

Implementing Cluster Based Farmer Field Schools (CBFFS) for Integrated *Striga* and Soil Fertility Management (ISSFM)



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Preface

This guide was initially developed during a collaboration between the Catholic Relief Services (CRS), the Institute d'Economie Rurale (IER), and the International Crops Research Institute for the Semi Arid Tropics (ICRISAT) within the framework of a project funded by the Bill and Melinda Gates Foundation (The Douentza District Crisis: Improving Household Resilience to Food Security Crises in Mali, 2006-2007). The guide has been further used and adapted within an IFAD-funded project for the intensification of sorghum and millet cropping systems, called PROMISO, IFAD-TAG817 (2006-2009). Technical assistance for the special-topic interventions was provided by researchers from IER and ICRISAT. Draft versions of the guide have already been used in training for the implementation of CBFFS for ISSFM in Mali, Niger, Nigeria and Ghana. This guide is intended for researchers, field technicians and extension workers as a step-by-step introduction to the implementation of CBFFS for ISSFM in farming communities of the semi-arid tropics of West Africa where *Striga hermonthica* and soil fertility are major constraints to production of cereals in general and of pearl millet and sorghum in particular. This region of Africa is home to a diversity of climates, soils, cropping systems and cultures; and as a result, the CBFFS approach must be adapted to each situation. When facilitating farmer experimentation with technologies to manage and deal with *Striga* and poor soil fertility, it is important for the field technicians and extension workers to remain flexible and to improvise where necessary. Field agents need to assist farmers to learn how to observe in a structured manner how different varieties and crop management practices perform and relate this to crop growth, climate, soil conditions and constraints to crop production. Based on these observations, the farmers can hold meaningful discussions, develop the appropriate knowledge and make informed decisions for reducing *Striga*, increasing yields and soil fertility of their fields. Facilitation of this process cannot be learned solely from a guide; it is a skill that requires practice. Before implementing CBFFS, it is advisable to train field technicians and extension workers in communication skills, facilitation of group dynamics and informal adult education.

List of Acronyms:

APU	Agricultural Production Unit
CBFFS	Cluster-Based Farmer Field School
DAP	Di-Ammonium Phosphate fertiliser
DAS	Days After Sowing
FFS	Farmer Field School
ICRISAT	International Crops Research Institute for the Semi Arid Tropics
IER	Institut d'Economie Rurale
IITA	International Institute for Tropical Agriculture
IPM	Integrated Pest Management
ISSFM	Integrated <i>Striga</i> and Soil Fertility Management
NPK	Nitrogen Phosphate Potassium fertiliser
PRA	Participatory Rural Appraisal
PAR	Participatory Action Research
SSP	Simple Super Phosphate fertiliser
TOT	Training of Trainers
TSP	Triple super phosphate fertiliser
WAS	Weeks After Sowing

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1. Introduction

1.1. *Striga hermonthica* and soil fertility management

Striga hermonthica is a parasitic plant that feeds itself with water, sugars and nutrients taken from the roots of a host plant. It penetrates the roots of the host with its own root and in this way causes damage to the host plant, which can be pearl millet, sorghum, maize, rain-fed rice or a wild grass species. *Striga hermonthica* is arguably the main biological constraint on production of pearl millet and sorghum in West Africa. *Striga* as a pest is difficult to control because of complex interactions between the host cereal, the parasite, the soil fertility and the cropping system. *Striga* develops into a serious problem when fields are continuously cropped with susceptible cereals and when the fields are not adequately fertilised.

Various options exist for keeping *Striga* under control and below damaging levels, namely: (1) application of different types of organic fertilisers, (2) localised application of different types of mineral fertilisers, (3) rotating or (4) intercropping with non-cereal crops such as cowpea, groundnut, soybean, cotton, sesame or sorrel, (5) use of cereal varieties that are resistant or tolerant to *Striga* and/or low soil fertility, (6) frequent or timely weeding or hand pulling during early flowering of *Striga* (before it sheds its seeds), and (7) ridging and hilling around the cereal stands to cover up emerged *Striga* plants (most of which are mentioned in figure 1). Several other traditional control methods exist, such as the treatment of seeds with dried fruit powder of locust bean tree (*Parkia biglobosa*) or Baobab (*Adansonia digitata*) dried leaf powder, as well as localised application of ash (by burning stalks in spots where *Striga* plant density was high the previous year). Although familiar with some of these options, most farmers in West Africa tend to implement only one or two at the most of these options, while a combination of methods would be far more effective for dealing with *Striga* and soil fertility. Even those farmers who are aware of a range of traditional and 'modern' options for managing *Striga* and soil fertility seldom implement an integrated approach. But by resorting to as many different options as is practical under the local circumstances, it is indeed possible for a farmer to achieve efficient *Striga* control and thus bring about improved crop yields, increased profitability, and long-term reduction of the *Striga* seed bank in conjunction with increased soil fertility.

There are two obstacles preventing farmers in sub-Saharan Africa from efficiently combining their strategies and effectively managing *Striga*. Firstly, most farmers lack the necessary understanding of *Striga* biology: how it parasitizes and affects the host cereal, how it reproduces and how it spreads. Secondly, many farmers are not aware of all the different options available for controlling *Striga* or minimizing its negative effects. Equipped with this knowledge, a farmer is automatically in a better position to make more practical decisions on how to manage a field with *Striga* infestation and a poor soil.

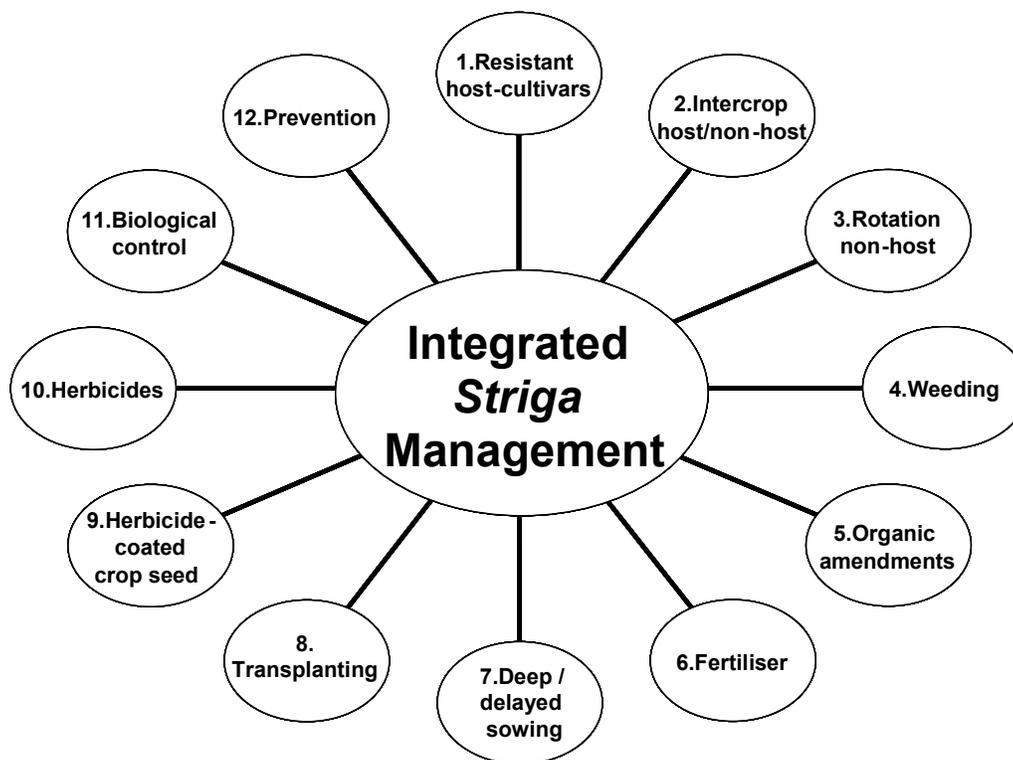


Figure 1. Potential control strategies for integrated *Striga* (and soil fertility) management. Strategies 1, 2, 3, 4, 5, 6, 7, 8, 10 and 12 may be used for sorghum while in millet, only 2, 3, 4, 5, 6 and 12 are currently available to farmers.

Integrated *Striga* and Soil Fertility Management (ISSFM) is, as the name suggests, an integrated approach for low-input sorghum and pearl millet production systems. ISSFM is based on the following principles: (1) a cropping system approach not focused on a single technology or product, (2) sound knowledge of *Striga* biology and control, (3) combinations of multiple component technologies or options, (4) adaptation of technologies and options to the local environment and socio-economy, and (5) short-term benefits in terms of crop yield and profitability, and (6) long-term reduction of *Striga* in conjunction with improved soil fertility.

In sub-Saharan Africa, it has been found that one of the most efficient ways of disseminating knowledge and intensive practices, such as IPM and ISSFM, is through participatory approaches such as the Farmer Field School (FFS) (Nabirye et al. 2003; Nathaniels 2005).

1.2. History and rationale of Farmer Field Schools

The Farmer Field School (FFS) is a participatory agricultural extension approach based on 'learning by discovery' (van de Fliert 1993). The FFS approach was developed in the 1980s by an FAO project in Southeast Asia as a way for small-scale rice farmers to learn for themselves the skills for Integrated Pest Management (IPM) and how to assess the benefits of these practices being tested in their rice paddy fields. The FFS approach was extended to several countries in Africa and Latin

America. IPM activities expanded from rice-based systems to other annual crops, vegetables, and cotton. More crop management aspects have been added to the program over the years (Hughes & Venema 2005).

The FFS approach is also people-centred learning that allows farmers to learn about alternative crop and livestock management practices and technologies with the aim of improving their own productivity; in other words, learning new ways to cope with old problems related to agriculture or livestock rearing (van den Berg & Jiggins 2007). At the same time, the approach allows farmers to investigate for themselves the costs involved and the different benefits of traditional and alternative practices, thus leading to swifter adoption of the successful practices or varieties of crops tested.

It has become increasingly clear over the past two decades that participatory approaches are required if agricultural research is to respond usefully to farmers' needs – technically, socially, environmentally, and economically. The FFS learning process builds on the existing knowledge of farmers, enabling them to combine and evaluate new and existing technologies in their own fields and to adapt new technologies to their own environments. Once farmers are able to combine and evaluate these technologies they will become more responsive to changing conditions, such as that of *Striga* and soil fertility, and will thus be able to develop cropping systems that are more productive, profitable and sustainable.

1.3. Cluster-Based Farmer Field School system for ISSFM

Since communities in West Africa are typically organised in groups of villages or sub-villages (ideally, clusters of 3-6 villages) it makes sense to organise Farmer Field Schools around these village clusters. The Cluster-Based Farmer Field School (CBFFS) system was hence developed by the International Institute for Tropical Agriculture (IITA) and national agricultural research institutes in West Africa (Nathaniels, 2005). The primary objective of a CBFFS is to encourage knowledge exchange between the farmers, the field agents and the researchers and to facilitate the exchange of information between farmers from within and between villages (farmer-to-farmer extension).

If the CBFFS is to focus on *Striga* and soil fertility, the biology and control of *Striga*, knowledge on soil fertility as well as options for achieving integrated *Striga* and soil fertility management form the main topics of intervention. This includes a local assessment of the *Striga* problem and the seriousness of *Striga* in comparison to other constraints to rain-fed agriculture in nearby villages. Farmer knowledge of *Striga* and its control should be used as a starting point for discussions and experimentation, which can be complemented with scientific and technical knowledge (e.g. potential “new” control options derived from research).

The second objective is to teach farmers how to implement and evaluate experiments that focus on ISSFM. With the aid of a technician or a scientist, farmers develop a protocol for the farmer practice and choose different options that will be used in the ISSFM strategy. In addition, one or two Participatory Action Research (PAR) topics are chosen. These PARs are often variations of individual options used within the ISSFM strategy, such as fertiliser type or dose, cereal variety or intercropping arrangements. To evaluate experiments, farmers need to have the capacity to observe in a structured manner crop characteristics, development and

yield, *Striga*, weeds, insect pests, climate, soil and water under different treatment plots. In this way farmers can discern relationships between observations and crop development, indicate problems and their causes, and find potential solutions. Ultimately the aim is to support farmers in making intelligent and balanced decisions on how to manage crops in relation to soil fertility, *Striga* and other constraints.

The third objective is to build capacity amongst farmers so that they can: organize activities; work in groups that transcend individual villages; structure and facilitate discussions; and pass on knowledge to their colleagues.

The fourth objective, which may surpass the time span of a typical FFS project cycle (generally 2-3 years), is to create social capital out of a tight-knit group of farmers that can have a durable and positive effect on the entire community rather than just an individual village. This group will hopefully teach and exchange knowledge with other farmers about technologies outside the setting of a FFS. This organized farmer group may also one day become a 'producer market group' or a cooperative that is able to access credit, seeds and inputs more efficiently and be in a stronger position when it comes to negotiating prices for their agricultural goods.

1.4. The cluster based farmer field school (CBFFS) and choice of villages farmer-trainers and participants

Villages willing to participate in a CBFFS for ISSFM nominate their own representatives, namely about 20 participants and 5 farmer-trainers each. The farmer-trainers are selected on the basis of their willingness and capacity to train and deliver their acquired technical knowledge to their peers. In the example below, there will thus be 30 farmer-trainers from 6 villages who agree to meet twice a month at a chosen site, called the Training of Trainers site. Each village sub-group of 5 farmer-trainers is put in charge of its own village-level Farmer Field School, which is made up of a Farmer Practice (FP) plot, an ISSFM plot and one or two small experiments, called Participatory Action Research plots, with 2-4 treatments each.

The Training of the Trainer (TOT) sessions are run by a well-qualified field technician, extension agent or literate farmer with previous experience of FFS facilitation. The village-level Farmer Field School sessions are held one to several days after the TOT sessions, thus enabling the master trainer to attend FFS sessions and to assess the performance of the farmer-trainers during the FFS sessions. Depending on the progress and experience of the farmer-trainers, they may act more independently of the master trainer in subsequent years. These steps are represented in Figure 2.

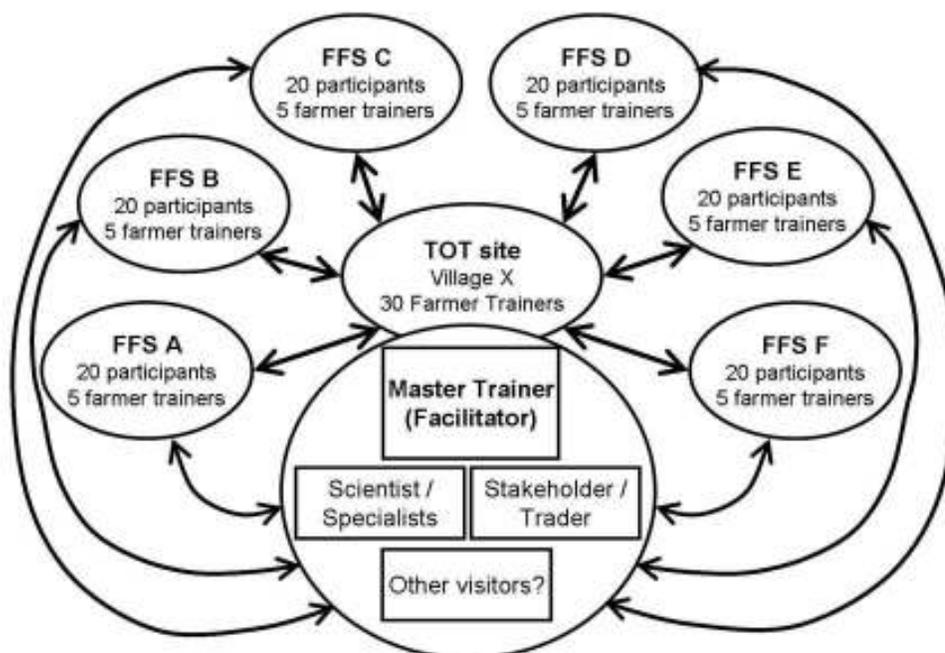


Figure 2. Example of a cluster based farmer field schools with one Training of Trainer (TOT) site and six FFS sites (usually villages). The farmer-trainers receive training and instructions usually every two weeks and are expected to pass this knowledge on to other participants in the village. The facilitator should visit at least two of the FFS sessions to check whether information is passed on properly and to provide support when problems arise. If the facilitator is absent, questions or problems of comprehension are noted and can be taken back to the master trainer at a subsequent TOT meeting.

2. Preparing the CBFFS for ISSFM

Because of the complexity of the CBFFS system in comparison to the conventional FFS, the process of preparing for the CBFFS activities requires substantial organisation. In fact, the most critical part of the CBFFS system is preparing the trainer-farmers, the villages and the community beforehand. In order to achieve true farmer-to-farmer knowledge exchange and dissemination, it is absolutely necessary that the villages and their representatives agree to the process and understand their roles. Only with this foundation can the CBFFS approach and activity become a success.

In the process of initiating cluster-based farmer field schools with ISSFM, a series of meetings must take place in order to meet certain criteria and to plan for the CBFFS activities. It is important to perform village interviews, or so-called Participatory Rural Appraisals (PRA) to verify that sorghum and pearl millet are important crops in the target villages and that *Striga* and soil fertility are indeed major constraints. Furthermore, it is important to establish the importance of *Striga* and soil fertility in relation to other constraints and to determine what farmers already know about *Striga* biology and control. The CBFFS system and activities can then be explained and villages are then asked whether they are willing to host the CBFFS on ISSFM. Once villages have expressed their interest and are ready to take on the

responsibility of hosting the CBFFS, the next steps for organising the CBFFS systems are taken.

2.1. Meetings and criteria for planning and installing CBFFS for ISSFM

(Set up 1 Training of Trainer site with 3-6 Farmer Field School sites)

1. Interview with local authorities or potential partner organisations

Meet with the local extension service agent, NGO or farmer organisation to determine the potential intervention area, i.e. where *Striga* infestations are present and represent a potential constraint and where villages are open to participatory agricultural research activities. This meeting is only necessary if the team has not yet chosen the intervention area.

2. Participatory Rural Appraisals in villages with at least 15 representatives

Using participatory rural appraisals (PRA) with village representatives collect basic agricultural data (major crops, cropping practices and constraints to agricultural production) in a cluster of 3 to 8 villages that are at 12 km maximum distance from one another. **(See appendix 5.1.1. "Participatory Rural Appraisal with village representatives")**

These initial meetings with the village representatives (village chief, men, women, elders etc.) are the first point of entry for an intervention and it is preferable that the field agent and technician or scientist (if available) are present during this interview. The questions are posed in an informal manner and are restricted to the village's main rain-fed crops, cropping systems, constraints on agricultural production and local options for the management of these constraints. The interview may start with asking an individual in the group to draw out the village territory with the help of other village members, marking out the cultivated fields, grazing pasture, waterways, and any other geographical landmarks of interest. This map will provide a concise overview of the village and serve as a spatial aid for the subsequent discussions.

Sources of income, crops and constraints

During the first interview the goal is to list and rank the main sources of revenue, the main crops, and the main constraints to agricultural production. After noting down the main crops and constraints, the interviewer should next inquire about the local/traditional strategies for dealing with these constraints. If *Striga* figures in the farmers' top six constraints there is a strong argument for intervention. If *Striga* is not ranked in the top eight, there is no need for intervention, unless the majority of the surrounding villages nominate *Striga* as a serious constraint.

***Striga* incidence and effects on cereal yields**

If *Striga* ranks as an important constraint the next step is to determine the level of infestation, i.e. the percentage of the total number of fields that are infested or the fraction of the number of farmers that have infested fields. It is also important to establish whether the infested fields are in any way different to the un-infested fields in terms of soil type, cropping history, time of cultivation, fertility management or location. It is equally important to determine what species of *Striga* is prevalent on what crop. In some locations, *Striga* incidence may be higher with sorghum than with pearl millet or vice versa (farmers may rotate these two cereals as a temporary control measure).

Knowledge of *Striga* biology and control

The third step is to assess local knowledge of *Striga* biology and control options. It is important for the field agent, technician and scientist to familiarise themselves with local *Striga* knowledge in order to have a basis on which new knowledge can be built. In other words, local or traditional control options for *Striga* can be combined with “modern” or “non-local” control options within the framework of an ISSFM practice. Since local knowledge of *Striga* may vary from village to village or even from farmer to farmer, CBFFS can serve as a useful tool for the exchange of information between farmers from different villages. (See appendix 5.1.1. “Participatory Rural Appraisal with village representatives”)

At the end of the PRA, the representatives of the villages are asked whether they are willing to host the Farmer Field Schools in each of their villages and whether 20-25 farmers are willing to participate and set aside one morning every two weeks during the growing season for meetings. The choice of participants should be representative of the village and preferably no more than one person per Agricultural Production Unit (APU) or family should be chosen. Women farmers should be encouraged to participate in the FFS if sorghum or pearl millet cultivation is part of their activities.

The participants are asked to nominate five farmers to act as farmer-trainers. These farmer-trainers will need to set aside one additional morning every two weeks during the rainy season for the TOT meeting. The farmers are given four criteria for selecting their farmer-trainers: volunteer, available, preferably literate and committed. The preliminary list of farmer-trainers can be revised if necessary during following visits and planning meetings. Each village is asked to provide a field that is heavily infested with *Striga* (minimum of 1/4 hectare) for experimentation over the next two growing seasons.

Criteria to be met at this stage is (1) sorghum or pearl millet ranks among the 5 most important crops in the village cluster, (2) *Striga* and/or soil fertility are main constraints to agricultural production of pearl millet or sorghum in at least half of all villages interviewed (3) multiple villages are found within a radius of 6 km (this can be determined with the local authorities or during the PRA).

3. Village and field visits by the field agent and technician

A follow-up visit of the villages will allow the field agent and technician to review the lists of participants and farmer-trainers proposed by the villages and to visit the fields selected for experimentation. The agent and technician will assess the size and position of the field, and whether the location is suitable for trial establishment. Important questions are “does the field avoid as much as possible heterogeneity factors such as trees, heterogeneity of soil, slope and depressions?” and “Is the field accessible and visible?”. It is advisable to draw out the field with the owner and give an indication of where the trials will be situated within the field. Once the area for the trial has been confirmed, the technician can interview the owner of the field and record the field history and the knowledge of the farmer in regard to *Striga* biology and its control (See appendix 5.1.2. “Interview for owner of field selected for trial establishment”). If necessary, soil samples can be taken at this point for analysis of soil granular composition, soil chemical properties and *Striga* seed bank density.

2.2. Planning the CBFFS activities

If the aforementioned criteria are met and the workshop has informed the necessary persons, the planning of the CBFFS can start. The next meeting is held with the farmer-trainers in a neutral environment (preferably not a participating village).

5. Meeting with farmer-trainers only, held preferably in a neutral place (not a participating village)

Divide farmer-trainers into workgroups. Each group will consist of five farmers that will carry out observations on the part of the experimental plot allotted to them. Each group will be given a number or name (the farmers can choose their own group name if they wish) and will work together throughout the season.

How to organise the farmer-trainers:

One can use the ballot box method followed by re-defining or regrouping to form balanced and diverse groups (if 15 people, 3 groups of 5; if 20, 4 groups of 5, etc). This can and should be done in a participatory way. For example, one can determine with the farmers what capacity needs to be represented in each working group and re-distribute persons if necessary for balancing out the groups. Criteria for redefining/ regrouping the workgroups: Each group should have: (1) equal numbers of literate farmers, (2) members from as many villages as possible and (3) men and women equally distributed, unless the women prefer to form their own group due to practical and/or cultural reasons.

Choice of a leader for each workgroup of farmer-trainers at the TOT site. The leader will be responsible for overseeing the work of the group, stimulating group spirit and cohesion, and solving practical problems with the organisation of the TOT meetings, in addition to managing disputes between members of the groups. A chief will also be chosen for the whole group of farmer-trainers at the TOT site, who will be responsible for monitoring attendance, behaviour and group spirit. If necessary, the chief can appoint an advisor to help execute his/her tasks. These steps are essential to the implementation and success of the CBFFS system. Good facilitation and guidance by the field technician is therefore crucial.

The process of constituting workgroups and choosing leaders of workgroups and a chief for the group as a whole should be replicated at the village-level, with the farmer-trainers taking responsibility.

Choice of the location of the TOT site and a day of the week for bi-weekly meetings. This TOT site should be central, so that no farmer-trainer group from any one village has to travel more than 6 km to reach the TOT site. The site should also be accessible to visitors, so that anyone interested can visit the location and assist during meetings. Another important issue is the village that hosts the TOT meetings, as they will have to facilitate and host people from the other villages as well as host a secondary FFS site.

6. Pre-season meeting with the farmer-trainers at the TOT site

This meeting with the farmer-trainers from the different participating villages is critical for the choice of the cereal crop species the group will be working on (sorghum or pearl millet), the development of a protocol and cropping calendar for farmer practice (FP) and ISSFM practice. Opportunity costs of labour and farmer

options for *Striga* control and for the main cereal crop will be determined during this meeting. It is also important to determine whether the farmers' strategies for a *Striga*-infested field differ from that of a non-infested field in regard to tillage, sowing date, sowing densities, varieties used, weeding etc. (See appendix 5.1.3. "Identification of the farmer practice for pearl millet or sorghum")

Using the information about the farmer practice as a basis, one can start to develop an ISSFM strategy with the farmers. The process should be based on open dialogue between trainer-farmers, master trainer, technician and/or scientist. A short participatory intervention aims to let the participating farmers cite and list all the different options they know for the management of *Striga* and soil fertility. This list will then be amended by the facilitator with options not mentioned by farmers, but which are known to control *Striga*, improve yield under *Striga* infestation or improve soil fertility. By taking into account the obtained list and the farmers' physical and socio-economic environment one can start to combine options for a specific ISSFM strategy and develop a provisional calendar of activities. This ISSFM practice needs to be adaptable to local practices based on availability of local inputs (e.g. organic and mineral fertiliser types and quantities available) and practicability for the farmers' way of life (is a given option possible with oxen-drawn plough and sowing machine) (see Appendix 5.2.1. "Farmer practice and ISSFM protocol"). A list of potential control methods is given below.

Potential component options of an ISSFM strategy

1. Varietal resistance or tolerance.
2. Intercropping a cereal with a non-host or trap crop such as cowpea, peanut or sesame (a high density of intercropping is preferable, a ratio of between 2:1 and 1:1 for a cereal-cowpea or sesame intercrop, and a ratio of between 1:2 and 1:4 for a cereal-groundnut intercrop).
3. Rotation with non-host crops such as cotton, cowpea, groundnut, sesame, roselle (*Hibiscus* spp.), bambara nut or sweet potato.
4. Mineral fertiliser with phosphorus (NPK, DAP, SSP, TSP) applied to the cereal crop at or shortly after sowing (application mode: micro-dose or application to rows or ridges preferred).
5. Mineral fertiliser with nitrogen (Urea, or DAP) applied to cereal crop at booting stage.
6. Organic fertiliser (manure or compost, applied to planting holes (Zai) or broadcast and ploughed/worked into the soil)
7. Additional weeding or ridging after the second weeding (more than 60 DAS)
8. Pulling *Striga* plants when the first flowers appear (between 75-120 DAS)
9. Delayed sowing or very early (dry) sowing in planting pits (Zai)
10. Deep sowing with reduced tillage or transplanting
11. Application of *Parkia biglobosa* fruit powder or *Adansonia digitata* leaf powder to the soil or to planting holes or as a seed dressing
12. Application of herbicides, post emergence
13. Any other local practice specific to *Striga* that is being used and may be promising.

Intercropping deserves special attention. To be effective against *Striga*, a high density of intercropping is required with as little time as possible between sowing of the cereal crop and the associated intercrop (usually cowpea or groundnut). However, the reality in farmers' fields is often a very low frequency of the associated crop and haphazard crop arrangements. On the other hand, the density of the associated crop should not be so high as to compete with the principal cereal. The combination of good quality organic fertiliser (preferably compost) with small amounts of mineral fertiliser is considered an effective means of mitigating the negative effects of *Striga* on the host crop and reducing *Striga* emergence. The way the fertiliser is applied must also be taken into consideration. Micro-dosing is an effective way of getting small amounts of fertiliser to the young crop plants and thus giving them a jumpstart before the parasitic *Striga* can attach itself and begin its detrimental relationship. In some instances, farmers have mixed cereal seeds with very small amounts of fertiliser before sowing to great effect with a ratios of 3:1 to 1:1 volume ratio of seeds to fertiliser.

Criteria for incorporating a control option into ISSFM

The second phase involves the scientist and farmers deciding on a shortlist and combination of potential control methods for the ISSFM strategy that is best suited to the environmental conditions and socio-economic circumstances of the region. Through negotiation and compromise, the master trainer and technician try to incorporate intercropping of the main cereal with a leguminous crop (cowpea, groundnut or soybean) at a high density, using mineral and organic fertiliser and hand pulling of escaping *Striga* plants at flowering. One should be careful with the choice and use of a resistant variety because it may not be adapted to the prevailing environmental conditions and may not have traits that are preferred by the farmers. When the varieties proposed have not been previously tested in the area, it is advisable to test several different resistant varieties as a side PAR experiment before deciding to incorporate a specific variety into the ISSFM practice the following year. It is not a problem to use a local variety in the ISSFM practice in the first year and in some cases, local varieties exist that tolerate/resist *Striga*.

Once it has been decided what components are to be used in the ISSFM strategy, a protocol for ISSFM and a seasonal calendar can be drawn up (**see Appendix 5.2.1. "Farmer practice and ISSFM protocol" and Appendix 5.2.2. "Example of a seasonal program"**).

Having developed the ISSFM practice, the farmers can now choose research themes for the PAR trials at the TOT site (1-2 topics). These trials are most often component technologies of the ISSFM practice, but are also studied as a single factor at different treatment levels (for instance fertiliser doses, type of fertiliser, variety of cereal etc.). The PAR trials are preferably installed in both the TOT and FFS sites, but it is possible to change the treatments or the number of treatment levels according to the field size, capacity and interests of the participants in the FFS. The experimental setup will be discussed in chapter 3.2.

Preparations for the experimental plot (measuring out the plots and transport of organic fertiliser) should be carried out by the farmers during a meeting in the field where one can also test the seed material before sowing (**see Appendix 5.6.1. "Germination test and field preparation"**). During the following meeting (when

rains have started) tilling and sowing can be carried out. From the day of sowing (DAS) onwards, bi-weekly meetings are held on the experimental field.

3. Establishing experimental fields and conducting CBFFS

Establishing experimental fields requires careful consideration of the two conditions under which the trials will be implemented, namely, *Striga* infestation and infertile soils. An approach needs to be developed for managing these two conditions in a practical, profitable way. The preparatory meetings allow for the selection of the field in which the trials will be established. The experimental field that is shown as an example in Appendix 5.3., consists of two large plots of 20m x 30m in which the farmer practice will be evaluated against the ISSFM practice, in addition to one or two smaller trials that generally consist of four 10m x 10m plots (or smaller) for different treatments. (see Appendix 5.3. “Experimental layout showing the ISSFM plot, FP plot, and PAR trial plots”)

3.1. Materials required for installing the experimental field:

The number of experimental fields will depend on the number of FFS sites, usually 1 or 2 FFS per village and the number of villages participating in the CBFFS activity.

Material required for establishing one experimental field (FFS or TOT site):

- rope (50m), measuring tape (20m), sticks, pegs, name plate or tags for the FP, ISSFM and PAR test plots
- seeds of cereal (local variety and *Striga* resistant/ tolerant varieties) and intercrop (appropriate varieties for agro-ecology and farmers preferences)
- mineral fertiliser (composite and/or nitrogen fertiliser) and/or organic fertiliser (compost, manure or farmyard manure)
- optionally, a sprayer and insecticide to treat the cowpea intercrop

The following list is adapted from an example of FP and ISSFM in pearl millet as determined with farmers in the Mopti region in Mali (2009). Farmers in different regions and countries have different soils, crops, and constraints to deal with, so there is no “one size fits all” solution to *Striga* and soil fertility. As FP and consequently ISSFM will differ between regions, countries and crops, this list is meant merely as a guide for the process of calculating the quantity of materials necessary for a trial. It is not intended as a “standard package” for *Striga* control.

Cereal seeds:

- Variety: ISSFM and FP, improved adopted variety of pearl millet
- Quality: Germination percentage over 80% recommended
- Quantity: Enough to sow a plot of about 600m²
 - FP, pure stand, 4-6 kg/ha: $(600/10000) * 4-6 \text{ kg} = 0.24-0.36 \text{ kg/field}$
 - ISSFM, alternating rows, so half the density of a pure stand, 4-6 kg/ha: $(600/10000) * 2-3 \text{ kg} = 0.12-0.18 \text{ kg/field}$

Intercrops/ trap crops according to the farmers’ choice

Cowpea seeds:

- Variety: FP, none as intercropping is not a general farmer practice

ISSFM, improved or local variety (spreading type preferable for good soil cover)

Quantity: ISSFM, half the density of a pure stand, 15-20 kg/ha:
(600/10000) * 15-20 kg = 0.9-1.2 kg/field

Groundnut seeds:

Variety: FP, none as intercropping is not a general farmer practice
ISSFM, improved variety, (if known to be adapted to conditions)

Quantity: Enough to be able to sow a plot of about 600m²
ISSFM, half the density of a pure stand, Groundnut (30 kg/ha):
(600/10000) * 30 = 2.4 kg/field

One may consider reserving extra seed weight and packing some extra bags if quantities are not restricted, as re-sowing might be necessary.

Fertiliser:

Organic fertiliser:

Type: FP and ISSFM, Compost (preferred), manure, farm yard manure
(depending on availability)

Quantity: Quantity determined with farmers for fertilisation of a plot of about 600m²
Example: organic fertiliser (2-4 t/ha): (600/10000) * 2000 or 4000 =
120 - 240 kg/field

Mineral fertiliser:

Type: FP, mineral fertiliser generally not used on pearl millet
ISSFM, DAP at sowing or at first weeding and Urea at second weeding

Quantity: Enough to micro-dose a plot of about 600m²
DAP and Urea (30 kg/ha): (600/10000) * 30 = 1.8 kg field

Depending on the topics and the treatments for the PAR plots, one might need additional amounts of seed varieties and intercrops, additional fertiliser etc.

3.2. Experimental setup

The experimental plot of each site should ideally be 30m x 20m for the FP and 30m x 20m for the ISM. Small side plots can be established for PAR options (20m x 20m, 4 treatment plots of 10m x 10m) up to a maximum of three topics per site. These can differ per site according to the wishes of the farmers. Topics can be variations of individual ISSFM components and/or other technologies such as (1) seed dressing (with fungicides and insecticides), (2) different doses of organic or (3) mineral fertiliser, (4) combinations of organic and mineral fertiliser, (5) different sowing densities of cereal and intercrop, (6) different relative sowing dates of cereal and intercrop, and (7) different cereal varieties with resistance to *Striga* (see Appendix 5.3. Experimental plots and PAR options).

3.3. Activities during the season

Program and planning of season activities: A work plan should be prepared in advance in order to guide the facilitator through the season activities (see Appendix 5.2.2 "Example of a seasonal program"). The program shows the timeline of the cropping season with developmental stages of the main crop related to anticipated

days after sowing, in addition to the activities planned, special topics for discussion/training, objectives, and resource persons.

Bi-weekly meetings: The CBFFS ISSFM activities are based on bi-weekly meetings. These meetings are essential to the functioning of the CBFFS. Every fortnight farmers exchange knowledge and learn something new about the crops, constraints and ways to deal with these constraints.

Daily planning: Daily planning is important for steering the bi-weekly meetings. It involves a short list of daily activities, such as checking who is present /absent, work and observation in the field, as well as special topics to be discussed (**see Appendix 5.4. “Daily Planning of field activities during the cropping season”**).

Observations: The farmers will carry out observations every week on the plants (cereal and intercrop), the *Striga*, the weeds, the insects, and the climate. These observations, which are performed in small groups, are then presented to the farmer-trainer group. These observations form the basis of discussions between farmers, master trainer, and visitors. To standardize observations, one should make use of an Agro-Eco-System-Analysis form (**see Appendix 5.5. “AESA form”**).

Discussions: Farmers from each workgroup present their findings and observations to the entire group. This should lead to discussion, a consensus and recommendations for action regarding crop management.

Special topics: According to budget and availability, a number of specialists/scientists may visit the FFS once every two, three or four weeks to discuss or present a special topic, such as germination tests, crop phenology, observation of crop growth using AESA, weeds and weed control, *Striga* and its control, insect pest control, seed conservation practices etc. The *Striga* interventions are fixed whereas other topics may be deleted or added to the curriculum according to the wishes of the participants.

(**see Appendix 5.6. “Special Topics”**).

Daily evaluation: At the end of every meeting an evaluation sheet is to be filled in. Farmers provide a score on this sheet as to how satisfactory or interesting they found an activity to be and for what reason.

(**see Appendix 5.4. “Daily planning of field activities during the cropping season”**).

3.5. Materials for FFS activities during the season

List of materials needed for the master trainer and farmers

Item	Use	Who uses it?	Number per FFS site	Frequency (season)	Total
20m-measuring tape	Plot measuring delimitation	All participants	1	1	1
50-meter cord	Plot measuring delimitation	All participants	1	1	1
Name plates	Indication ISM, FP and PAR plots	All participants	2	1	1
Notebook	Observe and note	Farmers	20-30	1	20-30
Blue and red pen	Observe and note	Farmers	20-30	1	20-30
Pencil	Observe and note	Farmers	20-30	1	20-30
Eraser	Observe and note	Farmers	20-30	1	20-30
Document holder	Observe and note	Farmers	20-30	1	20-30
Measuring tape (2m)	Observe and note	Farmers	20-30	1	20-30
Scissors	Cut paper, tape etc.	Workgroups	4-5	1	4-5
Permanent marker set (1 blue, 1 black, 1 red and 1 green)	Present AESA observations on poster sheet	Workgroups	4-5	2 or 3	8-10 or 12-15
Poster-size paper sheets	Present AESA observations on poster sheet	Workgroups	4-5	14 to 18	56-70 to 72-90
100kg grain bags	Harvest plots (ISSFM and FP)	All participants	2	1	2
50kg grain bags	Harvest plots (ISSFM and FP)	All participants	2	1	2
25kg grain bags	Harvest PAR plots	All participants	8-10	1	8-10

3.6. Evaluation of FFS experiments

The evaluation of the efficacy of the ISSFM strategy is based on three criteria. The first is the effectiveness of the *Striga* control on the short and the long term. It is important to establish whether the ISSFM package has reduced *Striga* incidence (number of flowering plants and/or seed bank density). This can be done by comparing observations from AESA on emerged and flowering plants in the ISSFM with the FP plots. The soil can be sampled before and after the season in the two plots in order to detect increases or decreases in the seed bank and the effect of ISSFM (see **Appendix 5.1.2. Interview with owner of field selected for trial establishment**). For the analysis of soil samples a specialised laboratory will be required for sample analyses. The second criterion is crop yield. Harvest data will give an indication of the yield of the FP and ISSFM strategy. Thirdly, an agro-economic evaluation of FP and ISSFM should indicate the economic efficiency of the ISSFM strategy compared with FP. A cost-benefit analysis should provide farmers with an honest and clear impression of the effectiveness of the ISSFM package and show them how they could analyse their own experiments in future in terms of revenue (see **Appendix 5.6.8 “Economical evaluation of FP and ISSFM plots”**). A separate field book is provided to the master trainer to note down all relevant information regarding data collection and monitoring of the trials and the CBFFS activities during the season (see **document Fieldbook FFS-ISSFM**).

3.7. Impact assessment of FFS activities

Measuring the impact of the CBFFS activities is complicated by the fact that an FFS is not focused on a single technology and cannot be measured by adoption rates of a single technology. A CBFFS merely offers farmers a range of technologies to choose from and combine in order to achieve satisfactory yields and profits. Adaptation and combination of multiple control methods by farmers in their own fields can be a possible indicator, yet it is difficult to measure and usually a project does not continue long enough for such effects to be measured. An indication can only be gained in the third year, after two seasons of CBFFS activities. Another indicator is the new knowledge and techniques obtained by farmers. Baseline interviews and post-CBFFS activity interviews with farmer-trainers, participants and non-participants within and outside the villages can provide indicators on the information gained and or diffused within the communities.

4. Data gathering, analysis and reporting

There are multiple stakeholders taking part in the CBFFS activities for ISSFM. Each group of stakeholders wants different information. Thus, before CBFFS activities can start, in particular the data collection, a careful assessment with participants and stakeholders of what data is needed and for whom will be of benefit to everyone concerned.

The farmers need information on the crops and (a)-biotic environment to understand the development of the crops and the constraints that act on crop development so as to be able to make better decisions on crop management. At the end of the season they need information on crop yields, labour and input

investments and cost-benefit ratios of an ISSFM practice compared to the farmer practice.

The master trainer or field agent needs information on the progress of the work, attendance at meetings, and what farmers find interesting or not. The master trainer or facilitator needs this information to report to a coordinator (researcher/extension coordinator) and to be able to modify the program when necessary. The master trainer has the role of linking the farmers to the technician and scientist, in other words, facilitating information exchange and data collection. The farmers, too, should be able to influence the program if a situation arises that demands change.

The technician and scientist need information to establish whether the ISSFM strategy is effective, practical and economically viable. They will need data on the *Striga* population, crop growth, yields, input costs and labour costs.

It is therefore important to establish what information and data the different stakeholders want before preparing observation sheets and carrying out the observations. It is recommended to carefully assess the Fieldbook beforehand (see **Fieldbook FFS-ISSFM**) and adapt it to the needs of the project.

The donor that funded the CBFFS project or activity may need specific information on the number of men and women farmers trained and the subjects of these trainings. It is thus important to inquire what data the donor needs, before starting the activity.

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