambiaka, have a longer cycle than Bouaké 189. Growing Bouaké 189 means that a farmer can in principle grow two rice crops on the same field in a year if water is available. Farmers especially appreciate Bouaké 189 for its high yield, medium duration, resistance to diseases, adequate tillering and good resistance to iron toxicity.

Planning good crop-management practices

To apply good crop-management practices, it is necessary to know the various development stages and phases of the rice plant (Reference 8). For example, to know the appropriate transplanting time, it is important to know when the rice plant starts developing tillers and for how long. When transplanting is late, a good part of the tillering potential can be lost. Plant development also determines the 'right' time for weeding and fertilizer applications. This module deals with the links between plant growth stages and the appropriate timing of crop management practices. This module also links to References 6, 7 and 11.

Learning objectives

At the end of this session farmers will:

- Have an overview of the rice-plant developmental stages.
- Have a good knowledge of the critical stages in plant development, i.e. tillering, panicle initiation and flowering.
- Know the optimal management practices to be carried out at the different developmental stages, i.e. transplanting, weed control, fertilizer application and water management.

❶ Introduce the materials (e.g. cotton cloth, figures) and the principles used for constructing the calendar.

❷ Picture the rice-plant development cycle:
- Start with extreme stages—seed and rice plant at the maturity phase;
- Introduce successively the following stages: flowering, booting, panicle initiation, then seed germination, four-leaf, tillering initiation and maximum tillering stages;
- Introduce the three plant development phases;
- Make a metaphor with the construction and filling of a grain store.

❸ Develop the cropping calendar with a few representative farmers:
- Start with the extreme stages—nursery sowing and rice harvesting;
- Then introduce successively the following practices: transplanting, weed control and fertilizer application.

❹ Discuss the appropriate crop management practices, in particular timely transplanting, weed control and timely fertilizer application.

Procedure

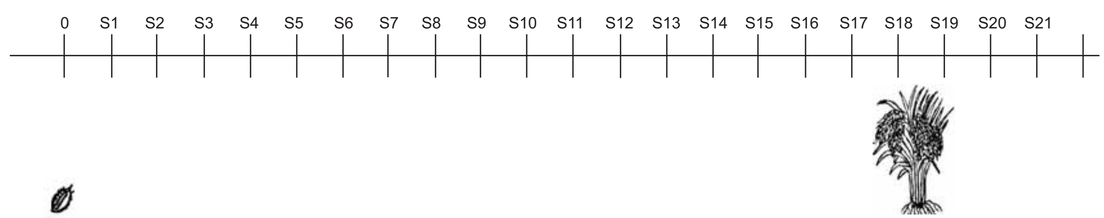
1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator briefly reviews the previous module and invites farmers' feedback.

2. One of the PLAR-IRM team members explains the learning objectives and procedures for the current module.

3. The facilitator displays a piece of cotton cloth with a horizontal line in the middle, graduated into 21 weeks of 7 days each and he/she explains that time is represented on the horizontal line. The facilitator explains that *below* the line, small 'figures' will be placed to represent the plant development stages and that *above* the line; figures will represent the major management practices[1].

4. First, the rice-plant development cycle is discussed using plants of different ages taken from the field and figures, which will be placed below the timeline:
   - The facilitator first shows the seed and the figure that represents the rice seed and explains that this rice development stage corresponds to point 0 on the timeline and that it is also the time for *nursery sowing*. The facilitator places the figure at point 0 below the timeline.
   - Then farmers discuss about the duration of the cropping cycle (in days or weeks) of the commonly grown lowland rice variety in the area. The facilitator presents a plant at maturity stage and the figure of the rice plant at *maturity*, and invites a volunteer farmer to put that figure at the week on the calendar corresponding to the duration of the rice cycle (below the line), i.e. the period coinciding, in general, with the harvesting time.
   - Then, the facilitator asks farmers about the stage prior to 'maturity' and thus presents the *flowering* stage, which usually takes place some four weeks before maturity. The facilitator shows a plant at the flowering stage and leads the discussion on the period between the

Step 1: Beginning and end of plant development cycle of rice



1. To efficiently 'set' the schedule with farmers, the facilitator must have some knowledge of the duration of the seedling (seed) development cycle up to the maturity stage for the most common variety.

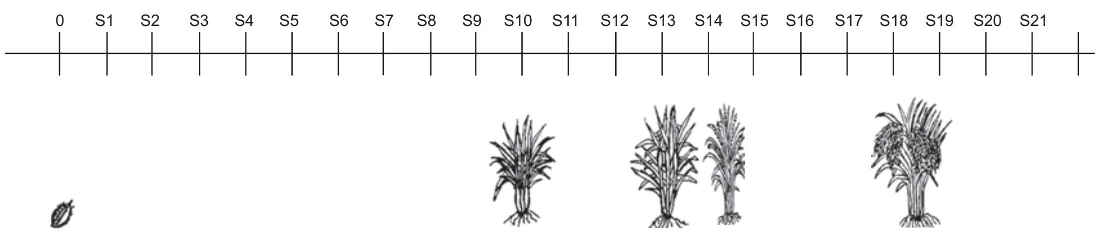
flowering and maturity stages and invites a volunteer farmer to identify the corresponding figure and to fix it on the calendar in the appropriate place below the timeline.

- Afterwards, the stage prior to flowering is introduced, i.e. *heading* stage. The facilitator shows a plant at heading; leads the discussion and invites a volunteer farmer to identify the corresponding figure and to fix it on the calendar below the timeline, i.e. about a week before flowering.

> Between panicle initiation and heading, the panicle is developing in the tiller, a stage that is referred to as booting.' Farmers usually know this stage and often call it 'pregnancy'; they generally know that the swelling of the leaf sheath contains the panicle that comes out shortly before flowering, a stage that is called 'heading.'

- Then, the *panicle initiation* stage is introduced. The facilitator takes a plant at panicle initiation stage and opens the leaf sheath lengthwise right above the base node to show the 'whitish cone,' which is the beginning of the panicle. The facilitator asks farmers their opinion on the duration between this stage and flowering, and explains that panicle initiation starts some four weeks before flowering and the corresponding figure is placed at the right location on the calendar below the line.

Step 2: Further development of cycle, including flowering, booting and panicle initiation

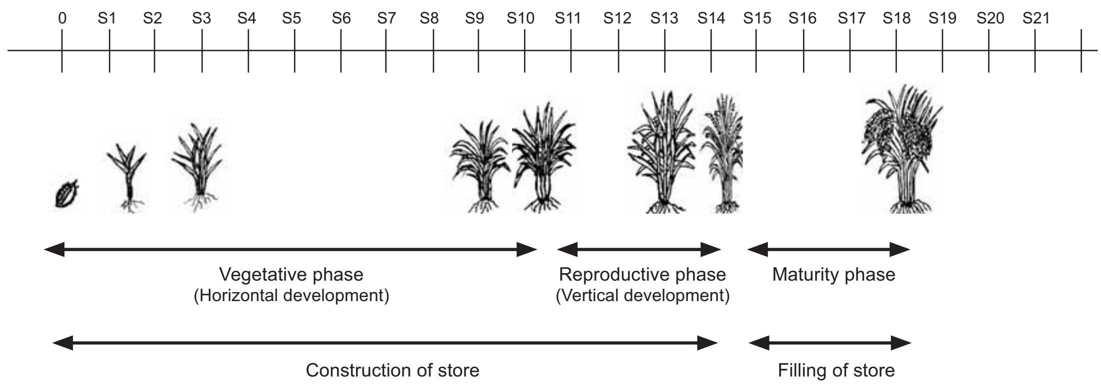


- Afterwards, the facilitator goes back to the first figure, i.e. 'the seed' and presents the stages of *seed germination* and *four-leaf seedling.* Farmers put the corresponding figures below the line, at locations corresponding to the stage after sowing.
- Then, the facilitator asks farmers about their knowledge of other development stages between 'four-leaf seedling' and 'panicle initiation,' and thus presents the phenomenon of *tillering initiation*. The facilitator asks farmers about the starting time of tillering. He/she shows a plant at tillering stage and the figure of tillering initiation is put at the corresponding location on the calendar below the line. Then, farmers discuss about the period when the tillering stage ends and the figure of *maximum tillering* is put at the corresponding location on the calendar below the line. He/she shows a plant during the maximum tillering stage.

> Farmers generally do not have a clear idea of the end of the tillering stage and may think that tillering can last until flowering. It is necessary to indicate that maximum tillering takes place just before panicle initiation. It can be useful to show a plant at maximum tillering stage and to indicate its age.

- After viewing the main plant development stages, the facilitator introduces the three development *phases*: the *vegetative phase* (sowing to panicle initiation), the *reproductive phase* (panicle initiation to flowering) and the *maturity phase* (flowering to maturity). The facilitator explains that the reproductive and maturity phases each last about one month. The vegetative phase lasts longer and is more variable depending on variety, sowing time and weather conditions. The facilitator explains to farmers that, as a 'rule of thumb,' only the duration of the vegetative phase varies in rice and accounts for the differences in growth cycle between varieties.

Step 3: Further development of cycle, including four-leaf stage, beginning of and maximum tillering

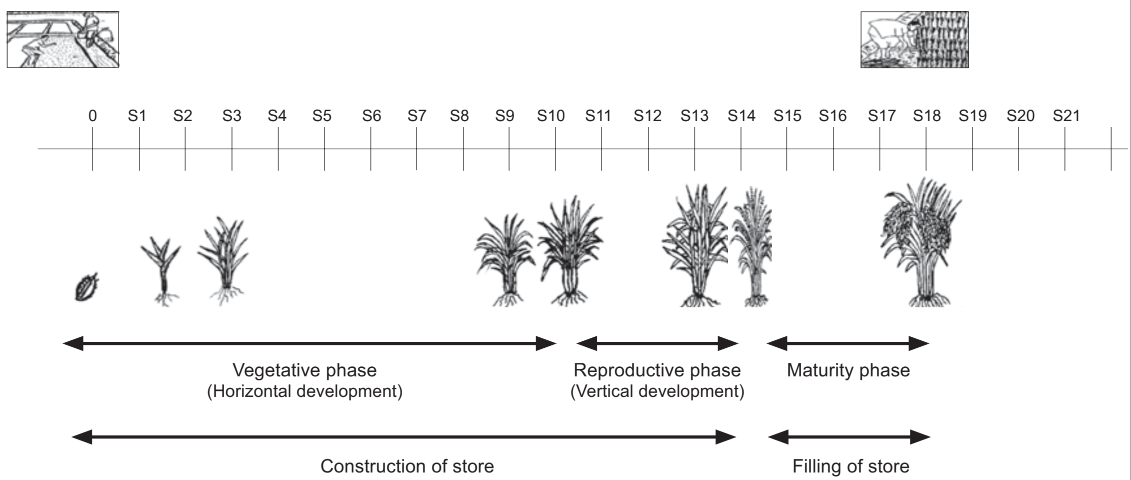


- Then the facilitator introduces a metaphor to compare the rice-plant development phases with the construction and filling of a grain store:
  - The vegetative and reproductive phases are compared to the construction of the store: the vegetative phase—which corresponds to the 'horizontal' development of the plant—is likened to the laying of the foundations for the grain store, and the reproductive phase—which corresponds to the 'vertical' development of the plant—is likened to the construction of the store walls and roof;
  - The maturity or grain-filling phase (when seeds are filled) is compared to the filling of the store;
  - The facilitator explains that it is important to build a store adequately, i.e. a well-built big store should stand on a solid foundation (vegetative phase) with adequate space inside, solid walls and roof (reproductive phase) that will allow the stockpiling of a lot of rice grains (maturity phase). If, on the contrary, the foundation and walls of the store are not well laid and raised, no matter what is done afterwards (i.e. after the vegetative and reproductive phases), there will never be a lot of space to store the rice.

5. Next, the crop management practices are displayed on the calendar by fixing the figures above the timeline. The facilitator can choose a few scenarios with farmers who have contrasting practices. The scenarios are addressed one after another:

   - The facilitator first takes the figures for *nursery sowing* and *rice harvesting* and invites one farmer to put them above the timeline.

Step 4: Visualizing farmer practices, beginning and end



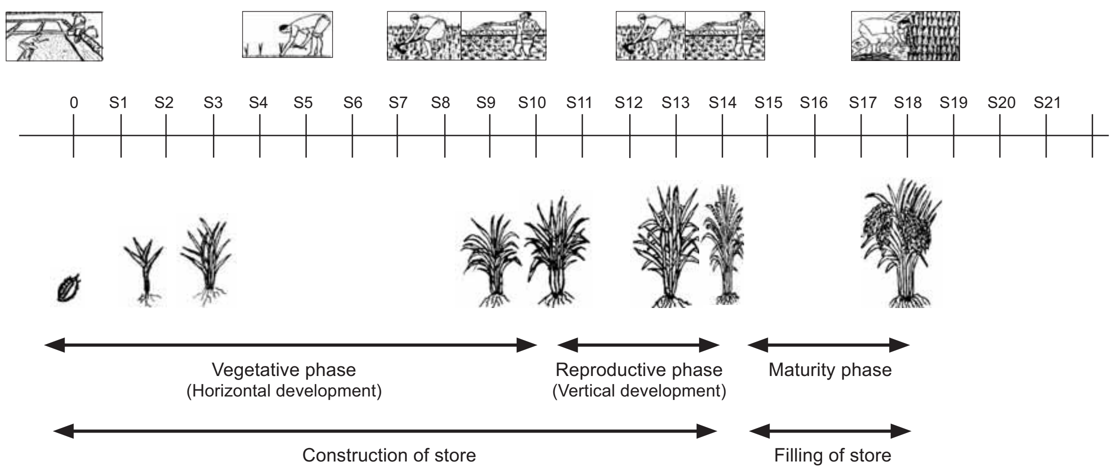
   - Afterwards, the facilitator shows the figure for *transplanting* and farmers discuss about the transplanting period. The farmer puts the figure at the location corresponding to the time when he/she transplants.

> It is very important to differentiate between what farmers know (consider as optimal) and what they actually do. Farmers often know the optimum transplanting period (2 to 3 weeks after sowing), but observations in the field will often show that only a few actually transplant at that time. At the beginning of the discussion, farmers may claim that they do everything the optimal way; however, it is obvious that in fact this seldom happens. The facilitator must then explain clearly the importance of presenting the field reality so as to discuss afterwards about the constraints that prevent them from applying optimal management practices.

   - Next, the facilitator addresses weed management practices. The facilitator leads the debate, asking the following questions:
     - why is it important to weed? Think of competition for light, water and nutrients, the air circulation, hindrance to tillering, accumulation of heat—weeds are often more competitive than rice plants,
     - what are the indicators for weed control? How are weeds controlled: through herbicide application, manual and mechanical weeding; when are these activities conducted and why at these specific moments? Are there constraints to their implementation?

- Farmers are invited to place the figures for *manual weeding*, *chemical weed control*, *mechanical weed control, mineral fertilization*, and *organic manuring*. It is important that the farmer represents his or her own management practices and does not represent an 'ideal' scenario.
- The facilitator addresses fertilizer practices in rice cultivation. The facilitator leads the discussion using the following questions:
  - why is it important to fertilize rice? Think of the nutrient requirements,
  - what are the indicators that the plant should be 'fed'? Which types of mineral or organic fertilizers are used? When are they used and why are these activities conducted at those stages? Are there any constraints to optimal fertilizer application?
- The farmer is invited to put the figures for fertilizer application at the appropriate locations on the calendar, on the same line as the figures for weed control.

Step 5: Further developing the cropping calendar, including transplanting, weed management and fertilizer application



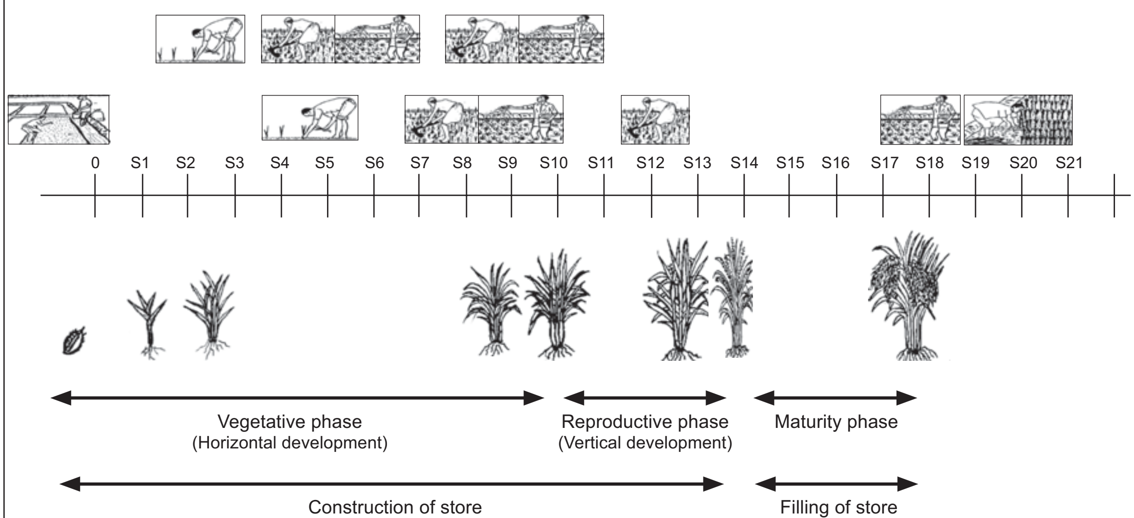
6. Discussion of appropriate practices necessary to allow the rice plant to develop well (vegetative and reproductive phases):
   - Timely transplanting: when the seedling has four leaves and before tillering; on the calendar, this means 2 to 3 weeks after sowing:
     - On a point above the lines on which farmers indicate practices, the figure for transplanting (usually in a different color from the one representing farmer practices) is put at the appropriate location (i.e. two to three weeks after sowing);
     - Farmers discuss factors preventing them from transplanting on time; this can highlight a need to design a specific module focusing on these topics.

Transplanting is stressful to the plant—the plant will experience a 'transplanting shock,' which usually lasts for at least four days; during that period, the young plant must produce new roots to settle in the soil—the younger the plant at transplanting the better its ability to withstand transplanting shock, because it will require fewer roots to settle. An older plant has a lot of roots that are going to die after transplanting and a lot of new roots are needed for an older plant to recover from transplanting shock (a comparison can be made with someone who breaks his leg: a young person will recover more quickly than an older person).

Given that the tillering period is restricted to the vegetative phase, everything should be done so that the plant can grow normally and in a condition to produce tillers; this is not possible in the nursery because there is not enough space. When transplanting is carried out late, there is little time for the plant to produce enough tillers. For example, if transplanting is carried out at six weeks after seeding and given that the plant requires almost a week to recover from shock after transplanting, there would be only two weeks left to produce tillers[2]; it will not be a surprise if such plants develop only a few tillers.

Late transplanting is often associated with organizational issues. For instance, when water management is an issue, farmers can be prevented from transplanting young seedlings because of the risk of flooding. Improving the water distribution (irrigation and drainage) system can solve part of the issue. This requires cooperation among the farmers or within the local organization. Similarly, the problem of timely land preparation may be the issue. This may be due to poor organization to arrange timely arrival of the land-preparation equipment.

Step 6: Elaboration of cropping calendar with appropriate practices

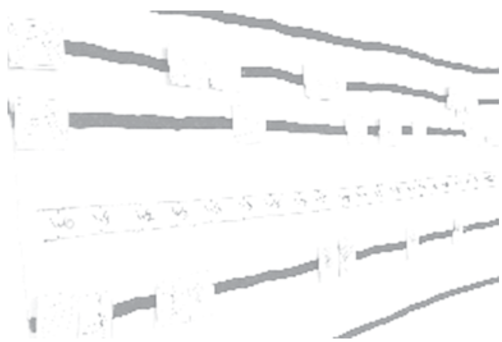


2. In this example, the period between sowing and panicle initiation was estimated at nine weeks.

- Weed control and fertilizer application:[3] The following topics are addressed:
  - the importance of regularly inspecting the field,
  - the most harmful period for weed infestation—note that weeds can especially be detrimental during the tillering stage,
  - the importance of removing weed spikes after rice flowering so as to avoid weed seeds falling to the ground and causing more problems in the future,
  - the period of fertilizer application (just after weeding). Otherwise, fertilization has little or no effect on rice growth. The most important nutrient for rice is nitrogen (N), which is very water-soluble and therefore lost quickly through leaching or volatilization (gaseous losses to the air),
  - there are two important times for urea (N) application: after weed control (i.e. 3 to 4 weeks after transplanting) and at the beginning of panicle initiation (7 to 8 weeks after transplanting),
  - applying fertilizer after flowering will often be a waste,
  - fertilizer application during or before it rains should be avoided, because the fertilizer can be washed away by water;
- Above the lines that indicate farmer practices, fix figures for weed control and fertilizer application (in a different color from those representing farmer practices) at the appropriate spots;
- Farmers discuss the factors that prevent them from controlling weeds and applying fertilizers in a timely manner.

7. Evaluation: the facilitator asks what the farmers appreciated (or did not appreciate), what they learnt, and what they intend to do with their newly obtained knowledge.

8. The facilitator asks volunteer farmers to conclude the session, and then invites farmers to the next session.



3. There are specific modules focusing on soil fertility and weed control.

Time required

- Three hours

Materials required

- Cotton fabric to represent the schedule.
- Figures.
- Markers of several colors.
- Rice plants at various development stages.

Box 6

After a detailed discussion of the cropping calendar with farmers from Bamoro, we asked them what should be done to build a good 'grain store':

- Farmers said that a good location should be found for the nursery, and that appropriate land preparation and seed priming (Module 5) are necessary. (There will be a specific session on nursery establishment.)
- Thereafter, the discussion focused on transplanting in relation to the tillering period. Farmers were familiar with the idea of transplanting at more than 30 days after sowing, but admitted that this was more a wish than reality. In fact, transplanting was often conducted at 50 or even 60 days after seeding. The ideal is between 15 and 20 days, but farmers knew that this is difficult in their lowland with poor water management, because the young seedlings may be submerged. The following elements were discussed in relation to transplanting at 20 to 30 days after sowing:
  - Transplanting gives a shock to the seedlings, lasting for at least four days; during this period, the young seedling must produce new roots to re-anchor in the soil—a younger plant will withstand this transplanting shock better than an older plant, because it will need to produce fewer roots to become secure in the soil. On the other hand, an old plant has a lot of roots that are going to die after transplanting and a lot of new roots are needed for it to recover from the shock (a comparison was made with someone who breaks his leg—a young person will recover more easily than an old person);
  - Because the tillering period is limited, everything should be done so that the plant grows normally to attain the best tillering conditions: adequate tillering is not possible in the nursery, because there is not enough space. When transplanting is conducted late, there is little time for the plant to produce enough tillers needed for a good grain yield; for example, if transplanting is conducted at 40 days and given that the plant needs almost five days to recover from stress after transplanting, there will be only 10 days left (days 45 to 55) to produce tillers, it will therefore not be a surprise that such a plant will produce only a few tillers.
- A third way of building a sound 'grain store' was discussed related to weeding and fertilizer application. Farmers first explained the reasons for timely weeding: allowing air movement between rice plants, avoiding rodents and pests, and ensuring tillering. They did not talk about competition for nutrients, water or sunlight. Weeds are often more efficient at capturing solar energy and extracting soil nutrients, to the detriment of rice plants. The following comparison was made: there are people who were not invited but who come to eat from your plate; in this case, there will be less for you. Farmers indicated that they start weed control about 20 days after transplanting, which corresponds to about 50 days after sowing, as they indicated that transplanting is conducted at 30 days.
- The discussion focused on the detrimental effect of weeds during tillering and panicle initiation until flowering.
- The case of *Echinochloa* was discussed—the importance of removing the spikes after rice flowering was stressed to avoid *Echinochloa* seeds shattering, causing more problems in the future.

Preparing the rice field

Appropriate land preparation is one of the key determinants of rice yield in inland-valley lowland rice production systems. Timely land preparation is crucial to avoid delays in crop establishment and to enable decomposition of organic material, such as crop residues and weeds. Land-leveling facilitates water management, reduces weed germination and increases the efficiency of mineral fertilizers. This module mainly deals with technical aspects of land preparation (Reference 12). The various steps in land preparation (from initial removal of weeds to land-leveling) require at least three weeks. It is, therefore, usually not possible to evaluate all these stages in the field during a single PLAR-IRM session. Module 9 will discuss time-management aspects of land preparation. The present module enables farmers to share experiences in field preparation, but does not include either a field demonstration or an evaluation.

❶ Start a discussion of farmers' experiences in field preparation.

❷ Go deeper into the subject by discussing the following aspects: cleaning-up, pre-irrigation, first tillage, flooding, basal fertilization application, second tillage, leveling, drainage, etc.

Learning objectives

At the end of this module, farmers will:

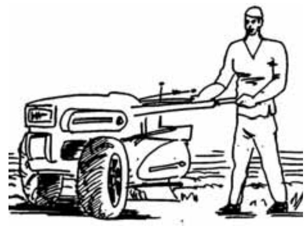
- Be aware of the importance of appropriate land preparation to integrated rice management and rice yield.
- Know the most important steps to be taken to ensure adequate land preparation.

Procedure

1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator briefly reviews the previous module and invites farmers' feedback.
2. One of the PLAR-IRM team members explains the learning objectives and procedures for the current module.
3. Discuss farmers' experiences in rice field preparation. The facilitator asks about any activities farmers carry out before sowing:
   - Which activities?
   - How are they implemented: timing and equipment used?
   - In what order?
4. The facilitator goes deeper into the subject by addressing the technical and practical aspects, the 'how,' time-management and 'objective' for carrying out the practices. Land preparation may include land-clearing, weeding, pre-irrigation, first and second plowing, and leveling.

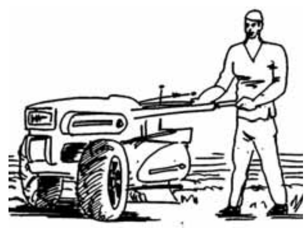
It is important to note that these are only options. Special attention must be given to differences between farmers. For instance, in undeveloped inland valleys, the option often chosen by farmers is zero-tillage—fields are cleared and flooded for one or two months before transplanting without plowing nor leveling. The following aspects of land preparation and their objectives can be discussed:

- Field clean-up: clear the field and place all tall vegetation on the bunds; cut and mix the smaller vegetation with crop residues and spread on the field.
- Pre-irrigation: the field is flooded during two to three days depending on soil type to:
  - soften the soil to facilitate tillage;
  - facilitate incorporation of crop residues and weeds;
  - kill or expel (chase away) insects that hide in the crop residues.



- First tillage to:
  - turn and loosen the soil;
  - incorporate rice straw and other plant residues to hasten their decomposition;
  - break-up soil clogs;
  - increase contact between soil and water.

- Flooding the field with about 10-cm layer of water for two to three weeks to:
  - kill insect pests that hide in weed and crop residues and in the soil;
  - decompose all plant residues;
  - allow weed seeds to germinate or rot.
  - Application of basal organic fertilizers:
  - organic fertilizers: domestic waste, manure, compost.



- Second land preparation to:
  - turn the soil and mix with water;
  - distribute decomposed organic residues;
  - remove germinated seeds;
  - puddle the soil to make leveling easier and to prepare a good bed for transplanting.

- Land-leveling, i.e. moving soil from the higher portions of the field towards the lower portions of the field to achieve even flood-water depth in the whole field.

- Drainage and possibly basal fertilizer application:
  - basal mineral fertilizer: phosphorous or compound fertilizers (Module 10).
- Transplanting seedlings or direct-seeding.

5. Evaluation: the facilitator asks what the farmers appreciated (or did not appreciate), what they learnt, and what they intend to do with their newly obtained knowledge.

6. The facilitator asks volunteer farmers to conclude the session, and then invites farmers to the next session.

Time required

- Two hours

Materials required

- If a field demonstration is planned, a power-tiller or rake may be required for the different steps in land preparation.

Box 7

Farmers and owners of power-tillers in the irrigated rice scheme of Lokakpli blame one another for the delays that are observed in land preparation. Farmers complained and accused the owners of the power-tillers of lack of cooperation. Power-tiller owners countered by saying that they refused to help many farmers because they did not settle debts accrued over the previous seasons. A report is given (below) of a meeting held between power-tiller owners and farmers of Lokakpli to illustrate this type of problem, which is relatively frequent, and the need to find workable solutions for both sides. Objectives of the meeting held in Lokakpli were to find solutions to the land-preparation issue raised by the two parties and improve the understanding between farmers and owners of power-tillers. The meeting also aimed at creating an organizational structure capable of resolving this type of problem in the future. The meeting started with each party telling its side of the story.

Issues emphasized by farmers

- Machine owners do not respect the tillage schedule or the terms of the agreement, and do not have a set work-plan or schedule for operating their machines. They may stop preparing a rice field to give priority to those who pay more or pay cash.
- Some farmers think that the number of power-tillers available (five) is too few for the size of the irrigation scheme (about 120 ha); they emphasized the lack of cooperation and coordination among machine owners and users.

Issues emphasized by machine owners

- Many farmers do not pay their debts accrued over the previous seasons.
- Many of their machines are old (17-years old for some) and due for replacement, but they cannot afford to replace them and, if farmers do not pay on time, the owners do not have enough cash to buy spare parts.
- The prices of fuel oil and spare parts have increased over the last year, but their fees per hectare did not change.
- Good mechanics for the machines are scarce and some spare parts cannot be found on the local market.

Possible solutions: Suggestions by machine owners

- The tillage fee per hectare should be raised from CFA 72,000 to CFA 80,000 with an advance of CFA 50,000.
- After the first land preparation, farmers should be obliged to flood their fields before the second land tillage.
- Farmers should not set up their nursery in the middle of their plot, because it obstructs the field-preparation work. Farmers should inform machine operators that they want a second field preparation at least three days before transplanting.
- Farmers should strive to clean up their fields of any weeds before requesting land tillage.

Farmers' response

- Farmers said that the 'perimeter' development project started badly. The coordinating agency, *Projet riz centre* (PRC), put farmers in debt from the beginning. They said that PRC charged up-front costs for initial land preparation, which many farmers are still repaying. For them, it is difficult to repay all debts at the same time.
- They added that in late 1999, the tillage costs per hectare was CFA 60,000, but that in 2000, the price increased up to CFA 72,000, which they consider too high. They finally accepted to pay that fee during the past year, hoping to receive a better service, but they were disappointed because instead of improvement, the machine owners have made things worse. They said that the amount of CFA 80,000 currently suggested is very high. (Owners explained that the costs of fuel, oil and spare parts had also increased.)

Tremendous efforts were made to help both parties agree and find an acceptable solution. Farmers finally agreed to pay CFA 80,000 for tillage (an amount suggested by machine owners), but only provided that the machine owners comply with their work schedule. The amount must be paid as follows: CFA 50,000 as an advance and the remainder at harvest. This means that the advance payment is CFA 25,000 for 0.5 ha and CFA 12,500 for 0.25 ha. The PLAR-IRM team suggested that the farmers set up a liaison committee to manage issues like this one. This committee will be responsible for (1) collecting money from farmers who want their fields to be tilled, (2) discussing with machine operators, (3) planning work according to the advance payments received, and (4) ensuring that work is conducted adequately. Users (farmers) did not agree to set up such a committee because there are already several groups. Then, the suggestion was made for owners to set up a committee in order to better manage operations. It was agreed that the work and the money representing advance payments would be split among owners. Each power-tiller will be used for one block of fields before moving onto the next block, i.e. each block will have one power-tiller dedicated to it and that block will be completed before the power-tiller is moved to another block, rather than power-tillers being moved around the blocks and fields in an ad-hoc fashion. Then, a few farmers were chosen to represent the users of machines in a larger committee in charge of defining the terms of agreement between owners and users, with the support of the PLAR-IRM team.

Establishing a nursery

A nursery that has been carefully established will produce uniform and vigorous rice seedlings that can be uprooted easily for transplanting (Reference 13). This module deals mainly with the technical aspects of establishing a good nursery. It is strongly recommended that a practical session in the field be included. Note that the planning of all field preparations, including seedling-nursery establishment will be addressed in Module 9.

❶ Summarize notions of quality seeds.
❷ Discuss farmers' current practices in nursery establishment and give advice if necessary.
❸ Observe farmer practices and demonstrate how to lay out a nursery.

Learning objectives

At the end of this module, farmers will:

- Be able to understand how to establish a good nursery and produce high-quality seedlings (vigorous, hardy stem, green, adequate root development, etc.).
- Be able to establish rice nurseries according to the land area to be transplanted.
- Choose a suitable location within their fields for volunteer farmers to set up a nursery for the varietal selection experiment (Module 5).

Procedure

1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator briefly reviews the previous module and invites farmers' feedback.

2. One of the PLAR-IRM team members explains the learning objectives and procedures for the current module.

3. Review of farmers' notions of quality seed (Module 5):
   - Farmers are invited to list the characteristics of good-quality seeds. If necessary, the facilitator adds aspects of homogeneous shape and color, purity versus contaminated seeds.
   - The facilitator summarizes the importance of conducting a germination test before sowing. Experienced farmers are invited to explain how they carry out germination tests.
   - Farmers summarize their seed-priming practices and the facilitator highlights the importance of seed priming, if necessary (Reference 13).

4. Discussion of different farmers' practices for laying out nursery beds. The facilitator addresses the topics below through questions on farmer experience. Care should be taken to adequately cover the various experiences and practices that exist among farmers, by asking whether there are farmers who have a different opinion or other experiences or practices. The facilitator should ensure that farmers explain why they have a certain opinion or practices.

- Site selection:
  - the facilitator introduces the following elements:
  - the site can be in the valley bottom, hydromorphic zone or uplands—consider aspects of drainage, irrigation, protection against theft, distance between the nursery and the transplanting area, etc.,
  - protection against predators,
  - shading by large trees and their effects on plant vigor,
  - soil type and consequences on plant vigor, ease of uprooting the seedlings, etc.

> If necessary, the facilitator pays special attention to the following aspects:the requirements for sunlight, water, air and good soil to produce healthy seedlings.

- Seedbed laying out and sowing: The facilitator introduces the following notions:
  - seedbed length, width and height,
  - seedbed position in relationship to the slope,
  - leveling: horizontal level of the seedbed,
  - texture of the topsoil,
  - sowing option: broadcast, in rows; wet or dry seeding,
  - seedbed covering and protection.

> If necessary, the facilitator focuses on the so-called 'standard' bed area to calculate the total requirement of nursery area, as well as on the need for homogeneous moisture distribution over the whole bed so as to ensure optimal and homogeneous germination.

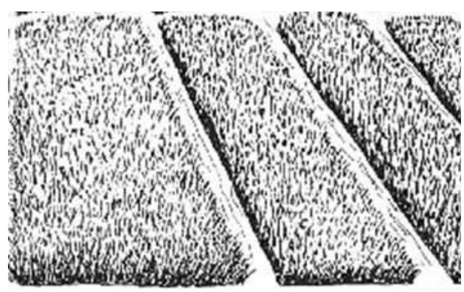
- The facilitator pays special attention on how to determine the quantity of seeds to sow and the nursery area based on the area to be transplanted (refer to Reference 16):
  - The facilitator asks farmers if they generally produce too many, not enough or just enough seedlings. Farmers share their experience in estimating the seed quantity used and the nursery area based on the area to transplant;
  - On a large sheet, a three-column table is drawn with these headings: area to transplant, nursery area, and seed quantity;
  - The facilitator invites a few volunteer farmers to give details on surface areas of their nursery beds and the quantity of seeds they use. In the first column, the surface area of the field to be transplanted is noted, followed by the nursery area and the quantity of seeds required;

Field area to be transplanted (m^2)	Nursery area to be established (m^2)	Quantity of seeds to be sown (kg)
1000	20	4
...	...	...
2500	50	10

- The facilitator introduces the idea of using a standard area for a nursery corresponding to a standard area to be transplanted—a nursery area of 50 m^2, using 10 kg of good-quality seeds can be used to transplant 2500 m^2;
- Farmers discuss the differences between farmer practices and 'standards,' and modify the table as necessary.

5. Farmers and the facilitator go to the field to observe and comment on farmers' practices in establishing a nursery. They also take part in the demonstration of actual nursery establishment. First, farmers observe and comment on an existing seedling nursery. The facilitator leads the discussion by addressing the following topics:

- The choice of location and conditions: light, space, protection, soil type.
- The position, shape and size of the seedbed.
- The texture of the topsoil of the seedbed.
- The quality of seeds used and the germination capacity.
- Establishment of a good seedbed. The key elements for the establishment of a good seedbed are addressed, namely:
  - The location and establishment conditions: flat ground next to a source of water and to the field to be transplanted;
  - Transplanting the bed: 1 m × 10 m; length perpendicular to the slope;
  - Digging drainage–irrigation furrows all around the area transplanted, and leveling the seedbed with the soil from the furrow;
  - Hand-tillage and turning of the soil with the hand-hoe. The bed is preferably raised by 5–10 cm. However, on heavier soils and when the land is well leveled, it is not necessary to raise the bed. In that case, the soil from digging the drainage–irrigation furrow is not placed on the bed but outside the bed, thereby constructing a small bund. The level of the bed should, however, be higher than the lowest level of the furrow to enable irrigation and drainage;
  - Puddling and leveling of the seedbed;
  - Broadcast sowing of primed seeds and light (gentle) compaction; to facilitate compaction it is recommended that the primed seeds are 'thrown' on the seedbed in such as way that they more or less stick to the soil and are therefore less likely to be washed away by irrigation water;



  - Covering of the seedbed with rice straw, topsoil, etc.;
  - Moisture conservation.[1]

6. The facilitator returns to the variety test (Module 5, Section 10). He/she specifies that farmers participating in this experimentation (i.e. the group of farmers conducting experiments) delimit part of the nursery bed for each variety tested. The farmer labels the varieties by putting the label tag in a plastic bag, which is tied to a stick beside each variety.

7. Back at the PLAR-IRM Center. Evaluation: the facilitator asks what the farmers appreciated (or did not appreciate), what they learnt, and what they intend to do with their newly obtained knowledge.

8. The facilitator asks volunteer farmers to conclude the session, and then invites farmers to the next session.

Time required

- Two–three hours

Materials required

- Flipchart pad and markers; shovel or hoe; rope and pegs.
- Two kilograms of primed rice seeds; rice straw.

Box 8

Farmers of Bamoro said that they generally produce too many seedlings. They concluded that, in fact, they use too many seeds. A key reason is that they did not know the quantity of seeds they should use in relation to the surface area to be transplanted. Moreover, farmers did not know the viability of their seeds because they did not generally conduct a germination test. They, therefore, compensated for possible inadequate germination by increasing the quantities of seed sown.

After the discussions, farmers—accompanied by the PLAR-IRM team—went to a selected site. Farmers were asked to make observations on a nursery already sown on that field. There were many problems with the seedbed: it was improperly made, oriented in the direction of the slope, and not quite uniform in width; one end was therefore drier than the other. Besides, seed distribution in the bed was not homogeneous. Seeds had been eaten by birds. The standard seedbed dimensions were not respected; the female farmer had made a nursery bed of 2 m × 6 m; furthermore, the seedbed was not high enough to protect plants in case of heavy rain.

After these observations, a demonstration was made of the establishment of a seedbed to serve as an example of how to make a good seedbed. With a one-meter stick, a bed was made of 1 m × 10 m and 15-cm height: higher to reduce risks of flooding, and narrower to make it potentially easier to water; primed seeds were sown and covered with a light layer of sand; the seedbed was also covered with straw for the first 5 days. The dimension of 10 m enables easily calculation of the number of nursery beds needed for the area of a given field. After demarcating the area of the seedbed, furrows were made around the seedbed. Next, grasses were removed and the seedbed was tilled with a hand-hoe, producing a loose topsoil layer.

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1. For one week after sowing, keep a 3–5 cm water layer.

Planning land preparation, nursery establishment and transplanting

This module is directly related to Modules 6, 7 and 8, and References 12, 13 and 16. It discusses the planning of land preparation, nursery establishment and transplanting. The various stages of planning of land preparation are addressed first (Module 7), followed by determination of the right times to establish a nursery (Module 8) and to transplant. This module completes the cropping calendar developed with farmers in Module 6. Also in this module, the idea of putting into practise any new techniques learnt during PLAR-IRM sessions is introduced. Farmers will identify a so-called *IRM field*, where they will practise any new techniques or knowledge acquired. Recording forms for the IRM field are also introduced.

❶ Summarize farmers' knowledge of land preparation for rice.

❷ Complete the cropping calendar developed in Module 6: visualize nursery seeding and transplanting, and other activities such as land cleaning and leveling, plowing, basal fertilizer application, flooding.

❸ Introduce the recording forms for the IRM field.

Learning objectives

At the end of this module, farmers will be able to:

- Plan all activities related to rice-field preparation.
- Determine the right moment to establish their nursery, on the basis of expected transplanting period, taking into account farmers' socio-economic environment and prevailing weather conditions.
- Fill in the first page of the PLAR-IRM recording form for the IRM field.

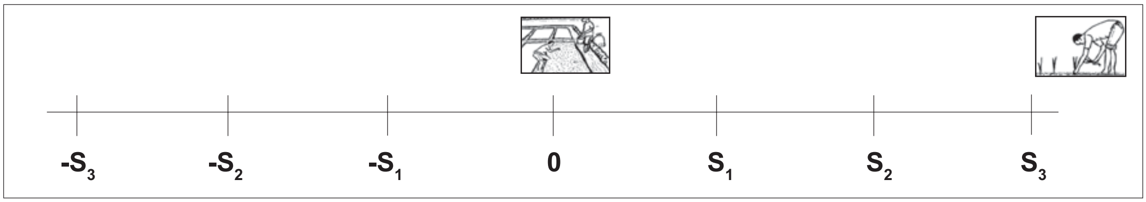
Procedure

1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator briefly reviews the previous module and invites farmers' feedback.

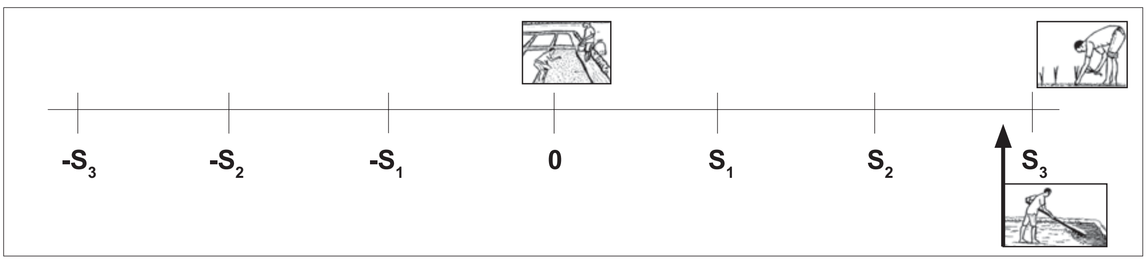
2. One of the PLAR-IRM team members explains the learning objectives and procedures for the current module.

3. Brief summary of the various activities in land preparation (Module 7). For each activity, the corresponding 'figure' is viewed: land clearing, initial flooding, tillage, basal fertilizer application, leveling, drainage.

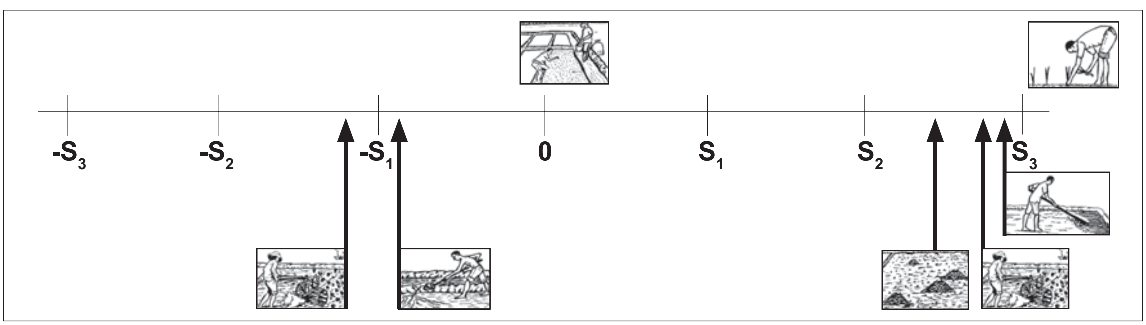
4. Establishment of a cropping calendar from land preparation to transplanting.
   - The facilitator displays a piece of cotton fabric that has a horizontal line in the middle, subdivided into four weeks with a mark in the middle with ‘**0**’ that indicates the seeding time in the nursery, a mark on the far left (**-S$_3$**) that indicates three weeks before sowing, and a mark on the far right (**S$_3$**) that indicates three weeks after sowing, which corresponds to transplanting time. The facilitator places the figures for seeding and transplanting.



   - The facilitator explains that, during this session, the figures representing the main field preparation activities will be placed first.
   - The facilitator asks farmers what activity they carry out right before transplanting and invites a volunteer farmer to place the corresponding figure below the line, at the right location in relation to transplanting.



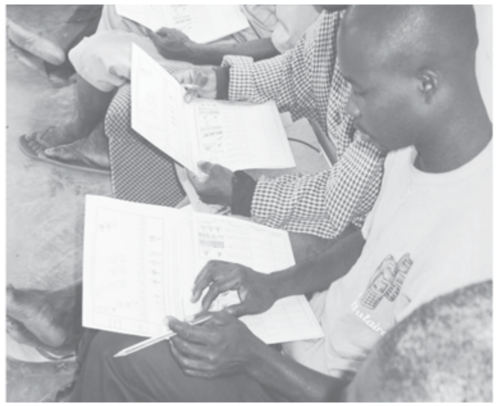
   - Farmers discuss the time of the various activities and put the corresponding figures on the calendar according to the time of their implementation.



- The facilitator helps farmers to agree on the optimal timing and on the time limits between activities according to the knowledge acquired in Module 7, to:
  - Reduce the negative effects of insect pests;
  - Enable weed and crop residues to decompose and restrict weed infestation;
  - Prepare a good soil bed for transplanting.

5. The facilitator then introduces the recording form for the IRM field (Annex 1) and explains in depth the first and second pages of the form.

   - The facilitator gives each farmer a recording form and explains that the purpose of this form is to help farmers to record their planned activities, monitor the implementation of those activities, and to make some specific observations during the cropping season. This module focuses on the recording of planned activities: what does the farmer plan to do and when?



   - The facilitator explains that the recording form is not used for all rice fields cultivated by a farmers, but only for the IRM field; each farmer, therefore, needs to identify a specific field where she/he intends to put the knowledge acquired during the PLAR-IRM sessions into practice; this field is referred to as the 'IRM field.' Clearly, farmers should not confine themselves to that field for the application of IRM practices. If they want, they can apply IRM practices on other rice fields. However, only the information related to the IRM field should be entered on the recording form. The farmer is invited to make a sketch of the IRM field on the first page of the recording form, showing a few reference points.
   - The facilitator then explains the various sections of the second page of the form, which aims to train farmers to visualize the planned practices for integrated rice management:
     - First the calendar time-line that is split into months and weeks;
     - Then, the figures that are found above the time-line.
   - The facilitator invites farmers to picture the time when they plan to implement an activity by putting an arrow from the figure to the time-line.
   - The facilitator invites a volunteer farmer to give an example of planning activities by proceeding step by step, as follows:
     - The farmer first determines the time when she/he plans to establish the nursery;
     - Then, the farmer pictures the planning of all activities to be implemented before transplanting by putting an arrow from the figures to the time-line. These activities are:

land clearing, initial land flooding, first tillage, second tillage, basal fertilizer application, and leveling and drainage;

– Afterwards, the farmer visualizes the planning of other management practices such as transplanting, herbicide application, fertilizer application, harvest, threshing/drying and storage.

- The facilitator invites each farmer to fill in the first and second pages of the recording form. PLAR-IRM members can help farmers to do this, if farmers request their help.
- The facilitator explains that farmers should bring the recording form to each PLAR-IRM session.

6. Evaluation: the facilitator asks what the farmers appreciated (or did not appreciate), what they learnt, and what they intend to do with their newly obtained knowledge.

7. The facilitator asks volunteer farmers to summarize and conclude the session, and then invites farmers to the next session.

Time required

- Three hours

Materials required

- Strong packing paper, markers.
- Cotton cloth for schedule and corresponding figurines.
- Recording forms for each farmer.
- Pencils for each farmer.

Box 9

In Bokakpli, during the session on time management before sowing, farmers discussed the reasons why there is an interval of two to three weeks between the first and second tillage. They said that it was necessary to: let weeds decompose, let weed seeds grow and uproot them afterwards, kill insects in the rice straw. During the second tillage, decomposed crop residues and weeds are distributed evenly and the field is puddled. In practice, there are many farmers who set up the nursery before the first tillage. Farmers understood that this is too early because the seedlings would then be too old at the time of transplanting.

Maintaining soil quality

To get a good yield, rice plants should be in good health. As the soil is the primary source of plant nutrients, the soil should also be in good health, i.e. it is important to maintain or improve soil quality. As we saw in Module 7, the soil has to be well prepared, but it is also important to ensure that the soil can provide all the nutrients the rice plants need (References 14 and 15).

Note: to simplify calculations of fertilizer needs in this module, all figures related to phosphorus (P) are expressed in reality in units of P_2O_5*, and all figures related to potassium (K) are expressed in reality in units of* K_2O*.*

Learning objectives

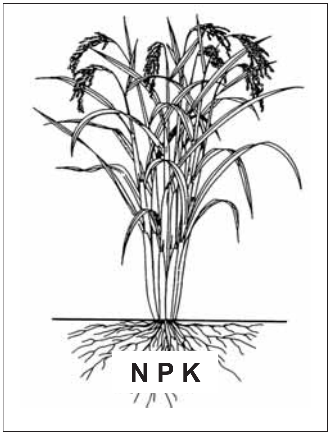
At the end of this module farmers will:

- Have exchanged their knowledge on what a good soil is.
- Have gained basic knowledge about plant nutrients:
  - The relative importance of the different nutrients;
  - Rice nutrient demand;
  - Nutrient uptake from the soil;
  - Nutrient inputs from organic amendments and mineral fertilizer.
- Be aware of nutrient fluxes in the soil.
- Be able to assess rice nutrient demand and corresponding fertilizer needs.
- Be able to recognize the importance of organic amendments.
- Decide on experiments aimed at improved soil-fertility management.

1. Appreciate farmers' perceptions on the concept of 'soil quality.'
2. Introduce basic ideas of plant nutrients.
3. Discuss the different types of mineral fertilizers and organic amendments.
4. Introduce fertilizer solubility.
5. Introduce fertilizer leaching.
6. Introduce the notions of potential yield, attainable yield, target yield and yield gaps.
7. Introduce the notion of nutrient-omission plots to estimate the soil's capacity to supply nitrogen (N), phosphorus (P) and potassium (K).
8. Estimate fertilizer needs to reach a target yield taking into account the soil's nutrient-supplying capacity.
9. Introduce experiments that focus on improving soil-fertility management.

Procedure

1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator briefly reviews the previous module and invites farmers' feedback.
2. One of the PLAR-IRM team members explains the learning objectives and procedures for the current module.
3. Discussions of farmers' perceptions of a good-quality soil capable of producing plants in good health. The facilitator introduces the discussion by addressing the following items:
   - What is a good-quality soil?
   - What does a plant need to develop well and protect itself against diseases?
   - What are the characteristics of a soil with a good nutrient-supplying capacity?
   - What do plants 'eat'?
   - How do they 'eat'?
   - What is the role of the roots and what is the relationship between root development, nutrient uptake of plants and rice development?
4. The facilitator introduces basic notions about plant nutrition:
   - Organic matter and mineral elements.
   - Decomposition of organic matter.
   - Nutrients in the soil solution.
   - The major nutrients for crop production: N, P and K.
   - Specific roles of these nutrients (N, P and K) in plant growth and development.
   - Soil nutrient reserves.
   - External nutrient inputs: organic and mineral fertilizers.



5. Discussion of the different types of mineral fertilizers.
   - Types of mineral fertilizers the farmers know, those available and those they use.
   - Single-component fertilizers and compound fertilizers, their nutrient composition; dosage of the nutrients; meaning of '%' and the real quantity of nutrients in fertilizer bags:

   Single-component fertilizer: there is only one nutrient in this type of fertilizer:
   – e.g. urea: contains only nitrogen,
   – e.g. TSP (triple super phosphate): contains only phosphorus;

   Compound fertilizers: there are several nutrients in this type of fertilizer:
   – e.g. NPK: contains nitrogen, phosphorus and potassium;

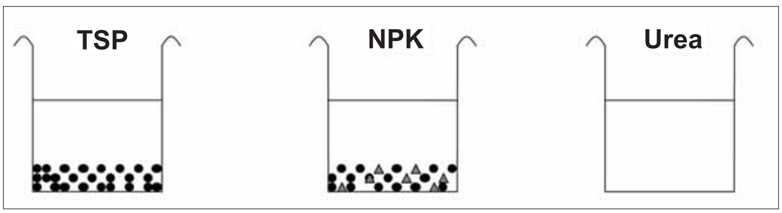
The nutrient content is usually expressed in percentage of N, P and K on the fertilizer bag:

- urea: '46% N' means that for every 100 kg of urea, there is 46 kg of nitrogen, the rest of the fertilizer is inert material,
- NPK is often 10-20-20 in Côte d'Ivoire (10% N, 20% P and 20% K)[1], which means that 100 kg of NPK contains 10 kg of nitrogen, 20 kg of phosphorus and 20 kg of potassium,
- TSP: '45% P' means that 100 kg of TSP contains 45 kg of phosphorus;

The quantities of nutrients in fertilizer bags:

- Urea: 100 kg of urea contains 46 kg of nitrogen, so a bag of 50 kg contains 23 kg of nitrogen,
- NPK: 100 kg NPK (10-20-20) contains 10 kg of nitrogen, 20 kg of phosphorus and 20 kg of potassium; so a bag of 50 kg NPK contains 5 kg of nitrogen, 10 kg of phosphorus and 10 kg of potassium.

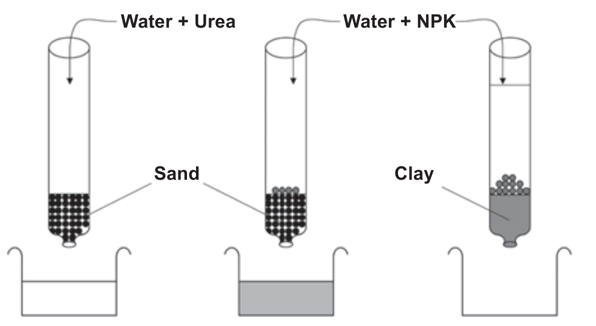
6. Solubility of fertilizer.
   - The facilitator demonstrates the solubility of different mineral fertilizers. She/he takes an equal quantity (e.g. 100 g) of three different types of fertilizers—urea, NPK (10-20-20) and TSP—and puts each in a different container. The same amount of water is added (e.g. 500 ml) and each container's contents are mixed. After five minutes, the farmers have a look and determine the level of solubility of the three types of fertilizer.



   - The facilitator introduces some notions of the consequences of solubility: absorption (uptake), mobility of nutrients and risks of losses due to leaching, i.e. the downward movement of water beyond the reach of the root zone.
7. Leaching of nutrients.
   - The facilitator demonstrates that nutrient leaching depends on the type of soil. She/he takes three empty water bottles from which the bottom has been removed and fills these with three different kinds of soil: two with sandy soil and one with clay soil. She/he then adds

1. Note that to simplify calculations P and K are used in the text instead of P_2O_5 and K_2O, respectively. However, the values used in the text are in reality expressed in units of P_2O_5 and K_2O.

water with dissolved urea to the first bottle filled with sand, and water with NPK to the second bottle (filled with sand) and the third bottle (filled with clay). Farmers observe the percolation of the solution in each of the three bottles (wait about 15 minutes).



- The facilitator talks about the necessity of dividing up urea inputs according to when the plant needs nitrogen most, i.e. at the start of tillering and at panicle initiation. This is particularly important for sandy soils. Phosphorus and K are usually applied as basal fertilizers, i.e. before or at transplanting or sowing.
- Next, the facilitator facilitates a discussion on the possibility of diminishing the effects of leaching by incorporating organic resources in the soil, e.g. decomposed rice straw.

8. The facilitator introduces the concept of potential yield and compares this with a 'yield ceiling'—the maximum yield that can be obtained with optimal integrated rice management (without pest and disease problems, nutrient deficiencies, etc.). She/he explains that, with good water management, this yield ceiling is only determined by climate (temperature and solar radiation). For undeveloped inland-valley lowlands without good water control, the yield potential is also a function of water availability during the season. The facilitator stimulates a discussion on the yield potential in farmers' fields. Are there any differences in terms of yield potential within the inland valley? Are there differences in terms of yield potential if a short- or medium-duration rice cultivar is used? For inland valleys where two crops of rice can be grown per year, it is important to talk about differences in yield potential between the growing seasons.

9. The facilitator introduces the notion of obtainable yield. She/he explains that it is not realistic to aim at attaining the potential yield. The obtainable yield is about 70 to 80% of the potential yield.

10. The facilitator introduces the concept of actual and target yields. She/he explains that farmers should go for a realistic target yield, that aims at obtaining a yield gain of between 0.5 and 1 t/ha compared to actual yield. With an example, she/he shows the three types of yield gap that exist (Reference 15): the yield gap between actual yield of a farmer and the yield obtained

by the best farmer (Yield gap 1); the yield gap between best farmer yield and attainable yield (Yield gap 2), and the yield gap between attainable yield and potential yield (Yield gap 3).

11. The facilitator introduces the concept of small (5 m × 5 m) nutrient-omission plots: zero-N, zero-P and zero-K mini-plots. Yields obtained on such plots can be used as a proxy for the capacity of the soil to supply nitrogen, phosphorus and potassium, respectively. Nutrient-omission plots should be installed at representative sites, where farmers expect to see a differences in terms of soil fertility (e.g. nutrient-omission plots should be installed on the major soil types, on sites that have been cultivated for a long time, and on sites that have been under fallow for a number of years).

12. The facilitator presents rice N, P and K needs to obtain a 1 t/ha increase in rice yield, while maintaining balanced nutrition: 15 kg of nitrogen, 6 kg of phosphorus and 18 kg of potassium (Reference 15).[2]

13. The facilitator discusses how to calculate fertilizer-nutrient needs, based on yields obtained in the zero-N, zero-P and zero-K plots, a target yield and balanced nutrition of 15 kg N, 6 kg P and 18 kg K to obtain a yield gain of 1 t/ha. The facilitator uses a recovery percentage of 30% for nitrogen and potassium and 20% for phosphorus. She/he can take the example used in Reference 15, but it is better to use data obtained from the field or to ask farmers to give estimations of yields obtained in the zero-N, zero-P and zero-K plots. Careful: the target yield should not be higher than attainable yield (i.e. 70 to 80% of potential yield) as nutrient needs to obtain a 1 t/ha yield gain increase rapidly above attainable yield.

14. The facilitator leads a debate on recovery rates used to calculate fertilizer needs. She/he makes a distinction between nitrogen, an nutrient that is very mobile, and potassium and phosphorus that are less mobile. She/he explains that there are often positive residual effects of P and K application in subsequent years. However, for nitrogen, losses are irreversible. She/he explains that it is, therefore, very important to try to increase the nitrogen recovery rate. She/he leads a debate on the importance of applying nitrogen fertilizer in several splits and on the importance of good crop management in general (Reference 15, Box 4).

15. The facilitator leads a debate on the nutrients that are exported from the farmer's field after harvest. She/he presents first the percentage of nitrogen, phosphorus and potassium in the rice plant at maturity in case of balanced nutrition (Reference 15):

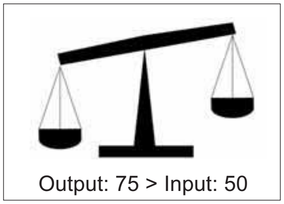
2. Note that to simplify calculations P and K are used in the text instead of P_2O_5 and K_2O, respectively. However, the values used in the text are in reality expressed in units of P_2O_5 and K_2O.

Nitrogen, phosphorus and potassium concentrations in rice grain and straw (%) in case of balanced nutrition

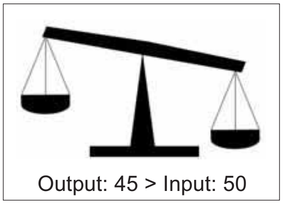
	Nitrogen	Phosphorus	Potassium
Grain	1.0	0.4	0.3
Straw	0.5	0.2	1.5
Total	1.5	0.6	1.8

- The facilitator first discusses nutrient exportation from the field. She/he explains that with rice harvest, the grain and a large portion of the straw produced are exported from the field, and with it a significant quantity of nutrients:
  - Laboratory analyses have shown that for a harvest of 5000 kg of paddy rice per hectare, about 50 kg of nitrogen, 30 kg of phosphorus and 15 kg of potassium are removed from the field with the grain harvest;
  - At the same time, a large fraction of the straw is removed as well. If all straw is removed, about 5000 kg of straw is produced, and this means that an additional 25 kg of nitrogen, 15 kg of phosphorus and 75 kg of potassium are removed from the field; this shows that rice straw contains a lot of potassium;
  - The total amounts of nutrients exported from a rice field with a yield of 5 t paddy/ha and 5 t straw/ha is, therefore, 75 kg of nitrogen, 45 kg of phosphorus and 90 kg of potassium.
- Next, it is possible to compare what is exported from the field with the harvest, and what has been brought in with fertilizers (for example, let us say 50 kg N/ha and 50 kg P/ha). We now can make a nutrient balance:

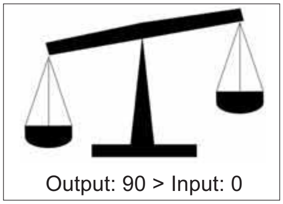
for nitrogen



for phosphorus



for potassium



Balance: –25 kg of nitrogen/ha: the soil N reserves decrease.

Balance: +5 kg of phosphorus/ha: the soil P reserves increase.

Balance: –90 kg of potassium/ha: the soil K reserves decrease.

- The facilitator stimulates a debate on the danger of 'mining' the soil's nutrient reserves. Often, zero-K plots will indicate that there is no need to apply potassium. In the long run, and if high yields are obtained and straw is removed from the field, this may not be sustainable and K-deficiency symptoms may start to appear. A maintenance application may, therefore, be needed to avoid mining of the soil's K reserves. Using organic amendments, such as compost, rice straw or manure, helps maintain soil fertility and the soil's nutrient reserves. The combined use of organic resources and mineral fertilizers increases the capacity of the soil to supply nutrients and may also increase the recovery rate of mineral fertilizer nutrients.

16. The facilitator leads a discussion on the possibility of running an experiment on fertilization (Reference 17).[3]
    - The farmers talk about the types of fertilizer they use, in what quantities per unit area, and the number of split applications per growing season.
    - The facilitator asks the farmers if they know and follow the recommendations (from the extension service) concerning the mineral fertilizer doses to apply:
    - In Côte d'Ivoire, the official recommendation for rice, over the whole country, is 200 kg NPK and 100 kg urea per ha.
    - The farmers discuss the recommended doses of N, P and K according to the extension service.
    - The facilitator introduces the idea of testing alternative doses, closer to the real nutrient requirements. To do this, it is necessary to know more about the soil fertility of the inland valley.[4]
    - With the facilitator, the farmers decide which alternative doses they want to test (treatments) in comparison with their own fertilizer practices and the recommended doses. The names of volunteer farmers are listed.
    - The farmers agree on the dimensions of the trial plots of the experimental design.
    - The field work will be done in Module 12.
17. Evaluation: the facilitator asks what the farmers appreciated (or did not appreciate), what they learnt, and what they intend to do with their newly obtained knowledge.
18. The facilitator concludes the session and invites the farmers to the next session.

3. This concerns farmers that have volunteered to do this type of experiment, it may be useful to have a special meeting with only these farmers.
4. If this is not the case, it is better to start with nutrient-omission trials to get an idea of the variability in terms of soil fertility in the inland-valley lowlands. The mini-plots need to be installed at representative sites where the farmers expect differences in terms of soil fertility (e.g. on the main soil types, on fields that have been cultivated for a long time, or have just been brought under cultivation). The following season these results can be used to test alternative soil-fertility management options.

Time required

- Three hours

Materials required

- Six empty mineral-water bottles:
  - 3 without bottoms, filled with soil: two with sandy soil and one with clay soil;
  - 3 with cut tops, serving as holders for the 3 filled with soil samples.
- 100 g of different fertilizers: NPK, urea, TSP, etc.
- A container for water.
- Strong packing paper, markers.

Box 10

The farmers in Bamoro decided to compare the dose recommended by the extension service (200 kg 10-20-20 and 100 kg of urea/ha) with several alternative doses.

- The farmers became aware that the recommended dose contains relatively little N, but a lot of P and K (i.e. 66 kg N, 40 kg P and 40 kg K).
- As a first alternative they wanted to invert the NPK and urea dosage: 100 kg of 10-20-20 and 200 kg of urea per hectare; that is 102 kg N, 20 kg P and 20 kg K per hectare, thus a higher dose of N (considering the potential losses of this nutrient that is easily leached), and less P and K.
- The farmers also wanted to test if P and K application is really necessary; so another alternative was proposed: applying only urea at 200 kg/ha.

Making field observations: Preparing the field and establishing the nursery

This module is the first of a set of four modules on 'formal' field observations to be made during the course of the whole curriculum; Modules 14, 18 and 23 will later complement this module.[1] The main objective of the PLAR-IRM Center is to learn new techniques and alternative management practices for integrated rice management. One of the methods used for learning in the PLAR-IRM Center is the field application of new techniques acquired during the PLAR-IRM sessions. Because these techniques are often new, farmers are advised to limit the field application of these new techniques to a specific plot, surrounded by bunds, during the first year. This will enable better comparison of performance with other fields (managed using farmers' normal techniques) and evaluation of whether the new techniques are indeed more effective. Therefore, each member of the PLAR-IRM Center will identify one bunded plot in his/her field, in which the new ideas will be put into practise. In this plot, he/she will implement some of the new techniques learnt during the PLAR-IRM sessions. Since the step-wise introduction of alternative crop management options is the basis of 'Integrated Rice Management,' this plot is called the 'IRM field' (*see* Module 9, in which the principles of the IRM field were introduced).

❶ Discuss what kind of observations farmers make when they are in the rice field.

❷ Introduce the notion of 'observation indicator.'

❸ Give examples of the importance of making valuable observations, which help in accurate analysis and decision-making.

❹ Visit the field to make observations on two fields at crop-establishment stage and on two seedling nurseries.

❺ Synthesize the results of the observations in plenary session.

❻ Continue to fill in the recording form for the IRM field.

Learning objectives

At the end of this module, farmers will be able to:

- Exchange their experiences and practical observations about crop management practices and environmental factors observed on the field.
- Review the importance of regular field observations, and their usefulness in the analyses of the health of the crop and environmental factors so as to take decisions for appropriate action.
- Decide which observations to make and what indicators to observe; in this case, specific indicators related to field preparation and nursery establishment are to be defined.
- Record the information from field observations.

1. Modules 19 and 24 also focus on field observations; however, they specifically concern the farmers' experimentation plots.

1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator briefly reviews the previous module and invites farmers' feedback.

2. One of the PLAR-IRM team members explains the learning objectives and procedures for the current module.

3. The facilitator encourages discussion on the meaning of observation, the types of observations farmers make in their fields, of the crop and its environment. The following topics are addressed:
   - What is: 'Making observations'?
   - Why do we make observations? Why is it necessary (or not) to make observations?
   - How do we make observations?
   - What are the points of reference when making observations?
   - How frequently should observations be made?
   - Are some periods of the year/cycle more important than others for making observations?
   - Is it useful to record what has been observed?
   - How should observations be used or what is the usefulness of what we observe?

4. The facilitator explains the importance of observing and introduces the notion of 'observation indicator.'

   - Making regular observations in the field is one of the major tools of the PLAR-IRM approach. The facilitator explains that in the following weeks a lot of observations will be made. Making observations will allow the farmer to verify whether the work has been done well, whether plant development is satisfactory, and whether insects or diseases are threatening the plants.
   - It is important to make valuable observations and, to do so, one has to be aware of what to observe. The elements to observe will be called 'observation indicators.' An indicator is a sign one observes in and around the rice field, it characterizes, e.g. the 'good health' of the plant or of the field. 'To observe' means that one watches certain phenomena very carefully, such as the state of the field or the growth and health of the plant:

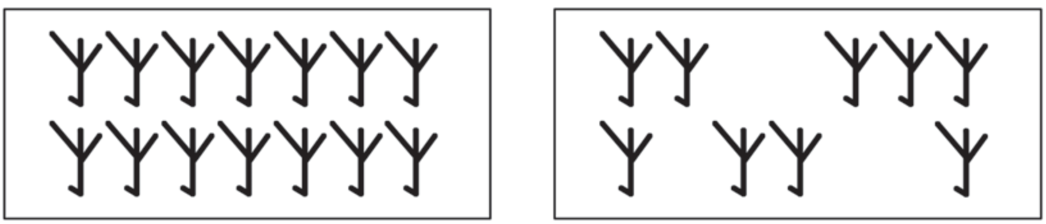
     – The facilitator invites the farmers to give some examples of indicators;
     – If necessary, he/she explains that it is something that will be 'observable' in the field, i.e. that can be seen with the naked eye;
     – The facilitator gives some examples, e.g. 'a completely flooded field.' We learnt in one of the previous modules that it is important to have a

completely flooded field to ensure total decomposition of crop residues and weeds so as to avoid early weed re-growth after transplanting. Now, a 'completely flooded field' is an easily observable indicator. On the contrary 'poor land-leveling' is not an observation indicator when the field is flooded, as land-leveling was done in the past. However, 'the quality of land-leveling' can be a factor *explaining* why a rice field is not completely flooded;

– It is very important for the farmers to understand exactly what an observation indicator is. Consequently, it is necessary to define the word 'indicator' in the local language. For instance, in Baoulé the word for indicator is *N'Zolié*;
– Factors or reasons for the 'poor state of health' of crops in any field can be associated with the management practices, or with the environmental conditions. In our example, poor tillage is a management practice;
– The main objective for making and analyzing observations is to take appropriate decisions for action to correct the situation or to prevent the re-occurrence of the phenomenon.

5. The facilitator gives an example showing the importance of good observations, allowing accurate analysis and appropriate decision-making.

- The facilitator shows a drawing of two nurseries and invites the farmers to make observations:

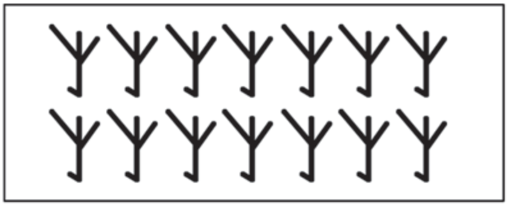


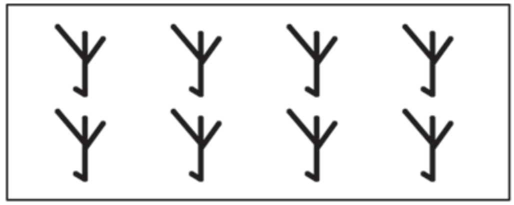
The facilitator makes sure that the farmers see that the nursery on the right has areas with a lot of seedlings and others without seedlings, i.e. density is heterogeneous;in the nursery on the left, seedling density is uniform.

- Subsequently, the farmers will be asked to suggest and analyze what factors might have caused 'heterogeneous density' in the nursery on the right or, otherwise said, what are the reasons for some areas growing many seedlings and others only a few.

t is pssible that in the areas with few seedlings there had been waterlogging, which killed the seedlings. Waterlog-ging can be due to poor field-leveling, which is a farmer management practice. Apart from management practices, waterlogging can also be caused by environmental conditions like heavy and continuous rain.

- Then, the farmers discuss options to avoid this problem.





- Next, the facilitator shows two other nurseries to be compared and invites the farmers to make observations.

> The facilitator makes sure that the farmers see (observe) that in the right nursery there are fewer seedlings than in the left nursery (there is a difference in density), but that the distribution of the seedlings is homogeneous in both nurseries.

- Afterwards, the farmers are invited to analyze their observations: which factors could explain that there is an area with a lot of seedlings and another with fewer?

> It is possible that the seed used in the second nursery was of poor quality.

- Then, the farmers say what they can do to avoid this problem.
- Comparing these two examples should demonstrate the importance of making good observations.

6. The facilitator explains that, in this module, observations will focus on field preparation, nursery establishment and seedling transplanting. In a few weeks, observations will be made on the next development stages of the plant.

7. The facilitator presents the field-observation *procedure*.
   - The farmers are divided into four sub-groups of four or five farmers each.
   - A farmer-facilitator and a farmer-rapporteur are chosen for each sub-group.
   - Each farmer sub-group visits four sites:[2]
     – Two sites in an advanced stage of field preparation—if possible one field in 'optimum' condition and another in 'poor' (less-than-optimum) condition;
     – Two other sites with established nurseries—if possible one with poor emergence of seedlings and the other with good emergence.
   - Each sub-group makes field observations—the farmers decide which indicators are important for them to observe, allowing them to judge field conditions and plant health.
   - Observations are discussed and analyzed within sub-groups, the farmers trying to establish the links between the indicators (what is seen) and environmental factors and farmers' management practices.

2. The observation sites will have to be prepared in advance by the team of facilitators.

8. The sub-groups of farmers and the facilitators go to the field. In turn they visit the four observation sites previously identified by the facilitators.
   - The facilitator helps the farmer-facilitator if necessary.[3]
   - The farmer-rapporteur takes notes.
9. Back at the PLAR-IRM Center, the farmers report and comment on their results:
   - The farmer-rapporteur of the first sub-group presents the results of the first observation site, 'Field preparation: Field 1.'
   - The facilitator synthesizes the results in the four-column table, in the row 'Field 1' (see below).
   - Afterwards, farmer-rapporteurs of other sub-groups 'complete' the first sub-group's report by adding comments from their sub-groups that were not mentioned by the first sub-group, and the facilitator summarizes these in the table.

Stage of observation	Observation indicators	Analysis	Decisions to be made
Field preparation			
Field 1			
Field 2			
Nursery establishment			
Nursery 1			
Nursery 2			

   - Then the farmer-rapporteur of the second sub-group presents the results of the second observation site, 'Field preparation: Field 2.'
   - The facilitator synthesizes the results in the row 'Field 2.'
   - Then, he/she invites the farmer-rapporteurs of the other sub-groups to complete the table.
   - And so on for 'Nursery establishment: Nurseries 1 and 2.'

Discussion about the IRM plots of each farmer

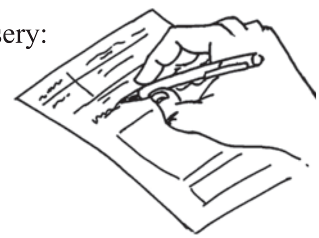
10. The facilitator asks how the farmers managed to fill in pages 1 and 2 of the recording form of the IRM field (Module 9):
    - A farmer volunteer presents how he/she filled in the first page.
    - Another farmer presents how the planning was done (page 2).

3. In the beginning, it is very important that the facilitator ensures that 'accurate' observations are made, in order to obtain good analyses and to make good decisions.

- The facilitator enquires about possible difficulties in filling in the form and suggests solutions or proposes that the farmers help each other; if necessary, an appointment is made for a meeting to help the farmers record their data after the session.

11. The facilitator introduces the notebook and the third page of the recording form for the IRM field; this is meant to train the farmers to record information from field observations made when transplanting and at the beginning of the vegetative phase.
    - The facilitator stresses the importance of recording the information: it will allow the farmers to remember the condition of the fields and plants, and it will also enable them to remember which activities contribute to the success of rice cropping.
    - The facilitator stresses the fact that recording should be done for the plot identified by the farmer, where he/she intends to implement the practices learnt during the PLAR sessions; therefore, recording will concern the IRM field, of which a sketch is made on the first page of the recording form.
    - The facilitator explains the four indicators for field preparation presented on the recording form:
      - Height and width of bunds;
      - Cleanliness of bunds and channels;
      - Incorporation of weeds and crop residues;
      - Complete flooding of the field;

      And also the seven indicators for the establishment of the nursery:



      - Length and width of the seedbed;
      - Height of seedbed;
      - Fineness of seedbed (i.e. absence of clods of soil);
      - Color of seedlings;
      - Vigor of seedlings;
      - Density of seedlings;
      - Uniformity of seedling density.

      ☛ *The facilitator explains the importance of each of the indicators*.

    - The facilitator explains that the farmers can indicate the degree of satisfaction with the state of health of their IRM field by ticking (checking) a box under the face corresponding to their judgment. If for an indicator the farmer's plot
      - gives complete satisfaction, he/she ticks the box under 
      - gives moderate satisfaction, he/she ticks the box under 
      - gives no or only little satisfaction, he/she ticks the box under 

- The farmers will then further analyze the indicators that give no or little satisfaction. They will explain the reasons for such a judgment and give details of the factors leading to these signs of poor or less satisfactory state of health and, hence, try to make links between the indicators and the causes or factors leading to these signs or symptoms.
- For these same indicators, the farmers are questioned about the decisions they will take to improve the field (by changing their management practices) and to prevent the phenomenon re-occurring.
- The facilitator invites each farmer to fill-in page 3 of the recording form; the extension agent will help any farmer to fill-in the form as necessary (i.e. upon request).
- The facilitator also invites the farmers to record some information on the management practices during sowing. This information should be recorded on page 6 of the recording form, in the second-to-last (penultimate) table.

12. Evaluation: the facilitator asks what the farmers appreciated (or did not appreciate), what they learnt, and what they intend to do with their newly obtained knowledge. The facilitator specifically asks which new ideas this module has generated and how farmers intend to put these into practise on their IRM fields.

13. The facilitator asks a volunteer farmer to conclude the session, and then invites the farmers to the next session.

Time required

- Three hours

Materials required

- Strong packing paper and markers.
- Notebook.
- Recording forms.
- Four observation sites identified by the facilitators:
  - 2 fields 'in preparation';
  - 2 nurseries,
  - preferably one field and one nursery with good management practices and the others where management practices, as taught during the PLAR sessions, are not accurately implemented.

Box 11

The farmers in Bamoro said that they make field observations every day to see how their crops develop and to evaluate the effects of their efforts. Comparisons are made between neighboring fields and over years. The farmers said they generally remember everything without taking notes. They said that it is very important to observe conscientiously so as to improve their practices and to know what has to be changed for the next season. We had to stress the importance of thoroughly analyzing the observations made. It seems that many farmers make observations, but don't analyze the situation very well. However, a good analysis is necessary to identify the right solutions. For instance, one farmer said that a part of his field was bad, that's why he didn't cultivate rice on that part of the field and left it uncultivated. He didn't try to understand why rice would not grow there. His peers told him that there might be other solutions.

After these discussions, we went to the field in three teams to make observations on five plots. We saw—among other observations—two nurseries with lots of problems, immediately acknowledged by the farmers. The major problems were due to poor leveling and the lack of fineness of the seedbed (i.e. it contained clods of soil), resulting in heterogeneous germination.

Transplanting and establishing experimental plots

This module discusses transplanting with special reference to age of seedlings at the time of transplanting, the advantages of transplanting over direct-seeding and the appropriate practices for transplanting (Reference 16). It also addresses the subject of farmers' experimentation and the choice of experimental treatments for the experiments that some volunteer farmers would like to establish in their own fields. It is possible that this module will not be finished in a single session, in which case, the part treating the establishment of experiments can be deferred to an 'extraordinary' session in which only farmers who volunteered to carry out experiments would be involved.

❶ Discuss farmers' transplanting practices and experiences.
❷ Introduce the practices recommended and their advantages.
❸ Conduct a practical transplanting demonstration.
❹ Review the agreed experimental treatments.
❺ Conduct a demonstration of how to install a farmer's experiment.

Learning objectives

At the end of this module farmers will:

- Have shared knowledge on transplanting practices.
- Have a good knowledge of appropriate transplanting techniques and their advantages.
- Be able to execute optimum transplanting.
- Be able (especially the volunteer farmers conducting experiments) to install variety experiments or fertilization experiments.

Procedure

1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator briefly reviews the previous module and invites farmers' feedback. The facilitator asks if the farmers have put in place any new practice on their IRM fields.

2. One of the PLAR-IRM team members explains the learning objectives and procedures for the current module.

3. Discussion of farmers' transplanting practices and experiences. The facilitator encourages the debate by highlighting the following topics and paying special attention to differences between farmers' practices.
    - What is transplanting?
    - Why is transplanting necessary?
    - What are the advantages of transplanting compared to direct sowing?

- How is transplanting carried out?
  - Watering the nursery;
  - Uprooting of seedlings, preparing the field: field condition and water management (Module 4);
  - Transplanting: depth, spatial arrangement, density.

4. Discussion on recommended practices and their advantages.
   - Advantages of transplanting compared to direct-seeding:
     - Controlling plant density;
     - Stimulating tillering;
     - Improved weed control.
   - Requirements for water management and condition of the field, especially the soil.
   - The ideal plant age at transplanting (15 to 21 days) enables early and fast growth initiation as well as adequate tillering (refer to Module 8).
   - Watering the nursery and uprooting the seedlings: minimize plant and root damage to ensure a quick re-start of growth.
   - Draining and leveling the field to ensure adequate puddling and avoid submerging young plants.
   - The ideal depth of transplanted plants (2 to 3 cm):
     - When transplanting is too deep, the start of growth is slow and there is a risk of diseases and seedling decay;
     - When transplanting is shallow, and plots are irrigated, there is a risk of plants being washed away.
   - Spatial arrangement and planting density: in rows, with plants spaced 20 cm apart in the row:
     - Using pegs and a long rope to guide the transplanters makes density management easier;
     - If plant stand is too close, tillering is not adequate and rice can be scrawny;
     - If plants are too far apart, vegetative cover (i.e. plant canopy closure) will not be optimal and solar radiation will hit the soil or water surface instead of the rice leaves, leading to reduced photosynthesis and reduced growth. It will also encourage weed infestation;
     - A reference line can facilitate transplanting in rows.
   - Time interval between seedling uprooting and transplanting should preferably be less than 2 days to avoid the death of roots.
   - Replacement of missing hills shortly after transplanting ensures an optimal plant population in the field.

5. The facilitator and farmers proceed to a farmer's field in the valley that is ready to be transplanted.

6. Observation of nurseries and transplanted fields, and transplanting demonstration.
   - Observation of a seedling nursery:
     – Age of seedlings, density, development and health.
   - Observation and possible rehabilitation of the field where seedlings will be transplanted:
     – Cleaning: removal of weeds;
     – Puddling and drainage;
     – Optimal leveling.
   - Uprooting of seedlings:
     – Watering of nursery;
     – Uprooting of seedling with a shovel, a hand-trowel or a hoe;
     – Cleaning the roots of excess soil.
   - Transplanting:
     – Demarcation of the reference line;
     – Transplanting parallel to the reference line while maintaining the optimum planting depth, spacing and number of seedlings per hill (ideally two to three).

Farmers' experimentation

7. Demonstrate the establishment of experiments. The example of variety and fertilization experiments is used here (refer to Reference 17). Please note that this section involves only farmers conducting experiments.

   - The facilitator invites farmers to briefly summarize the objectives of the experiment (Module 5, item 8 and Module 10, item 8).
   - Farmers explain the treatments:
     – Varieties involved in the test, including the local variety;
     – Fertilization options including farmer's practice.
   - The facilitator introduces the notions of:
     – Representativeness of the field;
     – Dimensions of sub-plots;
     – Calculation of fertilizer quantities for each sub-plot (fertilization test only).
   - The facilitator introduces the notions of:
     – Plot size—sub-plots should preferably be laid adjacent to one another with a small space between sub-plots;
     – Fix a tag that labels the treatment at the corner of each sub-plot. The sub-plot with the local variety or farmer's practice can be larger than the other sub-plots (of course, the rest of the field represents farmer's practice).

- The facilitator presents the small sachets of fertilizer that are to be applied as basal fertilizers (often a compound NPK or phosphorous fertilizer) for fertilization test. Then, farmers apply these fertilizers in the sub-plots as indicated on the labels. The fertilizer is incorporated into the soil.
- Farmers transplant rice plants into the various sub-plots. Special attention is taken to ensure that experimental treatments are not mixed up.

8. Back at the PLAR-ICM Center, the facilitator and farmers conducting experiments set dates to conduct the tests.
   - For each type of experiment, there is a list of farmers conducting experiments and the corresponding dates for field preparation, sowing the nursery, transplanting, and all major crop management practices. Normally, farmers are able to establish the experiment on their own, but they can request the facilitator's support if they wish.
   - The facilitator explains the importance of the observations to be made on the test plots. Test plots should not be confused with IRM plots, the observations will therefore not be the same either. Module 14 will deal with the observations and records to be made on experimental plots.
9. Evaluation: the facilitator asks what the farmers appreciated (or did not appreciate), what they learnt, and what they intend to do with their newly obtained knowledge. The facilitator specifically asks which new ideas this module has generated and how farmers intend to put these into practise on their IRM fields.
10. The facilitator asks volunteer farmers to conclude the session, and then invites farmers to the next session.

Time required

- Three hours

Materials required

- Sachets of fertilizer corresponding to the calculated rates for the experimental treatment and plot size.
- Well-labeled tags.
- Shovel or hoe to pull out seedlings.
- Already prepared rope to guide plant spacing.

Box 12

Farmers of Lokakpli had decided to experiment with the application of five levels of fertilizers:

1	2	3	4	5
*NPK=200 kg *Urea=100 kg	*NPK=100 kg *Urea=200 kg	*TSP=50 kg *Urea=200 kg	*Urea=200 kg	*Urea=250 kg

Urea contains 46% nitrogen (N); NPK contains 10% nitrogen (N), 20% phosphorus (P_2O_5) and 20% potassium (K_2O); TSP contains 45% phosphorus (P_2O_5).

Treatments were pictured as follows to indicate differences in contents of N, P and K. To adequately distinguish the quantities of the 3 nutrients, we represented N, P and K with small pieces of paper of different colors:

1	2	3	4	5
N N N P P K K	N N N N ½ N P K	N N N N P	N N N N	N N N N N

In the field, the practical aspects focused on a number of rules that need to be followed, i.e.:

- Identify the number of the sub-plots.
- Know the type of fertilizer treatment for each sub-plot.
- Take a tour of the plot so as to have an overview of the area to be treated.
- Apply small quantities of fertilizer at the time for better coverage of the whole area.
- Identify the right period to apply the fertilizer.

Thus, (basal) fertilizer was applied in the first three plots. It is advisable to apply the fertilizer on the day of transplanting. A transplanting demonstration was also conducted—there were two different opinions regarding the way of uprooting seedlings:

- One farmer said that it is better to dig up seedlings without damaging much of the roots.
- Another farmer said that you can actually cut off the roots, it does not have any effect on crop establishment.

Farmers decided to conduct a small experiment to compare these two types of seedling handling besides the original trial. We then conducted a demonstration of transplanting in lines with and without a rope. Farmers were impressed by the results when a rope was used.

Assessing farmers' knowledge and evaluating implementation of IRM practices

❶ Explain the evaluation procedure.

❷ Conduct evaluation in sub-groups.

❸ Compile results during plenary meeting.

It is useful to assess, on a regular basis, whether the objectives set at the beginning of PLAR-IRM are being achieved. PLAR mainly aims at improving farmers' knowledge and encouraging farmers to put this knowledge of improved and integrated rice management into practise. Thus, we can evaluate whether the time invested in the weekly PLAR-IRM sessions actually contributes to improving farmers' knowledge as well as motivating them to try out new practices. Although each farmer can assess his/her knowledge on an individual basis, e.g. through the observations made and the information recorded on the recording form of his/her IRM field, it is useful to test farmers' knowledge in small groups. This is what this module focuses on. The knowledge test is conducted in the form of multiple-choice questions. This makes processing the results obtained by the small groups easier, which further stimulates the debate on knowledge gaps and the discrepancies between farmer knowledge and actual practices.

Learning objectives

At the end of this module, farmers will be able to:

- Assess the knowledge they have acquired.
- Discuss discrepancies between knowledge and practices, and elaborate on the reasons for the discrepancies.

Procedure

1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator briefly reviews the previous module and invites farmers' feedback. The facilitator asks if the farmers have put in place any new practice on their IRM fields.
2. One of the PLAR-IRM team members explains the learning objectives and procedures for the current module.
3. The facilitator explains the evaluation *procedure*.
   - The farmers are divided into four sub-groups.
   - A farmer-facilitator and a farmer-rapporteur are chosen for each sub-group.
   - Each sub-group of farmers will visit the four sites that have been already chosen,[1] which may include:
     – A field in preparation phase (before nursery establishment);

1. The team of facilitators is to prepare the observation sites in advance; refer to section 'Materials required.'

  - A prepared nursery bed that has yet to be sowed;
  - A nursery with young seedlings;
  - A field with recently transplanted seedlings.
- At each site there is a ballot box and an envelope with four forms next to it (one for each sub-group) and a few multiple-choice questions that farmers are to answer.
- The farmer-facilitator will read the multiple-choice questions and farmers will choose their answers by general agreement.
- The answer sheet will be put in the ballot box before the sub-group leaves that site for the next one.
- Then, farmers will make field observations using observation indicators (refer to Module 11) and discuss the management practices applied in the field and differences between the new knowledge (or good practices) and management practices applied in the field.
- The sub-groups will then move to the next observation site and repeat the same procedure.
- After visiting all sites, the sub-groups will return to the PLAR-IRM Center.

4. The sub-groups of farmers and facilitators proceed to the field. In turn, each sub-group visits all four sites that the PLAR-IRM team identified before the session.
   - The PLAR facilitator encourages the farmer-facilitator in his/her role.
   - The farmer-rapporteur takes notes:
     - The sub-group first tackles the multiple-choice questions; the idea is not only to agree on the answer and write it down, but also to give the reasons of their choice;
     - Afterwards, farmers make field observations and discuss the management practices and discrepancies between the good practices learnt through PLAR and those applied in the field.

5. Return to the PLAR-IRM Center. Compilation of results:
   - Ballot boxes are opened successively and a volunteer farmer reads the answers to the multiple-choice questions. The facilitator makes a summary of results in a preset table (*see* 'Materials required' section *below*).
   - After completing the second column of the table, the facilitator repeats the questions one after the other and encourages debate on:
     - Different answers among the groups;
     - More thorough knowledge, i.e. why do farmers make this choice, which reflects 'factorial knowledge.'[2]

2. 'Factorial knowledge' means that the learners are not only capable of reproducing facts learnt, but they are also in the position to argue reasons for the facts known.

Site/question	Number of answers per choice	Management practices observed
Site 1		
Question 1		
	Choice 1:	
	Choice 2:	
	Choice 3:	
Question 2 …	Choice 1:	
	Choice 2:	
	Choice 3:	
Site 2		
Site 3		
Site 4		

- Then the results of field observations are presented:
  - The farmer-rapporteur of the first sub-group presents the results of the first observation site and the facilitator sums up the results in the third column of the table;
  - Afterwards, farmer-rapporteurs of other sub-groups 'complete' the first sub-group's report by adding comments from their sub-groups that were not mentioned by the first sub-group, and the facilitator summarizes these in the table;
  - Farmers discuss the differences in sub-group results and the facilitator stimulates a debate on differences between knowledge and practices observed in the field;
  - The facilitator leads a debate on possible gaps in knowledge and goes on to elaborate certain topics if needed;
  - After closing the debate on the first site, the second, third and fourth sites are dealt with.

6. Evaluation: the facilitator asks what the farmers appreciated (or did not appreciate), what they learnt, and what they intend to do with their newly obtained knowledge.

7. The facilitator asks volunteer farmers to conclude the session, and then invites farmers to the next session.

Time required

- Three hours

Materials required

- Four lists of multiple-choice questions (Box 13).
- Four ballot boxes, e.g. cartons previously containing reams of A4 paper with a slot made in the lid, or a small basket. Next to each ballot box, an envelope is placed with four sheets with identical multiple-choice questions. After filling-out the form, farmers place the form in the ballot box.
- The team of facilitators identifies four sites preferably where farmers do not fully follow the 'good' practices as treated in the PLAR-IRM sessions:
  - A field in preparation stage (before nursery establishment);
  - A nursery ready to be seeded;
  - A nursery with young seedlings;
  - A field with recently transplanted seedlings.

  On the morning of the Module 13 session, the facilitator puts the four ballot boxes at the four sites and the envelope with the forms to fill-in next to it.
- Strong packing paper with the preset table already drawn (*see* step 5).

Box 13

Site 1: Field preparation

1. The time interval between the first and second land preparation should be:
   ❑ 3 weeks ❑ 1 week ❑ Does not matter
2. The soil type found in your inland-valley lowland is mainly:
   ❑ Loamy-sandy ❑ Loamy-clayey ❑ Sandy

Site 2: Nursery and seedlings

1. The ideal age of plants to transplant is:
   ❑ At least 5 weeks ❑ Between 2 and 3 weeks ❑ Does not matter
2. For 1 nursery bed of 10 m x 1 m (i.e. 10 m^2), how many kilograms of good-quality seeds should I use?
   ❑ 2 kg ❑ 4 kg ❑ 6 kg
3. For how long do I prime the rice seeds before sowing?
   ❑ 2 to 3 days ❑ Half a day ❑ 5 days

Site 3: Transplanting

1. How many seedlings do I transplant per hill?
   ❑ 1 to 2 ❑ 2 to 3 ❑ More than 4
2. How deep should the transplanting be?
   ❑ More than 5 cm ❑ 3 cm ❑ Does not matter
3. How many days after transplanting does it take a young plant to re-establish growth and development?
   ❑ 4 to 5 days ❑ More than 10 days ❑ Less than 3 days

Making field observations: Transplanting and beginning of the vegetative phase

This module is the continuation of Module 11 and covers the observations made immediately after transplanting, i.e. at the beginning of the vegetative phase.

❶ Recall the importance of the 'observation indicator' concept.
❷ Review the recording form for the IRM field.
❸ Make field observations on the IRM fields in sub-groups.
❹ Summarize the observations in plenary session.
❺ Continue to fill in the recording form for the IRM field.

Learning objectives

At the end of this module, farmers will be able to:

- Discuss and review the importance of making regular field observations, better analyze the health of the growing crop and its environment, and take decisions for appropriate action.
- Decide on the observations to be made and on the 'observation indicators' related specifically to the transplanting phase and to the beginning of the vegetative phase.
- Record the information.

Procedure

1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator briefly reviews the previous module and invites farmers' feedback. The facilitator asks if the farmers have put in place any new practice on their IRM fields.
2. One of the PLAR-IRM team members explains the learning objectives and procedures for the current module.
3. The facilitator recalls the importance of making good observations and repeats the explanation of the concept of 'observation indicator' (Module 11).
   - 'To observe' means that one watches certain phenomena very carefully, such as plant development. These aspects are obvious because we find them relevant, i.e. they are 'observation indicators.' For instance, one observes that seedling density is not homogeneous (the nursery shows areas with a lot of seedlings and others with fewer).
   - An indicator is a sign that one observes in the field, indicating that, e.g. a plant is in good or poor health. The farmers must remember the exact word that means 'indicator' in their own language.
   - These observation indicators permit the understanding of what is happening now and what happened in the past; this kind of reasoning is called *analysis* of what we see, i.e. an effort at understanding the basic causes and factors determining plant development; e.g. the spots with few seedlings may be due to too much standing water (waterlogging) in that spot, which killed some the seedlings. However, two types of factors may be responsible: either

management practices or environmental conditions could be the cause of waterlogging. For instance, poor field-leveling or drainage, which are farmer management practices, could be the reason. Therefore, in analyzing one tries to understand what has been observed.

- The main objective for making observations and analyzing these phenomena is to take sound decisions for action to change (improve) the situation or to prevent the phenomenon from re-occurring.

4. The facilitator invites the farmers to present the pages of the recording form for the IRM field that they have filled in (i.e. pages 1, 2 and 3), as explained in Modules 9 and 11.
   - Some farmers present their recording forms.
   - They state the difficulties encountered in filling in the recording form and these difficulties are discussed.
   - The facilitator proposes that farmers help each other; if necessary, the PLAR-IRM team can help farmers record their data after the session.

5. The facilitator explains the field-observation *procedure* in PLAR-IRM.
   - The farmers are divided into four sub-groups of four or five farmers.
   - A farmer-facilitator and a farmer-rapporteur are chosen for each sub-group.
   - Each sub-group will visit four sites:[1]
     – Two sites that have been transplanted about one week earlier—if possible, one field in ‘good’ (optimum) condition and another in ‘poor’ (less-than-optimum) condition;
     – Two other sites that have been transplanted about two to three weeks previously—if possible, one field in ‘good’ (optimum) condition and another in ‘poor’ (less-than-optimum) condition;
     – Sub-groups will make field observations; the farmers deciding which indicators are most relevant to them, i.e. those that allow *them* to judge field conditions and plant health.

   - Sub-groups will discuss and analyze what has been observed: links to be made between indicators (what is seen, i.e. effects) and environmental factors and farmers’ management practices (i.e. causes).

6. The farmer sub-groups and the facilitator depart to the field. In turn, they all visit the four observation sites.
   - The facilitator helps the farmer-facilitator if necessary.[2]
   - The farmer-rapporteur takes notes.

1. The observation sites should be prepared in advance by the team of facilitators.
2. In the beginning, it is very important that the facilitator makes sure that ‘good’ observations are made, in order to obtain accurate analyses and efficient decisions.

7. Back at the PLAR-IRM Center, the farmers report and comment on their results:
   - The farmer-rapporteur of the first sub-group presents the results for the first observation site, 'Transplanting: Field 1.'
   - The facilitator synthesizes the results in the four-column table, in the row 'Field 1.'
   - Afterwards, farmer-rapporteurs of other sub-groups 'complete' the first sub-group's report by adding comments from their sub-groups that were not mentioned by the first sub-group, and the facilitator summarizes these in the table.

Stage of observation	Observed indicators	Analysis	Decisions made
Transplanting			
Field 1			
Field 2			
Beginning of vegetative phase			
Field 1			
Field 2			

   - Then the farmer-rapporteur of the second sub-group presents the results of the second observation site, 'Transplanting: Field 2.'
   - The facilitator synthesizes the results in the row 'Field 2.'
   - Then, he/she invites the farmer-rapporteurs of the other sub-groups to complete the table.
   - And so on for 'Beginning of vegetative phase Fields 1 and 2.'

8. The facilitator then introduces the fourth page of the recording form: this is meant to train the farmers in recording the information concerning the field observations made at transplanting and at the beginning of the vegetative phase.
   - The facilitator stresses the importance of recording the information and focuses on the fact that recording concerns the plot(s) identified by the farmer where he/she intends to implement the practices learnt during the PLAR-IRM sessions; therefore, recording will concern the IRM plot, of which a sketch is made on the first page of the recording form.
   - The facilitator explains the four indicators used in evaluating transplanting (as found on the recording form):
     – Field leveling;
     – Plant spacing (distance between hills);
     – Number of seedlings per hill;
     – Transplanting depth.

And the six indicators used in evaluating the beginning of the vegetative phase:

– Recovery after transplanting shock;
– Color of plants;
– Plant vigor and health;
– Cleanliness of field, absence of weeds;
– Water depth;
– Tillering.

☛ *The facilitator explains the importance of each of the indicators.*

- The facilitator explains that the farmers can note their degree of satisfaction for the state of health in their IRM field by ticking a box under the face corresponding to their judgment, for instance:
  – Gives complete satisfaction, he/she checks the box under 
  – Gives moderate satisfaction, he/she checks the box under 
  – Gives no or only little satisfaction, he/she checks the box under 
- The farmers will then further analyze the indicators that give no or little satisfaction. They will explain the reasons for their judgment and give details of factors responsible for these signs of poor or less-than-optimum condition, thereby trying to establish links between the indicators and the causes or factors leading to these signs or conditions. For these same indicators, the farmers are questioned about the decisions they will take to improve the field (by changing their management practices) and to prevent the phenomenon from re-occurring.
- The facilitator invites each farmer to fill in page 4 of the recording form; the facilitator can help to fill in the form, if the farmer asks for help.
- The facilitator also invites the farmers to record some information on the management practices in the IRM field. This information should be recorded on page 6 of the recording form, in the last table.

9. Evaluation: the facilitator asks what the farmers appreciated (or did not appreciate), what they learnt, and what they intend to do with their newly obtained knowledge. The facilitator specifically asks which new ideas this module has generated and how farmers intend to put these into practise on their IRM fields.

10. The facilitator asks a volunteer farmer to conclude the session, and then invites farmers to the next session.

Time required

- Three hours

Module 14

Making field observations: Transplanting and beginning of the vegetative phase

Materials required

- Strong packing paper and markers; notebook; recording forms.
- Four observation sites identified by the facilitators:
  - Two with a field in 'transplanting stage';
  - Two with a field at the beginning of the vegetative phase;
  - Preferably one field with good management practices and another where management practices, as taught during the PLAR sessions, have not been accurately implemented.

Box 14

In Lokakpli, as well as in Bamoro, five fields were visited by four sub-groups of farmers. After the four sub-groups had visited the fields, we discussed with the farmers the observations they made, the indicators they used, the important analysis to make and the actions to undertake. We stressed the necessity of making relevant observations and accurate analyses in order to make appropriate decisions for action. During the discussions, the following indicators were mentioned:

Observations on	Indicators
1. Plant health	Color, height compared to age, vigor (individual plants)
2. Plant density	Presence of empty spaces, number of individual plants (in clumps, high or low density), replacement of missing seedlings
3. Tillage quality	Incorporation of weeds, tillage depth
4. Leveling quality	Presence of water, dry or flooded parts
5. Quality of bunds	Height, width, cleanliness
6. Condition of canals	Cleanliness, fissures
7. Status of nursery bed	Height, width, length; leveling, fineness of soil (lack of clods), location
8. Transplanting	Mode, spacing of hills
9. Beginning of vegetative phase	Start of growth, soil cover, empty spaces, diseases, weeds

The farmers were able to define and agree upon these indicators themselves, which then served as a basis for finalizing the recording form for the IRM field.

Recognizing weeds

Weed infestation is one of the major constraints to rice productivity and profitability in inland-valley lowland rice production in West Africa. A good knowledge of weeds is therefore important in order to determine the causes of the infestation and have a good understanding of possible control measures (Reference 18).

1. Discuss what farmers know about weeds.
2. Observe and sample weeds in the field.
3. Synthesize the observations in plenary session.

Learning objectives

At the end of this module, farmers will:

- Have exchanged knowledge about weeds.
- Be aware of the importance of weed control.
- Be able to identify the most important weed families and the most frequent species found in their fields.

Procedure

1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator briefly reviews the previous module and invites farmers' feedback. The facilitator asks if the farmers have put in place any new practice on their IRM fields.
2. One of the PLAR-IRM team members explains the learning objectives and procedures for the current module.
3. The facilitator initiates the debate about weeds. The farmers exchange what they know about weeds and make an inventory of their practices in weed control. The following topics may be addressed:
   - What is a weed?
   - What are the different types of weeds?
   - Where do weeds come from?
   - What is their effect on rice?
   - At which stage of plant growth is their effect most harmful?
   - What are the most effective times for weeding?
   - What are the preventive and curative methods of weed management?
4. The facilitator presents the *procedure* for the field visit:
   - The farmers are divided into four sub-groups of four or five farmers.
   - A farmer-facilitator and a farmer-rapporteur are designated for each sub-group.
   - Each sub-group will visit four sites.

5. In the field, the farmers collect any types of weeds they find or those they think are predominant. This visit aims at building a herbarium of the weeds present in the inland valley. For each weed they collect, the farmers indicate:
   - The indigenous or local name.
   - The location where the weed was found (upland, hydromorphic zone, valley bottom).
   - Its prevalence.
   - The relative importance of the damage cause by the weed species on rice growth and yield.

6. Back at the PLAR-IRM Center, the farmers report and make comments on their results:
   - The facilitator asks the farmers if they can differentiate between the major families of weeds. She/he makes sure that the three most important families can be differentiated and gives the identification keys: grasses (Gramineae) and sedges (Cyperaceae) usually have narrow leaves (Reference 18). The broad-leaved weeds have, as their name suggests, leaves that are usually wider than those of grasses and sedges.
   - The facilitator invites the farmers to cut the stems of a few weeds to show the differences in the shape of the stems. She/he helps the farmers to determine the differences between the broad-leaved weeds that have round stems and the sedges that have angular stems.
7. The farmers classify the weeds collected in the field using the table below.
   - Each farmer sub-group shows the weeds they collected.
   - The farmer-rapporteur in each sub-group presents their weeds. Each weed is given an entry in the table. The prevalence in the field and the importance of the damage on the rice crop is assed by the farmers giving a score using a decimal scale, ranging from 1 (negligible) to 10 (very important). Farmers list any methods they currently use to combat particular weeds.
   - This leads the farmers to mark out the most prevalent and most harmful weeds.

Name in local language	Family[1] and scientific name	Environ-ment[2]	Time of appearance	Cycle	Preva-lence[3]	Importance[3] of damage on rice	Control methods
1.							
2.							

1: grasses, sedges or broad-leaved weeds;
2: valley bottom, hydromorphic zone, upland;
3: scores from 1 (negligible) to 10 (very important).

8. The weeds are spread out, labeled and placed between newspapers in order to build a weed herbarium.

9. Evaluation: the facilitator asks what the farmers appreciated (or did not appreciate), what they learnt, and what they intend to do with their newly obtained knowledge. The facilitator specifically asks which new ideas this module has generated and how farmers intend to put these into practise on their IRM fields.

10. The facilitator asks volunteer farmers to draw conclusions from the session, and then invites farmers to the next session.

Time required

- Three hours

Materials required

- Strong packing paper and markers.
- Newspaper.
- Knife.

Box 15

During the session in Bamoro, farmers said the following about weeds:

- Weeds are plants, which prevent the rice from growing by colonizing their territories.
- Weeds destroy the rice seedlings.
- Weeds provide shelter to insects and rats, which can in turn cause diseases in or damage to rice.
- Weeds compete with rice roots for nutrients from the soil.
- Weeds compete for light and reduce yields.

We visited the fields in three sub-groups. During the visit, each sub-group collected as many weeds as possible that they considered harmful. These weeds had to be collected in the valley bottom, on the bunds, in the hydromorphic zone or in the uplands. The results from the three sub-groups are summarized in the table below.

No.	Baoulé name(s)	Scientific name	Location found	Time of appearance	Cycle	Damage	Control means
1	Hidjerè kekléklé	*Leptochloa caerulescens*	Valley bottom	Early rainy season	Annual	10+++	Systematic uprooting
2	N'Gbé Avié	*Leersia hexandra*	Valley bottom and bunds	Early rainy season	Perennial	10++	Uprooting
3	N'Zuébonou N'Gattè	*Marsilea minuta*	Valley bottom	Any time	Perennial	9++	Uprooting
4	Sasa N'Gbo	*Cyperus sphacelatus*	Valley bottom	Early rainy season	Annual	8++	Cutting and flooding
5	Tanou Aya	*Nymphea lotus*	Irrigated valley bottom	Early rainy season	Perennial	3++	Cutting with machete
6	N'Drandran Waka	*Panicum laxum*	Valley bottom	Any time	Perennial	9+	Uprooting
7	N'Gbomi	*Rhynchospora corymbosa*	Valley bottom and upland	Any time	Perennial	4+	Cutting and flooding
8	Sida n°1	*Echinochloa colona*	Valley bottom and upland	Early rainy season	Annual	10+	Uprooting
9	Nani Kpa N'Gôh	*Brachiana lata*	Valley bottom	Any time	Perennial	8+	Cutting and flooding
10	Avié Akoa	*Fimbristylis littoralis*	Valley bottom	Early rainy season	Annual	6+	Cutting and flooding
11	N'Zuébonou Gnamien Houmanhou	*Commelina* spp.	Valley bottom and upland	Any time	Perennial	3+	Uprooting
12	Tanou Aya Bla	*Heteranthera callifolia*	Valley bottom	Early rainy season	Annual	5++	Uprooting
13	N'Zuébonou Kokomandjo Opio	*Ludwigia abyssinica*	Valley bottom	Early rainy season	Annual or perennial	2+	Cutting and flooding
14	Sida n°2	*Echinochloa* sp.	Valley bottom	Early rainy season		n.d.	Uprooting
17	Labou Salan	*Calopogonium mucunoides*	Valley bottom	Early rainy season	Perennial	n.d.	Cutting and flooding
18	Couverture	*Sorghum arundinaceum*	Valley bottom	Early rainy season	Perennial	1+	Cutting and flooding
19	Abokalo	??	Valley bottom	Early rainy season		–1	Cutting and flooding
20	N'Zuébonou Tanga	*Hibicus asper*	Valley bottom	Early rainy season	Annual	–1	Cutting and flooding
Note: n.d. = no damage.							

During the evaluation, the farmers said that they had found the field visits interesting, and that they appreciated their new acquaintance with some weeds they had not known before. They enjoyed the classification of weeds according to their level of damage and the discussion on control methods.

Integrated weed management

Integrated weed management combines different methods of weed control and aims at offering farmers a range of options to improve the efficiency of weed management. Preventive and curative methods will be differentiated. This module tries to demonstrate to farmers that several options do exist to protect their rice fields from weed infestation (Reference 19).

❶ Make field observations and collect weed samples.

❷ Synthesize the observations in plenary session.

Learning objectives

At the end of this module, farmers will:

- Know the different methods for controlling weeds.
- Be convinced of the importance of integrated management of weeds.
- Know the specific herbicides to control different weeds.[1]

Procedure

1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator briefly reviews the previous module and invites farmers' feedback. The facilitator asks if the farmers have put in place any new practice on their IRM fields.
2. One of the PLAR-IRM team members explains the learning objectives and procedures for the current module.
3. The facilitator presents the *procedure* for the field visit:
   - Division of the farmers into two sub-groups.
   - Designation of a farmer-facilitator and a farmer-rapporteur.
   - Each sub-group will visit four sites.
4. In the field, the farmers observe the weeds in the rice fields and discuss the following points:
   - Sources of weed seeds (from canal, with the wind, birds, etc).
   - Methods of weed control (preventive and curative methods).
   - The notion of integrated weed management.
5. Back at the PLAR-IRM Center, farmers report and comment on their observations. The facilitator stresses the importance of weed control using an integrated approach (Reference 19). The debate should focus on the distinction between preventive and curative methods of weed control.
   - First, the facilitator leads a discussion on <u>preventive</u> methods. She/he hints at the importance of: Preparing the fields; leveling; cleaning canals and bunds; using good seeds; good water management; manual weeding of flowering weeds.
   - Then, the facilitator presents the <u>curative</u> methods available for each of the weeds classified as harmful (Module 15 and Reference 19).

1. This objective only concerns farmers who are used to applying herbicides or who intend to use them.

- The facilitator encourages discussion on the use of early manual weeding at the vegetative stage, and emphasizes the importance of eliminating flowering weeds to prevent their seeds from dispersing in the field.
- If the farmers are used to using herbicides, the facilitator explains which product to use against which species, which stage of the crop to treat, and how to do it (Reference 20):
  – The facilitator explains the principle of the 'active ingredient' in herbicides. The examples of 2,4-D and propanil are presented with their prospective targets: 2,4-D against broad-leaf weeds and sedges (*Cyperaceae*), and propanil against grasses (*Graminaceae*);
  – The facilitator asks if farmers are aware of the difference between the commercial (trade) names and the name of the active ingredient;
  – She/he encourages discussion on the importance of knowing the active ingredient, so as to use herbicides products in an efficient and economic manner: for instance, the active ingredient 2,4-D can be found in Herbextra and Herbazol;
  – Farmers are discouraged from mixing products, as this may pose a health hazard, be harmful for the crop, or reduce herbicide efficacy. The facilitator explains that the products work best when applied at the right moment, e.g. at the 2–3 leaf stage of the weed;
  – She/he will explain the difference between contact herbicides (burning the leaves) and systemic herbicides (entering the plant by the leaves and passing down to the roots), and between pre-emergence herbicides (affecting emerging weeds) and post-emergence herbicides (only work when the weed seeds have already emerged).

6. Evaluation: the facilitator asks what the farmers appreciated (or not), what they learnt, and what they intend to do with their new knowledge. She/he specifically asks which new ideas this module has generated and how farmers intend to put these into practise on their IRM fields.
7. The facilitator asks volunteer farmers to draw conclusions from the session, and then invites all the farmers to the next session.

Time required

- Three hours

Materials required

- The weeds collected during the session on Module 15.

Box 16

The Lokakpli farmers visited two fields infested with weeds. They recognized five species of weeds in these fields, with *Echinochloa cruz-pavonis* dominating in Field 1 and *Marsilia minuta* in Field 2. The farmers debated the origin of all the weeds. *Echinochloa cruz-pavonis* was not found in the valley bottom before the installation of the irrigation scheme. Farmers thought that this weed was brought into the field with the rice seeds that they had bought. According to them, wind, birds, irrigation water, and the power-tiller machines can also bring weeds. As solutions against weeds, they mostly mentioned the use of herbicides, better field-leveling in order to improve water management, and annual clearing of the valley-bottom fields, canals and bunds.

Module 17

Using herbicides efficiently in inland-valley rice production

Herbicides are widely used in West Africa, especially in irrigated lowland rice, but farmers often handle them without realizing their potential dangers to health and without great efficiency. This module is designed to improve farmers' knowledge on: general herbicide handling, their potential danger to human health and the environment, and to improve knowledge on optimal timing, dosage and techniques of herbicides application. Such knowledge will help reduce incorrect use of herbicides while increasing their efficacy (Reference 20).

❶ Summarize farmers' knowledge about weeds, herbicide application and integrated weed management.

❷ Discuss farmers' experiences in the use of herbicides.

❸ Present key features for herbicide formulations: dosage of products.

❹ Demonstrate the use of herbicides in the field.

❺ Synthesize observations in plenary session.

Learning objectives

At the end of this module, farmers will:

- Know how to choose the most efficient herbicides to control the weeds in their fields.
- Know how to calculate the optimal doses of herbicides.
- Know correct methods of herbicides application, i.e. without endangering their health or that of the crop.
- Know correct timing of herbicide application for optimum efficiency.
- Know the best mode of application for the available commercial products.

Procedure

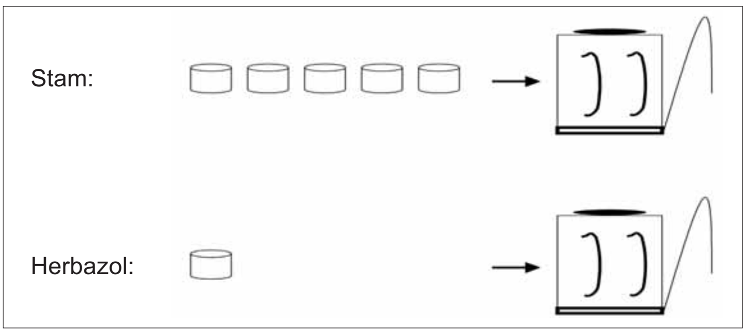
1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator briefly reviews the previous module and invites farmers' feedback. The facilitator asks if the farmers have put in place any new practice on their IRM fields.

2. One of the PLAR-IRM team members explains the learning objectives and procedures for the current module.

3. The facilitator reminds farmers of the following elements:
   - The role of herbicides in integrated weed management. Firstly, it is important to emphasize that herbicides are poisonous or may be harmful to human health and the environment when not used properly. Secondly, they are only *one element* in a range of techniques in integrated weed management.
   - The three main groups of weeds (grasses, sedges and broad-leaves): the farmers will show some samples from their own herbaria.

4. The facilitator stimulates a discussion on farmers' experiences with chemical weed control. They will talk about the commercial products available and their respective efficiencies (the facilitator brings samples of the commercial products commonly used in the area and will explain the labels).

5. Using the instruction leaflet (Reference 20), the use of herbicides is discussed, including the idea of using a 'small tomato tin.' The following topics are to be dealt with:
   - The number of herbicide sprayer (knapsack) loads that would cover a plot of 2500 m^2: with a 15-liter capacity sprayer, well adjusted, walking not too fast or too slow (60 m per minute), five sprayers will be needed to treat one rice field of 2500 m^2. Different sprayers will have different capacities and output will be affected by pressure and nozzles used. The calculations used here are for illustration only and they may have to be adjusted according to the equipment used.
   - The product to be used to combat sedges (Cyperaceae) and broad-leaf weeds: for instance Herbazol or Herbextra (with 2,4-D as active compound):
     – Dosage: one little tomato tin (50 ml) per sprayer-load.
   - The product to be used against grasses (Gramineae): for instance Stam (with propanil as active ingredient):
     – Dosage: five little tomato tins (5 × 50 ml = 250 ml) per sprayer.



6. The participants then depart to the fields and choose a plot that can be used for the demonstration. It is important to choose a well-drained field with weeds that have approximately reached the 2–3 leaf stage. The following issues will be dealt with:
   - The use of clean water in the preparation of the herbicide solution to avoid blocking the nozzle.
   - The use of the correct nozzle. There are nozzles for insecticides and other nozzles for herbicides. Farmers often use the nozzles designed for insecticides (which produce a cone-shaped spray instead of a fan)—these are not appropriate for herbicides, as the sprayed droplets from the insecticide nozzle are too small.
   - The importance of washing after applying or handling herbicides, changing clothes that become contaminated, and not smoking, eating or drinking while handling herbicides.

- The importance of the farmer wearing protective clothes: all injuries (cuts, grazes, etc.) must be covered; gloves, glasses and boots must be used, if they are available. Noses should also be covered with protective masks, that are usually easy to find and relatively cheap.
- Drainage of the field (except for some products, such as Londax).
- The plant development stage, i.e. for many post-emergence herbicides, weeds must be treated when they are at the 2–3 leaf stage for best effect.
- Testing the equipment with water. Treatment should start only after the functioning of the equipment has been confirmed with ordinary water.
- Rinsing the sprayer. The sprayer could still contain some remnant of another product and, for instance, it would be disastrous for the rice if this leftover were, e.g., Round-up.
- Filling the sprayer up to half its capacity.
- Pouring the contents of the 'small tomato tins' (e.g. one tin of Herbazol and five tins of Stam) into the sprayer and rinsing the tins with clean water. It is important to stress that the product should be added to the water and not the opposite. Therefore, water must not be poured on the product. The products must not be mixed together before dissolving them in water.
- Closing and shaking the sprayer.
- Completely fill the sprayer (15 liters) and rock gently to mix properly.

7. The facilitator then encourages a debate on the optimal conditions for chemical treatment:
   - No wind.
   - No strong sun.
   - No heavy dew.
   - No threat of rain.
   - Preferably done early in the morning (07:00–10:00) or late in the evening (16:00–18:00).

8. The facilitator invites a volunteer farmer to demonstrate how to fill the sprayer and how to spray. The other farmers watch how their peer is performing, they give their comments and pay particular attention to the following aspects:
   - The means of protection: gloves, mask and boots.
   - The height at which the spraying lance must be held: 0.7 m above ground.
   - The walking speed, which should be about 60 m per minute—that is, neither too fast nor too slow—, and walking in a straight line.
   - Walking, treating and pumping, which should be done simultaneously.
   - The width covered by the spraying nozzle, which should be about 1.5 m.
   - Turning around when arriving at the end of the field, and moving across 1 to 1.5 m.
   - The importance of not waving the spraying lance—it must be held steady and at a constant height.

9. Back at the PLAR-IRM Center, the facilitator encourages further discussion about the demonstration.
   - For example, if a plot of only 250 m^2 has been treated, how much water should be left in the sprayer. The farmers calculate. The rule is that a 2500-m^2 plot requires 5 sprayer loads, so a 250 m^2 plot—being 1/10 of the field—will require the use of 5/10 (half) of a sprayer load.
   - The facilitator explains that, if there is any left-over herbicide mixture, it should not be applied a second time on the same area of the field, as it may be dangerous for the rice because the dosage would then be too high. Do not dispose of any spare herbicide into waterways or drains, but instead, if surplus herbicide has to be disposed of, it should be sprayed onto a waste area away from habitation and waterways.
10. The farmers should talk about the time to flood the field after treatment: it should usually be done 2 to 3 days after treatment. Long delay should be avoided, otherwise the weeds could start growing from seed.
11. Evaluation: the facilitator asks what the farmers appreciated (or did not appreciate), what they learnt, and what they intend to do with their newly obtained knowledge. The facilitator specifically asks which new ideas this module has generated and how farmers intend to put these into practise on their IRM fields.
12. The facilitator asks volunteer farmers to draw conclusions from the session, and then invites all the farmers to the next session.

Time required

- Two–three hours

Materials required

- A sprayer with an appropriate nozzle; samples of the herbicides available in the area; a little tomato tin; clean water.

Box 17

The session in Lokakpli, where some farmers have been using herbicides for a few years, allowed a good discussion about the other methods to control weeds (manual weeding, good water management, good field-leveling) and also about the modes of application of herbicides. We verified that the farmers have a good knowledge of herbicides. They mentioned the following compounds: Tamariz, Calliherbe, Herbextra, Herbazol, Ronstar, Rical, Round-up and Gramoxone. What seemed less evident to the producers was the right timing and dosages of herbicides treatment.

A woman farmer said she used Herbazol, using one bottle of Herbazol (250 ml) per sprayer (which is far too high a dosage). Another farmer said that he used a mixture of Garil and Herbazol. Another farmer used either one “Herbazol bottle” filled with Herbextra to 15 liters of water or half a Herbazol bottle filled with a mixture of Herbazol and Herbextra to 15 liters; he also said that when mixed together, these two products are very effective and that the dose can be reduced afterwards.

Another farmer explained that he used Tamariz mixed with Herbazol, or Rical mixed with Calliherbe. A woman used Round-up three days after the second tillage.

Many farmers said that herbicides were effective on most weeds, except some weeds like ‘Denis Kouamé’ (*Echinochloa* spp.) and Ngaté or feuille de aranchide (*Marsilia minuta*), which resist any treatment. They were thinking that this was mostly due to the fact that chemical compounds could not kill these weeds.

Making field observations: The vegetative phase

This module is the continuation of Modules 11 and 14; it explores some particular aspects of observations to be made about one month after transplanting, during the vegetative phase.

❶ Review the recording form for the IRM field.
❷ Make field observations of the IRM fields in sub-groups.
❸ Summarize the observation in plenary session.
❹ Continue to fill in the recording form of the IRM field (page 5 of the form).

Learning objectives

At the end of this module, farmers will:

- Have reviewed the importance of making regular field observations, analyzing the health of the crop and its environment, and how to take decisions for appropriate action.
- Be able to decide on the important observations to be made and on the 'observation indicators' specifically related to the vegetative phase, i.e. the indicators he/she will observe.
- Be able to record the information on his/her recording form.

Procedure

1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator briefly reviews the previous module and invites farmers' feedback. The facilitator asks if the farmers have put in place any new practice on their IRM fields.

2. One of the PLAR-IRM team members explains the learning objectives and procedures for the current module.

3. The facilitator invites the farmers to present the filled-in pages of the recording form for the IRM field, as explained in Modules 9, 11 and 14. The difficulties in filling the recording form are discussed—this concerns pages 1, 2, 3 and 4 of the form.

4. The facilitator explains the field-observation *procedure* in PLAR-IRM:
   - The farmers are divided into four sub-groups of four or five farmers.
   - A farmer-facilitator and a farmer-rapporteur are chosen for each sub-group.
   - Each farmer sub-group will visit four sites[1] at the vegetative phase—preferably two fields in 'good' (optimal) condition and two in 'poor' (less-than-optimal) condition.
   - The sub-groups make field observations; the farmers decide which indicators are important for them, i.e. the most obvious ones that allow them to judge the field conditions and plant health.

1. The observation sites have to be prepared in advance by the team of facilitators.

- The sub-groups discuss and analyze what they observe: they must point to the links between the indicators (what is seen, i.e. effects) and the environmental factors or farmers' management practices (i.e. causes).

5. The farmer sub-groups and the facilitator depart to the field. In turn they all visit four observation sites.
   - The facilitator helps the farmer-facilitator if necessary.[2]
   - The farmer-rapporteur takes notes.

6. Back at the PLAR Center, the farmers report and comment on their results:
   - The farmer-rapporteur of the first sub-group presents the results for the first observation site, 'Field 1.'
   - The facilitator synthesizes the results in the four-column table, in the row 'Field 1.'
   - Afterwards, farmer-rapporteurs of other sub-groups 'complete' the first sub-group's report by adding comments from their sub-groups that were not mentioned by the first sub-group, and the facilitator summarizes these in the table.

Field	Observation indicators	Analysis	Decisions to be made
Field 1			
Field 2			
Field 3			
Field 4			

   - Then the farmer-rapporteur of the second sub-group presents the results of the second observation site, 'Field 2.'
   - The facilitator synthesizes the results in the row 'Field 2.'
   - Then, he/she invites the farmer-rapporteurs of the other sub-groups to complete the table.
   - And so on for Fields 3 and 4.

7. The facilitator then introduces the fifth page of the recording form for the IRM field; this is meant to train the farmers in recording the information from the field observations made during the vegetative phase.
   - The facilitator re-emphasizes the importance of recording the information and focuses on the fact that recording concerns the plot identified by the farmer where he/she intends to implement the practices learnt during the PLAR sessions. This means that recording concerns the IRM field, of which a sketch is made on the first page of the recording form.

2. In the beginning, it is very important that the facilitator makes sure that 'good' observations are made, in order to obtain accurate analyses and to make appropriate decisions.

- The facilitator explains the eight indicators:
  - Tillering (number of tillers per hill);
  - Plant density – degree of canopy closure;
  - Color of leaves;
  - Plant vigor;
  - Plant health;
  - Cleanliness of field, absence of weeds;
  - Water depth;
  - Absence of iron-toxicity symptoms;

  ☛ *for each of the indicators, the facilitator explains its importance*.

- The facilitator explains that the farmers can judge the degree of their satisfaction with the condition of their IRM field by ticking a box under the face corresponding to their judgment. If for an indicator the farmer's plot
  - gives complete satisfaction, he/she ticks the box under 
  - gives moderate satisfaction, he/she ticks the box under 
  - gives no or only little satisfaction, he/she ticks the box under 
- The farmers will then further analyze the indicators that give no or little satisfaction. They will explain the reasons for their judgment and give details of the factors causing signs of poor state of health of their fields and hence try to show the links between the indicators and the causes or factors leading to these signs or symptoms.
- For these same indicators, the farmers are questioned about the decisions they will take to improve the field (by changing their management practices) and to prevent the phenomenon from re-occurring.
- The facilitator invites each farmer to fill in page 5 of the recording form; the facilitator can help to fill in the form, if the farmer asks for help.
- The facilitator also invites the farmers to record some information on the management practices in relation to the IRM field. This information should be recorded on page 6 of the recording form, in the last table.

8. Evaluation: the facilitator asks what the farmers appreciated (or did not appreciate), what they learnt, and what they intend to do with their newly obtained knowledge. The facilitator specifically asks which new ideas this module has generated and how farmers intend to put these into practise on their IRM fields.

9. The facilitator asks volunteer farmers to conclude. He/she then invites only those farmers who have volunteered to conduct experiments to the next session, while inviting all the farmers to the session for Module 20.

Module 18

Making field observations: The vegetative phase

Time required

- Three hours

Materials required

- Strong packing paper, markers, recording forms.
- Four observation sites are identified by the facilitators:
  - Two fields with good management practices;
  - Two fields where management practices are not accurately implemented.

Box 18

The session at Lokakpli demonstrated that some farmers need time to understand the objective of making observations. Each observation field had been marked with a white signboard and the farmers made observations.

Each sub-group subsequently presented the results of their observations during the plenary sessions. Farmers had almost no problem identifying diseases or insects. Iron toxicity was mentioned several times. Many problems seemed to be linked to poor leveling. The farmers brought back samples of plants in poor health, such as plants attacked by African rice gall midge. They did not seem to have problems estimating the importance of damage in fields. The farmers often mentally divide a field into four parts and estimate the damage in each part. During this evaluation, one farmer said that spreading and incorporating rice straw before the start of the growing season gave good results. Another farmer said that he appreciated the recording forms as they helped him to keep record of the observations made.

Managing experiments, making observations and recording information during the vegetative phase

This module is specifically designed for the group of farmers conducting experiments, and refers to the experiments initiated during previous modules. In this module, two different experiments are covered: one concerns the new varieties introduced in Module 5 and the other the alternative fertilizer doses introduced in Module 10. It should be clear that this module could be adapted to any other type of field experiment. Module 19 also refers to Section 7 of Module 12, which addresses the establishment of experiments. Apart from the management aspects, this module also deals with making observations and recording information specifically from the experiments. It is important to mention that the observations and recording discussed in this module do *not* concern the IRM field; the IRM field is dealt with in Modules 11, 14, 18 and 23.

Module 19 and Module 24 form another set of modules designed to provide detailed information on the implementation and monitoring of farmers' experiments (*see also* Reference 17). In addition to this general recording form, the facilitator may plan to collect other detailed experimental data from the farmer-led experiments. In that case, other data-recording forms must be designed for the researcher's use.

❶ Recall the experimental objectives, design and treatments.
❷ Summarize the progress in the implementation of the experiments.
❸ Make field observations.
❹ Synthesize the observations in plenary session.
❺ Introduce pair-wise comparison for the experimental treatments.
❻ Introduce the recording of information and recording forms for the experiments.

Learning objectives

At the end of this module, farmers will:

- Have reviewed the different treatments of the experiments being implemented by farmers.
- Be able to decide on the management practices to carry out in the experimental fields.
- Be able to decide on the observations and records to be made for the current experiments.
- Know how to record the information on a pre-established recording form.

Procedure

1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator briefly reviews the previous module and invites farmers' feedback. The facilitator asks if the farmers have put in place any new practice on their IRM fields.

2. One of the PLAR-IRM team members explains the learning objectives and procedures for the current module. The facilitator clearly indicates that this module does not deal with the IRM fields, but with experimentation and therefore specifically addresses the group of farmers who are conducting experiments.

3. The farmers recall the experimental objectives, design and treatments for each experiment:
   - Objectives and hypotheses: what is the aim of the experiment and what do we want to learn through this experiment?
   - What are the treatments used in the experiment: what varieties are compared or what alternative fertilizer doses are compared? What is the control treatment?
   - For the fertilizer experiment, the facilitator should check what the farmers know about plant nutrients (N, P, K) and their role in plant nutrition.

4. The facilitator and the farmers discuss the progress made in setting up the experiments, and prepare a table with the names of the farmers and the key dates for action in each experiment.

   Example of a summary table

Type of experiment: e.g. varietal test on iron toxicity				
Farmer's name	**Sowing date**	**Transplanting date**	**Observations**	
...				
Type of experiment: e.g. inorganic fertilizer doses				
Farmer's name	**Sowing date**	**Transplanting date**	**Date 1st urea application**	**Date 2nd urea application**
...				

   This table allows each farmer to identify the interventions to be carried out during the coming weeks. It also allows them to choose the fields to be visited by the PLAR-IRM team.

5. The facilitator leads a discussion on the importance of regular observation of the experimental fields and the necessity to develop performance indicators, which allow comparison between treatments.

6. The facilitator explains the *procedure* for making observations on the experiments:
   - A farmer-facilitator and a farmer-rapporteur are chosen for each sub-group.
   - Each sub-group of farmers will visit the four experimental sites—if there are two types of experiments, two fields for each experiment will be visited.
   - Farmers in each of the sub-groups will make field observations:

     – The farmers will observe and judge the overall performance of the field and the crop: soil, water, cleanliness of field and bunds (i.e. absence of weeds), plant health status and plant development stage as compared to surrounding fields;
     – The farmers will make comparisons between the treatments and with the control treatment, and decide on the 'comparison indicators' (e.g. color, height, stem vigor, tillering, vegetative cover);

- The farmers will discuss the reasons for these different results: is there a relation between the treatments and the experimental factors, or are the differences based on other factors such as management practices or environmental conditions?

7. The farmers who are conducting experiments and the facilitator depart to the field to visit the four experimental sites, previously identified by the facilitators.
   - The facilitator helps the farmer-facilitator if necessary.
   - The farmer-rapporteur takes notes.
8. Back at the PLAR Center, the farmers report, summarize and comment on their results.
   - The farmer-rapporteur of the first sub-group presents the results of the first site: (i) overall performance of the field, environment and plants, (ii) 'comparison indicators' between treatments, (iii) causes of differences between treatments.
   - The facilitator synthesizes the results in the four-column table.

   Example: Experiment 1:…

Overall performance	Comparison indicator	Cause of difference between treatments
Field 1		
Field 2		

   - After summarizing the information for the first experiment (Field 1), the second experiment (Field 2) is dealt with.
9. The facilitator then introduces the pair-wise comparison method: he/she prepares a matrix table with the treatments in rows and columns.

   Matrix for pair-wise comparison of treatments (to do for each type of experiment)

	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Treatment 1				
Treatment 2				
Treatment 3				
Treatment 4				

For each white cell, the farmers' preference from the pair of treatments compared is recorded.

   - Farmers are invited to identify the best treatment for each pair, and this choice is recorded in the corresponding cell. It is clear that the opinions of the farmers may differ. When this is the case, it is possible to record the number of farmers choosing one treatment rather than the other.
   - The farmers discuss the reasons for their choices.

10. The facilitator leads a discussion on the benefits of recording information about the experiments. The farmers decide what information they want to record:
    - Information about the management practices:
        - dates of: sowing, transplanting, fertilizer application, weeding, insecticide application, irrigation, etc.
    - Information about the comparison indicators between treatments (e.g.):
        - color, vigor, height, health, plant density;
        - tillering;
        - cleanliness of field.
11. The facilitator introduces a recording form for each type of test. This form should be simple enough to allow the farmers to record their data with the help of the facilitator or any other field agent. This form consists of a single page and will be filled in during the session for Module 24.

    An example of a recording form is shown on the facing page; nevertheless this form will have to be adapted to the type of experiment and to the information that the farmers and the facilitator decide to record. The form consists of three parts:

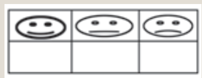
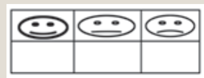
    - Data about management practices, mainly the dates of interventions (leave empty rows to be filled-in during session on Module 24).
    - Data on comparison observations (leave empty rows to be filled-in during session on Module 24).

      The pair-wise comparison matrix of treatments (two: one to fill in during the vegetative phase and the other during the maturity–harvest phase; *see* Module 24).

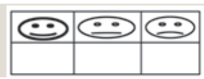
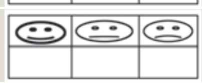
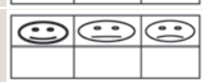
    For practical reasons, a draft form can be presented during this session, but will have to be finalized by the facilitators after the session. Each farmer participating in the test receives a copy. Keep in mind that the farmers should always bring their recording forms when coming to the PLAR-IRM Center.

Example of a recording form (to establish for each type of test)

Name: .... Village: .... Inland valley site:	Sex: Male? Female? Age: ....

	Treatment 1	*Treatment 2*	
Management practices			
Sowing date			
Transplanting date			
Fertilizer application: - 1: Date / type / quantity - 2: Date / type / quantity - 3: Date / type / quantity			
Weeding: - 1: Date - 2: Date			

Comparison observations

Color of plants			
Vigor of plants			

Pair-wise comparison matrix of treatments (vegetative phase)

	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Treatment 1				
Treatment 2				
Treatment 3				
Treatment 4				

For each white cell, the farmers' preference from the pair of treatments compared is recorded.

Pair-wise comparison matrix of treatments (maturity–harvest phase)

	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Treatment 1				
Treatment 2				
Treatment 3				
Treatment 4				

For each white cell, the farmers' preference from the pair of treatments compared is recorded.

12. Evaluation: the facilitator asks what the farmers appreciated (or did not appreciate), what they learnt, and what they intend to do with their newly obtained knowledge.
13. The facilitator asks volunteer farmers to conclude the session, and then invites farmers to the next session.

Time required

- Three hours

Materials required

- Strong packing paper, markers.
- Summary table (Section 4), synthesis table (Section 8) and comparison matrix (Section 9); these can be prepared in advance on strong packing paper.
- A draft form of the recording form (Section 11) can be prepared on A4 format.

Box 19

During the session in Bamoro, we first discussed the on-going experiments on the management of soil fertility. It became clear that the farmers were not well aware of the existence of the different treatments. We therefore reviewed the different treatments and their effectiveness.

Subsequently, we discussed the varietal experiments, which the farmers understand more easily. They knew that the varieties WITA 7, 9 and 12 had been chosen for their good yields, WITA 4 and WAB 638 for their good taste, Suakoko 8 for the zones susceptible to inundation, and WITA 1, 3 and CK4 for the zones known for iron toxicity. The farmers had noticed the good tillering and green leaves of WITA 4.

Then we left for the field. Some farmers had difficulties filling in the form. There was not enough space to fill in the observations. The sheet has to be split into two or three pages. It would also be efficient to use symbols for the illiterate farmers. Farmers had difficulties rating weed infestation. The sheet had to be refined. We took samples of plants suffering from waterlogging, from African rice gall midge and from stem borer.

Afterwards, the results were discussed in plenary session. These discussions made clear that there were problems of diseases and insects in Bamoro. A weed called ‘lettuce’ was also a problem here.

Insects in rice cultivation

When human beings don't eat well enough, they will not be healthy and will easily fall ill. Taking medicine in such a state is quite meaningless, as the cause of the illness is known: it is due to an inappropriate diet. This is also true for plants. Indeed, healthy plants are naturally protected against attacks from diseases and pests. For a plant to be in good health, there should be enough sunlight, space, water and nutrients. Module 10 dealt with a healthy soil and the role of nutrients in growing healthy, vigorous plants. In spite of all the precautions that may have been taken to grow healthy plants, they cannot be totally protected from harmful insects. Parts of the plant may suddenly begin to fade or to change shape, or color. The first thing to do is to make good observations of the problem. Next, a sound analysis is made of the problem, resulting in appropriate decision-making of what to do. As previously seen in Modules 11, 14 and 18, it is important to make an accurate analysis, as this will lead to taking appropriate decisions. In this module, we will discuss insects that endanger rice cultivation and insects that are beneficial to rice growth (Reference 21).

❶ Summarize farmers' knowledge on harmful insects: identification and damage to rice.
❷ Make observations in the field.
❸ Synthesize the observations in plenary session.
❹ Discuss differences between useful and harmful insects in rice cultivation.

Learning objectives

At the end of this module, the farmers will be able to:

- Recognize the most common harmful insects (*enemies of rice*) and the useful insects (*friends of rice*) in rice production.
- Recognize the types and the importance of damage and of the diseases caused by insects.
- Classify insect damage in relation to the development stages of the rice plant.
- Recognize the different stages in the development of the major harmful insects.

Procedure

1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator briefly reviews the Module 18 and invites farmers' feedback. The facilitator asks if the farmers have put in place any new practice on their IRM fields.
2. One of the PLAR-IRM team members explains the learning objectives and procedures for the current module.
3. Summarize farmers' knowledge of insect damage and management in rice. The facilitator starts the debate by asking the following questions:
   - What is a healthy plant? (Recalling the discussion in Module 10.)
   - How do you know a plant is not in good health?

- Could you list some symptoms of disease or some damage caused by insects?
  – Which ones? The facilitator will need to be cautious—the farmers themselves should have made the observations of symptoms or damage!
  – At which stage of growth of rice do these symptoms or damage occur on the field?
  – Which insect or agent causes these symptoms or damage? The facilitator stresses the importance of the farmers differentiating between symptom or damage and the causative agent or insect; this is linked to the distinction between observation (symptoms or damage signs) and analysis (causative agent or the insect responsible for the damage).
- Are there other insects that can often be found in the paddy fields?
  – Do these insects also cause any damage?
  – If not, what do they do?

4. The facilitator presents the *procedure* for field visit and observation.
   - Division into four sub-groups of four or five farmers.
   - Designation of a farmer-facilitator and of a farmer-rapporteur for each sub-group.
   - Each sub-group will visit four sites.[1]

5. The farmers and the facilitator depart to visit the four sites.

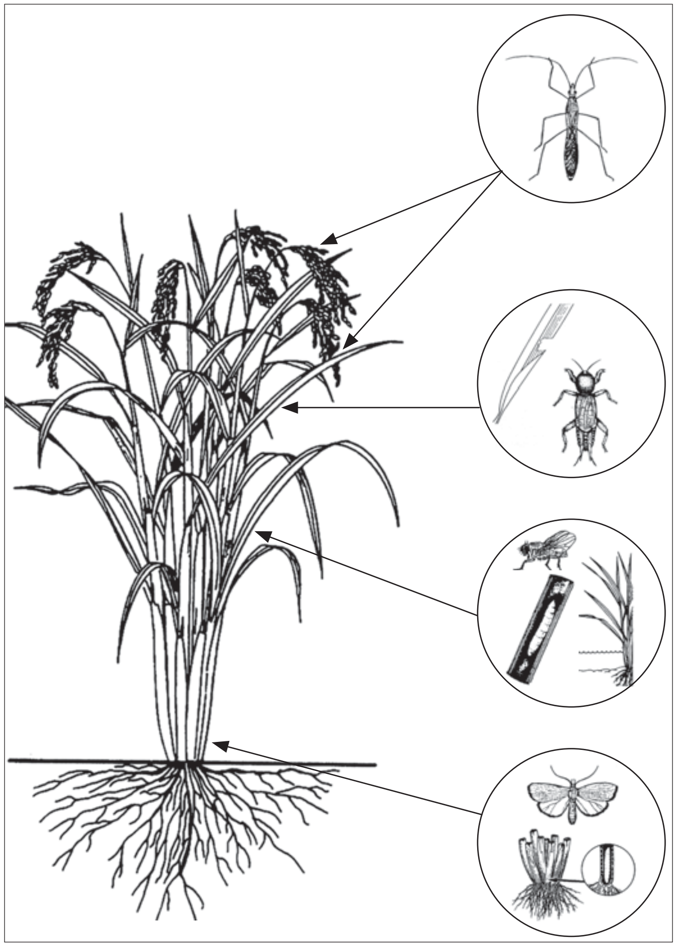
   - Visit of the fields with rice plants in different rice development stages.
   - Observation of the symptoms of disease (or damage) due to insects on rice plants.
   - Discussion of the importance and causes for each of the damage symptoms observed.
   - Sampling of damaged rice plants, which are placed in small plastic bags.
   - Sampling of the insects found in the field, which are caught using an insect trap and then kept in glass jars.

6. Back at the PLAR-IRM Center, the farmers report and comment on their results: each sub-group presents its samples of damaged rice plants and its jars containing insects.
   - The facilitator prepares a large sheet of strong packing paper: he/she draws a six-column table with the following headings:

Symptom description	Type of damage	Plant development stage	Cause / agent	Importance of damage	Harmful effect on rice yield
...	...	...	...	...	...
...	...	...	...	...	...

1. The team of facilitators should prepare the observation sites in advance.

- The first sub-group's rapporteur begins by describing the symptoms in the first plant sample.
- The facilitator briefly notes the description in the first column.
- The facilitator invites the farmers in this sub-group to specify the type of damage; he/she helps the farmers by telling them that it can be:
  - Cut leaves;
  - Deformed leaves;
  - Perforated leaves;
  - Discolored or spotted leaves;
  - Drilled/bored stems;
  - Discolored panicles;
  - Cut panicles, etc.



- The farmers specify the stage of plant development that the symptom appears.
- Then the facilitator encourages debate on the causes of the damage and tries to obtain the widest range of information from the farmers:
  - When the farmers mention an insect as the cause, he invites them to identify ("to find") the insect on the leaves or the roots, inside the stem (as a larva) or in one of the jars;
  - The facilitator notes the causes mentioned by the farmers, even when the farmers mention causes other than insects—local names will be used preferably;
  - Using the data from Reference 21, the facilitator can also add elements about:
    - the different stages in the development of insects (the life-cycle) and the most sensitive development stages for rice,

- ❍ the kind of damage: the distinction between four types of infestation by insects and larvae must be clearly made:[2]
  - √ those that stay outside the leaf, and cut or nibble/gnaw them,
  - √ those that enter the plant through the leaf and migrate downwards,
  - √ those that enter the plant from the bottom of the stem or the roots and migrate upwards,
  - √ those that suck the sap from the leaves and grains and thus transmit diseases from one plant to another (compare with HIV/AIDS),
- ❍ the factors due to weather, environment and management practices which may influence the degree of infestation,
- ❍ natural enemies.

- After surveying all the damage found by the first group, the facilitator asks the other farmer-rapporteurs if their sub-groups found some other damage different from these already mentioned. In such a case, these will be added to the table.
- Then, using column 5, the farmers classify all the damage described by degree of severity, by scoring: for instance, score 1 for the most severe damage, 2 to the second most severe, and so on. The same process is repeated for column 6.
- The facilitator encourages discussion about the damage (and causes) that the farmers considered as most important. The facilitator explains that, in the following weeks, the ways to tackle these problems will be discussed.

7. The facilitator initiates debate on possible beneficial insects (and similar creatures) to rice cultivation.
   - The farmers identify the insects (and similar creatures) that cause no harm to rice but that are nevertheless often present in the field. The farmers describe what these insects (and similar creatures) do and how they feed.
   - If necessary, the facilitator gives some details about the behavior, life-cycle and activity of these beneficial insects (and similar creatures) (Reference 21):
     - Dragonflies;
     - Spiders;
     - Grasshoppers/locusts with long antennae.

8. The facilitator initiates a discussion on how to preserve useful insects:
   - He explains that certain weeds can shelter useful insects; e.g. *Paspalum scrobulatum* shelter natural enemies of rice gall midge. He tries to find the plant in the field and identifies the local name together with the farmers ;

2. Apart from these four types attacking the plants, there are also bugs that attack and suck grains (sucking bugs).

- Various means to preserve useful insects are discussed (e.g. to avoid buring the rice stubble and to leave *Paspalum scrobulatum* on the field bunds) and the risks of using insecticides and herbicides are listed.

9. Evaluation: the facilitator asks what the farmers appreciated (or did not appreciate), what they learnt, and what they intend to do with their newly obtained knowledge. The facilitator specifically asks which new ideas this module has generated and how farmers intend to put these into practise on their IRM fields.

10. The facilitator asks volunteer farmers to draw conclusions from the session, and then invites farmers to the next session.

Time required

- Three hours

Materials required

- Strong packing paper and markers.
- Small plastic bags.
- Insect traps.
- Samples of the growth stages of the most widespread harmful insects; preferably as models, photos or drawings.
- The team of facilitators will have identified four observation sites representative of four rice development stages: just after transplanting, vegetative stage, reproductive stage, and maturity stage. They will have to make sure that these sites show insect damage.

Box 20

We explained the objectives of the module to farmers in Lokakpli and Bamoro by giving the following example. If someone is ill, she or he can show symptoms such as tiredness, aching joints and headache. These are symptoms that point to malaria. Malaria is the sickness and the headache is a typical symptom of malaria.

The farmers then talked about what they know about damage caused by insects. They mentioned: rice 'dead heart'; black spots on rice grains; yellowing of leaves after transplanting; caterpillars at the panicle stage; rice can also dry up in some areas. The farmers also talked about the causes of damage and mentioned: green caterpillars, which seem to induce seedling yellowing in the nursery; locusts eating the leaves at panicle-initiation stage; red worms gnawing the roots after transplanting; dragonflies sucking plant sap while fluttering from seedling to seedling; white butterflies, which lay eggs that become larvae that bore into the stems; ladybirds on rice; the fly with antennae, which cuts the leaves; there are also caterpillars inside the rice leaves.

Afterwards, we made three sub-groups of farmers and departed for two different fields, where we collected plants and insects. After coming back, we collected the data, beginning with the first sub-group. The observations are summarized in the following table:

Symptom description	**Type of damage**	**Plant development stage**	**Field occurrence**	**Effect on yield**	**Cause**
1. White leaf – onion leaf	Discolored and deformed leaves	Vegetative stage: 0–15 days: +++; 15–50 days: ++; >50 days: 0	++	+++	Insect (gall midge larva)
2. Cut and nibbled leaves	Cut leaves	Vegetative stage > 50 days	+++	+	Locusts Butterfly larvae
3. The heart of the flag leaf is yellow to brown and is dead	Discoloration and deformation of stem and leaf	Beginning of panicle initiation	+++	++	Various butterfly species
4. Yellow and brown round spots on leaves	Discolored and spotted leaves	Fleshy vegetative stage or aged nursery	++	+++	Grasshoppers transmitting rice yellow mottle virus
5. Perforated leaves with translucent areas filled with gnawing insects	Perforated leaves	Fleshy vegetative stage after tillering	+++	+	Small white insect (Caseworm or *Nymphula*)
6. White empty seeds	Discolored and cut panicle	Flowering stage	+	+	Drought Insect if the panicle can be withdrawn easily: *Sesamia*

1. Some farmers noticed neither the insect nor the larvae: this suggests they don't know them. We asked farmers to open the 'onion leaf' so that they could find the larva. After that demonstration, they understood that the larva had entered the leaf and that, before becoming a larva, there had been an egg laid by an insect, they named 'mosquito.' We showed them a photo of the insect. Farmers had difficulty making the link between the larva and the adult; then they were shown a picture of an immobilized cocoon; they then understood that the larva had transformed into a cocoon and that the cocoon would undergo other transformations before becoming an adult midge.
2. No specific comments.
3. The farmers found a hole at the bottom of the stem, which they opened and where they found a larva. We explained that the soil had a role in the cycle: the insect lays eggs on the grass, the larvae survive in the soil waiting for the rice to grow, and then they enter the stem from the bottom.
4. This is an example of transmission of the rice yellow mottle virus; there are several insects that can transmit this virus as the locusts do.
5. These larvae hibernate inside the leaves and stay there.
6. No specific comments.

Afterwards we talked about the insects (and similar creatures) that are not harmful, which are beneficial because they eat the pests, for instance, ladybirds and spiders. The insect reproduction cycle was also presented: Adult–egg–larva–cocoon (pupa)–adult.

Integrated pest management: African rice gall midge

This module is directly linked to Module 20 and provides details about methods used to control an insect that is harmful to rice. In this module, insect management will be considered in an integrated way, which means that the control will not be based on a single technique but rather that different methods of control will be used. The choice of different methods and combining them in an integrated manner requires a good knowledge of the life-cycle of the insect. Various aspects of insect control were initiated in Module 20 and will be completed in this module. It must be made clear that use of insecticides usually demonstrates a lack of understanding of the biology of these insects. Use of insecticides should be avoided. Insecticides can be considered as poisons that not only kill the insects, but disturb the ecosystem as a whole. This is because most insecticides are not manufactured to target a specific insect, but can kill all kinds of insects, including beneficial ones (Module 20). This module focuses specifically on African rice gall midge, the insect that causes 'onion tubes' to appear in the rice crop (Reference 22).

❶ Recall the different types of attack by harmful insects.

❷ Review farmers' knowledge and their practices.

❸ Introduce the basic principles of integrated pest management.

❹ Reconstruct the life-cycle of African rice gall midge.

❺ Discuss the methods for integrated management of African rice gall midge.

Learning objectives

At the end of this module, farmers will:

- Know the different methods for controlling harmful insects: chemical control and control through improved crop management practices using preventive and curative methods.
- Be aware that integrated and effective management of harmful insects must be based on a combination of these methods, and that the use of insecticides should be avoided.
- Be able to evaluate the nature, severity and economic importance of the damage caused in view of taking appropriate action (intervention).
- Be able to make rational decisions about insect control according to (i) the nature and severity of the attack, and (ii) the development stage of the rice plant and of the insect.

Procedure

1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator briefly reviews the previous module and invites farmers' feedback. The facilitator asks if the farmers have put in place any new practice on their IRM fields.

2. One of the PLAR-IRM team members explains the learning objectives and procedures for the current module.

3. Recall the main types of attack from harmful insects (Module 20). If necessary, the facilitator helps the farmers to complete the list:
   - Insects that cut or nibble the leaves.
   - Insects that enter the plant through the leaves and migrate down the stem.
   - Insects that enter the stem from the bottom or from the roots and migrate upwards.
   - Insects that suck the leaves' sap and thus transmit diseases from plant to plant (comparison with malaria).
   - Insects that attack and suck grains (sucking bugs).

4. The facilitator leads a discussion of farmers' knowledge and practices for controlling harmful insects and shows the diversity of knowledge and practices among farmers: for each practice identified, the farmers are invited to share individual knowledge and to be specific on the following points:
   - Is it a curative or preventive control method?
   - Is this practice targeting one specific insect or is it a rather a generalized intervention?
   - If necessary, the facilitator shows the difference between curative and preventive methods by explaining the treatment of a sickness like malaria: (i) treating with Quinemax after the patient has displayed some symptoms of malaria is a curative action, while (ii) avoiding mosquito bites by sleeping under a mosquito-net is a preventive action.
   - The facilitator draws a five-column table on a large sheet of strong packing paper to note the farmers' answers. The headings will be as follows:

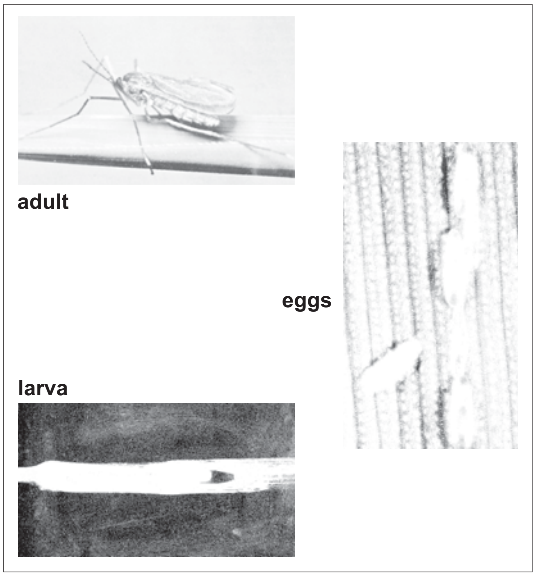
Practice / knowledge	Curative	Preventive	General	Specific/targeted
...	...	...	...	...
...	...	...	...	...

   - The facilitator asks the farmers to give their opinion on the importance and the efficacy of each practice.

5. The facilitator introduces the basic principles of integrated pest management by presenting the following elements (Reference 21):
   - The ecosystem as host to the rice plant, other plants, and insects (both harmful and beneficial).
   - The dangers of insecticides, which are poisons and which, in most cases, do not target specific insects but kill all kinds of insects (and other creatures), including useful ones.
   - The dangers of insecticides to human health.
   - The risk of limiting insect control to a single technique.

- The efficiency achieved by combining several methods; and, moreover, the principle that it is better to prevent (preventive actions) than to cure (curative actions).
- The need to thoroughly understand the behavior and biology of the insect in order to be able to make rational decisions.

6. The facilitator encourages discussion about the integrated management of African rice gall midge[1] (causing 'onion leaves' to appear in the rice crop), one of the main rice insect pests.



The life-cycle of African rice gall midge[2]

- The facilitator shows samples of rice plants presenting the symptoms of African rice gall midge attack.
- Briefly review the symptoms and the type of attack (Module 20). Distinguish between these symptoms and the symptoms of 'dead heart' caused by drought.
- One farmer is invited to find 'the insect' (Module 20); if necessary, the facilitator will help him/her.
- After isolating the larva from the stem, the facilitator shows a picture of the larva inside an 'onion leaf' and places the picture at the bottom of the board.
- Thereafter, the farmers deduce the origin of the larva and how it entered the plant.
- Then the farmers have to find where the eggs were laid and what happened to the eggs. The facilitator shows pictures of eggs and of the adult insect and places these pictures on the board, respectively to the right and directly above the picture of the larva.
- Next, the facilitator helps the farmers to describe what happens to the larva after it has eaten enough. In order to rest, it builds a home in which it hides and stays still before transforming itself into an adult flying insect. The facilitator shows the picture of the cocoon and places it on the board to the left of the larva.
- Then the facilitator shows, by drawing arrows between the different pictures, that the life-cycle of African rice gall midge is a four-stage cycle.
- After reconstructing the life-cycle of African rice gall midge, the facilitator helps the farmers to determine the duration of each stage and at which stage of rice plant development each insect stage occurs. The facilitator notes these answers on the board.

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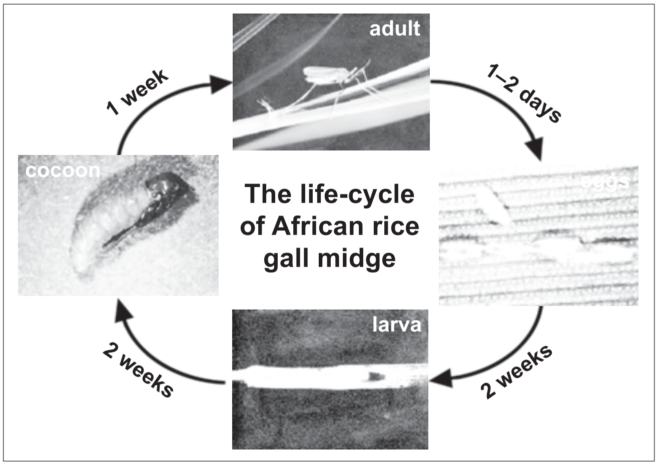
1. The facilitator or some farmers will bring some samples of rice attacked by gall midge.
2. The facilitator will be using representations of the insect, the larva, the cocoon, the eggs (*see also* Materials required).



- The facilitator assists the farmers in evaluating the number of eggs laid by an adult female and hence shows the potential multiplying factor of 400 in a five-week period.
- If required, the facilitator gives more information about the insect's biology.

Control methods

- The facilitator encourages the farmers to think about the life-cycle of African rice gall midge, and asks the following questions:
  - How is it possible to interrupt the life-cycle of African rice gall midge?
  - Is it easy to attack the larva, the cocoon or the eggs?
  - Given the short life of the adult, is it easy to kill the insect?
  - What is the feasibility of using a curative method as compared to a preventive method to solve the problem?
  - How is it possible to prevent the adult insects from multiplying and thus from laying eggs?
    - ❍ the facilitator leads the following reasoning: if today one midge lays 400 eggs on a seedling in Farmer A's nursery (which was the first to be sown), after a month, there will be 400 new midges, of which 200 will be females. When Farmer B will be sowing three weeks later, the 200 females (from Farmer A's plot) can, in theory, lay 80,000 eggs. How could such a multiplication of midges be avoided? In general, the farmers rather quickly state that the solution lies in simultaneous sowing;
- Then the facilitator asks where the insects may survive when there is no rice in the field. If the farmers do not find the answer, the facilitator assists the farmers to understand that the insect can also infest some weeds, e.g. wild rice (*Oryza longistaminata*):
  - the facilitator assists the farmers in identifying ways to avoid a high population of the insect's adult stage (midges) at the beginning of the season. In general, the farmers quickly state that the solution lies in bund cleaning and regular weeding;

- The facilitator assists the farmers in finding other ways to control African rice gall midge, e.g. treating the nursery with a low dose of insecticide three days before transplanting, appropriate water management, or synchronized sowing.

7. The facilitator introduces discussion on preserving beneficial insects.
   - He/she explains that certain weeds play host to beneficial insects, for example, *Paspalum scrobulatum*, which plays host to natural enemies of African rice gall midge. He/she identifies the plant and asks the farmers for the local name.
   - He/she elaborates with farmers the possible ways of preserving the plant:
     - They reflect on how to prevent putting fire in the farm, and thus preserve *Paspalum scrobulatum* plants;
     - They reflect on the danger associated with indiscriminate use of insecticides or herbicides, which could kill all insects including the beneficial ones, or kill plants including the host.
8. Evaluation: the facilitator asks what the farmers appreciated (or did not appreciate), what they learnt, and what they intend to do with their newly obtained knowledge. The facilitator specifically asks which new ideas this module has generated and how farmers intend to put these into practise on their IRM fields.
9. The facilitator asks a volunteer farmer to make a summary and conclude the session, and then invites farmers to the next session.

Time required

- Three hours

Materials required

- Strong packing paper and markers.
- Samples of rice plants manifesting the symptoms of 'onion leaf.'
- Pictures on glazed paper representing the four stages of African rice gall midge life-cycle.

Integrated pest management: Rice stem borer

This module is similar to Module 21 and is also closely linked to Module 20. In this module, the integrated management of the rice stem borer is considered. Several species of rice stem borers are found in West Africa (e.g. *Maliarpha*, *Diopsis*, *Sesamia* and *Chilo* species), but in this module, only one of the species (*Diopsis*) is discussed as an example of integrated pest management (Reference 23).

❶ Make observations in the field; sample infected plants.
❷ Reconstruct the life-cycle of a species of rice stem borer most common from the samples.
❸ Discuss the methods of integrated management of stem borer.

Learning objectives

At the end of this module, farmers will:

- Be able to recall the main attacks of harmful insects, the different control methods and the principles of integrated pest management.
- Be aware that it is the combination of methods that builds integrated and effective management of harmful insects.
- Be able to evaluate the nature, severity and importance of damage with a view to taking rational decisions for integrated control.
- Be able to take rational decisions to control the insect, based on the (i) nature, severity and importance of the attack, and (ii) development stage of the rice plant and of the insect.

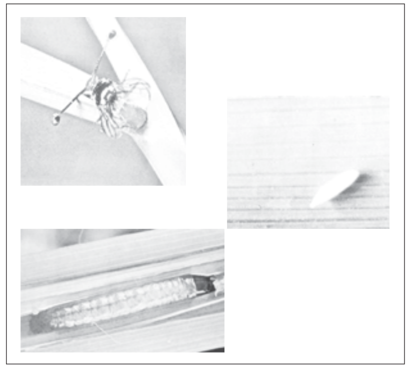
Procedure

1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator briefly reviews the previous module and invites farmers' feedback. The facilitator asks if the farmers have put in place any new practice on their IRM fields.
2. One of the PLAR-IRM team members explains the learning objectives and procedures for the current module.
3. In a brief review, the farmers recall the types of attacks by insects (Module 20), the control methods and the principles of integrated pest management (Module 21). If necessary, the facilitator helps the farmers.
4. The facilitator presents the working *procedure* for the field observations:
   - Division into four sub-groups of four or five farmers.
   - Designation of a farmer-facilitator and of a farmer-rapporteur for each sub-group.

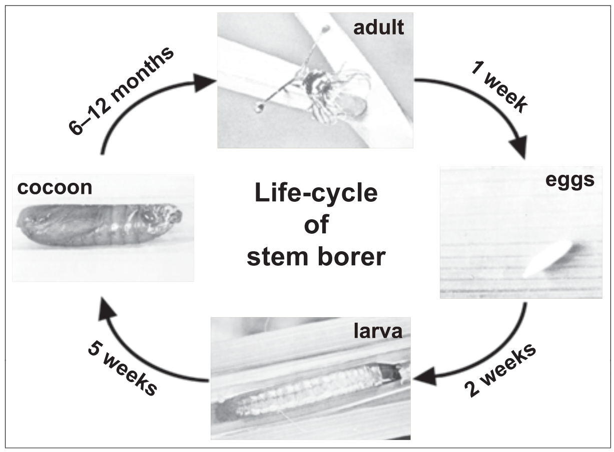
- Each sub-group will visit four sites:[1] the farmers will have to find examples of the damage caused by stem borers.

5. The facilitator and the farmers depart to the field for observation and sampling.
   - Visit to the different fields at different stages of rice development.
   - Observation of the different symptoms and discussion of their severity and importance.
   - Sampling of damaged rice plants, which are placed in small plastic bags.
   - Sampling of insects present in the field, which are caught using sweep nets and then kept in glass jars.
6. Back at the PLAR-IRM Center: presentation of the sub-groups' observations.
   - Each sub-group places its samples of damaged rice and its glass jars on the ground.
7. Reconstruction of the life-cycle of stem borer.
   - Brief review of the various symptoms and types of attack (Module 20).
   - The farmers distinguish between the two main symptoms—'dead heart' and 'white panicle', and also the differences in attack related to plant development stages.
   - They compare the rice developmental stages at which the attack of stem borers is most noticeable with that of African rice gall midge, and farmers discuss the differences:
     – The facilitator assists the farmers in finding the answer for themselves: African rice gall midge appears soon after transplanting, whereas 'dead heart' symptoms are generally observed later in the vegetative stage, and 'white panicles' only after flowering.
   - The farmers discuss the causes for such differences:
     – The facilitator assists the farmers in finding the answer: there is a difference in the life-cycles.
   - The farmers discuss the implications of these differences between African rice gall midge and stem borer, with respect to the risks of proliferation and the implications for rice yield:
     – The facilitator encourages the farmers to think of the relationship between (a) plant vigor, health and age, and (b) its vulnerability to insect attack, and then to evaluate the potential impact of attack before and after tillering.
   - The facilitator briefly reminds the farmers of the interest in understanding insects' life-cycles in order to choose the right time and the right plant development stage to intervene (control).
   - The farmers are divided into their sub-groups and encouraged to find the insects by opening the stems of the plants they sampled in the field.

1. The observation sites should be prepared in advance by the team of facilitators. They should preferably comprise sites showing rice at different growth stages, e.g. at vegetative stage and presenting the symptoms of 'dead heart,' at reproductive stage or maturity stage presenting the symptoms of white panicles.



- After isolating the larva, the facilitator shows the picture of a larva that can be found in infested stems, and places this picture at the bottom of the board.[2]
- Thereafter, the farmers should deduce the origin of the larva and how it entered the stem.
- Next, the farmers have to find where the eggs were laid and what happened to them. The facilitator shows pictures of eggs and of the insect and pins these pictures on the board, respectively to the right and above the picture of the larva.
- Next the facilitator assists the farmers in describing what happens to the larva after it has eaten enough. In order to rest, the larva builds a home where it hides and 'hibernates' until it transforms into an adult insect that can fly. The facilitator shows a picture of a cocoon and pins the image on the board, to the left of the larva picture.



- The facilitator then shows—by drawing arrows between the different pictures—that this represents the four-stage cycle of the insect.
- After reconstructing the life-cycle of a stem borer, the facilitator assists the farmers in determining the duration of each life stage and aligning each with the corresponding rice development stage:
  - The facilitator must demonstrate that the life-cycle of the stem borer (*Diopsis*) is much longer than that of African rice gall midge. Its larval stage can last up to five weeks, as compared to two weeks for African rice gall midge. Furthermore, the adult stage is also longer. The *Diopsis* cocoon, for example, can remain for up to 12 months if the conditions for cocoon hatching are not favorable.
- If necessary, the facilitator provides more information about the insect's biology.

2. We have chosen here the example of *Diopsis*, because it is one of the most frequent stem borers found in the area around Lokakpli and Bamaro where the PLAR-IRM work was initiated.

Control methods

- The facilitator encourages the farmers to reflect on methods for controlling stem borers (in this case, *Diopsis*), using the knowledge obtained from the life-cycle. He/she will stimulate the debate by dealing with the following topics:
  - How can the life-cycle of the stem borer be interrupted?
  - Which of the insect's developmental stages will be easier to attack or eliminate—eggs, larva, cocoon (pupa) or adult?
  - What method control would be more feasible: curative or preventive?
- Next, the facilitator stimulates farmers' curiosity to find out where the cocoon is hidden during unfavorable periods (i.e. when it hibernates) and asks farmers to suggest or identify ways to destroy the cocoons.
  - If necessary, the facilitator may suggest burning crop residues or flooding the field completely for at least three days before plowing.
- The facilitator encourages the farmers to think about other possible techniques for controlling stem borer, for instance, localized insecticide treatment or the use of a trap crop (Reference 23).

8. Evaluation: the facilitator asks what the farmers appreciated (or did not appreciate), what they learnt, and what they intend to do with their newly obtained knowledge. The facilitator specifically asks which new ideas this module has generated and how farmers intend to put these into practise on their IRM fields.

9. The facilitator asks a volunteer farmer to draw conclusions from the session, and then invites farmers to the next session.

Time required

- Three hours

Materials required

- Strong packing paper and marker pens.
- Observation sites with severe damage by stem borers, both at vegetative stage (with 'dead heart') and at reproductive stage (with 'white panicles').
- Pictures showing the four stages in the life-cycle of stem borers.
- Small plastic bags and glass jars.

Making field observations: Reproductive phase

This module is the continuation of Modules 11, 14 and 18, and covers observations to be made about two to three months after transplanting, during the reproductive phase of the rice crop.

❶ Recall the principles of making observations and determining observation indicators.

❷ Make field observations in sub-groups.

❸ Summarize observations in plenary session.

❹ Introduce page 5 of the recording form for the IRM field.

Learning objectives

At the end of this module, farmers will be able to:

- Review the importance of making regular field observations, enabling them to analyze crop development, its environment and production practices, as well as to take decisions for appropriate action.
- Decide on the observations to be made and on the 'observation indicators' specifically related to the reproductive phase.
- Record the information on the recording form.

Procedure

1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator briefly reviews the previous module and invites farmers' feedback. The facilitator asks if the farmers have put in place any new practice on their IRM fields.

2. One of the PLAR-IRM team members explains the learning objectives and procedures for the current module.

3. The facilitator recalls the importance of observing and the concept of 'observation indicator' (Modules 11, 14 and 18), and invites the farmers to present the filled-in pages of the recording form for their IRM fields. Difficulties in filling out the recording form are discussed.

4. The facilitator explains the field-observation *procedure* in PLAR-IRM.
   - The farmers are divided into four sub-groups of four or five farmers.
   - A farmer-facilitator and a farmer-rapporteur are chosen for each sub-group.
   - Each farmer sub-group visits four sites[1] with plants at reproductive phase—preferably two fields in 'good' (optimal) condition and two fields in 'poor' (less-than-optimal) condition.
   - Make field observations in sub-groups: the farmers decide which indicators are important to them, allowing them to judge field conditions and plant health.
   - Discussion and analysis in sub-groups of what has been observed: establish links (through analysis) between the indicators (what is seen, i.e. effects) and the environmental factors or farmers' management practices (i.e. causes).

1. The observation sites should be prepared in advance by the team of facilitators.

5. The farmer sub-groups and the facilitator depart to the field. In turn, they all visit the four observation sites.
   - If necessary, the facilitator helps the farmer-facilitator.[2]
   - The farmer-rapporter takes notes.
6. Back at the PLAR Center, the farmers report and comment on their results:
   - The farmer-rapporteur of the first sub-group presents the results for the first observation site, 'Field 1.'
   - The facilitator synthesizes the results in the four-column table, in the row 'Field 1.'
   - Afterwards, farmer-rapporteurs of other sub-groups 'complete' the first sub-group's report by adding comments from their sub-groups that were not mentioned by the first sub-group, and the facilitator summarizes these in the table.

Field	Observation indicators	Analysis	Decisions to be made
Field 1			
Field 2			
Field 3			
Field 4			

   - Then the farmer-rapporteur of the second sub-group presents the results from the second observation site, 'Field 2.'
   - The facilitator synthesizes the results in the row 'Field 2.'
   - Then, he/she invites the farmer-rapporteurs of the other sub-groups to complete the table.
   - And so on for Fields 3 and 4.
7. The facilitator then introduces page 5 and the top of page 6 of the recording form for the IRM field—this is meant to train the farmers in recording field observations at the reproductive phase of the rice crop.
   - The facilitator recalls the importance of recording the information and focuses on the fact that recording concerns the plot(s) identified by the farmer where he/she intends to implement the practices learnt during the PLAR sessions, so recording concerns the IRM field, of which a sketch is made on the first page of the recording form.
   - The facilitator explains the six indicators:
     – Plant density or soil cover;
     – Number of fertile tillers;
     – Absence of disease symptoms;
     – Absence of insect damage;

2. In the beginning, it is very important that the facilitator makes sure that 'accurate' observations are made, in order to obtain relevant analyses and to make good decisions.

- Cleanliness of field, absence of weeds;
- Water depth,

☛ *the facilitator explains the importance of each indicator.*

- The facilitator explains that the farmers can judge the degree of satisfaction for the condition of their IRM field by ticking a box under the face corresponding to their judgment. If for an indicator the ICM plot
  - gives complete satisfaction, he/she ticks the box under 
  - gives moderate satisfaction, he/she ticks the box under 
  - gives no or only little satisfaction, he/she ticks the box under 
- Then farmers further analyze the indicators that give no or little satisfaction. They give reasons for their judgment and details of the factors causing the observed 'poor' state of the field. They then try to link the indicators and the causes or factors leading to these signs or symptoms.
- For these same indicators, they elaborate on their decisions to implement changes in their management practices to obtain better results or to prevent the phenomenon from re-occurring.
- The facilitator invites each farmer to complete page 6 of the recording form; the facilitator can help to fill in the form, if the farmer asks for help.
- The facilitator also invites the farmers to record some information on the management practices in relation to the IRM field, on page 6 of the recording form, in the last table.

8. Evaluation: the facilitator asks what the farmers appreciated (or did not appreciate), what they learnt, and what they intend to do with their newly obtained knowledge. The facilitator specifically asks which new ideas this module has generated and how farmers intend to put these into practise on their IRM fields.

9. The facilitator asks volunteer farmers to conclude. He/she then invites only those farmers who have volunteered to conduct experiments to the next session, while inviting all the farmers to the session for Module 25.

Time required

- Three hours

Materials required

- Strong packing paper, markers.
- Recording forms.
- Four observation sites identified by the facilitators:
  - Two fields with good management practices and two fields where management practices, as taught during the PLAR sessions, are not accurately implemented.

Box 23

A total of 21 farmers from Bamoro, 28 from Lokakpli and the PLAR-IRM team met for this session. The objectives of the meeting were explained and the previous module on observation at the vegetative phase was reviewed. The farmers chose the following indicators to make observations at the reproductive phase: leaf condition (green, yellow, presence of spots), vegetative cover (open or closed spaces), presence of diseases, presence of areas with poor plant development (homogeneity of plant stand), presence of weeds, size of plants relative to age, presence of swollen stems (booting). Then, we left for the field with three sub-groups of farmers. Each sub-group visited three fields. The first field was at mid-tillering stage, the second at booting/heading stage and the third at flowering stage. We then invited the farmers to discuss the observations they had made on the three fields, to analyze the causes and to propose actions to be undertaken. The following table was drawn:

Visited site	Indicators / observation	Analysis	Actions
	1. Leaf status		
Field 1	√ yellow leaves	- no water	- flood rice field
Field 2	√ green/yellow leaves	- lack of water	- flood rice field
Field 3	√ green with dead heart	- good color but insects present	- remove affected plants
	2. Vegetative cover		
Field 1	√ covered	- good density but moderate tillering due to lack of water	- use fertilizer and flood the field
Field 2	√ poor cover	- moderate tillering: old nursery, lack of water, late weeding	- good leveling, weed on time
Field 3	√ good cover	- good development for age	- use fertilizer
	3. Presence of diseases		
Field 1	√ white panicles	- insects, stem borers	- pull out sick plants and destroy insect larvae
Field 2	√ perforated yellow leaves, stunted plants	- insects, drought condition	- pull out sick plants and destroy insect larvae
Field 3	√ dead heart	- insects, stem borers	- pull out sick plants and destroy insect larvae
	4. Poor plant development areas		
Field 1	√ no spots (±)	- fewer tillers	
Field 2	√ lots of spots (++)	- lack of water	
Field 3	√ fewer spots (–)	- lack of water	
	5. Presence of weeds		
Field 1	√ (–) weeds	- well weeded, flooded after weeding	- weeding is necessary, respect
Field 2	√ (±) weeds	- not flooded after weeding	the cropping calendar
Field 3	√ (+) weeds	- lots of weeds	
	6. Water level		
Field 1	√ low level	- not enough water	- flood the field
Field 2	√ bad (dry)	- poor water management	- already too late
Field 3	√ good	- wet	
	7. Stem status		
Field 1	√ good (normal)		
Field 2	√ thin	- lack of water, crop not good because of poor soil	
Field 3	√ normal		

During the evaluation, farmers said that now they really understand what ‘indicator’ means and also that the indicator could change along the development cycle of rice or any other crop. The farmers enjoyed finding the Baoulé word for ‘indicator,’ *N’Zolié*.

Module 24

Managing experiments, making observations and recording information at maturity phase

This module is the continuation of Module 19 and refers to the experiments established by the farmers who volunteered to conduct experiments. Like Module 19, it should be stressed that the observations and recording do *not* concern the IRM field, but concern only specific aspects of management, observations and recording to be carried out on the experimental plots.

❶ Recall the experimental design.
❷ Summarize progress in the implementation of the experiments.
❸ Make field observations.
❹ Synthesize the observations in plenary session.
❺ Recall the pair-wise comparison of experimental treatments.
❻ Recap the recording of information and the recording forms for the experiments.

Learning objectives

At the end of this module, farmers will be able to:

- Review the different treatments of the experiments they implemented.
- Decide on the management practices to carry out on the experimental fields.
- Make observations on the different on-going experiments.
- Record the information on pre-established recording forms.

Procedure

1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator briefly reviews the previous module and invites farmers' feedback. The facilitator asks if the farmers have put in place any new practice on their IRM fields.

2. One of the PLAR-IRM team members explains the learning objectives and procedures for the current module. The facilitator clearly indicates that this module does not concern the IRM fields, but deals with experimentation and is therefore specifically designed for the group of farmers who volunteered to conduct experiments.

3. The farmers recall the experimental design for each experiment: objectives, hypotheses and experimental treatments.

4. The facilitator and the farmers discuss the progress made in setting up the experiments. The summary table in Module 19 (Section 4) is reviewed, completed and changed where necessary. The farmers discuss the activities to be implemented during the following weeks.

5. Some farmers present their recording form with the observations they have made from their experiments (Module 19). The farmers discuss which data to record and make propositions on possible changes to be made.

6. The facilitator presents the *procedure* for making observations on the experiments:
   - A farmer-facilitator and a farmer-rapporteur are chosen.
   - The group will visit four experimental sites; if there are two types of experiments, two fields each for each type of experiment will be visited.
   - Field observations will be made by the group:
     – Farmers will observe and judge the general performance of field and crop;
     – Farmers will compare treatments, review the 'indicators' for the comparison as decided during Module 19 (recording form), and decide on complementary indicators;
     – Farmers will discuss the reasons for these differences: is there a relationship between the treatments and what is observed, or are the differences due to other factors, such as management practices or environmental conditions? Are these differences consistent across different farmers' fields?
   - Results will be presented by the farmer-rapporteur, then summarized and discussed in plenary session.

7. The farmers who volunteered to conduct experiments and the facilitator depart to the field to visit the four experimental sites.
   - If necessary, the facilitator helps the farmer-facilitator to stimulate debate in the field.
   - The farmer-rapporteur takes notes.
8. Back at the PLAR Center, farmers report, comment on and summarize their results.
   - The farmer-rapporteur presents the results for the first site: (i) overall performance of the field, environment and crop; (ii) 'indicators' used for comparing treatments; (iii) causes of differences between treatments.
   - The facilitator synthesizes the results in a four-column table on a flipchart.

Example: Experiment 1: ...

	Overall performance	**Indicators used for comparison**	**Causes of difference between treatments**
Field 1			
Field 2			

   - After summarizing the information of the first experiment (Fields 1 and 2), the second experiment is discussed.
9. The farmers compare the treatments using the pair-wise comparison method, the matrix table is laid out and the farmers are asked to give their opinions and choices.

Matrix for pair-wise comparison of treatments (to do for each type of test)

	Treatment 1	**Treatment 2**	**Treatment 3**	**Treatment 4**
Treatment 1				
Treatment 2				
Treatment 3				
Treatment 4				

For each white cell, the farmers' preference from the pair of treatments compared is recorded.

- Farmers identify the best treatment for each pair, and this choice is recorded in the corresponding cell. In each case, the number of farmers making that choice is noted.
- The farmers discuss the reasons for their choices.
- The facilitator displays the matrix table of comparisons made during the session on Module 19 and the farmers discuss the differences.

10. The facilitator takes the recording form of each experiment and leads a discussion of the complementary information to be recorded concerning farmer management practices and the observations made to compare the treatments. The facilitator invites the farmers to complete the left column of the recording form with the complementary information.
    - Remember that in most cases this information is specific to the reproductive or maturity phase, such as:
        - Number of fertile tillers;
        - Panicle filling;
        - Plant density or soil cover;
        - Absence of diseases and insect damage;
        - Absence of bird damage;
        - Yield level.
    - Complementary management practices such as harvesting dates are noted.
    - A column or row should be reserved for yield estimation or yield sampling.
11. The facilitator motivates the farmers to fill in their recording forms; they can help each other and ask for assistance from the PLAR-IRM team as they wish.
12. The facilitator discusses the *procedure* for taking yield samples from the experiments. The results of this sampling will be treated in Module 26. The facilitator makes an appointment with the farmers.
13. Evaluation: the facilitator asks what the farmers appreciated (or did not appreciate), what they learnt, and what they intend to do with their newly obtained knowledge.
14. The facilitator asks a volunteer farmer to draw conclusions and close the session. The facilitator then invites farmers to the next session.

Time required

- Three hours

Materials required

- Strong packing paper, markers; Summary table elaborated during the session for Module 19.
- Synthesis table (Section 7) and comparison matrix (Section 8) can be prepared on strong packing paper.
- Copies of the draft model of the recording form can be prepared on A4; at the end of this session it should be possible to develop a final version of the recording form.

Box 24

The discussion with the farmers of Lokakpli began with the importance of the experiments and observations. The farmers recalled the different treatments of fertilizer application. The farmers defined new observation indicators. Although we had agreed that all farmers would visit all the experimental sites to make observations during the preceding week, only five farmers had actually done so. Most of the farmers had, therefore, not yet made their personal observations.

- The indicators defined by the farmers and the sites visited are shown in the table below.
- We asked the farmers to specify the most important indicators at the reproductive or maturity stage.

Results of field observations at the reproductive or maturity stage at Lokakpli

	Treatments				
	T1 N ●●● P ○○ K ✚✚	T2 N ●●●●◖ P ○ K ✚	T3 N ●●●● P ○	T4 N ●●●●	T5 N ●●●●●
Field 1 <u>Kouamé Affoué Jacqueline</u> Stage: Maturity Presence of N'déni Kouamé Color: test > control	Panicles – Color – Yellow Cycle shorter Tillering average	Panicles – Color – Yellow Cycle shorter Tillering average		Panicles + Presence of areas with poor growth Color +	Panicles + Color + Cover + Height + Tillering +
Field 2 <u>Kouassi Fulgence</u> Stage: Heading Height/tillering: test < control Iron toxicity	Cover + Height average Tillering – Color homogeneous	Cover + Height + Tillering average Color –	Average height Tillering Color homogeneous	Cover + Average height Tillering – Color homogeneous	Cover + Height + Tillering + Color –
Field 3 <u>Kouassi Koffi Firmin</u> Stage: Maturity Emergence/height: test = control Grains: test > control	Height + Color + Cover +	Height + Color – Tillering –	Height + Color + Cover + No. grains +	Height – Mouse damage	Height – Mouse damage
Field 4 <u>N'guessan Raymond</u> Stage: Heading Good field cover			Tillering + Cover +	Color green + Cover + Height +	Color green + Cover + Height + Panicles +

– : negative appreciation by farmers; + : positive appreciation by farmers.

Harvesting and post-harvest activities

The harvest and post-harvest activities are the final stages in the rice cropping calendar (Reference 26). These stages are essential in the overall farm management plan, because harvest and post-harvest losses—in terms of rice quantity and quality—can be very high. Very often some parts of the harvest are kept as seeds for the subsequent season, and this requires particular care. This module also provides the opportunity to make the final observations on the IRM field and to complete the recording form. Module 25 can therefore be seen as the continuation of Modules 11, 14 and 18.

Learning objectives

At the end of this module, farmers will be able to:

- Exchange knowledge on harvest and post-harvest practices.
- Discover good harvest and post-harvest management practices.
- Decide on the criteria for selecting good-quality seeds.
- Know how to select parts of their field for seed-production purposes.
- Decide on the observations to be made and on the indicators specifically related to maturity phase.
- Be able to record the information and to complete the recording form for the IRM field.

❶ Discuss farmers' harvest and post-harvest practices.

❷ Launch a debate on good harvest and post-harvest management practices.

❸ Recall the major techniques for seed production and conservation.

❹ Make field observations.

❺ Synthesize observations in plenary session.

❻ Introduce the last page of the recording form for the IRM field.

❼ Discuss the procedure for taking yield samples from the IRM fields.

Procedure

1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator briefly reviews the Module 23 and invites farmers' feedback. The facilitator asks if the farmers have put in place any new practice on their IRM fields.

2. One of the PLAR-IRM team members explains the learning objectives and procedures for the current module.

3. The facilitator stimulates discussion on farmers' harvest and post-harvest practices, beginning with the last drainage of the field before harvesting.

4. The facilitator encourages debate on good harvest and post-harvest practices (Reference 26).
   - Review of the most important development phases and stages of the rice plant, and of the importance of the period before flowering: the construction of the grain store (foundations and walls–roof) and the filling of the store (Reference 8 and Module 6).

- Importance of the date of last drainage of the field: about 2 to 3 weeks after flowering.
- Best harvesting period: when at least 80% of the grains have turned yellow and the remaining 20% have reached the dough stage; grains are clear and hard upon dehulling.
- Consequences of late harvesting: losses due to birds, rats, shattering, etc.
- Importance of drying the paddy properly; threshing and winnowing as soon as possible after harvest to ensure good grain quality (few broken grains).

5. Then the facilitator recalls Module 5, which covered the production and conservation of seeds.
   - The farmers discuss the method for selecting a part of their field well before harvest and the selection criteria used to obtain good-quality seeds: carefully observe the vigor of the plants, uniformity, remove off-types and weeds.
   - The part selected for seed production has to be harvested before the rest of the field, and has to be threshed, winnowed and dried separately (Reference 9).
6. The facilitator presents the field observation *procedure* of PLAR-IRM:
   - Division into sub-groups of four or five farmers.
   - A farmer-facilitator and a farmer-rapporteur are chosen for each sub-group.
   - Each farmer sub-group will visit four sites[1] at maturity stage.
   - Sub-groups will make field observations; the farmers will decide which indicators are important to them, allowing them to judge field conditions and plant health.
   - Sub-groups will discuss and analyze what is observed: links between the indicators (what is seen, i.e. effects) and the environmental factors or farmers' management practices (i.e. causes).
   - A segment of each field will be identified for seed-production purposes.

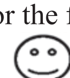
7. The farmer sub-groups and the facilitator depart to the field. In turn, they all visit the four observation sites.
   - The facilitator helps the farmer-facilitator if necessary.[2]
   - The farmer-rapporteur takes notes.

1. The observation sites should be prepared in advance by the team of facilitators.
2. In the beginning, it is very important that the facilitator ensures that 'accurate' observations are made, in order to obtain appropriate analyses and to make good decisions.

8. Back at the PLAR Center, the farmers report and comment on their results.
   - The farmer-rapporteur of the first sub-group presents the results for the first observation site, ‘Field 1.’
   - The facilitator synthesizes the results in the four-column table, in the row ‘Field 1.’
   - Afterwards, farmer-rapporteurs of other sub-groups ‘complete’ the first sub-group’s report by adding comments from their sub-groups that were not mentioned by the first sub-group, and the facilitator summarizes these in the table.

Field	Observation indicators	Analysis	Decisions to be made
Field 1			
Field 2			
Field 3			
Field 4			

   - Then, the farmer-rapporteur of the second sub-group presents the results of the second observation site, ‘Field 2.’
   - The facilitator synthesizes the results in the row ‘Field 2.’
   - Then, he/she invites the farmer-rapporteurs of the other sub-groups to complete the table.
   - And so on for Fields 3 and 4.

9. The facilitator then introduces the rest of page 6 of the recording form for the IRM field; this is meant to train the farmers in recording the information from field observations made at maturity stage.
   - The facilitator explains the six indicators:
     – Number of fertile tillers;
     – Panicle filling;
     – Plant density or soil cover;
     – Absence of diseases and insect damage;
     – Absence of bird damage;
     – Yield level,
     ☛ *the facilitator explains the importance of each indicator*.
   - The facilitator explains that the farmers can judge the degree of satisfaction on the health status of their IRM field with the help of a ‘good-health indicator,’ by ticking a box under the face corresponding to their judgment. If for an indicator the farmer’s plot
     – gives complete satisfaction, he/she ticks the box under 
     – gives moderate satisfaction, he/she ticks the box under 
     – gives no or only little satisfaction, he/she ticks the box under 
   - The farmers then further analyze the indicators that give no or little satisfaction. They explain the reasons for their judgments and give details of the factors causing ‘poor’ signs or less satisfactory state of health, and hence try to establish links between the indicators (what is seen) and the causes or (unseen) factors responsible for these signs or symptoms.

- For these same indicators, the farmers explain the reasons for their decisions to implement changes in their management practices in order to obtain better results or to prevent the phenomenon from re-occurring.
- The facilitator invites each farmer to fill in the last-observation part (page 6) of the recording form.
- The facilitator also invites the farmers to record some information on the management practices in relation to the IRM field. This information should be recorded on page 6 of the recording form, in the last table; these are data on the harvesting date and on the quantity of rice harvested.
- The facilitator also invites them to indicate on the sketch-map the location of the plot designated for seed production.

10. The facilitator and farmers discuss the yield-sampling procedure for the IRM fields and control plots (where the usual crop management practices were applied). The facilitator encourages a debate on the importance of measuring the effect of the implementation of IRM practices as compared to their usual practices. The results of the sampling are treated in Modules 26 and 27. The facilitator makes an appointment with the farmers for the following meeting.

11. Evaluation: the facilitator asks what the farmers appreciated (or did not appreciate), what they learnt, and what they intend to do with their newly obtained knowledge.

12. The facilitator asks volunteer farmers to draw conclusions from the session, and then invites farmers to the next session.

Time required

- Three hours

Materials required

- Strong packing paper, markers.
- Recording forms.
- Four observation sites identified by the facilitators.

Box 25

The farmers in Bamoro had a meeting in late December 2001 at their PLAR Center. They discussed their harvest and post-harvest practices. Generally, they thresh and winnow their rice production soon after harvesting in order to sell as soon as possible. They keep some part of the production as seed for the next season. The farmers greatly appreciated the field visits. Their practice before was to choose the seed after harvesting and threshing. They said that starting from this harvest, they had identified a part of their field which they had selected a long time before harvest for seed production; they threshed and winnowed the produce of that part first and kept it separate from the rest of the crop from that field.

Evaluating the results of the cropping season

Evaluating the results of the cropping season is a very useful tool to measure the work done during the season and also to identify ways and means of improving the performance of the farm (Reference 27). It draws comparisons between the results obtained by different farmers and also between the IRM field (or other experiments) and the other fields. The evaluation consists of a simple value–cost analysis, comparison of performance, and identification of improvements for the next season. The evaluation is thus not only an analysis of the end-of-season results, but also a first step in the preparation for the next season.

❶ Discuss production factors.

❷ Prepare the financial balance-sheets for two volunteer farmers.

❸ Analyze and discuss the differences in terms of production costs and benefits between the two farmers.

❹ Calculate and discuss costs, benefits and ratios.

❺ Compare the IRM fields (or any other experimental treatments) with fields where the usual crop management practices were implemented, calculate additional costs, additional benefits and ratios.

❻ Summarize results in plenary session.

Learning objectives

At the end of this module, farmers will be able to:

- Evaluate the major activities performed during the season.
- Estimate crop production costs.
- Know how to establish a financial balance-sheet of the season—comparing the usual crop management practices with those implemented in the IRM field or in any of the experiments.
- Identify alternative management options that should improve their financial balance-sheet.

Procedure

1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator briefly reviews the previous module and invites farmers' feedback.
2. One of the PLAR-IRM team members explains the learning objectives and procedures for the current module.
3. The facilitator initiates a debate on the major production factors the farmers put in place, covering the whole cropping season.
4. The farmers discuss discrepancies between what was planned and what was actually done.
5. Two volunteer farmers present their financial balance-sheets for the season that has just ended.
    - A large sheet of strong packing paper is shown with three columns.
    - The facilitator invites the farmers to list the major production factors and inputs used in the column on the left: only those factors or inputs that involved a monetary cost or an 'in kind' exchange are listed.

- In the other two columns, each farmer reports the actual money (nominal) cost spent per surface unit[1] related to conventional crop management practices.[2]
- The facilitator assists the farmers in adding up all the costs to calculate the total.

6. The farmers analyze the different production costs, their relative importance and effectiveness.
7. Then, the two farmers present the results they obtained from their plots in terms of rice production and value per unit of surface area.

Costs–values (per unit surface area)	**Farmer 1**	**Farmer 2**
1. Cost of production factors and inputs		
Seed		
Plowing		
Transplanting		
Herbicide		
Fertilizer		
Weeding		
Threshing		
Insecticide		
Harvesting		
Transport from field to city		
Total costs (A)		
2. Production		
Weight		
Production value (B)		
3. Net benefits: B–A		

8. The farmers complete the financial balance by calculating net benefits: production value (B) minus total costs (A).
9. The farmers compare and discuss the results.
   - To help the farmers understand the concepts of costs, benefits and ratios, the facilitator can visualize monetary 'units' using (e.g.) small stones or leaves.[3]
   - What are the reasons explaining the differences?
   - What could be done to improve the results?

1. In the case of the rainfed lowlands in central Côte d'Ivoire, the farmers subdivided their fields into plots called 'squares,' each covering 2500 m^2.
2. It will be preferable to begin with the cultural practices called 'usual,' distinguishing them from the practices establish in the IRM fields and other experiments, which will be dealt with in Section 11.
3. In Bamoro and Lokakpli, one stone represented 10,000 FCFA (Box 26).

10. Then the facilitator presents the yields obtained from the IRM fields and a control field (Module 25) or from any of the experiments done during the season (e.g. fertilizer experiments).
    - A large sheet of strong packing paper is used to draw a table with enough columns to show the alternative options (i.e. management practices; *see* table *below*).
    - The facilitator asks the farmers to list the production factors and the inputs used in the column on the left: only the additional factors and inputs used in the implementation of the management alternatives are taken into account; the additional cost of the IRM field or of a specific treatment is calculated (A).
    - Then, the benefits additional to the conventional practice (control field) are calculated (B).
    - Afterwards, net benefits are calculated in comparison with the farmers' conventional practices (B–A).
    - Finally, ratios are calculated of the additional value over the additional cost (B/A). The facilitator explains that the investment in the new practice is not interesting when the ratio is lower than 1.5.
    - The production factors that are easily accounted, e.g. family labor, will also be discussed.

Costs – additional value	Conventional practice: control field (*see* first table)	IRM practices	Treatment 1	Treatment 2	…
1. Cost of inputs and production factors					
Total					
Additional (A) • Labor • Fertilizer • …					
2. Production value					
Total					
Additional (B)					
3. Net benefits					
Total					
Additional (B–A)					
4. Ratio of additional value/additional cost (B/A)					
Ratio (B/A)					

11. Farmers exchange ideas about ways and means to improve their financial balance-sheets.
12. Evaluation: the facilitator asks what the farmers appreciated (or did not appreciate), what they learnt, and what they intend to do with their newly obtained knowledge.
13. The facilitator asks volunteer farmers to draw conclusions from the session, and then invites farmers to the next session.

Time required

- Three hours

Materials required

- Strong packing paper, markers.

Box 26

The Bamoro farmers met at their PLAR-IRM Center. Two farmers (Christophe and Dembelé) volunteered to calculate a financial balance-sheet for the previous cropping season. Both fields were about one '*carré*' (approximately 2500 m^2).

	Christophe's field	Dembelé's field
Crop management practices [1]		
Seed (CFA)	0	0
Plowing (CFA)	0	12,000
Transplanting (CFA)	6,000	0
Herbicide (CFA)	0	2,500
Fertilizer (CFA)	0	1,750
Weeding (CFA)	0	0
Threshing (CFA)	5,000	8,000
Insecticides (CFA)	0	0
Harvesting (CFA)	1,000	0
Transport from field to city (CFA)	4,000	5,000
Total costs (CFA)	16,000	29,250
Production (no. paddy bags)	6	9
Value (CFA)	93,750	135,843
Net benefits (CFA)	77,750	106,593

Note: 1. We only used cash costs; the benefit–cost analysis should normally cover all costs

Later, we discussed the differences between the two farmers' financial balance-sheets. The farmers agreed that Dembelé had a better balance, because he had invested more by plowing correctly, by treating against weeds and by applying some fertilizer.

Afterwards, we presented the preliminary results from the experiment on fertility management. There had been six treatments (Module 10): the usual practice, without any fertilizer (CP); 200 kg NPK + 100 kg urea per hectare (T1); 100 kg NPK + 200 kg urea per hectare (T2); 50 kg TSP + 200 kg urea per hectare (T3); 200 kg urea per hectare (T4); 250 kg urea per hectare (T5). We presented the results per 'square,' because the farmers are used to this surface unit.

Financial balances using a partial budget for the experiment on fertilizer management in Bamoro, 2001 rainy season (per 'square')

	CP	T1	T2	T3	T4	T5
Fertilizer cost (= additional cost compared with CP) in FCFA	0	16,000	15,500	13,000	10,000	12,500
Production (no. bags)	6.5	7.2	7.9	7.3	7.2	7.1
Additional production compared with CP (no. bags)	0	0.7	1.4	0.8	0.7	0.6
Gross benefits in FCFA		11,000	22,000	12,500	11,000	9,500
Net benefits (benefit – additional cost) in FCFA		–5,000	6,500	–500	1,000	–3,000
Value–cost ratio		0.7	1.4	1.0	1.1	0.8

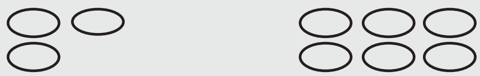
This presentation was followed by a lively discussion, as the farmers discovered that most treatments made them lose money! Consequently, they all said that treatment T2 was the best and that they would use it for the following season. Indeed T2 could be a good strategy, as the value–cost ratio is 1.5 (usually value–cost ratios exceeding 1.5 to 2 are considered to be necessary for farmers to adopt a new technology). One of the farmers said that he definitely wanted to use some fertilizer, as he thought that it would speed up the development of their inland valley.

Afterwards, we used small stones (1 stone representing 10,000 FCFA) to explain the financial balances and the value–cost ratio in more detail. We used the following examples:

Farmer 1 — Invested — Additional value

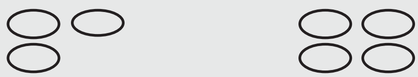
The value–cost ratio for Farmer 1 is 3. So, for every stone invested he gets three stones in return. A very good investment. We then explained the situation for Farmer 2:

Farmer 2 — Invested — Additional value



The value–cost ratio for Farmer 2 is 2. So for every stone invested he gets two stones in return. Still OK. We then explained the situation for Farmer 3:

Farmer 3 — Invested — Additional value



The value–cost ratio for Farmer 3 is 1.3. So for every stone invested he gets 1.3 stones in return. This is not a good investment.

The farmers mentioned that, before using fertilizers, it would be better to improve other aspects of rice management, especially water management and weed control. Farmers also discovered that the fertilizer doses used in this experiment were too high for the Bamoro valley, where water control is rather poor. We also mentioned some other sources of plant nutrients, such as burying rice straw or incorporating compost. We also discussed options to use very low doses of mineral fertilizer, giving priority to nitrogen, e.g. 50 kg of urea per hectare, and combine this with the practices discussed during previous modules—weeding before applying fertilizers, fertilizing at early tillering stage, panicle initiation or both, applying fertilizers when water level is low.

Evaluating the PLAR-IRM curriculum

Evaluating the PLAR-IRM curriculum aims at appreciating to what extent the PLAR-IRM objectives have been obtained. PLAR aims essentially at improving farmers' knowledge and at encouraging them to apply their newly obtained knowledge on integrated and improved rice management in their own fields. This module complements Module 13, a first evaluation of the curriculum. The evaluation in this module is more in-depth. It evaluates knowledge acquired by the farmers, discusses the performance of new technologies and practices in the IRM fields, and evaluates farmers' appreciation of the learning tools and modules used in the curriculum. This evaluation will enable farmers and the PLAR-IRM team to improve their performance during the next season, and to identify the major tools and modules best suited for taking the knowledge obtained to neighboring inland valleys.

❶ Evaluate, in sub-groups, the technical knowledge of the farmers, and their appreciation of the learning tools and the PLAR-IRM modules.

❷ Consolidate and discuss results obtained.

❸ Present the yields of IRM fields and control fields.

❹ Identify the four or five major techniques to increase yield.

❺ Identify the difficulties involved in applying these techniques on a larger scale, and the ways and means to overcome these constraints.

Learning objectives

At the end of this module, farmers will be able to:

- Evaluate the acquired knowledge.
- Exchange ideas about the major practices implemented on their IRM fields.
- Appreciate the results of their activities in terms of yield obtained from the IRM field.
- Evaluate the learning tools and modules of PLAR-IRM.

Procedure

1. Farmers and the PLAR-IRM team meet at the PLAR-IRM Center. The facilitator briefly reviews the previous module and invites farmers' feedback.

2. One of the PLAR-IRM team members explains the learning objectives and procedures for the current module.

3. The facilitator presents the *procedure* for the evaluation in sub-groups.
   - The farmers will be divided into four sub-groups of four or five farmers.
   - A farmer-facilitator and a farmer-rapporteur will be designated for each sub-group.

4. Each sub-group receives three questionnaires: one to test knowledge of IRM practices, one to gauge farmers' appreciation of the learning tools, and one to gauge farmers' appreciation of the PLAR-IRM modules.
   - In each group, the farmer-facilitator reads the questions and tries to get a consensus on the answers, which are then noted by the farmer-rapporteur.
     - First, the questionnaire concerning IRM knowledge is addressed—the questions require a 'right' or 'wrong' answer (*see* model in Box 27);
     - Next, the second questionnaire about the learning tools and the third about the PLAR-IRM modules are discussed. For these two questionnaires, farmers provide answers by ticking a box under 'the face' corresponding to farmers' judgment—complete satisfaction, moderate satisfaction, little satisfaction,
       - the idea is not only to agree on the answers, but the group also has to discuss the reasons for its choices and answers.
5. Consolidation of results.
   - The rapporteur of each sub-group presents the results, first of the first questionnaire, then of the other two. The facilitator summarizes the results in a pre-established table (*see* Materials required *below*).

Table for first questionnaire: IRM knowledge test

Site / question	Number of answers per choice	Reasons for choice
Question 1	Right: Wrong:	
Question 2	Right: Wrong:	
...		

Table for second questionnaire: appreciation of learning tools

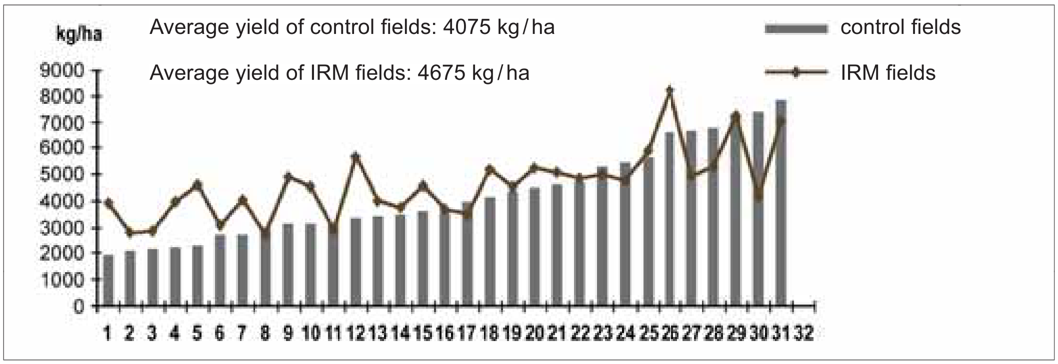
Learning tools	Number of sub-groups that gave score			Total of scores
	1	2	3	
Tool 1				
Tool 2				
...				

Table for third questionnaire: appreciation of PLAR-IRM modules

PLAR-IRM module	Number of sub-groups that gave score			Total of scores
	1	2	3	
Module 1				
Module 2				
...				

- After filling out Table 1, the facilitator repeats each question, one after the other, and stimulates a discussion on:
  - The answers given, and differences among groups;
  - The reasons for answers, reflecting 'factorial knowledge.'[1]
- Tables 2 and 3 are addressed in a similar manner—the facilitator stimulates a discussion on the learning tools and modules most and least appreciated, and reasons behind the ranking.

6. The facilitator presents the yields obtained in the IRM fields and compares them with the yields obtained in the control fields.[2]
   - The results are presented in a pre-established table on a large sheet of strong packing paper. The yields of the control fields are in increasing order, represented by histograms. On the same vertical line of each histogram, a dot represents the yield of the IRM field.



   - The facilitator stimulates a discussion on the differences between control-field yields and IRM-field yields. The variability of these gaps is linked to the yield level of the control fields.
   - The facilitator asks if farmers can identify the reasons for these differences in yields and leads a discussion on the major new practices the farmers implemented in their IRM fields and not in their control fields.

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1. 'Factorial knowledge' means that the learners are not only capable of reproducing facts learnt, but they are also in the position to argue reasons for the facts known.
2. For each farmer who has an IRM field, yield has been sampled for the IRM field and for an adjacent field where the farmer did not apply the new techniques.

7. The farmers identify the four or five major techniques that—according to them—can contribute to yield increase in the short term.

8. The facilitator stimulates the farmers to think about the difficulties that could eventually arise when implementing these techniques on a larger scale (i.e. in all their fields) and on how to address these constraints.

9. Evaluation: the facilitator asks what the farmers appreciated (or did not appreciate), what they learnt, and what they intend to do with their newly obtained knowledge.

10. The facilitator invites farmers to conclude the session, and then invites them to the last session of the season.

Time required

- Two hours

Materials required

- Questionnaires: test of knowledge, evaluation of learning tools, and evaluation of modules.
- Strong packing paper with pre-established tables (Section 5).
- Yield samples from each IRM field and from the adjacent control fields (where the farmers did not apply new techniques).

Box 27

Example of yield estimation

For estimating yield in IRM fields with an area of 1000 m^2, use two yield-sampling 'squares' of 4 m^2 each. If the rice area is 2,3 or 6 times bigger then use 2,3 or 6 times the squares. To delineate the yield sampling area, use a metal frame with 2 m sides or set out a square using four stakes, each two metres apart. If this cannot be done then use some other form of measuring device for which the surface area is known (i.e. a tyre or a bicycle wheel) and take sufficient samples to represent 4 m^2. Place your measuring device at random in the crop, but avoiding the edges, and harvest and thresh that area separately, drying and weighing both the grain and the straw.

Where two 4 m^2 squares have been sampled in a 1000 m^2 field, the calculation is carried out as follows: if 2.5 kg of grain has been obtained from the first sampling block and 3 kg from the second, the yield estimate for the field is: (2.5 + 3.0)/2/4 = 0.69 kg/m^2. The yield per hectare is: 0.69 × 10 000 = 6.9 tonnes per hectare.

If the straw yield from the first sample is 2.7 kg and the yield from the second square is 2.4 kg then the estimated straw yield for the field is: (2.7 + 2.4)/2/4 = 0.63 kg/m^2.

Straw production per hectare is: 0.63 × 10 0000 = 6.3 tonnes per hectare.

	Weight Sample 1 (kg)	Weight Sample 2 (kg)	Total (kg)	Average (kg)	Yield of the field (kg/m^2)	Yield (t/ha)
Farmer 1						
IRM field						
Grain	2.5	3.0	5.5	2.75	0.69	6.9
Straw	2.7	2.4	5.1	2.55	0.63	6.3
Control field						
Grain	1.4	1.7	3.1	1.55	0.39	3.9
Straw	1.5	2.1	3.6	1.8	0.45	4.5
Farmer 2						
IRM field						
Grain						
Straw						
Control field						
Grain						
Straw						
…						

It is important that results are ultimately expressed in units that farmers are familiar with, such as number of bags per '*carre*' (i.e. 2500 m^2) in the Bamoro and Lokakpli inland valleys. Researchers in the PLAR-IRM team may still want to evaluate the moisture content of the rice grains, and standardize grain yields at 14% moisture, using the formula: [(100 – moisture content at weighing) / (100 – 14)] × weight.

E.g. If we take Farmer 1, and grain moisture content at harvest is 17%, grain yield adjusted to 14% moisture content is [(100 – 17)/(100 – 14)] × 6.9 **= 6.6 t/ha**.

Example of questionnaire

Box 27a: Knowledge test

1. There are 2 types of weeds:
   - ☐ right
   - ☐ wrong

   Explanation:
2. The period from flowering to maturity is the same for almost all varieties:
   - ☐ right
   - ☐ wrong

   Explanation:
3. You have to weed before applying fertilizers:
   - ☐ right
   - ☐ wrong

   Explanation:
4. All insects can damage rice:
   - ☐ right
   - ☐ wrong

   Explanation:
5. The rice stem borer causes 'onion tube':
   - ☐ right
   - ☐ wrong

   Explanation:

Box 27b: Appreciation of learning tools

1. The calendar and figures
2. The map
3. Observations and analysis in sub-groups
4. The plenary sessions after field visits
5. The experimentations
6. The IRM fields and putting into practise new ideas
7. Recording forms
8. The evaluations at the end of the session

Box 27c: Appreciation of PLAR-IRM modules

1. Module 2: Mapping an inland-valley catchment area
2. Module 3: Making a transect walk in the inland-valley lowlands and the catchment area
3. Module 4: Maintaining inland-valley lowland infrastructures for better water management
4. …

Closing session of the PLAR-IRM curriculum

At the end of the PLAR-IRM curriculum, an official closing session is organized. This session is intended for all farmers who participated in the PLAR-IRM sessions, but also for guests, e.g. farmers of the same inland valley or from neighboring inland valleys. During this session, PLAR farmers give an overview of what they learnt during the PLAR-IRM sessions. This overview will probably create new demand for PLAR-IRM support from farmers who did not participate in the PLAR-IRM sessions. PLAR farmers who successfully completed the curriculum receive a certificate. After the distribution of the certificates, the farmers discuss the continuation of the activities for the next season. This module is extremely important and requires the presence and participation of the whole PLAR-IRM team. The organization of this module creates the conditions for the extension of the program to neighboring inland valleys and villages.

❶ Present the newly acquired knowledge and the new practices implemented.
❷ Call for the farmers' point of view for the continuation of the program.
❸ Identify the interest of farmers who did not participate in the PLAR-IRM program.
❹ Analyze the possibilities for farmer-to-farmer training.
❺ Distribute the certificates.

Learning objectives

The objectives of this module are to:

- Officially close the PLAR-IRM curriculum at the end of the growing season.
- Reward PLAR-IRM farmers by distributing certificates.
- Identify, with PLAR-IRM farmers, new ideas or activities that can be introduced and developed in new PLAR-IRM modules.
- Gauge the interest of other farmers in becoming involved in PLAR-IRM.

Procedure

1. Meet at the PLAR-IRM Center.
2. The head of the PLAR-IRM team opens the session officially and explains its objectives.
3. The facilitator asks the farmers to present, taking turns, what they learnt during the sessions of the PLAR-IRM curriculum. The facilitator summarizes the results in the first column of a two-column table.
4. The facilitator asks the farmers to list each new practice they implemented in their IRM fields. She/he refers to the newly acquired knowledge in the first column of the table.

5. Next, farmers explain which new practices they expect to implement on a larger scale during the next season and discuss the conditions required to implement them.

6. The facilitator asks the participating farmers which activities and PLAR-IRM modules they would like to repeat during the next growing season.

7. The facilitator gauges the interest among new farmers to participate in a PLAR-IRM curriculum during the next growing season.

8. The facilitator examines to what extent farmers of the PLAR-IRM Center could train new farmers during PLAR-IRM sessions in neighboring inland valleys, i.e. farmer-to-farmer training. The facilitator identifies farmers that are interested in becoming farmer-trainers and have the necessary capacities to facilitate such training sessions.

9. The head of the PLAR-IRM team distributes the PLAR-IRM certificates to the farmers who participated.

10. The head of the PLAR-IRM team officially closes the session.

Time required

- Two hours

Materials required

- Large sheet of strong packing paper, markers.
- Certificate of participation for each PLAR farmer.

Evaluation form PLAR-IRM

Participatory Learning and Action Research
PLAR

Integrated Rice Management
IRM

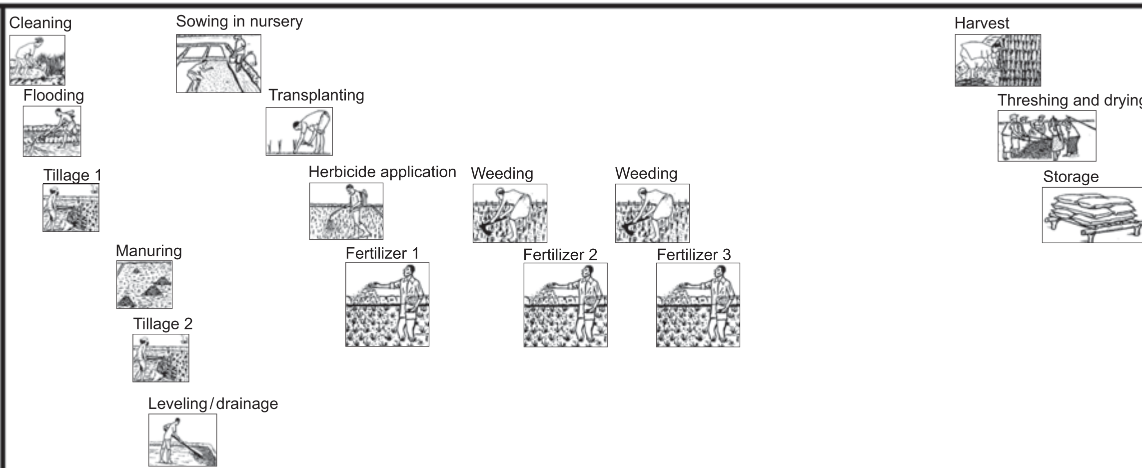
- Name: …………………………………........ Sex: male ❑ female ❑
- Village: ……………………………………. Age: ……………
- Location of lowland: ……………………………. Extension service: …………….

- Are you a household head? no ❑ yes ❑ or a bachelor? no ❑ yes ❑
- How many of your household are engaged in farming? …….. ;
  How many people work full-time on the farm? ………..
- What is the size of your farm? ……….ha; What is the size of the rice farm? ……..ha
- What percentage of your production is consumed? ……% and sold? ……%
- Do you normally take loan to farm? no ❑ yes ❑ ; if yes, what type? ………………………..…
- What is your major source of information on agriculture? ………......………………………………
- What is your level of education? ………………………..……………………………………………
- Do you belong to any farmers' association? no ❑ yes ❑ ; if yes, which one? ……………......

Draw your IRM field (show bunds, canals and area)

Plan and evaluate integrated rice management practices

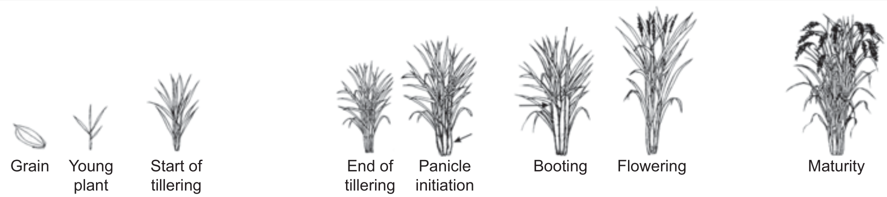
Planning & implementation of crop management practices



Calendar

Weeks	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4	S_5	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4
Months	**June**				**July**					**August**				**September**				**October**				**November**				**December**			
Weeks	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4	S_5	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4

Development stages of rice



Before growing season:

* Indicate the weeks you plan to conduct agricultural activities by drawing arrows from the figures (above) towards the calendar.

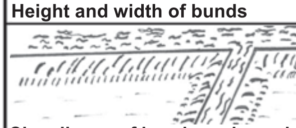
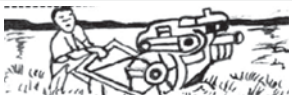
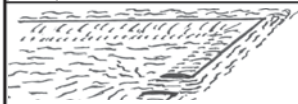
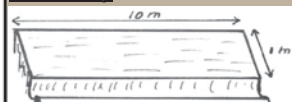
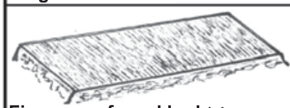
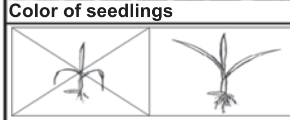
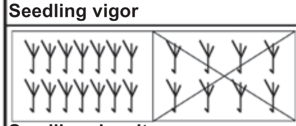
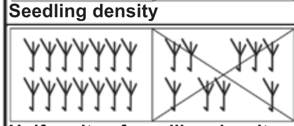
During the growing season:

* Indicate the weeks which correspond to the stage of rice development by drawing arrows from the figures (below) towards the calendar.
* Indicate the weeks you plan to implement agricultural activities: if the actual time of implementation is different from what was planned, cross out the arrow and replace this with a new one indicating the time you implemented the activity; leave the arrow if the planning corresponds with implementation.

Reasons for differences between planned and actual implementation of activities:

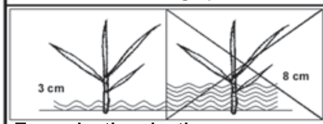
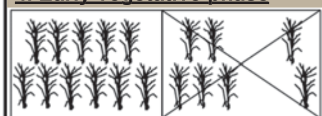
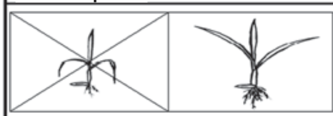
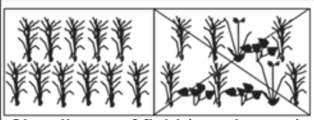
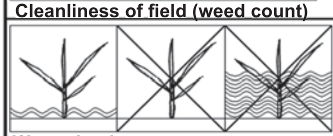
Activities implemented not according to plan	Reasons

Observing and analyzing to improve decision-making

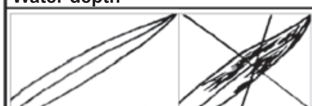
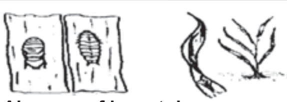
Field observations				Detailed observations and analyses	Decisions for action
Stage/indicator	*Level of appreciation*				
1. Land preparation	Date of observation:../..				
 Height and width of bunds	☺	😐	☹		
 Cleanliness of bunds and canals	☺	😐	☹		
 Incorporation of weeds and residues	☺	😐	☹		
 Complete flooding of field	☺	😐	☹		
2. Nursery	Date of observation:../..				
 Length and width of seed bed	☺	😐	☹		
 Height of seed bed	☺	😐	☹		
 Fineness of seed bed (absence of clods of soil)	☺	😐	☹		
 Color of seedlings	☺	😐	☹		
 Seedling vigor	☺	😐	☹		
 Seedling density	☺	😐	☹		
 Uniformity of seedling density	☺	😐	☹		

Annex 1

Evaluation form PLAR-IRM

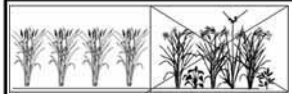
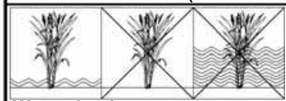
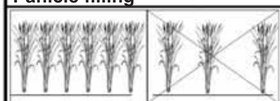
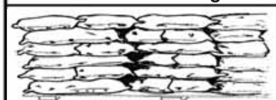
Field observations				Detailed observations and analyses	Decisions for action
Stage/indicator	*Level of appreciation*				
3. Transplanting	Date of observation:../..				
 Field leveling					
 Plant spacing					
 Number of seedlings per hill					
 Transplanting depth					
4. Early vegetative phase	Date of observation:../..				
 Recovery after transplanting shock					
 Color of plants					
 Plant vigor and health					
 Cleanliness of field (weed count)					
 Water depth					
 Tillering					

Evaluation form PLAR-IRM

Field observations *Stage/indicator*	*Level of appreciation*			Detailed observations and analyses	Decisions for action
5. Vegetative phase	Date of observation:../..				
 Tillering	☺	😐	☹		
 Color of leaves	☺	😐	☹		
 Plant vigor	☺	😐	☹		
 Plant health	☺	😐	☹		
 Cleanliness of field (weed count)	☺	😐	☹		
 Water depth	☺	😐	☹		
 Absence of iron toxicity symptoms	☺	😐	☹		
6. Reproductive phase	Date of observation:../..				
 Plant density/soil cover	☺	😐	☹		
 Number of productive tillers	☺	😐	☹		
 Absence of disease symptoms	☺	😐	☹	Name of disease:	
 Absence of insect damage	☺	😐	☹	Name of insect:	

Annex 1

Evaluation form PLAR-IRM

Field observations: *Stage/indicator*	Field observations: *Level of appreciation*	Detailed observations and analyses	Decisions for action
 Cleanliness of field (weed count)			
 Water depth			
7. Maturity phase	Date of observation:../..		
 Number of productive tillers			
 Panicle filling			
 Plant density/soil cover			
 Absence of disease or insect damage			
 Absence of bird damage			
 Yield			

Details on crop management practices

Nursery Source of seed Seed certification No: Yes: Germination test No: Yes: Sowing date Quantity of seed (kg) Area of seed beds (m^2)	IRM field	Other fields
Transplanted fields Date of transplanting Area of field (m^2) Herbicide Fertilizer - 1 - 2 - 3 Harvest	IRM field Date Quantity Product	Other fields Date Quantity Product

Evaluation form of a PLAR-IRM session

1. Zone: ____________________ Village: __________________ Name of group: ___________________
2. Number of session: __________ Module number and subject: ________________________________
3. Date: _________________ Starting time: _________ End time: _________
4. Number of farmers present: _________ Number of women: _________ Number of men: __________
5. Names of facilitators: ___________________ ; _____________________ ; ______________________
6. Supervisors participating: __________________ ; Date of preparation for the session: _____________

Minutes of the session

7. Steps of procedure followed in the meeting
Steps: indicate also the place (room, field, etc.)
a. b. c. …
Areas of divergence from the standard module (and reasons)

8. Farmers' evaluation of the session		
Points more/less appreciated	***New knowledge***	***Usefulness of the new knowledge (*)***
Suggestions for improvement		
* What farmers intend to put into practise in their IRM fields.		

9. Facilitators' evaluation of the session	
Content of the module	***Facilitation of the session***
Strong / weak points	Strong / weak points
Suggestions for adaptation	Suggestions for improvement

10. Other comments

Lowland baseline characterization for PLAR-IRM

Date: ____________ **Country:** ________________ **Site:** ______________________________ **Ref PLAR-IRM:** __________

1. Charactization of village using or owning the lowland (LL) N E S W Alt

Village/quartier …………………… Locality …………………. Informant(s) …………………… Position of village ………… …………… ……..............

Economic activities (specify importance 1,2,3): …………………….. Position of lowland (LL) ...……………........…….. ……......

[ ] Artisan [ ] Commerce [ ] Fishing [ ] Livestock [ ] Crop lowland .... [ ] Crop upland .... [ ] Other ……………..

Ethnic groups: Dominant …………… Secondary …………… Tertiary ……………

2. Accessibility of village/lowland (LL)/market

LL/Village access .... km ❑ Tarred road ❑ Unpaved road ❑ Cart path ❑ Footpath ❑ None ❑ Other ……………..

LL/Village access .... km ❑ Tarred road ❑ Unpaved road ❑ Cart path ❑ Footpath ❑ None ❑ Other ……………..

LL/Village access .... km ❑ Tarred road ❑ Unpaved road ❑ Cart path ❑ Footpath ❑ None ❑ Other ……………..

LL/Village access .... km ❑ Tarred road ❑ Unpaved road ❑ Cart path ❑ Footpath ❑ None ❑ Other ……………..

3. Major uses of watershed (specify importance in terms of land area, 1,2,3):

[ ] Buildings [ ] Fallow [ ] Savanna [ ] Forest [ ] Other ………………. [ ] Crops ……………...

4. Major uses of the hydromorphic fringe (shallow water table, specify importance in terms of area 1,2,3):

[ ] Not applicable [ ] Fallow [ ] Vegetables [ ] Roots and tubers [ ] Cereals [ ] Others ………...

5. Major use of lowland

a. Total area …………………… Area used in rainy season …………………… Area used in off-season ………………………..........

b. Dominant crop, rainy season: ❑ Rice ……..……..% ❑ Vegetable ……………% ❑ Other ……………………………….……..%

……………………..………….. .... ❑ Other ……………………………….……..%

off-season: ❑ Rice ……..……..% ❑ Vegetable ……………% ❑ Other ……………………………..………%

……………………..………….. .... ❑ Other ……………………..……….………%

c. Soil texture – (a) Topsoil ❑ Clay ❑ Sandy ❑ Loamy (b) Sub-soil ❑ Clay ❑ Sandy ❑ Loamy

d. % Population using the lowland ………… Ethnic group of users: (a) ………………..% (b) …………..……..% (c) ……………………..%

(a) Users: ❑ Natives ❑ Migrants (b) Users: ❑ Male ❑ Female Observations: ……...……………………………

e. Labor: ❑ Household ❑ Local self-help group ❑ Local – daily labor ❑ Seasonal migrants ❑ Others: ……………………………………..

f. Important changes in lowland use (10 previous years): ❑ No ❑ Yes ………………………………………………………………………………

6. Lowland development

a. Type: ❑ Not used ❑ Not developed ❑ Developed with dam ❑ Developed diversion of water course ❑ Developed, other ……………………

In case of development: When: ………… Institution: ……………………… Users' organization: ……………………………………………………………

b. Water control (a) rainy season: ❑ None ❑ Partial ❑ Total (b) dry season: ❑ None ❑ Wells ❑ Others ……………………………

c. Infrastructure: ❑ None ❑ Bunds ❑ Terraces ❑ Other ……………………..…………

7. Use of inputs Vegetables: ❑ None ❑ Fertilizer ❑ Herbicides ❑ Improved varieties ❑ Pesticides ❑ Other ………………………………………

LL Rice: ❑ None ❑ Fertilizer ❑ Herbicides ❑ Improved varieties ❑ Pesticides ❑ Other ………………………………………

Crop establishment in lowland: ❑ Direct seeding ❑ Transplanting

8. Production constraints

❑ Variety ❑ Weeds ❑ Insects ❑ Rodents ❑ Birds ❑ Diseases ❑ Other ……… ❑ Other ……..

❑ Soil ❑ Water control ❑ Input price ❑ Input access ❑ Marketing ❑ Loan ❑ Land tenure ❑ Mechanization ❑ Others ………………

Annex 3

Lowland baseline characterization for PLAR-IRM

9. What are your major crops by ecologies (traditional LL, irrigated LL and upland)? What are the periods of planting [P] and harvest [H]?

		Month																			
	Crops	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	…	…
Traditional lowland																					
Irrigated lowland																					
Upland																					

Socio-economic baseline form for PLAR-IRM

Date:___________ Ref PLAR-IRM:________________ Country:_________________ Site: _________________

1. Name of farmer: ___________________________ Ethnic group: ____________________ Village: ____________________
2. Age: ______ Native of village: No ❑ Yes ❑ If not, number of years in village: ___________________________
3. Household head: No ❑ Yes ❑ Sex: Male ❑ Female ❑
4. What is your family composition and major occupation of the members?

	Composition		Principal occupation [*] (*only one per person*)					
Type	No. Male	No. Female	Agricultural activities	Other household activities	Activity outside home	At school	Very young/ old	Others ……
Household head								
Members								
Children (<16)								
Other adults in the home								
Other children in the home								

[*] Ensure that the total at the left (composition) corresponds to the total on the right (major occupation)

5. Do you use additional hired labor? 1. None; 2. Daily paid; 3. Unpaid labor; 4. Others______
6. How big is your land? large ❑ medium ❑ small ❑

	Lowland	Upland	Total (lowland + upland)
What is the estimated land area cultivated			
What is the major form of access to land	1. Own; 2. Usufruct ; 3. Borrowed; 4. Mortgage; 5. Others________	1. Own; 2. Usufruct ; 3. Borrowed; 4. Mortgage; 5. Others________	

7. For how long have you used the lowland: _________(*years*)
8. What crops do you grow?

Crop	Location	Major use	Estimated area	Crop	Location	Major use	Estimated area
……………………	LL / UP	Con./ sold	……	……………………	LL / UP	Con./ sold	……
……………………	LL / UP	Con./ sold	……	……………………	LL / UP	Con./ sold	……
……………………	LL / UP	Con./ sold	……	……………………	LL / UP	Con./ sold	……

LL : Lowland; UP : Upland; Con.: consumption.

9. What animals do you have?

Type (*)	No. owned now	No. sold last year	Price sold (*per unit*)	Type (*)	No. owned now	No. sold last year	Price sold (*per unit*)
………………………	……	……	……	………………………	……	……	……
………………………	……	……	……	………………………	……	……	……

** Indicate if cow is for milk.*

10. What is your major source of revenue? ____
11. Do you have other sources of revenue? No ❑ Yes ❑;
    - if yes, which? ____

Annex 4

Socio-economic baseline form for PLAR-IRM (for individual farmer)

12. Do other members of the household do daily-paid work?: No ❑ Yes ❑
13. Do you usually take loan? No ❑ Occasionally ❑ Every year ❑;
    If yes: - What type? 1. Formal ________________ 2. Informal ______________________
    - For what use? ____
14. What are your major sources of agricultural information: _________________; _________________; ___________________
15. What is your level of education? ________________________ Can you read? No ❑ Yes ❑
16. Do you belong to a farmer association? No ❑ Yes ❑; If so, which? ______________________________________

____

17. Is there a farmer association for the lowland? No ❑ Yes ❑ If yes, are you a member?: No ❑ Yes ❑
18. Do you have agricultural equipment? No ❑ Yes ❑; If yes, which type? _____________________________________
19. Do you have means of transport? 0. No; 1. Bicycle; 2. Motorcycle; 3. Car; 4. Other _____________________
20. Do you have a radio? No ❑ Yes ❑ A television? No ❑ Yes ❑
21. What are the characteristics of your house (your major building)?:

Roof		Light source	
Wall		Water source	
Floor			

22. Do you use traction? No ❑ Mechanized ❑ Animal traction ❑ For which crops? ___________________________
23. Do you use mineral fertilizers? No ❑ Yes ❑ For which crops? ____
24. Do you use improved seed? No ❑ Yes ❑ For which crops? ____
25. Do you use herbicides? No ❑ Yes ❑ For which crops? ____
26. Do you use pesticides? No ❑ Yes ❑ For which crops? ____
27. Can you control water in your rice field? No ❑ Drainage ❑ Irrigation ❑
28. What rice varieties do you use in the lowland? ____
29. Can you estimate your paddy rice production in a normal, good or bad year?

	Normal (average)		Good		Bad	
	Production	Area	Production	Area	Production	Area
Main season	………..	………..	………..	………..	………..	………..
Secondary season	………..	………..	………..	………..	………..	………..

Specify the units and conversion rate corresponding to each farmer (e.g. 1 bag paddy = ... kg, 1 square = ... ha).

30. What was your total paddy production last year? What did you do with it?

Total production	Quantity already sold	Saved to be sold in future	Quantity for consumption	Quantity for seed	Other uses (specify _____)	Other uses (specify _____)

Ensure that the total on the left (production) corresponds to the total on the right (consumption).

31. How many kg of rice did you buy last year? __________ Which type? 1. Imported; 2. Local ______________________
32. In general, when do you need to buy rice? Start (date): ___________ End: ___________
33. What constraints do you have in rice production? 1. ________________________ 2. ________________________
    3.________________ 4. ________________ 5. ________________ Which is the most serious? __________________
34. How many days were you sick (that you did not work) last year? _________
35. Can you send your children to school as much as you desire? No ❑ Yes ❑

Monitoring form for new practices put in place in the IRM field

Date: __________ **Ref PLAR-IRM:** ________________ **Country:** ____________________ **Site:** __________________

Date of 1st visit: ___________________ 2nd visit: ______________________ 3rd visit: ___________________
Date of 4th visit: ___________________ 5th visit: ______________________ 6th visit: ___________________

1. Site: _____________________________ 2. Name of farmer: ____ ;

3. Age: _________ 4. Sex: __________ 5. Total area of farmer's rice fields: __________________m²

6. Village: ___________________________ 7. Head of enterprise: No ❑ Yes ❑

8. (*In the case where PLAR-IRM sessions took place last year*)

   Did you participate in the PLAR-IRM sessions last year: No ❑ Yes ❑

   - If *not*, why not? ____

   ____

9. What is the area of your IRM field *this* year? ________________ m²

10. Date of planting in the nursery (for IRM field): _______________

11. Date of transplanting: _______________________

12. (*If the farmer participated in PLAR-IRM session last year*)

    Did you have an IRM field last year? No ❑ Yes ❑

    - If *not*, why not? ____

    ____

    ____

    - If *yes*, what was the area? __________m²; If the area was different from this year, why? _______________________

    ____

    ____

Annex 5

Monitoring form for new practices put in place in the IRM field

13. With respect to PLAR-IRM sessions and new ideas, what are the new practices that you have applied on your IRM field?

T1: ____ (Title)

Details of the innovation

(a) What is the reason for your choice of the new practice (what did you hope to obtain, or what problem do you want to solve with it)? *Take enough time so to find out from the farmer*

Reason/Objective

(b) Where did this idea come from?

Source of idea

(c) What stimulated you to try this idea and to put it into practise?

Stimulus

(d) Did you also apply the technique last year, even if it was not exactly the same way? No ❑ Yes ❑

- If *not*, why not? ____

____

____

- If *yes*, is it ***exactly the same way***? No ❑ Yes ❑ ; If *not*, what is the difference? _________________________

____

And why this difference? ____

____

(e) Did you apply the same practice on other fields apart from the IRM field? No ❑ Yes ❑

- If *not*, why not? ____

____

- If *yes*, what was the area? _____________ m^2. If it was not the entire field, why not? ____________________

____

Use the same format (Question 13) for T2, T3, T4, etc.

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