NATURAL RESOURCES SYSTEMS PROGRAMME

PROJECT REPORT[1]

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Overview

Farming systems in sub-Saharan Africa show a high degree of heterogeneity and complexity, determined by the wide range of socio-economic conditions, access to resources, and environmental diversity (Defoer, 2002). The development of technologies appropriate to such diverse conditions clearly requires careful consideration of biophysical conditions, farmers' livelihood circumstances, and the equitable input of the farmers. The objective of the project 'Shortened bush fallow rotations for sustainable livelihoods in Ghana', funded by the Natural Resources Systems Programme of the UK Department for International Development, was to develop technology options which address a common constraint across a range of socio-economic and biophysical circumstances. A range of technologies was considered to enhance the experiential process through exposure to a number of options, and to develop a 'culture of inquiry'.

This is not a manual of methods and only brief descriptions of the methods used are included. There is a wealth of published material on the rudiments of conducting Participatory Rural Appraisal (PRA) and other tools employed within the project. Indeed, there is a danger in emphasising the use of specific methods of management and research as solutions to perceived development problems (Biggs and Smith, 1998). Rather, this document presents a discussion of the process of technology development and iteration employed in the project process. Sumberg and Okali (1997) note that, although the literature is replete with examples of outputs of farmers' experimentation, little is indicated with respect to the actual process of experimentation in terms of the motivation, the type or sequence of activities, duration, sources of information or characteristics of the experimenters. This document should contribute to the discussion of the Participatory Technology Development (PTD) process, by providing an example that systematically describes the approach from the perspective of the external facilitators. The strengths, weaknesses and effectiveness of the methods we used are discussed throughout. We are not suggesting that this is a rigid framework for implementation, nor a compilation of tools, but an approach which attempts to harmonise several different methods to operationalise the participatory process. The technologies under development and their suitability are discussed – many papers on participatory research are focussed on the methodology, to the exclusion of any data, and/or description of the technologies generated, even to the extent of failing to mention the crop under study (Bentley, 1994). We present a practical description that can be judged by whether the methodological approach was able to generate useful techniques for rural people.

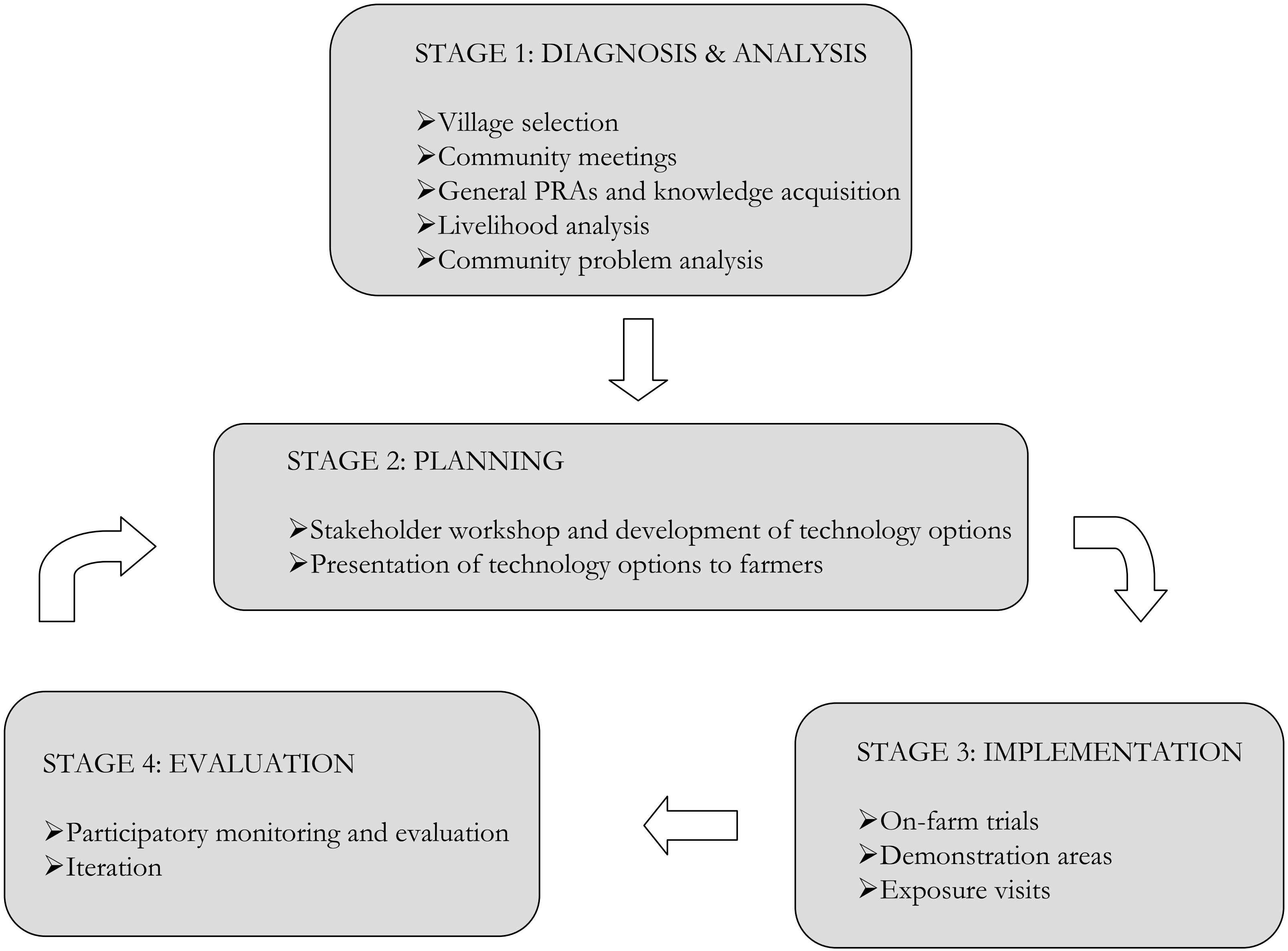


Figure 1. The Participatory Technology Development (PTD) Process (adapted from Defoer, 2002)

1 *STAGE 1: DIAGNOSIS AND ANALYSIS*

Participatory Rural Appraisal (PRA)

The first step in the Participatory Technology Development (PTD) process involved participatory rural appraisal and knowledge acquisition of farming and livelihood systems in the study areas. Specifically, the PRA comprised of tools for characterizing farming systems especially livelihood systems, documenting farmer's ecological knowledge and their agricultural production constraints. The main objective of the PRA exercise was to generate baseline information for understanding the dynamics and functioning of the farming and livelihood systems of the study communities (Box 1). The PRA phase of the project involved a combination of tools, applied in both group meetings and individual interviews (Table 1). Details of the tools used are described in following sections.

Village selection

To work across a broad agro-ecological range, representing contrasting farmers' livelihoods, study sites were selected from districts within the forest, transition and savannah zones. Exploratory visits were made to several districts within the three zones to obtain an overview of /background information on potential study areas. Critical to the district selection was the extent of previous project activity. Brong Ahafo has been the focus of extensive project activity funded by DFID and other donor agencies. This necessitates a consideration of how such project activities can be built upon to facilitate scaling-up of research outputs, and the potential linkages with the target institutions. However, it also cautions against focusing on villages or individuals that have been 'projectised' and hence have high expectations, even before commencement of the new activities. This can clearly interfere with the project process.

Consequently, the districts of Wenchi and Tano in Brong Ahafo, and Atwima in Ashanti were selected as representative (Figure 2). Exploratory visits were made to each district to establish a rapport with district and village authorities and to select pilot sites in each of the three districts for detailed characterization and later on-farm experimentation. Since the district administration in Ghana has recently been decentralised, the first appropriate point of contact was with the various District Assemblies located in the respective district capitals in selected project districts, i.e. Nkawie (Atwima), Bechem (Tano) and Wenchi. In each district, the project team called on the District Chief Executives (DCE) to brief them about the project. Copies of the District Development Plans containing the district profiles were then obtained from the Planning Offices of the District Assemblies.

Box 1. Key tenets of PRA

- Participation. Local people's input into PRA activities is essential to its value as a research and planning method and as a means for diffusing the participatory approach to development.
- Teamwork. To the extent that the validity of PRA data relies on informal interaction and brainstorming among those involved, it is best done by a team that includes local people with perspective and knowledge of the area's conditions, traditions, and social structure and either nationals or expatriates with a complementary mix of disciplinary backgrounds and experience. A well-balanced team will represent the diversity of socio-economic, cultural, gender, and generational perspectives.
- Flexibility. PRA does not provide blueprints for its practitioners. The combination of techniques that is appropriate in a particular development context will be determined by such variables as the size and skill mix of the PRA team, the time and resources available, and the topic and location of the work.
- Optimal ignorance. To be efficient in terms of both time and money, PRA work intends to gather just enough information to make the necessary recommendations and decisions.
- Triangulation. PRA works with qualitative data. To ensure that information is valid and reliable, PRA teams follow the rule of thumb that at least three sources should be consulted or techniques should be used to investigate the same topic.
- A PRA covering relatively few topics in a small area (perhaps two to four communities) should take between ten days and four weeks, but a PRA with a wider scope over a larger area can take several months

Source: World Bank Participation Sourcebook.: http://www.worldbank.org/wbi/sourcebook/sbhome.htm (2002)

The next point of contact was the District Office of the Ministry of Food and Agriculture (MOFA) also situated in the various district capitals. The team briefed the District Directors of Agriculture (DDAs') on the objectives of the project and the team's mission. The DDAs' also briefed the team on the general agricultural and livelihood conditions in the district.

In consultation with the DDAs' candidate areas where PRA exercises could be conducted were selected. For each district, a two-day familiarization visit was conducted to tour the selected areas by the team (comprising research and extension staff). A number of farming villages were visited to secure general information on the farming system. At each village visited, information on particularly the major crops, ethnic background of the people, land availability and tenure, trends in agricultural production, availability of fallow lands, trends in fallow periods and production constraints was obtained from key informants (Box 2) such as the chief of the village, assembly man, Unit committee chairman and farmers.

Table 1: Activities in the Participatory Rural Appraisal

Activity	Objective	Tools/Methods	Expected Output	Who Involved	Time Spent
Exploratory survey	Familiarization and selection of study sites Introduce project to district and village heads, extension staff and establish rapport Collect secondary information form District Assemblies and Agricultural offices	Key informant discussions Secondary information	Overview of study area obtained Rapport with district and village authorities established Study sites selected	Researchers Extension agents Key informants (District chief executives, District Agricultural Directors village heads, Farmers, etc.)	Flexible (2 days or more)
General village meeting	Introduce project to whole village and establish rapport Background information on livelihood, farming system, natural resources, etc.	Discussion Resource mapping	Background information on study sites Rapport with villagers established	Researchers Extension agents Farmers	2 days
Transect walk	Ground touring/ Perambulation	Discussion Diagramming Photos	Cross section diagram/profile of farm landscape	Researchers Extension agents Village heads Farmers	1 day
Focus group meetings	Detail livelihood and farmer ecological knowledge, characterization of study site	Semi-structured interviews and discussions	Information on -Main livelihood types Agricultural land use -Changes in farming system -Cropping systems -Indigenous ecological knowledge on crops, soils, weeds, trees, fallow rotation -Land rotation -Land tenure -Labour -Finance -Marketing -Gender issues -Agricultural production constraints	Researchers Extension agents Farmers	Flexible
Problem causal diagramming	To identify and analyse agricultural production constraints	Scored problem diagramming		Researchers Extension agents Farmers	1 day
Individual interviews	To confirm issues discussed at group meetings	Semi-structured interviews		Researchers Extension agents Farmers	Flexible
Farm visits (During growing season)	To assess cross section of cultural practices, cropping patterns, characteristics of soils, trees on croplands and fallows, etc.	Discussion Diagrams Photos		Researchers Extension agents Farmers	Flexible

The information obtained was critically assessed at the end of the two days to ascertain whether the information collected provided adequate and balanced baseline information representative of the major agricultural activities of each district. From this, representative villages were selected – these were Gogoikrom, Subriso III and Yabraso representing Atwima, Tano and Wenchi Districts respectively. The team then re-visited these villages to formally introduce the project to the village heads and schedule appropriate times for community meetings and focus group discussions with the whole village.

Box 2. Key informants

Key informants are a source of information which can assist in understanding the situation context, or clarify particular issues or problem. Key informants within the community were identified as individuals who:

- as a result of their knowledge, previous experience or social status in a community have access to information which can give insights about the functioning of a society, or its problems and needs.
- possess specialist knowledge about a particular topic, or have a particular skill

However, because of the inevitably subjective nature of the selection of key informants, it is inevitable that the issue of bias will arise. Since initial discussions involving the project were held with key informants, their subsequent role in the project as a key player, or spokesperson is hard to counter or mitigate.

Community meetings

The village meetings involved semi-structured interviews (Box 3) and discussions with the inhabitants in order to introduce the project to the whole village and to obtain background information on the prevailing demographic and socio-economic characteristics, production systems and natural resources. The participants sketched village and resource maps (Box 5) of their villages with facilitation from the team including extension staff. The resource map showed the position of the villages relative to their surrounding natural resources, i.e. rivers, streams, farmlands, fallow lands, sacred groves etc. From the resource map transect routes were selected for the forthcoming transect walks (Box 6) .Transect walks were planned to ground-truth and verify or elaborate some of the issues discussed during the semi-structured interviews.

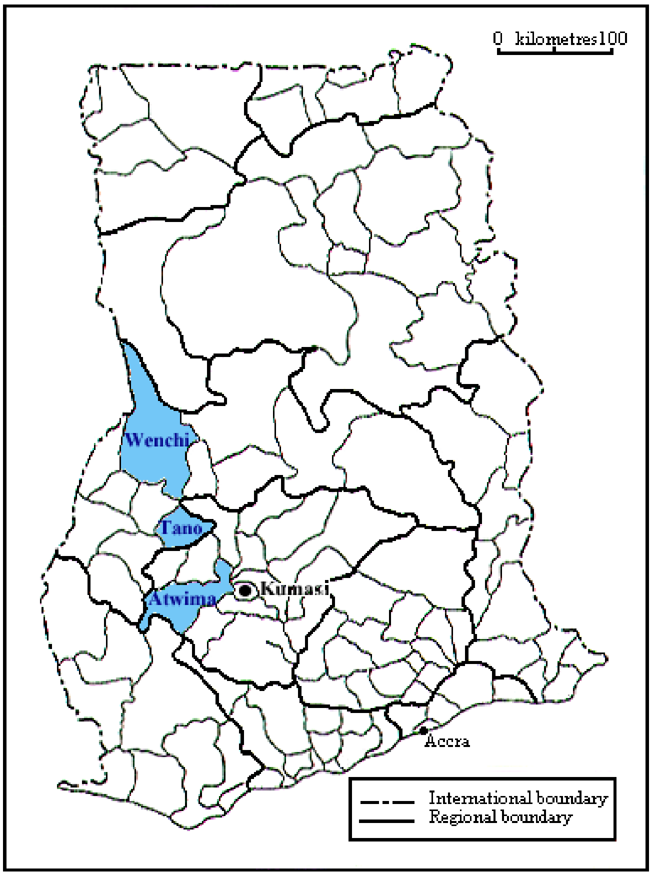


Figure 2. The forest-savanna transition zone in Ghana and project study districts

Box 3. Semi-structured interviews
Semi-structured interviews involve the preparation of a pre-determined set of questions or issues that are to be explored during an interview. This serves as a checklist during the interview and ensures that the same basic information is obtained from a number of people. However, the interview is flexible, with the interviewer able to explore in more depth areas of interest as they arise. A disadvantage of the method is that different interviewers may stress different areas of emphasis, thus reducing comparability. However, it does delimit the topics or issues of interest discussed which ensures the information derived is somewhat systematic and comprehensive.

Focus Group discussions

Based on the information obtained at the village meetings, the population of each village was first stratified into natives and settlers and then by gender. The farmers identified residential status as the main criterion influencing their activities as this determines the extent to which they have access, rights and control over land, the main resource on which their livelihood depends. The team also considered separation by gender to be appropriate so as to provide a forum where people could discuss issues openly (Box 4).

Box 4. Focus group discussions
Focus group discussions are interviews with small groups of relatively homogeneous people with similar background and experience. The purpose is to enable researchers to understand better the range of perspectives in the community surrounding a specific issue or set of issues. Participants are asked to reflect on the questions asked by the interviewers, provide their own comments, listen to what the rest of the group have to say and react to their observations. The facilitator should aim to elicit ideas, insights and experiences in a social context where people stimulate each other and consider their own views along with the views of others. Typically, these interviews are conducted several times with different groups so that the evaluator can identify trends in the perceptions and opinions expressed. The interviewer acts as facilitator introducing the subject, guiding the discussion, cross-checking comments between participants and encouraging all members to express their opinions. The main advantages of this technique are firstly that participant interaction helps weed out false or extreme views, thus providing a quality control mechanism. Secondly, that gathering groups of, for example, a single gender provides a non-threatening environment for people to talk about issues they might discuss as openly if they were in a mixed group. However this tool requires a skilful facilitator to ensure an even participation from all members.

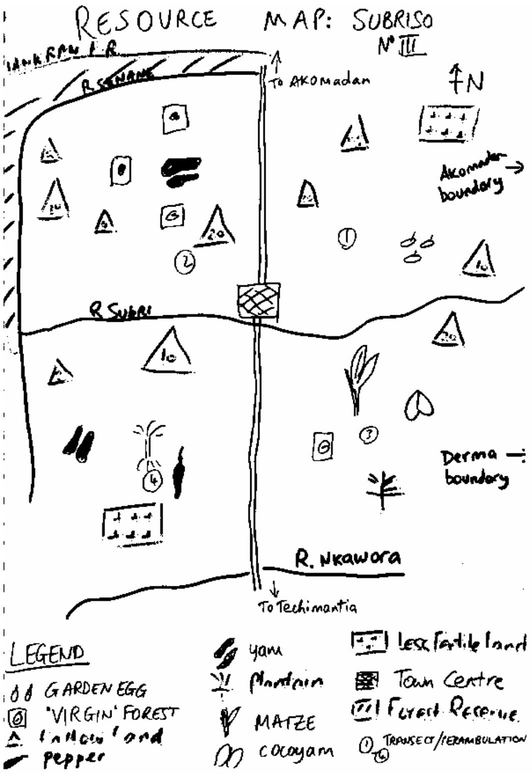
Group meetings were held with the four classes of farmers on a number of occasions, each coinciding with a taboo day of a particular village. The taboo days were convenient for these meetings, as farmers did not go to the farm on such days; hence quite a number of them were able to attend the meetings and made lively contributions to the discussions. The major issues discussed included changes in farming systems; cropping systems (crops, cropping pattern, cultural practices); indigenous ecological knowledge of crops; soils, weeds, trees, land and fallow rotations; land tenure, labour use, seasonality and availability; credit and marketing systems; gender issues; and agricultural production constraints.

The group meetings were followed by individual semi-structured interviews and farm visits. These were conducted on days of the week when farm work was in progress. The research team, together with extension staff visited farms and talked to randomly selected farmers working on their fields. The issues were the same as those discussed in the focus group discussions, to gain individuals' perspective, and included cropping pattern; soils and their management; fallow management; trees on fallow and farm/crop lands their importance, management and uses; and weeds, their importance and management.

Mapping

Small groups of farmers, in participation with research and extension staff, constructed social maps, where villagers showed the location of households, the relationships between them, and the factors relevant to their relative wealth and poverty (Figure 3a); and land use maps, which were used to analyse the linkages, patterns and inter-relationships of land use in the area (Figure 3b). The maps were etched into dirt and then transcribed onto paper by project staff.

Box 4. Mapping
Mapping is an inexpensive tool that can be used to gather both descriptive and diagnostic information. Mapping exercises are useful for collecting baseline data on a number of indicators — as part of a beneficiary assessment or a sequence of rapid appraisal studies — and the process can lay the foundation for community ownership of development planning by including diversely interested groups of people. Maps are an excellent starting place for social assessment studies because of the high level of participation they can encourage, and because the recorded, visual output can be used immediately to bridge any verbal communication gap that might exist between local people and outsiders such as development planners. The mapping exercise can be used to generate discussions about local development priorities and aspirations, and the maps themselves will be useful as verification of secondary source information and as training tools. In monitoring, changes can be recorded on maps made during project planning. In evaluation, comparative maps reveal both the status of actual changes in community resources or infrastructure and of perceived costs and benefits of the changes that have taken place. Maps can depict historical changes, social factors, health risks, water sources and land-use amongst others.



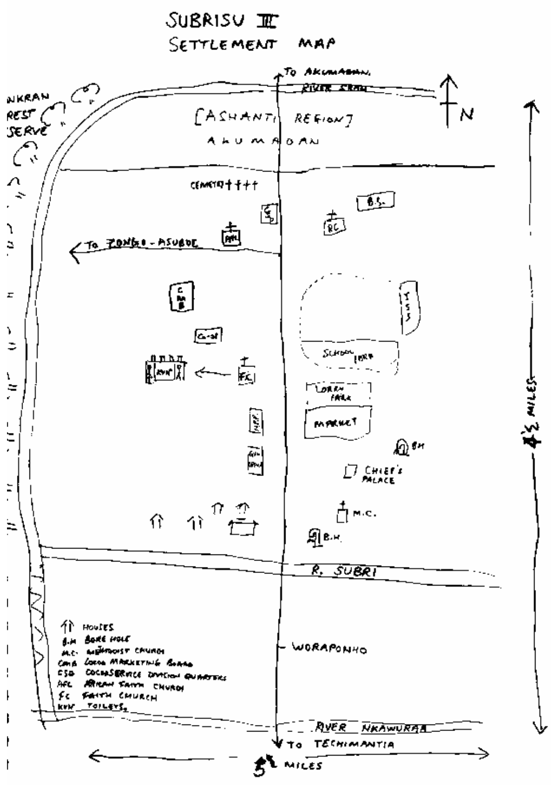


Figure 3 (a) Resource map of Subriso No. 3   Figure 3 (b) Settlement map of Subriso No.3

Box 6. Transect walks

Maps are often complemented by transect walks through the "radius" of the village to encourage local participants to recognize "blind spots" in their representation which may be caused by familiarity. The transect exercise is also helpful because it forces research teams to carry out a thorough traverse of the village or location, rather than surveying only the most easily accessible zones at the expense of hard-to-reach places and populations which might also benefit from or be adversely affected by projects. Transects are diagrams or maps which are products of a systematic tour of a community, village or specific geographical area. Transects, like maps, can make explicit the relationships between zones in a project area. Focusing attention on the different micro-environments in a project area, transects can identify in advance the locations of potential problems and opportunities in a village or agro-ecosystem
(Figures 4 and 5).

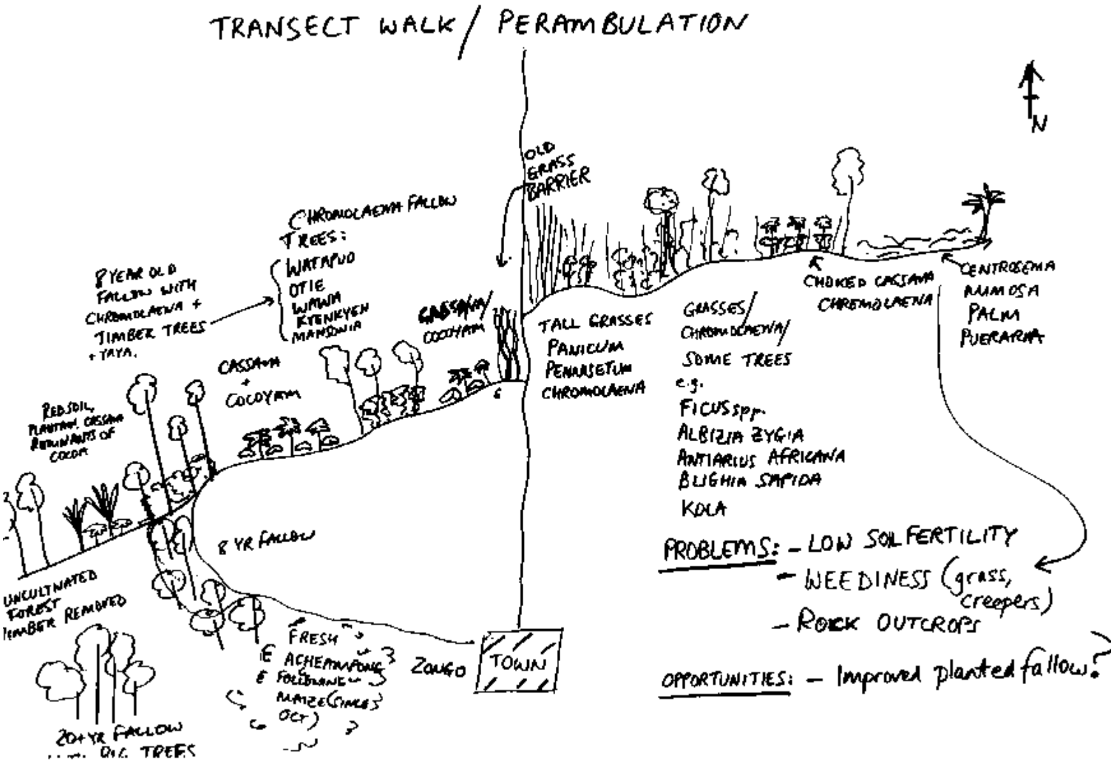
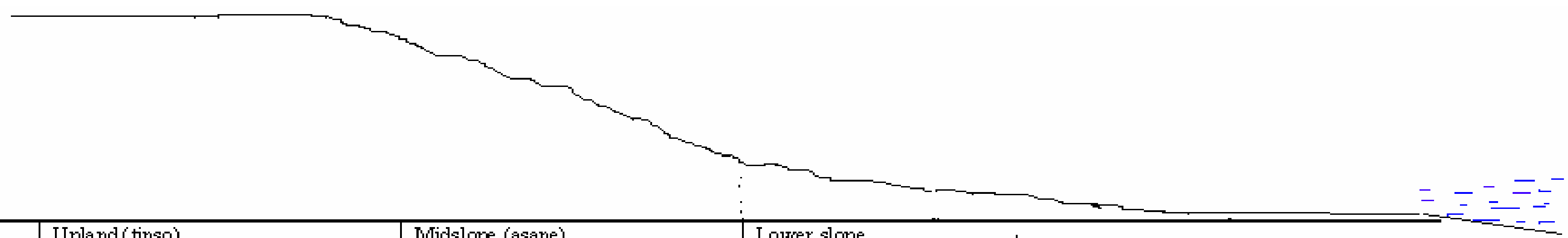


Figure 4. Transect walk in Subriso No. 3



Farmland Location	Upland (tinso)	Midslope (asane)	Lower slope (fom/bepoyase)	Lowland/Valley (Afonweamu)	
Soil type (Local name)	Asase kokoo/Anwea kokoo	Asase kokoo Mixture of asase kokoo & tuntum	Asase Tuntum	Afonwea tuntum	Afonwea fufoo
Description	Red soil Loamy-clay (sticky rainyseason, hard and cracks dryseason) Could be loamy (friable – fitufutu) or gravellyat some places	Red soil Loamy-clay (sticky rainyseason, hard and cracks dryseason) Could be loamy (friable – futufutu) or gravellyat some places	Black soil Most desired soil	Black sandysoil	White sandysoil
Crops grown	Cocoa, oil palm, maize, groundnuts, plantain, cassava, cocoyam, yam, cowpea, Major season vegetables - tomatoes, pepper, okra, garden eggs, onion/shallots Teak, cashew	Cocoa, oil palm, maize, groundnuts, plantain, cocoyam, cassava, yam, cowpea Major season vegetables - tomatoes, pepper, okra, garden eggs, onion Teak, cashew	Cocoa, oil palm, maize, groundnuts, plantain, cocoyam, cassava, yam, cowpea, Major season vegetables - tomatoes, pepper, okra, garden eggs, onion	Cocoa, oil palm, maize, cassava, plantain, groundnuts, yam, Rice, Dry season vegetables (tomatoes, pepper, okra, garden eggs)	Oil palm, Rice, maize, plantain, yam, cassava, groundnuts, pepper, Dryseason vegetables (tomatoes, okra, garden eggs, onion)
Crop rotation	Maize – Cassava Groundnuts – Cassava Yam – Cassava Tomato – Cassava	Maize – Cassava Groundnuts – Cassava Yam – Cassava Tomato – Cassava	Maize – Cassava Groundnuts – Cassava Yam – Cassava Tomato – Cassava	Maize – Cassava/Dry season vegetables Groundnuts – Dry season vegetables	Maize – Cassava/Dry season vegetables Groundnuts–Dryseason vegetables
Soil fertility management	Weeding Fallow Crop rotation Fertilizer for tomatoes & garden eggs	Weeding Fallow Crop rotation Fertilizer for tomatoes & garden eggs	Weeding Fallow Crop rotation Fertilizer for tomatoes & garden eggs	Weeding Fallow Crop rotation Fertilizer for tomatoes & garden eggs	Weeding Fallow Crop rotation Fertilizer for tomatoes, okra & garden eggs
Constraints	Weeds Soils exhausted	Weeds Soils exhausted	Weeds Soils exhausted	Weeds, especially grasses Soils exhausted	Weeds, especially grasses Soils exhausted

Figure 5. Farmers soil description and management along a toposequence at Subriso No. 3

Seasonal calendars, time lines and trend analysis

Seasonal calendars show the major changes that affect a household, community, or region within a year, such as those associated with climate, crops, labor availability and demand, livestock, prices, and so on. Such diagrams highlight both the times of constraint and opportunity, which is critical information for planning and implementation. The objective of timelines, seasonal calenders, historical profiles, and matrices is to look at the way factors of interest have changed over time, i.e. how the situation today compares with the past. This is important because key historical events may have a direct influence on the present situation.

The construction of these did not involve comparing 'real' data in the sense that the change is not measured using quantitative data or statistically valid techniques. Instead what was consulted was the memory of people who are, and have been, familiar with an area. During meetings, farmers were asked whether something had changed and how it had changed over a particular period of time; this period of time may being as short as an agricultural season and as long as several decades across th study villages.

Construction of the calendars and timelines was conducted with groups. As people argued about what changes had taken place, the researcher was provided with the opportunity to ask questions about why things had changed, and to discover more about the cause of significant factors. Simple timelines were constructed to help set the baseline and background (Figure 6; Table 2).

Activities	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Clearing	■	■	■									
Burning			■									
Planting		■	■	■	■	■						
Weeding					■	■						
Harvest of 'green' cobs						■						
Harvesting								■	■			
Minor season												
Clearing/burning/ Planting							■	■	■			
Weeding									■			
Harvesting	■											■

Figure 6. Annual Maize Cropping Calendar - Yabraso

Table 2: Major farming system events between the 1990's-2000 in Subriso No. 3

Period	Event
1990 - 2000	• Cocoa yields continue to decline • Increase in cultivation of cassava, plantain, cocoyam, oil palm, groundnuts, yam, garden eggs, peeper, onion, okra for cash • Increase monocropping for especially maize and vegetables • New / improved crop varieties – (maize- obatanpa), (oil palm-hybrid), (tomato – from Italy), pepper, etc. • Increase of population pressure on land (competition - renting and sharecropping increase) • Increase of cropping intensity, rampant wild fires and increased logging (loss of big trees) • Increased deforestation – forest giving way to grassland • Decline in fallow length (2-5 years) • Rapid decline in soil fertility • More weeds (including noxious ones) mostly grasses (*Panicum, Pennisetum, Imperata*, etc.) and other plants – *Centrosema, Ceida aquita*, etc • Weed management difficult – increase weeding frequency (4 times), ridging sometimes to minimize weeds ⇒ increase labour and cost • Crop yield decline • Increase of incidence of plant pests and diseases (cocoa – black pod and termites), cassava – mealy bug, plantain – black sigatoka, tomato rot and leaf curl, maize – stem borers, ants, termites and weevils • Increased use of agrochemicals (inorganic fertilizer, fungicides, insecticides, weedicides, etc)

Knowledge acquisition

Explicit descriptions of local agroecological knowledge are particularly useful for establishing general patterns of knowledge about processes that are common across cultural and ecological divides (Sinclair and Walker, 1999). These can usefully be documented by a sequence of activities with differing objectives and sampling strategies at each stage (Table 3).

- Scoping - an introduction to the communities using methods familiar from PRA
- Definition – development of an overall understanding of the recommendation, defining boundaries and identifying terminology
- Compilation – recording detailed knowledge on the domain by repeated interviews with a small, purposively selected set of key informants. Farmers' current knowledge and practice is acquired using a combination of PRA tools. Based on the group and individual interviews, a small purposive sample (usually about 5 key informants) of farmers is selected who can be interviewed in depth.
- Generalisation – testing the representativeness of the elicited knowledge for the community as a whole in order to; validate the knowledge base as representative of the knowledge held by the community; explore the distribution of knowledge among people within the community; and augment the knowledge base with detail not recorded in the compilation phase.

Table 3. Different stages of knowledge acquisition

	Scoping	Definition	Compilation	Generalisation

Objective	To refine knowledge acquisition objectives	To generate a broad understanding of domain and define boundaries and terms	To create a coherent and comprehensive knowledge base	To validate the representativeness of the knowledge base and the distribution of knowledge
Informants and activities	A broad range of activities in order to familiarise with the source community and get a broader understanding of the knowledge held	One or two intensive interactions with a small number of purposively selected informants	Repeated interaction with stratified sample of key informants, knowledge representation and evaluation of emerging knowledge base	A variety of questionnaire-based survey approaches on a sufficiently large and randomly selected sample of informants from the community
Tools	A range of PRA techniques	Focus group discussions	Focus group discussion and repeated informal interviews	Sample household interviews

Such activities might yield, for example, that particular farmers classify soils by a number of functions and choose crops according to soil suitability (Table 3). This highlights the necessity to take into account farmers' sophisticated local knowledge in fine-tuning extension recommendations. Using farmers' terms for soil suitability classes eases communications and enhances mutual understanding (Steiner, 1998). The classical recommendation domains for entire administrative regions or agro-ecological zones are hardly relevant for farmers and rarely adopted. It is important to understand, and allow for, flexibility in the interpretation of such recommendations.

Table 4: Soil types identified by farmers on farms

Soil type	Description	Location	Uses	Importance/Characteristics
Afonwia *Afonwia kokoo* *Afonwia tuntun* *Afonwia fufuo*	Moist sandy soil Red moist sandy soil Black moist sandy soil White moist sandy soil	Lowland Valley bottom	Rice, maize, oil palm, cassava, vegetables, cocoa	Crop growth is poor with low rainfall or moisture
Asase kokoo	Red soil	Upland Slope Lowland	Cocoa, maize, cassava, plantain, cocoyam	Soil fertility is good/high Has higher water holding capacity
Asase tumtum	Black soil	Slope Lowland	Cocoa, maize, yam, cassava, plantain, cocoyam	Soil fertility is good but higher than that of *asase kokoo* Has higher water holding capacity
Hyire	Whitish clayey soil			Hard texture with low moisture level Higher amount on farm causes poor crop growth under low moisture conditions

Livelihood analysis

A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living, (Carney, 1998, Scoones, 1998). Alternatively, it can be described as the activities, the assets and the access, that jointly determine the living gained by an individual or household, (Ellis 1999). Descriptions of farmers' livelihoods based on typical farm/plot types can serve as recommendation domains for probable adoption of technologies that might emerge from the on-farm experimentation.

The sustainable rural livelihood concept as conceived by the Department for International Development of the United Kingdom (DFID) can be viewed as a holistic approach to analysing and understanding rural livelihood systems, particularly those of the poor in developing countries, to purposely build on their existing strengths and to ensure that these systems are sustainable and ultimately to alleviate poverty. Essentially then, it is a poverty alleviation strategy, which can be attained through various 'windows or entry points' either by way of research or by addressing developmental and/or political and environmental concerns. According to the Natural Renewable Resources Department (NRRD) of DFID, the SRL concept is at present more or less a hypothesis that " the integrated management of livelihood assets in rural areas is a universally applicable means of eliminating rural poverty," (Carney, 1998).

The DFID version of the SRL concept is embedded in a SL framework that serves as an analytical structure able to portray the complexities of livelihoods, and which can also help in understanding the influences of poverty and identifying where interventions can best be made. The basic assumption underlying this framework is that people pursue a range of livelihood outcomes (health, income, reduced vulnerability, etc.) by drawing on a range of assets to pursue a variety of activities. Activities people adopt and ways they reinvest in asset building are partly driven by their own preferences and priorities, and partly influenced by types of vulnerability including shocks such as drought, and various prevailing trends (in for instance resource stocks and seasonal variations). Options people make for livelihoods are also determined by structures such as government or private sector roles and factors such as institutional, policy and cultural processesThe totality of these factors dictate actors access to assets and livelihood opportunities and the way in which, these can be converted into outcomes, (Farrington et. al. 1999).

Table 5: Capital assets related to the sustainable rural livelihood concept (adapted from Carney, (1998)

Capital Asset	Definition	Examples
Natural capital	The natural resource stocks from which resource flows useful for livelihoods are derived.	Land (including soil type and quality, altitude), water, forests/vegetation, wildlife (animals, etc.) biodiversity, climate and other environmental resources
Social capital	The social resources upon which people draw in pursuit of livelihoods or the institutions, relationships, networks and norms that shape the quality and quantity of a society's social interactions or social cohesion	Networks, membership of groups, relationships of trust, access to wider institutions or Kinship ties, power, relationships, rights and responsibilities, formalised institutional relationships (government, law and judicial system, civil and political liberties
Human capital	The skills, knowledge, ability to labour and good health important to the ability to pursue different livelihood strategies. Or, the level of skills and knowledge and the ability to use them	Muscle, brain and health (natural ability) plus expertise/training/education amounting to labour and enterprise
Physical capital	The basic infrastructure and the production equipment and means which enable people to pursue their livelihoods	Infrastructure - transport, shelter, water, energy and communications Production equipment-machinery, animal/draught power, seeds, fertilizer, irrigation and drainage
Financial capital	The financial resources which are available to people and which provide them with different livelihood options	Cash-savings, supplies of credit, regular remittances or pensions Gold, jewellery, household assets, etc.

The SRL framework identifies five main types of capital assets which rural people usually build up or draw upon for their livelihoods namely, natural, human, social, physical and financial. Table 2.1 describes the five SRL asset types. These assets more or less constitute livelihood building blocks and may to some limited extent be substituted for each other. For instance, the poor may draw on social capital such as family or neighbourhood security mechanisms at times when financial capital is in short supply. Adams, et. al. (1999), observed that the SL framework was useful in considering options for change and their likely impact on peoples' asset status whilst analysing land tenure reforms in Southern Africa. They further noted that the peoples' access to capital assets, including finance, land, natural resources and social capital, determined how far livelihoods could be enhanced. Where financial resources lacked, social capital provided the basis for a range of livelihood opportunities, including customary access to land and natural resources and opportunities for the poor to sell their labour.

The SL framework also recognizes the fact that people may pursue multiple activities and outcomes. For example, one person may depend on income from his/her own farming, sell labour locally for money or migrate elsewhere to work for money all within the same year. Livelihood outcomes will not only be monetary or even tangible in all cases. They may include intangible factors such as a sense of empowerment which might enable an actor to make wider or clearer choices. Positive general livelihood outcomes might include more income, increased well-being, reduced vulnerability, improved food security and more sustainable use of the natural resource base, (Farrington et. al. 1999).

Whilst the SRL approach is implicitly systems-based and people centred, it does not compromise on sustainable use and management of the environment. More generally, it puts the poor at the centre of analysis and aims to identify interventions to meet their needs and opportunities through a comprehensive analysis of their assets. It is believed that interventions to generate a sustainable livelihood will be most effective when there is a sound understanding of the assets and their interrelationships. Of utmost importance is the understanding of the variability within the assets and the interactions between them such that the potential effects of interventions on livelihoods can be predicted, (Carney 1998).

One suggested method to conduct farmers' livelihood analysis is by a largely qualitative approach using diagrams to portray the livelihood pattern of the study communities (Figure 7). The analysis centres mainly on characteristics of the people, their access to land (the main natural asset on which their livelihood is based) and uses of the land for various farm enterprises. Labour, finance and marketing situations associated with farm production were also be assessed in the example as well as the contribution of other complementary sources of livelihood including livestock rearing and off-farm employment. The communities' management of fallow in relation to soil fertility management to sustain crop production was also analysed.

Livelihood diagrams can then be used to:

1. Organise existing knowledge of extension workers, development workers and researchers including both local knowledge and information gathered from a literature search
2. Identify gaps in existing knowledge that need to filled through further research

The focus of the diagrams is land use by both individuals and households. All the different criteria to disaggregate the people within the target area were listed. These included gender, age, ethnic group, origin (which is important for access to land and integration within the community) and marital status (degree of independency or dependency), which are all relevant to livelihood strategies. The information represented can be tailored to the purpose for which the diagram is being drawn, but it is suggested that the following factors are necessarily integral to any holistic understanding of natural resource based livelihood strategies:

- land use
- access to land
- labour
- other income generating activities

It is relevant to complete a livelihoods analysis at the level of individuals but at some point, individuals should be considered within the social context of households, families and villages since this has implications for the assets that are available for farming and for livelihood building.

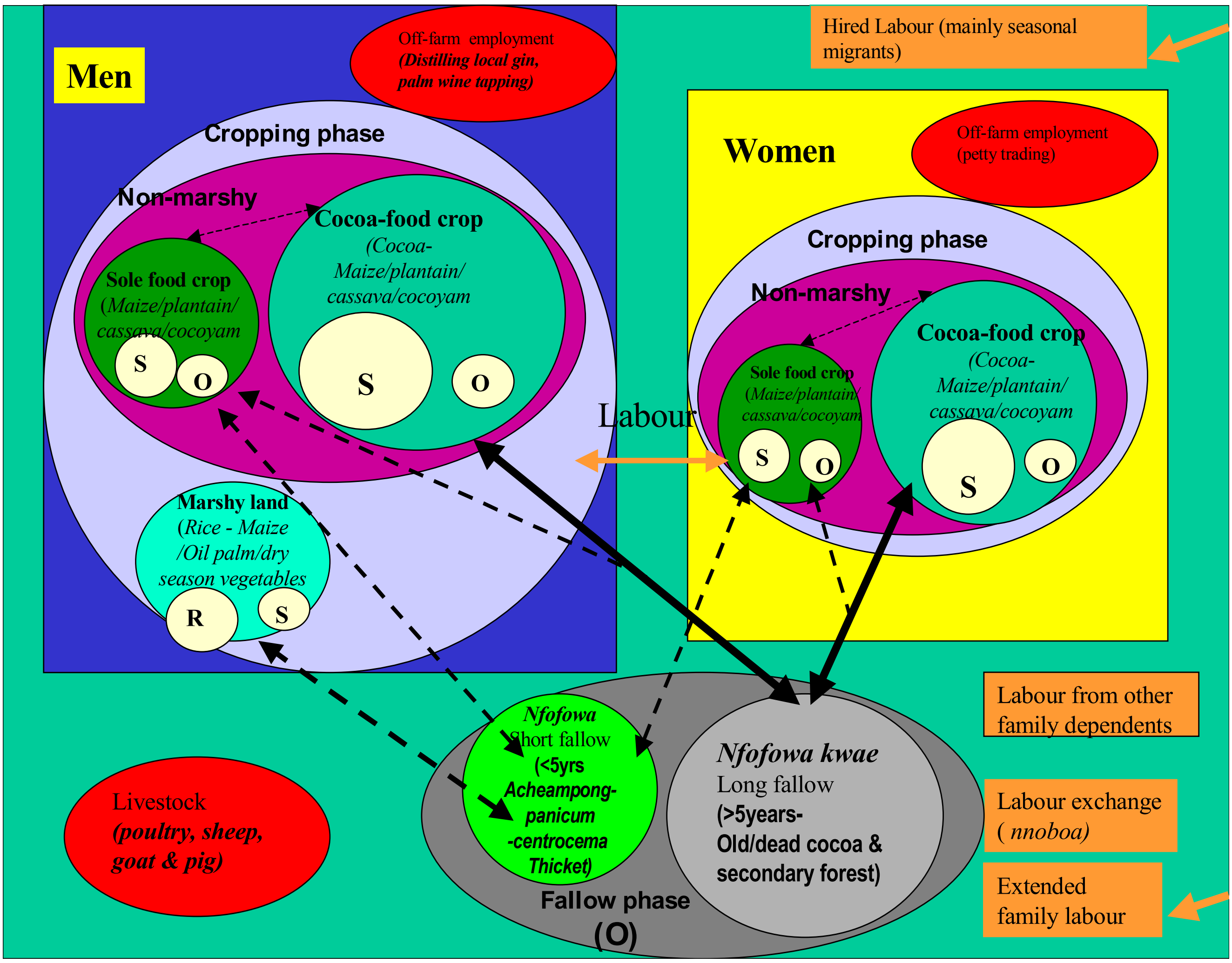


Figure 7. Example of native livelihood system diagram for Gogoikrom. The 'O' 'R' and 'S' represent Owned, Rented and Sharecropped land

Community problem analysis

A critical step in any effort to enable the poor to participate in development processes involves learning from them firsthand about the problems they face, how they have tackled them, and their proposals for gaining more control and influence over development initiatives (Norton and Stephens, 1995). In our case this was achieved by a scored causal diagramming methodology (Galpin *et al.* 2000, (Box 7)). Scored causal diagrams have been developed to aid farmers identify problems in the farming system and their root causes (which need to be addressed). Problems identified are scored to analyse their relative importance in order to prioritise them.

Box 7. Scored causal diagrams

Causal diagramming helps farmers and researchers to identify linkages and relationships between different problems. Scored causal diagramming helps to identify the relative importance of a particular problem, or the relative contribution of a particular factor to a problem. They can identify the root causes of problems which need to be addressed. This is the first step in identifying possible solutions to problems. Causal diagrams can look at general problems, or those associated with a specific crop or systems, faced by individuals or the community as a whole. A cautionary note is that problem analyses may lead to a focus on a statement of problems only, and on the linkages between these. It can lead to a disaster scenario that may not really reflect the real situation. The analyses must include looking into the opportunities and areas of advantage in present farm activities. Farmers are often very aware of opportunities and the research should consider how to bring these out.

Firstly, with facilitation from the researchers and extension staff, each stratum of farmers identified problems and constraints in agricultural production and their respective causes. The "end problem" i.e. the ultimate effect of all the problems listed was then identified, for example low farm incomes, poverty, etc.. Then, following some discussion, starting with the major identified reasons for the end problem farmers built up the causes that led to the other problems into cause and effect diagrams. When the farmers were satisfied that the diagrams were complete, they scored the causes using counters. The scoring involved grouping a number of the counters at the end problem and then distributing them up the causal chain in proportion to the relative importance or magnitude of each problem. Bigger weights were assigned to priority causes. Stone pebbles, neem seeds and maize grains were used respectively as counters in Gogoikrom, Subriso III and Yabraso.

Plate 1. Causal diagramming at Subriso No. 3

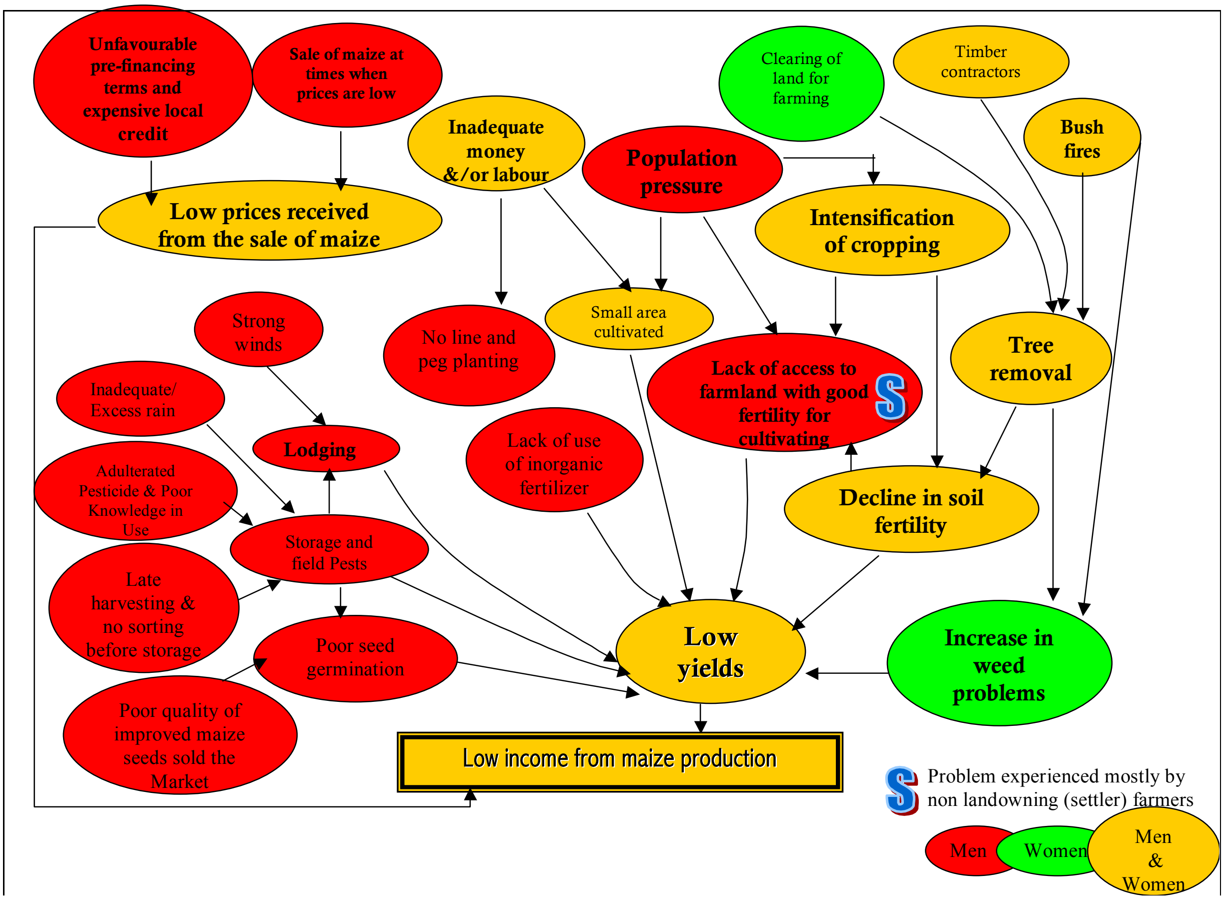


Figure 8. Causal diagram analysing farming problems at Subriso No. 3

Structured interviews

A questionnaire survey of individuals and households was administered after the PRA exercises. This was necessary to verify and complement data collected from the PRA and support on-farm experimentation. The data was analysed qualitatively for livelihoods and economic status based on typical farm/plot types that can serve as recommendation domains for probable adoption of technologies that might emerge from the on-farm experimentation. A comparative analysis of the three villages was also conducted to portray their contrasting livelihood features. (Annex B).

Comments

The decision on where to work was largely preordained by logistic and administrative reasons, and this is likely to be common to projects of this nature. However, it still remains feasible to select villages or communities within the target district that can enable generalisations on the basis of results obtained from meaningful comparisons based on the identified exogenous factors thought to influence farmers' decision making. Caution is required in identifying such factors as they are very much based on researchers' understanding of specific situations. There is a danger that professional researchers, albeit sharing similar cultural backgrounds and language can under-estimate the complexity of the constraints faced by farmers operating in an exposed manner in vulnerable circumstances that requires a highly reactive response to externalities. This goes some way to justifying the large quantity of information recorded using a number of tools as indicated in the preceding sections. It is a criticism commonly levelled at PRA exercises that they make unreasonable demands on farmers' time, and are extractive by nature, thereby not justifying the time that the farmer dedicates to the interaction. However, our experience was that, if the activities are focussed, than a great deal of information can be gathered over 1-2 days (Table 1), and can be economical in terms of time and expense (many of the communities will be remote from the researchers base which can incur high costs if maximum use is not made of available time). Even if all the information acquired is not useful, this is an easier *a posteriori* decision and it allows for objective analyses and insures against having to make repeat visits to conduct similar exercises, which is tedious for farmers. It is easy with hindsight to identify elements of the diagnosis that add little to the overall analyses, but this may not be evident at the time, even if the researchers are familiar with the study area. 'Optimal ignorance' is key (Box 1), and must trade off the information required with farmers' availability and the resources available to the researchers. There is no implication that researchers will have prior insight into the farmers' constraints, even if they are of a similar ethnic background. Obviously, selection of times appropriate to, and suggested by, the community (taboo days, early morning before leaving for farms, evenings etc.) ensures that as many people as possible can attend, and are not inconvenienced.

Our project experience was that village meetings were an invaluable part of the project process in terms of rapport building between the researchers and farmers, and enabling full discussion about the modalities of the project, but also to facilitate inclusiveness. It is a critical issue whether the very poor and excluded (illiterate landless and poor women) have been identified or included, as their livelihood strategies are diverse, and that they may not regard experimentation as relevant to them. There is real difficulty in 'seeking out' such groups to participate, as this will inevitably raise expectations, and provide no guarantee of any commitment to the project process. However, if all groups attend meetings and discussions, even if they play a passive role, then it is feasible to identify appropriate entry points. It is entirely reasonable that more marginal groups may choose to observe initially, and let more robust groups/individuals assume what may be seen to be an element of risk. The criticism that this therefore only includes an 'elite' group may be warranted in early stages, but it may nevertheless be appropriate as long as after observations of successful demonstration which is more likely achieved with the most motivated groups or individuals more widespread adoption/adaptation is facilitated and requested. Frequent iteration is required with the communities as a whole, and not just with participating farmers, to prevent alienation amongst non-participating farmers. Self-selecting participants will be the most likely to succeed, and as long as the technology is sufficiently simple to allow for large numbers of participants, should encompass a broad enough range of livelihood circumstances to consider how exogenous factors impact on different farmers' circumstances. However, although more motivated groups are easier to work with, it should not be assumed by the researchers that they know or fully understand the motivation. In the initial contacts, we found that, contrary to the researchers' understanding, the modalities and expectations of participation had obviously not been fully explained or understood, and that dropout occurred when more financial or material benefits were not forthcoming.

The classification of farmers into groups or wider categories, which are then used to differentially evaluate the effectiveness of the technology being tested, requires some judgement on the part of the researcher in the light of the available information. This will most usually refer to the presence, absence or extent of an attribute (in our case native v. settler, for example). This introduces subjectivity, and will always be open to the comment that more disaggregated account of variability between farmers, including intra-household relationships and labour effects will be more meaningful. Indeed, farmers' own classification may be value-laden and self-serving. In our case, natives v. settlers was also interpretable as strangers v. locals, depending on the length of time that individuals had been resident, and took into account position within the social hierarchy as well as land access. It is therefore critical to understand or be aware of implicit value judgements and social relations, but attempting to unpackage them may break down a very meaningful construct of a recommendation domain (Annex C).

One of the most contentious areas was seen to be that of problem analyses and whether they did in fact reflect the real situation, as this led to a focus on a statement of problems only and on the linkages between these. By looking at causation of soil fertility decline, does this ignore that fact that HIV/AIDS or lack of education is actually the paramount problem restricting social development? However, we felt that it was fundamental that we kept the discussion focussed on areas where were able to make a contribution, and kept the constraint analysis fairly specific. We wanted to identify areas of intervention where interaction between researchers and farmers could identify appropriate technologies or practices.

2 STAGE 2: PLANNING

Stakeholder workshop and development of technology options

It is critical that the information collected during the diagnosis phase is, in fact, appropriately analysed. The PRA and other tools must not be isolated from the general implementation context. Otherwise, the net effect is the production of diagrams and calendars, the construction of which has drawn on farmers' time, and which are not sufficiently linked to the implementation process (Hagmann *et al*., 1999).

To ensure maximum use was made of the diagnostic phase, a workshop was held soon after the collection of baseline/PRA information. The aim of the workshop was to present the PRA findings to all project collaborators (UWB, FORIG, IITA, MOFA, GOAN, etc.) and other stakeholders namely, District Agricultural Officers, Cocoa Research Institute of Ghana, Crops Research Institute, University of Science and Technology and the GTZ Sedentary Farming Systems Project. Table 6 is a summary on the activities undertaken during the workshop.

The information so presented was analysed/discussed to consider local ecological, agronomic and socio-economic (cultural and tenurial) conditions. The major constraints to farmer livelihoods were considered and a range of interventions conceived. After analysis and discussion of the livelihood systems, ten interventions were proposed to alleviate the identified constraints, six of which were considered to be mutually applicable to Wenchi and Tano and four to Atwima (Table 7). Protocols on various interventions were then developed for discussion and rating by farmers in the three districts.

The proposed interventions were represented pictorially (Figure 9), to simplify or facilitate presentation of the interventions to farmers. It was also to ensure that farmers understand the technological components and their respective functions. However, the descriptions were intended to be frameworks for the farmers' to consider and adapt to their own circumstances.

Table 6: Activities in the Workshop

Activity	Objective	Tools/ Methods	Expected Output	Who Involved	Time Spent
Presentation and discussion of PRA findings	To understand the dynamics/functioning of the farming and livelihood system	Presentations Discussions	Background knowledge for critical analyses of farming and livelihood systems to aid proposing of on-farm interventions obtained by participants.	UWB, FORIG, IITA, MOFA, GOAN, CRIG, CRI, UST, GTZ-SFSP	1 day
Field trip to study sites	Other participants from IITA, MOFA, GOAN, CRIG, CRI, UST, GTZ to familiarize or have overview of study sites to aid understanding of farming system	Community meeting Farm visits	IITA, MOFA, GOAN, CRIG, CRI, UST, GTZ participants obtain overview of study site	UWB, FORIG, IITA, MOFA, GOAN, CRIG, CRI, UST, GTZ-SFSP	1 day
Analytical sessions	To analyse farming/livelihood systems and propose/ develop protocols on appropriate interventions for farmer prioritisation and subsequent on-farm experimentation	Expert/technical group discussions Pictorial representations of proposed interventions	Protocol of proposed interventions developed	UWB, FORIG, IITA, MOFA, GOAN, CRIG, CRI, UST, GTZ-SFSP	2 days

Table 7. Interventions developed for presentation at each site

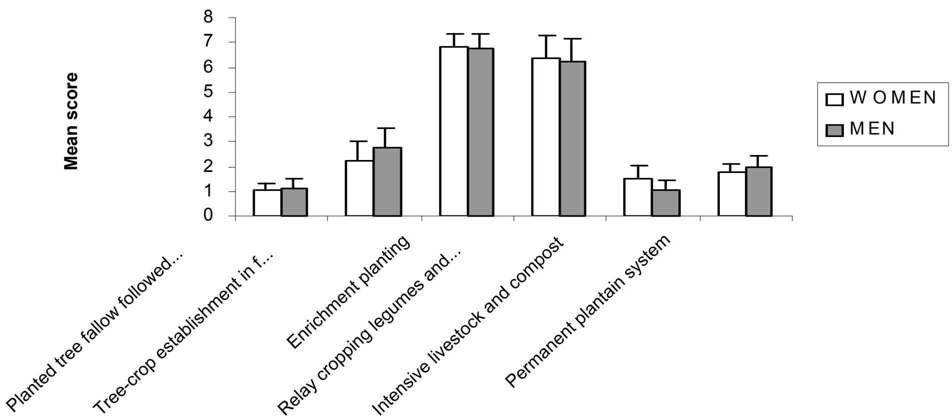
Intervention	*Problem intervention addresses*	*Description*	*Site*
Relay cropping legumes and maize	Declining soil fertility + short land tenure + no opportunity to fallow + weeds	At tassling stage of main season maize (60 days after planting), plant long season *Mucuna, Canavalia* or cowpea (possibly during the last maize weeding). The legume will add nitrogen and smother weeds increasing soil fertility, reducing weeds and increasing yield of subsequent crop (which may be any crop).	All
Planted tree fallow followed by woodlot	Declining soil fertility + weeds + firewood (cash)	Establish trees in food crop (fast growing species - e.g. *Gliricidia, Cassia* plus high value timber species e.g. *Tectona grandis*). Harvest poles and then timber - return to cropping.	Wenchi, Tano
Tree-crop establishment in food crop	Declining soil fertility + weeds + cash + declining availability of forest and long fallows	Establish high value trees in food crop phase, possibly plus cover crops, for conversion to tree-crop system e.g. cashew, cocoa, oil palm.	Wenchi, Tano
Enrichment planting	declining soil fertility + cash+declining tree cover	Establish high value trees at low density in food crop phase and protect during fallow phase to result in permanent agroforestry system (trees in fields). Intervention to include village level domestication (improvement) of high value trees.	Wenchi, Tano
Permanent plantain system	Declining availability of forest and long fallows + need for long fallow for good yields of plantain + cash	Establish trees (hedge species - e.g. *Flemingia, Gliricidia, Inga edulis*) in food crop. Fallow for two years, cut back trees to hedges and establish plantain (cocoyam) and perennial cover crops (e.g. *Pueraria* - but preferably something that doesn't climb). Harvest plantain for one or two ratoons. Fallow for two years *ad infinitum*.	All
Intensify livestock and compost	Declining soil fertility, need for fertiliser and cash	Control livestock movement, increase livestock numbers, improve feed for livestock (fodder banks); collect more dung and mix with other residues to make compost, apply compost to crops and increase yield at same time as increasing livestock productivity and cash income from it.	All
Cocoa established with a cover crop	Declining soil fertility; increase in weeds lead to problems in establishment of cocoa	In March, clear land and establish a cover crop/maize relay intercrop. Short duration could be Mucuna (8 months) and longer duration, *Pueraria* (2 years). Shade trees are established at the same time. In April, food crop and cocoa establishment	Atwima
Organic/inorganic fertiliser usage	Declining soil fertility reducing cocoa yields	Use of organic and inorganic fertilisers, as prescribed by the Cocoa Research Institute of Ghana.	Atwima
Manipulation of cocoa shade	Requirement for shade reduces cocoa yields directly and	Early shade is intended to comprise of the farmers' food crops and the treatments will	Atwima

	indirectly by utilisation of crop land; declining soil fertility	be the farmers' normal practice of inter-planting with plantain, cassava, maize and cocoyam. Identification of potential late shade species will be by farmer survey of desirable criteria and species' characteristics, and by ecological survey and use of existing data sets.	
Improved cocoa germplasm	Declining cocoa yields because of varietal drift and pest/disease problems	Replacement of traditional Amelonado stock with improved hybrids developed by the Cocoa Research Institute of Ghana.	Atwima

Presentation of technology options to farmers

Farmers rated the proposed site-specific workshop interventions to assess suitability with respect to socio-economic, cultural and ecological needs (preferences, species, and tenure constraints) to refine them to suit farmers. It was also to set priority on interventions to be implemented based on most preferred farmer choices and ecology. Activities undertaken during the rating of proposed workshop interventions by farmers are summarised in table 8 below.

The interventions were first presented to farmers in the three villages in separate fora for discussion and to assess their preferences for the interventions for prioritisation. The researchers first described each intervention represented pictorially. The description covered technological components and problem(s) the intervention is to address as well as potential benefits. After each of the options had been thoroughly described, farmers asked questions for clarification. The farmers were each given a sheet with the pictorial interventions and twenty matchsticks. They were asked to distribute the twenty match sticks among the interventions presented; giving the highest number to the intervention preferred most, the next highest to the second preferred intervention in that order (Plate 2). The results



were disaggregated on the basis of gender (Figure 10a) and tenure (Figure 10b).

Figure 9. Mean scores for interventions at Yabraso a) on the basis of gender b) on the basis of tenure

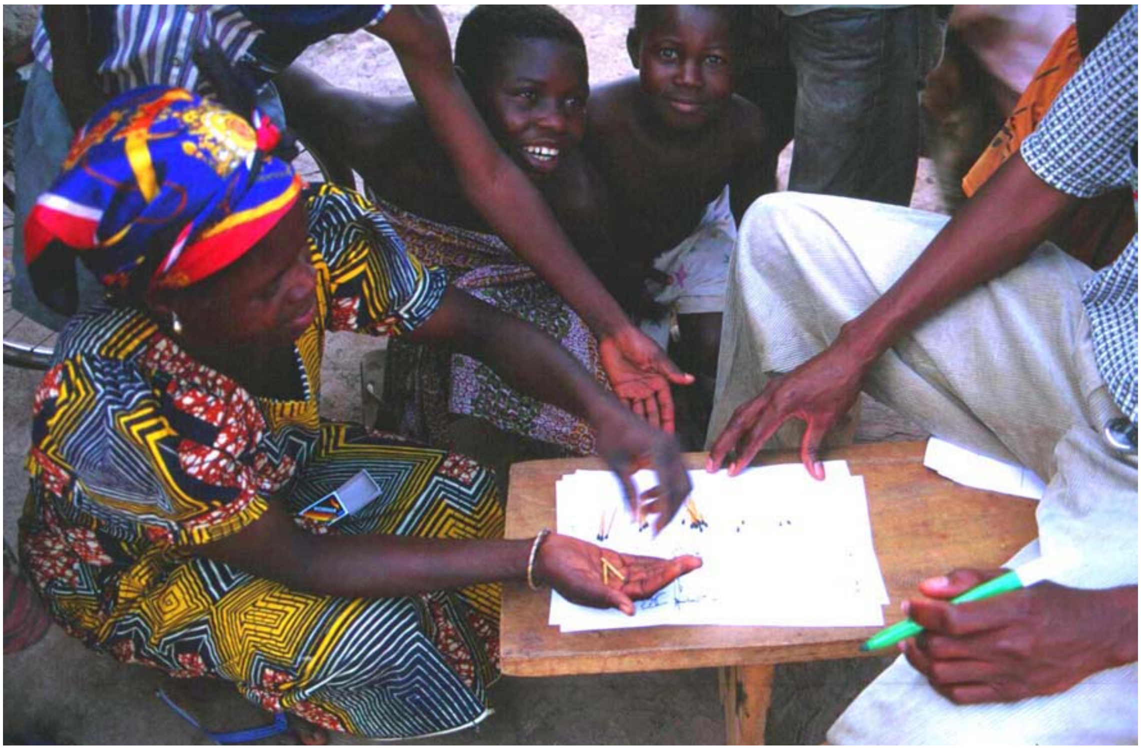


Plate 2. Farmers' voting for interventions at Yabraso

The data on the various ratings made by farmers was analysed by researchers to ascertain priority choices for the interventions among the different strata of farmers. At Gogoikrom-Atwima, the cocoa-legume cover crop was the most preferred of the interventions by both men and women followed by cocoa hybrid. The permanent plantain followed by intensive livestock systems and maize-legume relay were the most preferred by both men and women at Subriso III with planted tree fallow the least preferred. However, women (majority native) showed more interest in plantain and men more interest in livestock and maize-legume relay. The trend at Yabraso-Wenchi, was enrichment planting followed by maize-legume relay (Figure 10). Planted tree fallow again was the least preferred. The outcome was presented to the farmers and reasons for the observed scores or preferences were discussed.

Table 8: Activities in farmer rating of proposed interventions

Activity	Objective	Tools/Methods	Expected Output	Who Involved	Time Spent
Presentation of proposed workshop interventions to farmers in the three study communities	Explain site specific interventions to farmers To sensitise farmers on proposed interventions To set the background for farmer rating of proposed interventions based on their own criteria	Pictorial presentations of interventions Discussion	Farmers understand the principle underlying each proposed intervention	Researchers Extension Farmers	1/2 days
Farmers ranking of proposed interventions	To identify priority interventions among different strata of farmers To assess farmers' perception on suitability, choices/preferences modifications or additions to proposed interventions	Discussions Ranking using counters (20 match sticks)	Priority interventions identified for each community Farmers' perceptions of interventions assessed including reasons for their preferences, etc.	Researchers Extension Farmers	
Analysis of outcome of farmers' ranking of proposed interventions	To identify feasible interventions for each community for on-farm experimentation	Discussion	Feasible interventions to be experimented in each village/ecology identified	Researchers	2 days
Farmer choice of on-farm experiments Listing of farmers for on-farm experimentation	To assess farmer choices/preferences of feasible interventions List farmers willing to experiment different interventions	Explanations on technological components Pictures on some interventions from GTZ *Field visit to demonstration site Discussion Listing of farmers	Farmer understand the nature of each experiment Farmers listed for on-farm experimentation	Researchers Extension Farmers	1day

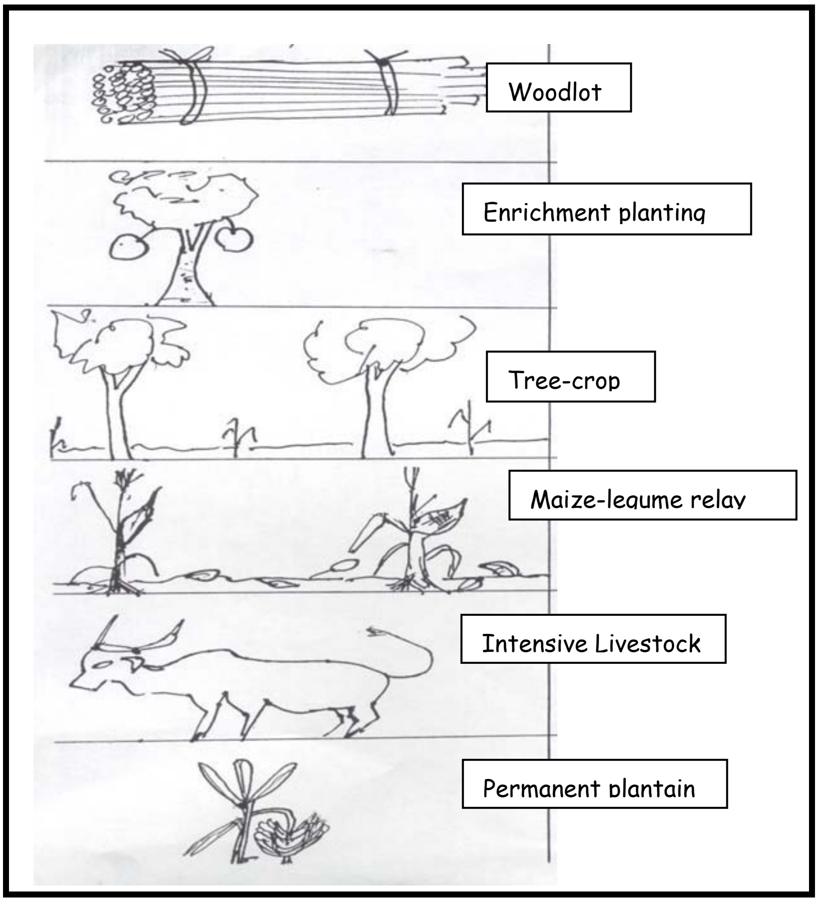


Figure 10: Pictorial representation of proposed workshop interventions for the Tano and Wenchi Districts

Following the second discussion with the farmers, and their further iteration, feasible on-farm interventions were developed from the prioritised choices made by farmers. Table 9 below shows the interventions researchers identified for on-farm experimentation for the three districts.

Comments

The important role of researchers and other stakeholders involved in the diagnostic phase is to provide their knowledge and analytical skills to identify solutions to problems that may not be apparent to the farmers. The iterative phases of diagnosis and analysis, consultation with farmers, and reassessment facilitated the proposal of technologies which were feasible to implement, and addressed the problems identified. Obviously, this process is influenced by the particular expertise of the researchers involved in the project. We do not see this as counter to the participatory process, as it is fundamental to keep the discussion focused on areas where a contribution can be competently made. Rather, this points to the necessity of ensuring multi-disciplinarity in the composition of the project team, and to the flexibility of introducing other members into the team if it is apparent after initial diagnostic phases that individuals with certain skills are not represented.

Table 9: Interventions selected for on-farm experimentation

Village	Intervention Presented
Gogoikrom-Atwima	Maize-legume cover crop (*Mucuna* spp, *Lablab purpureus, Pueraria* spp, *Canavalia ensiformis, Clitoria ternatea, Stylosanthes hamata, Stylosanthes guianensis*)
	Permanent plantain system with legumes (*Canavalia ensiformis, Gliricidia sepium, Flemingia macrophylla*)
	Cocoa-shade tree: mixed hybrid cocoa-food-shade trees such as *Albizia zygia* (Okoro), *Newbouldia laevis* (Sesemase), (Prekese) *Terminalia ivorensis* (Emire), *Entandrophragma angolense* (Edinam), *Pericopsis elata* (Kokrodua), *Entandrophragma utile* (Utile)
	Improved fallows, i.e. any field going into fallow planted to tree legume (Gliricidia sepium)
Subriso III-Tano	Maize-legume cover crop (*Mucuna* spp, *Lablab purpureus, Pueraria* spp, *Canavalia ensiformis, Clitoria ternatea, Stylosanthes hamata, Stylosanthes guianensis*
	Permanent plantain system with legumes (*Canavalia ensiformis, Gliricidia sepium, Flemingia macrophylla*
	Improved fallows, i.e. any field going into fallow planted to tree legume (*Gliricidia sepium*)
Yabraso-Wenchi	Maize-legume cover crop (*Mucuna* spp, *Lablab purpureus, Pueraria* spp, *Canavalia ensiformis, Clitoria ternatea, Stylosanthes hamata, Stylosanthes guianensis*)
	Yam-cover crop (*Canavalia ensiformis, Stylosanthes hamata, Stylosanthes guianensis*)
	Tree-food crop: (Tree species -teak, cassia, oil palm, mango, cashew
	Improved fallows, i.e. any field going into fallow planted to tree legume (*Gliricidia sepium*)

3 3 *STAGE 3: IMPLEMENTATION*

On-farm trials

To determine the effect of an intervention, it is necessary to sift out its effect from other factors—a somewhat complex task. Various methods for this include the use of comparison or control groups (those who do not participate in a programme or receive benefits), which are subsequently compared with the treatment group (individuals who do receive the intervention). Control groups are selected randomly from the same population as the project participants. Both the comparison and control groups should resemble the treatment group in every way, the only difference between groups being participation. It is, however, quite tricky to net out the intervention impact from conditions that can be affected by history and selection bias. Experimental or randomised designs are generally considered the most robust of the evaluation methodologies. By randomly allocating the intervention among eligible beneficiaries, the assignment process itself creates comparable treatment and control groups that are statistically equivalent to one another, given appropriate sample sizes. This is a very powerful outcome because, in theory, the control groups generated through random assignment serve as a perfect counterfactual, free from the troublesome selection bias issues that exist in all evaluations. The main benefit of this technique is the simplicity in interpreting results—the project impact on the outcome being evaluated can be measured by the difference between the means of the samples of the treatment group and the control group.

While experimental designs tend to be considered the optimum approach to estimating project impact, in practice there are several problems. First, randomisation may be unethical owing to the denial of benefits or services to otherwise eligible members of the population for the purposes of the study. Second, it can be politically difficult to provide an intervention to one group and not another. Third, the scope of the intervention may rule out the possibility of selecting a control group such as with a nationwide program or policy change. Fourth, individuals in treatment or control groups may change certain identifying characteristics during the experiment that could invalidate the results. If, for example, people move in and out of a project area, they may move in and out of the treatment or control group. Alternatively, people who were denied a project benefit may seek it through alternative sources, or those being offered a project may not take up the intervention. Fifth, it may be difficult to ensure that assignment is truly random. An example of this might be administrators who exclude high-risk applicants to achieve better results (Baker, 2000).

Notwithstanding, whatever the nature of the project, having a basis for comparison is fundamental to the process. It is essential to be able to compare the situation before the project started with the current situation; otherwise it is not possible to be sure the extent of impact of the project itself, compared to other extraneous factors. Depending on the project actions, it may be sufficient to conduct a baseline study at the beginning of the project and to compare with changes monitored in a non-project area. Clearly, this brings in subjectivity, as there may be significant differences between the project and non-project areas, which may indeed by why the project area was initially selected. There are also ethical questions in excluding farmers from the project process, simply to monitor them to evaluate impacts elsewhere. For this reason, participating farmers conducting their own controls is the ideal situation. This was relatively easy to achieve in the bush fallows project as the technologies under test fitted into existing cropping patterns and management, but this will not always be the case, for example, if large-scale mechanisation is the technology being tested. Comparisons in this case would depend on finding areas sufficiently similar to the project area, yet unaffected by the changes in the project.

Box 8. On-farm experiments:

Farmer-managed on-farm trials are the only way to test adoptability of an intervention under representative farmer conditions and management. However, such trials are different from on-station trials. Most importantly, biophysical within-site and socioeconomic across-site variability should be analysed and explained rather than artificially controlled as in on-station trials. Therefore:

- many observations of farmers' actual practices should be made on variables that might influence the outcome of the experiment, e.g., shading, weeding, farmer age and sex, and included as covariates in the analyses; this also helps to deal with heterogeneity at the plot level, which is particularly acute in the forest zone
- maximising the number of sites is generally more important than replication within sites; it is recommended to have 15-20 sites or farms with 1 farm as replicate, which also accounts for usually high (30-50%) loss rates of data by farmer harvests, animal damage, fire or theft; for the ANOVA, 12 degrees of freedom are recommended for the error term
- the target population of farmers or field types should be clearly defined for each intervention to be tested; ideally participating farmers in the trial should have the same characteristics as farmers in the target population; e.g., if farmers usually plant a crop over a period of 2-3 months, then the trial should cover this period
- the number of treatments should be limited to 4-6 and farmers' practice should serve as control in order to facilitate observation of the trial by farmers
- the plot size should be such that farmers work a field comparable to their normal field size; this allows for labour measurements under real-farm conditions, but requires for planted fallow testing sufficient seed availability, etc.
- treatment plots should have good separation to minimise edge effects, especially when working with trees

(adapted from Mutsaers and Walker, 1990; Mutsaers, 1991; Mutsaers *et al*., 1997)

Farmer choice of interventions for on-farm experimentation

Feasible on-farm interventions were selected by the researchers, from among the prioritised choices made by farmers, after a second analysis of the information with input from farmer/researcher discussions on their priority choices and local production systems.

The cocoa-shade tree, maize-legume relay, permanent plantain and improved fallow interventions were suggested for Gogoikrom-Atwima, suited to the short fallow systems practiced for rice and maize production systems which are normally fallowed from 1 to 3 years or more. It became apparent from the discussions with farmers that although cocoa-legume cover crop and cocoa-fertilizer were most preferred, farmers were nervous of the ability of the creepy legume they referred to as carpet to climb or strangle the cocoa. Also fertilizers (both organic and inorganic) are difficult to come by.

Maize-legume relay, permanent plantain and improved fallow interventions were suggested for Subriso III-Tano. Maize and plantain are predominantly grown and were among the interventions most desired by farmers. Moreover these production systems are commonly fallowed from 1 to 3 years or more. The livestock system could not be pursued although farmers expressed much interest because there was a MOFA project in the district working on that aspect.

Maize-legume relay, yam-legume relay, improved fallow and tree-crop interventions were suggested for Yabraso-Wenchi. Maize and yam are commonly grown in the area and desired by most farmers. Again these systems are commonly fallowed from 1 to 3 years or more. Tree-food crop systems with cashew, mango and teak tree species are increasingly being adopted in the area. Also farmers showed much interest in enrichment planting which involved planting or retaining high value trees on food croplands, which they mistook as fruit trees with food crops.

These interventions were repeatedly presented to farmers to enable them exercise their choices for on-farm experimentation at the beginning of each farming season for two years. During the presentation details on technological components of the feasible interventions identified as relevant for the particular village were again discussed with farmers. Some photographs of the interventions, such as the maize-*Mucuna* and maize-*Canavalia* systems (demonstrated on farmers' fields by the GTZ project based in Sunyani-Brong Ahafo) as well as sketches of the permanent plantain system were also shown to the farmers to further enhance their understanding of these interventions during the presentation.

During the first year at Gogoikrom-Atwima District, farmers also visited the village demonstration plot established by the project to observe the growth habit and performance of some legume species. Farmers asked for clarifications and posed questions on the interventions. At Yabraso-Wenchi District, farmers suggested a yam-legume cover system, which was added to the list of feasible on-farm experiments.

After the presentations and discussions, farmers interested in particular technologies for on-farm experimentation were then listed. Roles that farmers, researchers and extensionists would play during experimentation were also defined. Researchers and extension agents were to assist farmers technically and with some planting materials whereas farmers were to manage their fields (which should have at least a year's tenancy remaining in the case of tenants), plant crops and weed when necessary. At the beginning of the second year, the previous years' activities were first reviewed with the farmers to identify bottlenecks that required redress. The review was followed with the discussions on the experiments to remind the farmers of the functions of the technological components, after which they exercised their choices for on-farm experimentation.

The activities undertaken for the on-farm experimentation are shown in Table 10. The farm plot of each participating farmer was visited/inspected to ensure that it was ready for planting before some planting materials were distributed to farmers for planting on these plots. This was to ensure uniformity in planting material (for the maize, tree seedlings and cocoa) and as an incentive for participation.

For maize, farmers opted to plant Abelehi, an improved early maturing and high yielding maize variety, which, according to farmers' observations, does well even with inadequate rain. The project did not supply yam seeds as yam fields had already been planted before farmers were listed for on-farm experimentation. The farmers planted yam varieties of their own choice. Farmers also planted plantain varieties of their own choice, however, the project provided the plantain suckers. Hybrid cocoa, which was suggested at the workshop, was planted for the cocoa experiment; however, most farmers wish to plant this variety anyway, as it is early maturing. During the PRA phase farmers identified the tree species eventually used for the cocoa experiment from among several indigenous species as species compatible with cocoa/suitable as cocoa shade trees. All the leguminous species planted for maize, yam, plantain and improved fallow were also suggested at the workshop. It was observed that farmers had virtually no experience with these leguminous species, although some appeared to have knowledge of local varieties of *Mucuna* and C*anavalia* used in preparing sauce for consumption.

For the on-farm experiments researchers developed field protocols based on the local cropping patterns. For maize and yam experiments, the protocol was developed for combination of appropriate legume cover species with particular crops and cropping patterns. This was based on earlier discussions with farmers about technological components. Legumes with creeping vines like *Mucuna*, and Lablab were planted on monocrop fields whereas the non-creepers like *Canavalia* and *Stylosanthes* were planted on mixed crop fields in the maize and yam systems. This was done to minimize constraints associated with use of creepy covers as these have the tendency to strangle crops.

Activity	Objective	Tools/Methods	Expected Output	Who Involved	Time Spent
Establishment of On-farm Experiments	On-farm testing and development of interventions for improving short fallows with farmers	Researcher designed-Farmer managed on- farm experiments	Farmers establish and manage experiments	Farmers Researchers Extensionists	Flexible -Maize- -Yam -Plantain -Cocoa -Improved fallow
Monitoring of On-farm Experiments	Assess progress of experiments during growing season Identify factors that affect experimentation on farmers' fields	Field visits Discussion with individual farmers	Progress of farmer experiments assessed during growing season Farmers' attitudes, perceptions and other human and natural factors affecting farmer experimentation identified	Researchers Extensionists	Once every one-two months
Researcher Evaluation of On-farm Experiments	To assess performance of legume cover on-farm with respect to -spread and biomass production -weed suppression -soil fertility, etc. To determine economic viability of experiments To determine adoption potential of interventions	-Legume cover biomass assessment, -Maize yield assessment -Weed assessment -Soil analysis -Input-output data (partial budget/gross margin/cost-benefit analysis) Linear programming Logit analysis	Soil improvement potential of fallow interventions assessed Profitability of interventions assessed Factors constraining profitability of interventions identified Adoptability of interventions assessed	Researchers Extensionists Researchers Researchers Researchers	As at when appropriate during the growing season End of each farming seas
Farmer Evaluation of On-farm Experiments	Farmers assessment of performance of experiments Identify factors that affect experimentation on farmers' fields Identify gaps/issues that require redress	Individual questionnaire interviews Field visits Group discussions	Further development considered on the basis of the iteration	Farmers Researchers Extensionists	At least one week in each village at the end of each farming seas

Table 10: Activities in On-farm experimentation

Farmers planted maize and yam the way they would normally do in any pattern they wished. The researchers assisted with the planting of legume covers (see Appendix 2 for planting details). For the plantain and improved fallows researchers assisted farmers with marking out the positions of trees, plantain, and legume covers as well as planting of these species. For the cocoa, farmers planted the cocoa seedlings and plantain (early shade for cocoa) the way the would normally plant or in any manner they preferred, after the tree positions had been regularly marked or pegged at 12 x 12m triangular spacing by researchers and farmers together. The farmers then planted seven different indigenous trees species according to their own preferences at the pegged positions.

Between March and June Farmers sowed maize at their own convenience. During the first year the legume covers for the maize system were sown 8 weeks after sowing of maize. This however, did not favour establishment with respect to production of enough biomass and spread of legume to suppress weeds. This was due to the fact that there was inadequate rain after sowing and also to the problem of shading by the food crops. Consequently during the second year, -depending on the species of legume and cropping pattern - the legume covers were sown quite early (4-6 six weeks after sowing maize) . *Canavalia*, a non-creeper was sown at 4 weeks on both mono and mixed fields, whereas *Mucuna*, a creeper was sown from 6 weeks.

During the first year, farmers preferred to plant the plantain between September and October reasoning that if planted earlier (with the major season rains), the pseudostems were likely to grow very tall and become highly prone to wind throw by the strong winds common at the onset of the next major season (between February and April). When planted later with the minor season rains in September/October, the stems are shorter and can withstand the strong winds. However, it was realized when the experiments were evaluated with the farmers at the beginning of the second year that there is the danger of early drought during the minor season, which could affect the uptake/establishment of the plantain suckers and legumes. During the second season the leguminous trees/shrubs were planted earlier (May-June) to ensure that they obtain adequate moisture for proper establishment.

Farmers planted their yam fields by December in the previous year. The time for planting legume covers was not fixed. The improved fallow species were planted during the minor season in October in the first year. This late planting resulted in the legumes establishing poorly in both experiments. The improved fallow fields were virtually replanted during the second year.

The cocoa experiments were planted in August in the first year. This was because the seedlings to be transplanted were still too small for transplanting by June when farmers normally prefer to plant cocoa as the rains peak around this time and there is adequate moisture in the ground. This severely affected uptake and establishment of both cocoa and shade trees, as the minor season rains did not extend well into the season. Most of the fields were replanted in June during the second year. Seeds of cocoa and shade trees were supplied to farmers for raising seedlings for transplanting on their farms in the second year. Farmers raised the seedlings either in their backyards or on their farms. This was to ensure that enough planting material was produced on time for the second years' planting.

Demonstration areas

Farmer field trips were organized during the first and second years of experimentation to expose farmers to researcher experiments and those of farmers participating in a GTZ project in other parts of the Brong Ahafo Region. Participating farmers in the 3 villages visited the project demonstration plot at the Wenchi Agricultural Research Station during the first year. The trip was organised well into the first season in September because it was by then that the plots were well established and could provide adequate demonstration. Farmers in Gogoikrom had earlier on in January visited the project demonstration plot established in the village with similar fallow species as those found at Wenchi to observe the physical characteristics of the fallow species and to aid in informing their decision and choice of experiments for on-farm.

The main objective of the Wenchi trip was to get the farmers to observe and assess the trial species (both herbaceous and woody) at first hand, especially their characteristics with respect to farm production. It was realized during the monitoring visits that although some of the species had been planted in the on-farm experiments on their fields, they were not yet established, hence making farmers unsure of their values with respect to species characteristics, potentials and disadvantages on the farm.

Seeing the species well established on the demonstration plots would assist in clearing doubts and fears with having them on farm as well as enabling farmers to appreciate some values as well as their potentials and weaknesses as farmers had never had any experience with most of them. Finally, the trip was also to get farmers participating in the on-farm trials in the 3 villages together to enable them to interact and share ideas and experiences.

During the second year farmers of Gogoikrom and Subriso III went on exposure visits to GTZ-MOFA farmers plantain experimental plots in the Asunafo District of the Brong Ahafo Region. Yabraso farmers did not go on this trip because emphasis was on the plantain system, which was not relevant for them. The objective of this trip was to enable the project farmers to interact with other farmers having more experience of the technology. The farmer experiments visited included plantain-legume (*Canavalia*, *Cajanus cajan*), plantain-animal manure and plantain-household residue systems. The farmers owning these experiments explained how they went about establishing their fields and what they expected to gain. The farmers in addition had the opportunity to visit GTZ maize-legume (*Mucuna, Canavalia* and *Cajanus*) experiments in the Sunyani District. The briefings from farmers, GTZ and MOFA staff on the various experiments visited strengthened the visiting farmers understanding of strategies for improving productivity of maize and plantain systems. The exposure visits facilitated social interaction between farmers from different communities, which permitted exchange of ideas and experience. This served to increase farmers' confidence in their experimentation.

Comments

On-farm as opposed to on-station trials are an expensive means of technology testing. The necessity for frequent travel, to scattered locations distant from the researchers' and extentionists' base (although ideally the trials should be clustered <u>within</u> a research location representative of a major target zone (Mutsaers *et al*., 1997)) consumes resources that may be in limited supply. However, the experiences of this project suggest that farmer-managed on-farm trials are the only way to test adoptability of an intervention under representative farmer conditions and management. The opportunity to examine biophysical within-site and socioeconomic across-site variability before initiating the design and testing stages of technology development provide the framework for appropriating recommendation domains and extrapolating project results, thus providing value for money. However, this does require that many observations of farmers' actual practices need to be made on variables that might influence the outcome of the experiment, e.g., shading, weeding, farmer age and sex, to deal with heterogeneity, which can be demanding on farmers' time if the information is not collected efficiently. With respect to the outputs of this project, the decision support tools were heavily influenced by the behaviour of the farmers in response to unexpected circumstances (e.g. delays in planting because of late on-set of rains), which are very difficult to predict and include as factors in experiments conducted under controlled conditions. Resource-poor farmers, out of necessity, have to be highly attuned to 'crisis management' and it is the responsibility of the researchers and extensionists to at least attempt to provide predictive tools that can assist farmers in contingency planning.

'Interference' in farmers practice was the introduction of controls. Farmers a) do not usually include control treatments in their experimentation, b) nor do they have replicates, or c) keep all factors constant aside from the experimental factor. However: a) we found that the concept of controls was easily facilitated and in fact welcomed by farmers to provide a basis for comparison. Given that the amount of planting materials (seed, sand, trees) was limited, and therefore insufficient to cover their whole field, it was a small incremental step to separate a nominally designated control from the rest of the field. With respect to b) replication this was catered for by including other farmers' fields as replicates, and c) multiple variables by multivariate analyses. The other option to having controls would have been to compare with non-participating farmers, or to compare to a baseline situation. The former was undesirable on the basis of being as inclusive as possible, and the latter because of the considerable year-to- year variation which it would not have been possible to account for reliably.

In terms of social cohesiveness, we found that farmers elected to internalise any element of risk or investment, for example, there was little interest in producing seeds or seedlings via the established communal demonstration areas. In Gogoikrom, researchers and extensionists had originally intended that cocoa pods and tree seedlings could be raised in community nurseries. However, farmers clearly expressed a preference to raising seedlings individually in backyard nurseries.

4 4 *STAGE 4: EVALUATION*

Participatory monitoring and evaluation

The farmer and monitoring evaluation involved three phases:

- An elicitation phase, in which information and opinions were recorded
- An analysis phase, where the information was summarised, aggregated or otherwise analysed to make it more useful for monitoring and evaluation
- A utilisation phase, where the information is communicated to those who need it to make decisions

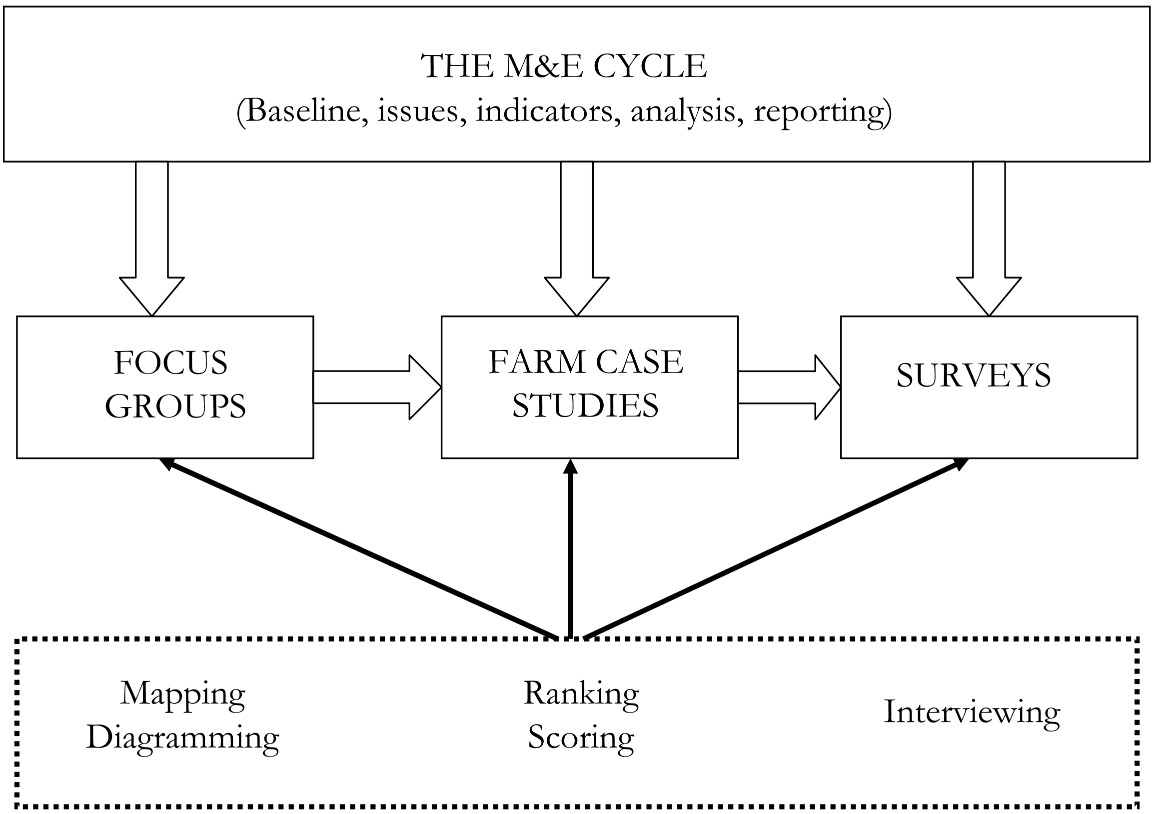


Figure 11. The monitoring and evaluation cycle (Cramb and Purcell, 2001)

Farmer Evaluation of On-farm Experiments

Participatory evaluation ensures that the perspectives and insights of all stakeholders, beneficiaries as well as project implementers, are taken into consideration. However, the participatory approach is very much action-oriented. The stakeholders themselves are responsible for collecting and analysing the information, and for generating recommendations for change. The role of an outside evaluator is to facilitate and support this learning process. Participatory MandE develops ownership by placing a strong emphasis on building the capacity and commitment of all stakeholders to reflect, analyse, and take responsibility for implementing any changes they recommend.

Typically, participatory methods have been used to learn about local-level conditions and local people's perspectives and their priorities during project appraisal. However, one can go further, and use participatory methods not only at project formulation stage, but also throughout the duration of the project, and especially for evaluating how the poor perceived the benefits from the project. Participatory monitoring and evaluation (PMandE) is an important management tool that provides task managers with quick feedback on project effectiveness during implementation. This has become increasingly important as development interventions move away from "blueprint projects" toward the more flexible planning which enables projects to learn and adapt on-the-ground.

There are many different participatory information collection and analysis tools. Most of these are not inherently MandE tools, but can be used for a range of purposes ranging from project planning and community mobilization through MandE depending on the way they are employed. As with all participatory approaches, the key to success is to be flexible and innovative in the use of appropriate tools and methods, and to be willing to adapt to local circumstances.

Development of indicators

The identification of appropriate indicators is central to most monitoring and evaluation processes. They can be quantitative or qualitative and depend entirely on the objectives of the PMandE process and the information needed (Gujit, 2000). Estrella and Gaventa (1998) use the acronym SMART to refer to indicators which are:

- Specific
- Measurable
- Action-oriented
- Realistic
- Time-framed

However, Gujit (2000) and Gaventa and Blauert (2002) caution against rigid adherence to monitoring against indicators. Defining indicators may not be straightforward, since they need to be suggested, adapted, negotiated and approved by all the relevant stakeholders (Abbot and Gujit, 1998). The selection of different kinds of indicators will ultimately depend on what is being assessed, who the end-users are, and how the information will be used (Estrella and Gaventa, 1998; Gujit, 2000). Farmers and scientists will likely have different indicators and their use must be flexible, possibly even to the extent of allowing indicators to change from one year to the next, so as to incorporate learning into the planning cycle (Lawrence *et al*, 2000; Sidersky and Gujit, 2000).

Thus, a contrasting acronym of SPICED is suggested by Roche (2002) for the selection of indicators which refers to:

- Subjective
- Participatory
- Interpreted
- Communicable
- Empowering
- Disaggregated

Box 9. The process of developing indicators with farmers

- situation analysis, to improve understanding of the inter-linkages in farming systems and to identify farmer perceptions; discussions with farmers regarding individual experiences with systems changes as a result of incorporating new farming practices;
- discussions with farmers (individually or collectively) regarding their expectations of incorporating new farming practices;
- indicator development together with farmers and researchers to show farming systems changes and impacts of new technologies;
- refining of systems indicators in the field by involving more farmers;
- use of matrix diagrams based on the identified indicators to rank and score changes.

(McDonald *et al.*, 2003)

In the context of the project, crop yield was a good indicator – readily measured by both researcher and farmer, relates well to the actions undertaken in the project, and can realistically be expected to be observed within the project time frame. Effects on soil fertility, although directed towards the project actions and hypothesis, are a longer-term indicator that may not be visible within the project time period and researchers felt it would not be appropriate for use by the farmers'. However, farmers' were confident that they could perceive changes in soil fertility, and included it as an indicator. Indicators improve farmers' and researchers' knowledge and thus improve decision-making in such a way as to affect production and resource management (Cramb and Purcell, 2001).

Box 10. Development of indicators

- A meeting of research farmers is held, to discuss and agree on a list of indicators, through which they would like to monitor changes due to the new interventions. Separate meetings should be organised for male and female household heads to collect gender differentiated indicators.
- Agree on the frequency of monitoring such changes in the same meeting.
- Researchers facilitate male and female household heads to score (separately if possible, otherwise jointly) against pre-agreed indicators for each farm.
- Indicators need to be useful, easy to collect and important to many of the stakeholders

The on-farm experiments were monitored by researchers and farmers at the start of each planting season, mid-way through the cropping cycle, and at harvest. The first monitoring visit was done to ascertain whether participating farmers had planted their fields. Thereafter, the performance of the food crops, trees and legumes legume growth and performance was monitored throughout the growing season; and farmers' behaviour/attitudes and perceptions and management, tenure and environmental factors that were impacting on the process. Quantitative assessment of the on-farm experiments was conducted with participating farmers at the end of each season for the two seasons. An open-ended questionnaire interview of individual participating farmers was first conducted before following up with group discussions in a village meeting. Matrix scoring was conducted using matches. The farmers' allocated a fixed number between the different criteria against which each indicator was being judged (Table 11).

Table 11. Ranking of indicators relative to control in maize systems in Subriso No. 3

		Indicator		
Farmer Name	**Gender**	**Yield**	**Weed Suppression**	**Soil Fertility**
Abena	f	3	2	5
Akua	f	4	3	3
Ama	f	3	2	5
Grace	f	3	3	4
Akosua	f	3	3	4
Afia	f	3	3	4
Adwoa	f	4	3	3
Nyarko	m	4	2	4
Peter	m	3	3	4
Frimpong	m	2	3	5
Kofi Asante Jnr	m	2	2	6
Akwasi Abebrese	m	3	2	5
Kwaku Acheampong	m	2	3	5
Kofi Asante Snr	m	2	3	5
Philip Warikam	m	1	4	5
Adu Frimpong	m	2	2	6
Joseph Asumadu	m	7	2	1
Salifu	m	5	2	3
Abukari Kabore	m	3	2	5
Sefa Amoako	m	3	3	4
Yaw	m	2	3	5
James	m	2	4	4
Anthony Mensah	m	3	3	4
Joe	m	1	4	5
Andrews	m	3	5	2
Haruna	m	5	2	3
Sumaila	m	8	1	1
Mean		**3.2**	**2.7**	**4.1**

Each participating farmers' view of his/her field was first assessed on his/her experimental plot. The objective of the exercise at the end of the first season was to assess farmers' perceptions of the on farm experiments particularly; the performance of the legumes covers with respect to establishment i.e. their ability to spread and form thick carpet/produce biomass and their ability to smoother weeds. Farmers' perceptions of soil fertility improvement potential of the experiments and their usefulness to the farm household for food, effect on labour requirements were also assessed, including problems encountered in experimentation and any suggestions for improving the trials in the following season.

A village meeting was then held after all individual field assessments had been completed for a more general discussion on the interventions and on-farm work including strengths and weakness observed by both participating and non-participating farmers. Farmers, including new participants were also listed for second season experimentation during the village fora. Recording of farmers' perceptions helped to identify factors influencing experimentation on farmers' fields and gaps/issues that required redress. It also helped in planning new strategies to improve the trials in the second season. This process was repeated at the end of the second season.

Iteration

During the monitoring visits it was realized that farmers in the three villages normally weeded their maize fields once. This was later confirmed during the questionnaire survey that for maize most of them would normally weed once, which was contrary to the twice/thrice reported in the PRA/baseline. The ideal is 2-3 times but in practice, most farmers do it once simply because maize is a short duration (3 months) crop and also through lack of money for second and third weeding before the maize is harvested.

In fact, if the maize is planted April to May ending, June-July is the recommended time for the second weeding (i.e. 8 weeks after sowing), which the team had designated (GTZ experience) as the time for planting of the legume cover. However, the baseline information and the questionnaire survey showed that this period coincides with the time most farmers have little or no money to engage labour because all money would have been invested in the farm, the previous years food reserves for sale might have dwindled and crops not yet ready for harvesting.

When the team of researchers and extension workers visited farms to facilitate sowing of the legume cover at around 8 weeks after sowing maize, most farms were very weedy and some of the farmers were not willing or prepared to do a second weeding. It was also observed that at 8 weeks the maize stand was dense and towered with very thick weed undergrowth on most farms. In some cases even if the weeds were cleared it was difficult to sow the cover crop and there was certain to be shading from the maize, which would delay establishment of the legume.

According to farmers the first weeding is crucial and the strategy by some of them is to delay it from 4 weeks after sowing maize to about 6 weeks after sowing depending on the aggressiveness of the weed type(s) found on the farm, so that weeding is done only once. After the maize cobs have formed i.e. about 8 weeks, there is no need for the second weeding. A second weeding might be done when weeds are so aggressive that failure to do it might result in crop failure.

Some farmers may delay sowing till about May/June or may do it very early February with the first rains to get the crop matured in 3 months and to avoid weeding more than once. These are all strategies to reduce labour cost. A second weeding might also be done if maize is intercropped with other crops like cassava, plantain, cocoyam, cashew, etc. to enhance their growth.

From the above, it was realized that the time suggested for under sowing the cover crop, i.e. 8 weeks after sowing maize might be ideal to prevent creepy legumes from strangling the maize but in reality but does not tie in well with the farmers' normal practice and socio-economic circumstances at that time. The legume covers have to be sown at the time farmers did the first weeding, 4-6 weeks after sowing maize to alleviate labour problems and ensure good establishment if the objectives of soil fertility improvement, weed suppression, reduced labour and other benefits, are to be achieved.

Box 11. Check-list for recording farmers' perceptions

a. Which aspects of the trial design did you like? Why?
b. Which aspects of the trial design didn't you like? Why?
c. Will the results obtained so far contribute to achieve the objective of the trial (intervention)? If yes, how? If no, why?
d. Do you think that the trial (intervention) design needs any modification? If yes, why and what modifications?
e. Are you willing to or thinking of adopting the intervention in other parts of your farm- land? ? If yes, which aspects of the interventions are likely to be adopted and why?
f. In your experience, will other farmers in the village adopt/adapt the interventions under trial? If yes, which aspects of the interventions are likely to be adopted and why?
g. Have you learnt anything new from implementing the intervention trial? If yes, what are those?

h. Have you shared or passed on your new findings/knowledge to others? If yes, to whom and where (in or outside the village)? i. Has anybody in or outside the village adopted or adapted any aspects or whole of the trial (intervention) design you are testing? If yes, please give his/her details. j. Your comments/suggestions for the improvements required in the trial designs.

Farmer evaluation of Researcher-managed experiments

While on the Wenchi trip the farmers evaluated the trial species with respect to weed smothering potential, biomass production potential, soil fertility improvement potential, suitability for different cropping patterns/systems (e.g. mono and mixed cropping.), suitability for fallow improvement. (Table 12). The scientist first named the species and spoke of its characteristics (N-fixing, soil improvement, other uses) and then asked farmers to assess it as they see it from their perspective.

About 9 species of herbaceous and woody legumes were established on the demonstration plot but only seven were present at the time of the visit. All the species were well established with respect to growth. Some of the short lived ones or annuals had been replanted but had not yet established.

Table 12: Farmer's Assessment of Trial Species at Wenchi Agricultural Station

Species	Farmer's Assessment
Gliricidia sepium	Dense shade controls weed growth Leaf litter drop improves soil fertility
Tephrosia candida	Shade controls weed growth Leaf litter drop improves soil fertility
Flemingia macrophylla	Shade controls weed growth Leaf litter drop improves soil fertility
Stylosanthes spp.	Effective for weed control Reseeding problem high Slow growth (observed on-farm)
Mucuna spp.	Fast growth (observed on-farm) Climbing could strangle crops Effective for weed control
Canavalia ensiformis	Fast growth (observed on-farm)
Lablab purpureus	Fast growth (observed on-farm) Creepy nature not good for cocoa (could strangle crop) Effective for weed control
Pueraria spp.	Effective for weed control

The farmer's also asked questions about some of the species including their management (time to prune trees for mulch, time to clear legumes in order to plant food crop, reseeding of legumes) and palatability. It was explained that when trees and food crops are planted together, the trees could be pruned anytime they appear to shade the food crops. Also species like *Gliricidia* could be left for 1-3 or more years after planting before clearing, depending on use, or if they are to be used for poles and charcoal, can be left even longer. *Flemingia* and *Tephrosia* may be similarly treated but are likely to die off with severe drought.

It was also explained that reseeding could be best managed by early weeding of the shoots to stop them from seeding. Grains from *Mucuna* and *Canavalia* are edible but it was made clear that they have to be boiled to remove the seed coat before consumption.

The farmers also gave their overall assessment (Table 13) of the different species with respect to some parameters (identified by the farmers' as being desirable factors).

Over all, it appeared that species with the ability to establish and produce a lot of vegetative growth or biomass seemed to be key to the farmers as this was what they could readily observe physically in the field. *Gliricidia* and *Mucuna* were the most fascinating species as they had dense vegetative growth and thus farmers believed had the greatest potential in suppressing weeds and improving the soil in a shorter time to enhance yield.

Farmers also assessed the effects of 2 planting dates of the *Mucuna* legume cover, 4 and 8 weeks after planting of maize, on maize performance and establishment of the legume (a researcher established plot) while on the field. The farmers commented that 8 weeks after planting of maize could be a better time for introducing/under-sowing the maize with the cover crop. This was because *Mucuna*, the cover species used is fast growing and being a creeper had began strangling the maize even before it was ready for harvesting. This could particularly increase labour for harvesting maize.

Table 13: Farmer's assessment of trial species with respect to farm production.

Parameter	Suitable species	Reasons
Ability to spread and cover land faster	*Mucuna* *Gliricidia*	Grow very fast
Ability to smother weeds better	*Stylosanthes* *Mucuna*	Grow profusely
Best Fallow species	*Gliricidia*	Grows very fast. Being a tree that can produce lot of biomass
Suitability for mixed cropping systems	*Gliricidia*	Does not climb Fast growth
Suitability for mono cropping systems	*Gliricidia*	
Ability to improve crop yield	*Gliricidia* *Mucuna*	Grow very fast. Biomass and shade (moisture) improve soil.

Researcher Evaluation of On-farm Experiments

Researchers collected plot level biological and socio-economic data during each growing season for analysis over two seasons. Data/farm record sheets were used for the data collection. The biological analysis comprised growth, biomass, weed and yield (maize-legume relay) assessments. Soil was also sampled from all plots for laboratory analysis to serve as baseline data.

For the socio-economic aspects, the data was on characteristics/profile of participating farmers and their respective plots such as age, tenure/access to land, farm size, labour, timing of activities, inputs and costs and output and their values. This data has been used for economic evaluation of the experiments to determine their viability and adoptability under existing farmer conditions.

Integrated approach

There is a growing acceptance of the need for integrating the different approaches to evaluation. Impact evaluations using survey data from statistically representative samples may be better suited to assessing causality by using econometric methods or reaching generalisable conclusions. However, qualitative and participatory methods allow the in-depth study of selected issues, cases, or events and can provide critical insights into beneficiaries' perspectives, the dynamics of a particular reform, or the reasons behind certain results observed in a quantitative analysis.

Integrating quantitative, qualitative and participatory methods can often be the best vehicle for meeting the program's information needs. For example, qualitative methods can be used to inform the evaluation questions and the questionnaire design, as well as to analyse the social, economic, and political context within which a program or policy takes place. Similarly, quantitative methods can be used to inform qualitative data collection strategies, including sample design, and, apply statistical analysis to control for household characteristics and the socio-economic conditions of different study areas, thereby eliminating alternative explanations of the observed outcomes.

There are a number of benefits of using integrated approaches in impact evaluations including the following:

- Consistency checks can be built in through the use of triangulation procedures that permit two or more independent estimates to be made for key variables (such as income, opinions about projects, reasons for using or not using public services, and specific impact of a project).

- Different perspectives can be obtained. For example, although researchers may consider income or consumption to be the key indicators of household welfare, case studies may reveal that women are more concerned about vulnerability (defined as the lack of access to social support systems in times of crises), powerlessness, or exposure to violence.

- Analysis can be conducted on different levels. Survey methods can provide good estimates of individual, household, and community-level welfare, but they are much less effective for analysing social processes (social conflict, reasons for using or not using services, and so on) or for institutional analysis (how effectively health, education, credit, and other services operate and how they are perceived by the community). There are many qualitative methods designed to analyse issues such as social process, institutional behaviour, social structure, and conflict.

- Opportunities can be provided for feedback to help interpret findings. Survey reports frequently include references to apparent inconsistencies in findings or to interesting differences between communities or groups that cannot be explained by the data. In most quantitative research, once the data collection phase is completed it is not possible to return to the field to check on such questions. In many cases the data analyst has to make an arbitrary decision as to whether a household or community that reports conditions that are significantly above or below the norm should be excluded (on the assumption that it reflects a reporting error) or the figures adjusted. The greater flexibility of qualitative research means that it is often possible to return to the field to gather additional data, thus allowing a rapid follow-up in the field to check on these cases.

Comments

The new technologies will either improve or substitute existing farmers' practice, and it is fundamental to understand their perceptions about the advantages and disadvantages of both, so that the technology can be modified if necessary, and extended, adopted and adapted. The means of recording these perceptions, as illustrated in this project, and in the literature reviewed in the preceding sections highlights the complexity of both anticipated and unexpected impacts. There can be no hard and fast rules in designing, or even doing away with indicators, but clearly measuring both objective and subjective impacts is necessary, particularly when the same technology may impact differently on members of the same community or even household. Externalities that go beyond the target group may also be important, for example in the dissemination of project results to non-participating farmers through visibility, information flow and exchange, and may be critical in defining effective promotion pathways.

Conclusions

Participatory technology development is a complex activity with effects at many levels. These include the process of technology development itself, and the impacts arising from the process – some of which will be more readily or immediately measurable than others. Measures of immediate or intermediate impact frequently have to be used as indicators of long-term development outcomes (such as poverty alleviation), and to ascertain the extent to which these effects are actually impacts of the project it is necessary to have a basis for comparison (Cramb and Purcell, 2001). The most effective indicators of this are likely to be the perceptions and experience of the project participants themselves – not just the farmers, but also the researchers and stakeholders not directly involved in the project activities. However, knowledge (of any dimension) is likely to outlive political agendas which may be driving the project in the first place, so the generation of information which is quantitatively assessed needs to be carefully recorded and fully documented as part of the project process.

Any participatory technology development will draw on an eclectic range of methods, and the project process should not be seen as a prescriptive research agenda. The transfer of methods from one context to the other raises concerns similar to past attempts to duplicate technological success by abstracting from the specific social, political and organisational conditions in which a specific technology emerged. It is essential to be critical in the development of participatory methods so that they do not generate the problem where exaggerated confidence in their efficacy leads to their being used exclusively and uncritically (Biggs and Smith, 1998). Participation is not a panacea, and does not necessarily guarantee inclusion, but implicit integration into project methodologies will bring about a greater degree of success. Integrating quantitative, qualitative and participatory methods can often be the best vehicle for meeting the program's information needs, the approach is costly but a much higher impact of the research is anticipated.

The experiences of this case study suggest that innovation is initially an individual experience, and social organisation will follow if the community is convinced of the benefits. Critical to this is enhancing the experiential process through exposure to a number of options. This is not in keeping with the findings of Hagmann and Chuma (2002) who consider that the innovation process should be embedded in a broader community development process including local organisational development. However, we would agree that innovation is a social process rather than solely technology-focused and process facilitation is a key determinant for success. The 'Participatory Extension Approach (PEA)' as advocated by the same authors was clearly the next step in our project experience. This will involve social mobilisation, implementation and self - and group, evaluation. However, gradual organisational development is important in preventing the imposition of outsiders' organisational models (van Veldhuizen, 1997). The broad lesson is that participatory research should be viewed as a process, rather than an episode of research whose findings need to be disseminated. This process needs to be based on an understanding of the local context, and designed accordingly (Adan *et al.*, 2002). Participatory research alone cannot change the world, but depending on how it is designed and executed, it can contribute to transformation of a broader strategy. To have significant, sustained impact on poor people's realities, the research must lead to concrete action, *inter alia*, including a process of gradual institutional change (McGee, 2002).

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Summary of Tools used for Collecting Information

Tools	*Description*
Surveys	Surveys can be of varying lengths and kinds. They can be used for gathering quantitative and qualitative information with different types of questions. The main feature is that the questions are pre-determined.
Workshops and discussion groups	Discussion groups can consist of 2 to 60 people. Larger groups are divided into smaller ones to encourage discussion from all participants. The facilitator structures the group and the discussion in such a way that people talk freely despite their differences.
Key informant interviews	Interviews with persons selected on the basis of their special knowledge and experience in area of interest. Number of informants usually varies between 5-10.
Focus groups	A group of 8 to 12 carefully selected people are brought together to discuss a specific topic with a facilitator encouraging and monitoring the flow of the discussion. Usually the participants come from similar backgrounds and experiences and the topic focuses on their opinions and knowledge of that common experience.
Informal surveys	These surveys are usually conducted with open-ended questions and administered to a sample size of from 25 to 50 people who are not selected randomly, but selected by some other less formal method. Participants answer questions about themselves as opposed to key informant interviewees who usually provide information about other people.
Interviews	Interviews vary by their degree of pre-determined form and structure. The type with least structure is open-ended interviews which are completely free-flowing conversations. Focused interviews have certain topics to cover in an unspecified order. Semi-structured interviews usually consist of open-ended questions that are asked in a predetermined order. The most structured interviews contain ordered questions requiring specific types of answers.
Social mapping	Constructing maps of communities or community facilities (or three dimensional models) on the ground or on paper.
Transects	Walking through an area perhaps associated with a mapping exercise.
Time lines and trend analysis	Chronologies of major events or graphs of seasonal patterns or perceived time trends (rainfall, prices, etc.).
Seasonal calendars	Seasonal calendar for items such as rainfall, labour, market prices.
Livelihood analysis	

Income, expenditure, off-farm income, dependency on natural resources, influences of gender, ethnicity, tenancy etc.

Causal diagrams

Diagram of chains of causality. Scored causal diagrams give weight to different factors or problems

Matrix scoring and ranking

Scoring (often using seeds, stones, matches or similar) for different indicators.