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GUIDELINES & METHODOLOGIES FOR SOCIOECONOMIC & POLICY ANALYSIS: "SITE CHARACTERIZATION" IN THE "S & B" PROJECT

DRAFT OUTLINE

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This document outlines guidelines, methodologies, and data needs regarding "site characterization" for socioeconomic and policy dimensions of the Global "Alternatives to Slash and Burn" project.

I. Project Goals and Objectives:

In establishing research methods and collecting data for the "Alternatives to Slash and Burn" project, it is important to work towards the fulfilling of the overall **goals** which are:

- to reduce the rate of tropical deforestation
- to improve the well-being of resource-poor farmers.

The **objectives** of the social science research component (as identified in the proposal) should also be taken into consideration:

- Assess and prepare diagnosis of the socioeconomic and cultural factors and the policy environment leading to slash and burn agriculture;
- Design and evaluate policy alternatives to eliminate or reduce S & B deforestation, promote sustainable agriculture and protect the environment;
- Develop methodologies and tools for policy [and socioeconomic] evaluation to facilitate decision-making processes for implementation of policy alternatives;
- Identify and adapt successful policy experiences from other countries and locations;
- Assess policy decision-making processes and identify critical intervention points an means to promote implementation of policy alternatives.

II. Key Guidelines, Processes, and Plans for Research Design:

a. Interdisciplinarity: The research should entail interdisciplinary teams of people in each site. For the policy/socioeconomic research, a preferable mix would include an economist, sociologist or anthropologist, an agricultural/resource policy expert, and a demographer or nutritionist; and these people should also work directly with the biophysical team. There should be a balance between natural and social scientists.

b. Acquisition of existing Data: The research team should avoid duplication of previous research and to take advantage of existing data. They should acquire existing documents and data that has already been collected in this field. Such information should be fully reviewed before starting the data collection, and research budgets should allow for throough investigation of existing data.

c. Participatory Approach: Participation and dialogue with farmers should be maintained at all stages of the research and development process -- ie, before, during, and following the project. This kind of participation can help to ensure success and adoption of changes, and will help facilitate effective follow up and execution of interventions. Specific methods and adaptations of participatory rural appraisal and agroecosystems analysis should be used. Specific guidelines for a participatory approach include the following:

1. Before undertaking any field research, group meetings should be held with the local community, farmers, and government agricultural agency (eg, extensionists), and policy makers. The research objectives should be discussed generally, and the local people should be encouraged to provide suggestions and ideas, and priorities. The "external" team should emphasize the importance of involvement of local people, and establish the basis for a participatory approach.

2. Partnerships with local groups should be formed; these people can help in the data collection and project activities. The local people involved can be selected by the communities, and they should represent diverse interests. Local people should be provided training onresaerch methods, and remuneration for their work, if possible.

4. Contacts or links are needed with key government institutions and NGOs that oversee education, agriculture, and resource mangement, to gain their collaborative support, and to assist in the identification of gaps, constraints, and needs. Extension agents and social workers may be particularly helpful as sources of information and potential help.

5. Participatory research methods, particularly PRA or adaptations of PRA, should be used for analysis and identification of needs and priority actions. A diversity of community members, including marginalized groups, should be involved in the exercises. (See Attachments A and B, and supplementary papers on participatory methods).

d. Economic Analytical Framework: Participatory methods or appraisal should be supplemented with field surveys (using questionnaires) and economic analysis of production data using modelling techniques. A comprehensive analytical framework/model may be used to articulate and test for the potential for technological, policy, and institutional changes. (See Attachment C) The framework can serve as a tool for identifying sample selection critera, to ensure variation in key variables over time and geographic areas. It also can be used for eventually testing hypotheses regarding the alteration of resource practices. These models should be site-specific, to accurately represent the biophysical and socioeconomic conditios of the study sites.

e. Systems Understanding: The research should be planned and carried out with a "systemic" or integrated approach, as opposed to a reductionist or commodity focus. Methods and ideas from "Diagnosis and Design" (D & D from ICRAF) and "Farming Systems" literature is relevant and should be incorporated.

III. Central Questions

The research methods, site selection, and data collection should revolve around testing hypotheses which are central to fulfilling the main objectives. *The gathering of extraneous information should be avoided*, in order to maintain a focus on the overall project purposes. The following key questions should drive the research efforts, and will help to maintain a focus.

1. **Who are the main agents (subgroups) responsible for deforestation in "new" land, and who is involved in settlement using slash & burn agriculture? What are the purposes and rates of the deforestation (by different groups)?**

2. **What are the main factors or circumstances -- including economic, political, institutional, and/or biophysical factors -- driving people to migrate, deforest, and use forest and land resources in the predominant ways?**

3. **Is deforestation is driven by other actors besides resource poor settlers, including, for example, forestry industry and well capitalized large enterprises (ranchers, plantations)?**

4. **What are the impacts and characteristics of slash & burn agriculture on resources and on social welfare & nutrition in various agroecosystems?**

5. **Does slash and burn agriculture offer forest margin settlers the best short term returns in comparison to available alternatives?**

6. **What are the roles of women and children in resource use decision-making and agricultural and extractive activities in this area?**

7. **What markets for agricultural and extractive products are accessible to people in this area, and what is the extent and nature of the markets? What are policies and other factors that determine the market characteristics? How do market factos affect farmer adoption of technologies?**

8. **To what extent do forest margin resources offer resources and economic opportunities to settlers? Do the forests themselves have social value?**

9. **What are the main constraints to productivity that farmers face? Do they have strategies and resources to deal with some of the major problems they face?**

10. **Have some technical options or projects for more sustainable land use systems in forest margins been developed by formal research entities, and/or by innovative farmers? What are they and to what extent have farmers**

participated in the projects and/or adopted the technologies?

11. What factors affect farmers' adoption of land-use/technology options? What changes are desired to enable adoption of more effective alternatives?
12. What institutional and policy changes are needed to facilitate adoption of sustainable land practices?

IV. Data Needs:

Answering these main questions requires collection of data on multiple variables at each level:[1]

a. Local/farm level data needs --

Demographic data (where from, reason for migrating/settlingin new area)
Farm production data (inputs, outputs, crops, yields)
Land tenure and titling (farm size, etc.)
Nutrition, health status, and diet
Household/family size and charateristics & dependents
Labor and division of labor (between women and men)
Household income and Off farm income sources
Perceptions of risk and of productivity changes
Farmer preferences and needs (technology, economic, and/or social)
Perceptions of crop diversity and reasons for diversity
Education level and services
Local infrastructure
Values of resource degradation and of conservation practices
Indigenous knowledge of resources and agroecology (men and women)
Marketing channels and constraints
Local level institutions and services
Informal organizations (NGOs) and farmer groups & their roles

b. Regional and national level data needs:

Land ownership structure and tenure systems and laws
Regional/national infrastructure
Marketing channels and policies
Government pricing policies affecting land

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[1] *When possible, data should be gathered on historical/past trends, as well as present circumstances affecting land use and slash and burn agriculture. It also should be realized that there is considerable overlap in these different levels.*

Regional & national land-use and agricultural policies
Forest Policies
Roles of institutions that regulate/affect use of land & resources
Demographic trends: Migration, population growth, and impacts
Role of agricultural extension and training
Educational services and policies
Technology policies
Roles of regional agricultural research institutions

c. International/Global level data needs:
Structural Adjustment policies that affect local land use
Environmental programs
Donor policies and projects, and their impacts in the area
Energy policies and prices that affect land use
International markets for agricultural & forest resource products in the area

In some cases, the desired data will not be available. The specific choice of data needs and the most important methods will depend on the local agroecological and social conditions. Adaptations to those local circumstances will be necessary. These methods and data needs/gaps should be discussed with the local researchers and team members in all cases.

V. Summary of Methods

The main methods to be used in the social science research will include:
a. participatory methods for rural appraisal
b. surveys: structured and semi-structured interviews, using a systems approach
c. economic analysis
- partial budgetting & production analysis (input-output)
- natural resource accounting
- market analysis

d. nutrition and demographic analysis
e. policy analysis (of several policy issues, as noted above)
f. interinstitutional workshops and policy dialogues.
If expertise on these methods does not exist, training would be recommended for team members.

VI. Attachments:

A & B: Information on Participatory methods
C: Economic analytical framework
Supplementary articles (From Fujisaka, and Chambers et al)

Attachment A: Excerpts from draft paper by A. Cornwall, I. Guijt, and A. Welbourn, "Acknowledging Process: Challenges for Agricultural Research and Extension Methodology," in workshop Beyond Farmer First: Rural People's Knowledge, Agricultural Research and Extension Practice, IIED/IDS, Sussex, October 27-29, 1992.

'Participatory' methodologies: an explosion of interest

Over the past decade or so there has been an explosion of interest in so-called 'participatory' research and extension methodologies. This has resulted in a plethora of acronyms, often jealously 'owned' by their respective protagonists. Amongst the rhetoric, taken on by everyone from the smallest NGO to the World Bank, there have been some important innovations and significant challenges to the mainstream approaches to agricultural research and extension.

There are of course many overlaps; some approaches focus more on problem diagnosis methodology (eg. AEA, RRA), others focus on community empowerment (eg. DELTA, GRAAP, PAR, TFD), yet others concentrate on facilitating on-farm work (eg. FPR, FSR), while others attempt to integrate a range of elements (eg. PTD).

Different people have different ideas of what 'participation' implies (Box 2). The banner of 'participation' has become so all-encompassing, that a more disaggregated analysis of methodological approaches is needed.

Box 2. What is participation? Some diverse views.

"We hear sudden declaration of fashionable support for participatory approaches... social scientists should not confuse these statements with actual participatory planning, because under the cloud of cosmetic rhetoric, technocratic planning continues to rule" (Cernea, 1992).

"The 'dialogue' with farmers is often simply and opportunity to gather information, that is [illegible] a research tool" ([illegible], 1988).

"Farmers are being asked to verify the talents of the external experts. She may be the 'expert', but he determines their participation." (Sperling, 1991)

"A process of purposeful and creative interaction between local communities and outside facilitators, in order to understand the main characteristics and dynamics of that particular agro-ecological system, to define priority problems, and to experiment locally with a variety of technological "options" (ILEIA, 1989)

"Given the chance, poor communities hold the key ot the solution of their own problems" (Cabannes, 1988).

"The proof of success.. is that they [outsiders] become redundant..., that is the transformation process continues without the physical presence of external agents, animators or cadres". (Fals-Borda and Rahman, 1991)

The following sections will review 3 of the approaches known as - FSR, FPR, [illegible] and PRA - exploring the strenghts, weaknesses and overlaps. Each approach has evolved in different ways in different places, each has obvious strengths and recognised weaknesses and each has different approaches to farmer participation, ranging from the contractual to the collegiate. The challenge for the future is to capitalise on this wide array of methodological experimentation, identify gaps and move forward.

Farming Systems Research and Extension

Farming Systems Research and Extension (FSR/E) emerged from a reaction to the prevailing transfer of technology model. It is based on positivist and empiricist assumptions about the nature of agricultural systems and, *"how their performance can be optimized through the intervention of 'the expert technologist' or managment consultant' (or extension agent). These are researched systems with scientists investigating on behalf of or even on their farmer 'clients'"* (Bawden 1992).

The principal argument for a new approach was that constraints at the farm level limited the adoption of technology coming from outside the system. Advocates of the FSR/E approach, principally agricultural economists in the early years, argued that research should be determined by explicitly identified farmer's needs, rather than by the preconceptions of researchers. Accordingly, the principal focus of applied agricultural research was shifted from the stations to the farm (Gilbert et al, 1980; Shaner et al, 1982; Collinson, 1981).

Today FSR/E exists in many shapes and sizes, making any generalisation difficult. Three commonly agreed key principles define FSR/E as being:

- an integrated effort by researchers, extensionists and farmers to design, test and modify improved agricultural technologies appropriate for local conditions;
- an holistic approach that attempts to consider all important interactions that affect the performance of the farm systems;
- an interdisciplinary perspective to problem analysis, technology design, trial implementation and evaluation (Patanothai, 1984 in Craig, 1988).

In practice, FSR/E activities stretch from basic (laboratory) research, to research station trials, on-farm trials, multi-location trials, extension programmes and production programmes. Most work is done through on-farm and multi-location trials, for testing under on-farm conditions and learning about farmers' problems and constraints, which are then communicated to experiment stations. It thus conforms to the linear model of conventional research, although in some applications initial diagnosis proceeds without specific reference to innovations which the researchers wish to introduce or test.

FSR/E's strengths are most obvious in a historical perspective. It signified a marked move away from a crop-only fixation (although this remains a favourite focus of activities) and a negation of 'the farmer' towards an appreciation of the complexity of agricultural systems and decision-making. It remained, however, largely insensitive to farmers' knowledge (Lightfoot and Barker 1988) and the flow of knowledge remained in the researcher-back-to-researcher mode (Gibbon, 1990).

Table 1. Farming Systems Research - Strengths and Weaknesses

Strengths	Weaknesses
Whole farm a system; alternative to single commodity based research	No livelihood focus; analysis often not systemic; hard systems approach
Attempt to understand farmer priorites, constraints and opportunities for technology development	Focus on seeking technology niches for off-the-shelf technologies.
Some social science work on farm	Limited methodological repertoire; heavy reliance on questionnaire survey
On-farm trial work, away from the station	Trials often designed and run by researchers, with limited farmer involvement
Economic analyses (eg partial budgeting)	Little examination of sustainability, externalities etc.
Disaggregated approach: farm types and recommendation domains	Often missed social complexity
Multidisciplinary teams	Limited integrated analysis
Development of new alliances and changed organisational arrangements in conventional research establishments	FSR Units marginalised by the mainstream; difficult relationships with extension departments; donor funding dependent
Contractual and consultative approach to participation	Collaborative and collegial approaches usually not attempted.

Farmer Participatory Research and Farmer Experimentation

Farmer Participatory Research (FPR) developed as a means of attempting to bring farmers more into the on-farm research process and to move beyond the 'contractual' or 'consultative' approach to participation found in most FSR programes.

A growing recognition of what became termed 'indigenous technical knowledge' (ITK) led to a focus on the farmer as innovator and as experimenter. This has led in recent years to increasing interest in 'collaborative' and 'collegiate' relations between researchers and farmers (Biggs, 1980; Richards, 1985; Farrington, 1988; Farrington and Martin, 1988; Amanor, 1989; Reintjes et al, 1991; Haverkort et al, 1991; Hiemstra et al, 1992).

Johnson's (1972) work on experimentation marked an important shift in perception. Johnson drew attention to the diversity of individual farmers' practices and demonstrated the extent to which systematic, low-risk experimentation characterised resource-poor farming systems. He argued that the introduction of technologies needed to be accompanied by the maintenance of diversity, rather than the kinds of prescriptive regulations extension systems tended to provide, and that testing under local conditions could be carried out by farmers within existing low-risk experimental approaches. As Chambers (1987) later noted, research station notions of uniformity are inimical to these dimensions. Changes were needed to bring farmers into the research process.

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There is now an extensive literature on farmers' experimentation (cf. Amanor 1989). A brief review of the literature reveals the significance of findings for new approaches to agricultural research and extension.

- Farmers continuously conduct their own trials and adapt technologies to their own particular circumstances (eg. Ghildyal, 1987; Maurya and Bottrall, 1987; Box, 1987, 1989; Bunch, 1990; Millar, 1992).

- There are significant differences between the process of farmers' and research station experiments (eg. Ashby et al 1987, Sumberg and Okali, 1988, Richards, 1989; Gubbels, 1992; Salas, 1992).

- There are key differences between farmers' and researchers' criteria for assessment (eg. Rhoades and Booth, 1982; Maurya et al 1988; Haugerud and Collinson, 1991; Jodha and Partap, 1992).

- Farmers' own analysis of farming systems offers important, and different, insights (Conway, 1989; Lightfoot et al, 1991; Guijt and Pretty, 1992; Chambers, 1992).

- Technologies are partially adopted and are locally adapted (eg. Basant 1988; McCorckle 1988; Winarto, 1992).

- The strategies of farmer experimentation are dynamic and adaptive strategies. In many cases farmer strategies are quicker and more able to accommodate changing circumstances and diversity than those of research scientists (Abedin and Haque 1987; Hossain et al, 1987).

How can the ongoing process of farmer experimentation be effectively linked with scientific experimentation? There are a number of conflicting ideas on how this could or should proceed.

Rapid and Participatory Rural Appraisal

Growing dissatisfaction with two common approaches to development research, 'rural development tourism' and 'survey slavery' (Chambers 1983) led to the emergence of Rapid Rural Appraisal (RRA) in the late 1970s (IDS, 1978, 1979, Carruthers and Chambers, 1981). RRA stressed cost-effective trade-offs between the quantity, accuracy, relevance and timeliness of information. The key principles of this approach were an emphasis on cumulative learning, on flexibility, on looking at things from a number of different perspectives through the application of different methods, on multi-disciplinarity, on the use of local categories and classifications, on exploring the extremes rather than the norms and on a process of action and reflection leading to the refinement of initial hypotheses through sequential review of findings throughout the research process. Initially, RRAs tended to be both one-off and extractive. Outsiders controlled, analysed and acted on the information. Fears emerged from many quarters that RRA provided legitimation for short-cuts which could have detrimental long-term consequences.

RRA continued to develop throughout the 1980s and gained a mantle of respectability. By the late 1980s, innovations and adaptations set in process a change in emphasis, fuelled by innovations in agroecosystems analysis (Gympmatitasiri et al, 1980; Conway, 1985, 1987), applied anthropology (Brokensha et al, 1980, Rhoades, 1982, 1990) and FSR/FPR (Ashby, 1990). A new label, Participatory Rural Appraisal (PRA) was coined and the focus shifted from the rapid collection of data to facilitating a more genuine participation from local people in information gathering (Mascarenhas et al, 1991, Theis and Grady, 1991; IIED, 1988-1992). This required more than innovative methods. Accordingly, the role of the outsider underwent a series of changes. A central facet of this was a stress on behaviour and attitudes. The role of outsiders in the research process was reconceived as one of facilitator and catalyst rather than as director and analyst. PRA practitioners aim in principle to devolve the production of knowledge, its analysis and the generation of potential solutions onto those whose livelihoods formed the subject for research. As a result, local people are no longer seen as *clients* or *beneficiaries*, but as *partners* in a process of research and development set into motion by the PRA.

The methods of RRA, and lately of PRA, emerged in the 1980s, and now comprise a rich menu of visualisation, interviewing and group work methods (Box 3) that have proven valuable for understanding the local perceptions of the functional values of resources, the processes of agricultural innovation and the complexities of social processes and structures. PRA approaches, combining research and practice also offer opportunities for mobilising local people for joint action (Mascarenhas et al, 1991; Devavaram, 1991).

Box 3. Methodologies used in Participatory Rural Appraisal

- *Visualised Analyses*
  - Participatory mapping and modelling (resource and social maps)
  - Aerial photograph analyses
  - Seasonal calendars
  - Daily and activity profiles
  - Historical profiles and trend analyses
  - Time lines and chronologies
  - Matrix scoring
  - Preference ranking
  - Venn and network diagrams
  - Systems and flow diagrams
  - Pie diagrams
- *Interviewing and Sampling*
  - Semi-Structured Interviewing
  - Transect walks and group walks
  - Wealth ranking
  - Direct observation
  - Focus groups
  - Key informants
  - Ethnohistories and futures possible
  - Matrices
- *Group and Team Dynamics*
  - Team contracts
  - Buzz sessions and reviews
  - Rapid report writing
  - Work sharing (taking part in local activities)
  - Villager and shared presentations
  - Self-correcting notes and diaries

One of the key strengths of this approach is its emphasis on diagramming and visual sharing. In formal surveys, information is appropriated by the interviewer who converts what is said into words

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on a page. Diagramming enables control over the creation and analysis of the maps, models or diagrams to be shared, providing a source of information which can be discussed, modified and extended. Local categories, criteria and symbols are used in the diagramming techniques, which range from mapping and modelling, to comparative analyses of local perceptions of seasonal and historical trends and to diagrammatic representations of household and livelihood systems. Rather than answering questions which are directed by the values of the researcher, local people are encouraged to creatively explore their own versions of their worlds.

Table 3. Comparing the verbal and visual.

	Verbal (interview, conversation)	Visual (diagram, model, drama, play)
Outsider's mode and role	Probing investigator	Facilitating initiator and catalyst
Insider's mode and role	Reactive respondent	Creative analyst and presenter
Investigative style	Extractive	Performative
Insider's awareness of outsider	High	Low
Eye contact	High	Low
The medium and materials are those of:	Outsider	Insider
Detail influenced by:	Etic categories	Emic categories
Information flow	Sequential	Cumulative
Accessibilty of information to others	Low Transient	High Semi-permanent
Initiative for cross-checking	Outsider	Insider
Ownership of information	Appropriated by outsider	Shared; can be owned by insider

Adapted from Chambers (1992)

Ranking and scoring exercises provide an opportunity to understand some of the complexities involved in decision-making. They are particularly valuable in the generation of locally appropriate, differentiated criteria for selecting and evaluating particular varieties or technologies. As such, they form an invaluable guide for agricultural researchers as to the requirements and preferences farmers have as regards varietal choice. Methods such as crop biographies, network and pathway diagramming (FARM-Africa 1991) and, more recently, systems diagramming (Guijt and Pretty 1992) have added to a repertoire of methods which can be effectively used in facilitating an interchange between research scientists and farmers.

Through a creative approach to the many different ways of knowing and through a challenging of biases and preconceptions about rural people's knowledge, PRA has the potential to instigate important changes in approach as it begins to be practised more widely.

However, PRA, as other approaches, has a number of weaknesses. These include:

- The political and social context of the use of methods is often underplayed. Despite the populist ideals, PRA can still be used in the process of interventionist development, rather than local self-development.

- The context of the research encounter and the power implications of the process of dialogue, interpretation and analysis are often insufficiently problematised.

- Social complexities and processes may be missed in the processes of information collection and analysis, which has historically emphasised agroecological issues.

- There is a tendency to assume that farmers are only too willing to participate in research and analysis as a thing-in-itself. This raises a number of problems in terms of the expectations which may be produced.

- Effective PRA work requires shifts in attitudes, behaviours and institutional settings, without these methods are not enough.

- Rushed and rapid is often wrong. PRA should be seen not as a one-off event, but as setting a process in motion in which incremental learning is part of a longer-term commitment.

3. Agricultural Methodologies: Contemporary Challenges

The shift away from specialisms and towards a more holistic or generalist approach has been provoked as much by practical contingencies as by changes in theoretical approaches. The 'old' approaches have been shown not only to be cumbersome and expensive, but also often quite ineffective in terms of bringing about positive change. Increasingly both natural and social scientists are working *with* local people and starting to learn *from* them.

Attachment B: Introductory section from Participatory Rural Appraisal Handbook: Conducting PRAs in Kenya, by the National Environment Secretariat, Egerton University, Clark University, and the Center for International Development and Environment of the World Resources Institute, 1991.

Chapter II
PRA: A Promising Approach "From The Ground Up"

Participatory Rural Appraisal, like its parent methodology of Rapid Rural Appraisal, is a "systematic yet semi-structured activity carried out in the field by a multidisciplinary team and designed to acquire quickly new information on and new hypotheses for rural development."[8] Its goal is socially acceptable, economically viable, and ecologically sustainable development. PRA assumes that rural communities form the active foundation for reversing Africa's current natural resource degradation and increasing food production. PRA assumes that communities need committed local leadership and effective rural institutions to do the job.

PRA can help:

- *renew Africa's natural resource base* with improved policy and action;
- *focus on rural communities*, especially vulnerable ecosystems;
- *integrate relevant sectors* in rural development by focusing on natural resources;
- *link technical and socio-economic issues* in defining problems and solutions; and
- *systematise participation* so that donors, governments, and non-governmental organisations (NGOs) arrest and reverse Africa's declining productivity.

PRA helps communities mobilise their human and natural resources to define problems, consider previous successes, evaluate local institutional capacities, prioritise opportunities, and prepare a systematic and site-specific plan of action—a Village Resource Management Plan

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8 Conway, G. and J. McCracken, 1990, p. 18.

(VRMP)—for the community to adopt and implement. Derived and managed by those who most benefit through their implementation, VRMPs offer a practical means for facilitating community self-help initiatives.

PRA enables multi-disciplinary teams of specialists and rural leaders to work more closely together and to understand better their problems, needs, and opportunities. Using the theme of natural resource management to integrate development sectors, PRA facilitates multi-sectoral (for example, agriculture, water resources, forestry), multi-disciplinary (economics, sociology, engineering, biology), and multi-institutional (government, NGO, university, donor) collaboration.

PRA is an excellent tool to bring together, on the one hand, development needs defined by community groups and, on the other, the resources and technical skills of government, donor agencies, and non-governmental organisations (NGOs). In so doing, it integrates traditional skills and external technical knowledge in the development process.

Chapter III
Getting Started

A typical PRA has eight clearly defined steps:

1. Site selection and clearance from local administrative officials;
2. Preliminary site visit;
3. Data collection: (a) Spatial; (b) Time-Related; (c) Social; and (d) Technical;
4. Data synthesis and analysis;
5. Problem identification and setting of opportunities to resolve them;
6. The ranking of opportunities and the preparation of a Village Resource Management Plan;
7. Adoption and implementation of the Plan;
8. Follow up, evaluation, and dissemination of findings.

Site Selection

Site selection can be accomplished in two ways. Either a government extension officer or other field worker identifies a village needing development assistance, or an organised community requests assistance. A few examples include:

- a community with a specific problem such as deforestation may request assistance, based on its familiarity with work that PRA has initiated in a nearby community;
- a village committee or leader may see PRA as a way to mobilise community institutions or to attract funding for village projects from a donor or government agency; or

- a Community Development Assistant or a Water Engineer might recommend a PRA for an area which has unique problems requiring special attention.

Whichever method is used, site selection is a prerequisite for work to begin. A visit to the community by members of the organising agencies should clarify the nature of PRA to the appropriate community leaders. If the community remains interested, an invitation to conduct the PRA should be formalised by a letter of request from the appropriate officer (for instance, from the Assistant Chief, Sublocation Development Committee, Community Development Assistant, or PRA team leader to the Divisional Officer, or District Commissioner). A visit to the District Commissioner should also be made to ensure technical and institutional backing. Information about the request and the team's visit should be sent to all concerned individuals and institutions in the village and district including, in Kenya, church groups, village educational leaders, and the Kenya African National Union (KANU, the national political party) representative.

Composition of the PRA Team

The composition of the PRA team greatly influences the quality of information, analysis, and the subsequent management plan. Teams are made up of a team leader and two or three core members from the organising groups, supplemented by technical extension officers (such as the water, agricultural, soil conservation, or cooperative agents) from the area under review, and, as appropriate, village leaders and interpreters. Membership should include both men and women, some with technical and others with social science experience. All should have considerable experience working at the local level as well as a good understanding of rural institutions and processes.

To assure full participation of PRA team members, brief *all* members and their supervisors in detail about the methodology. Several experienced PRA practitioners should be available to help team members less familiar with the methodology. Before embarking on a field exercise, it is recommended that all team members read background documents detailing the various PRA techniques and, preferably, participate in a PRA field exercise or training course.[9]

Under ideal circumstances, PRA would be institutionalised and organised as a single and fully integrated approach to rural development. However, the present system among development assistance agencies, donors, and governments is not structured in such holistic fashion. Thus, for administrative and funding purposes, PRA is carried out through individuals functioning in conventional sectoral positions. To assure maximum integration on the ground, it is recommended that the PRA team and village leaders organise a Village Coordinating Committee or Sublocation Natural Resources Committee. Such committees can help introduce the PRA exercise to the community and help the PRA team identify important local leaders and institutions for interviewing and organise group discussions to gather and analyse information.

Preliminary Visits to the Site

Three steps are involved in assessing a potential site.

1. Preliminary Site Visit

A preliminary site visit by the PRA team is the first step. The team introduces its approach to a broad representation of the community, including elders, the Sublocation Development Committee, leaders of self-help groups, church leaders, school headmasters and teachers, and other community leaders. The team should emphasize that the purposes of the PRA exercise are to gather information to help the community prepare an action plan—a Village Resource Management Plan—to improve local resources management and to mobilize community efforts to implement the identified activities.

This VRMP will enable community leaders and concerned residents to achieve their development expectations and needs with minimal dependence on external resources and agencies. It also helps the

9 [illegible], 1989.

community strengthen its internal development capacities and to communicate its need for external resources. This delicate balance between bolstering self-sufficiency and marshalling external assistance is essential to sound development.

During the initial visit, the PRA team should encourage the community to examine past successes carefully in order to understand the root causes underlying these performances. The PRA team should begin collecting information on completed or on-going development activities that have worked effectively in the community or in nearby villages, as well as proposals submitted by the village to external institutions for support. Examples of some of these existing activities include projects that have improved water supplies, agricultural activities, soil conservation, reforestation, school expansion, road and transport development, income generation, and health care.

2. Community Review

After this initial meeting, community leaders and members should meet in private to consider the PRA exercise. They may need a period for full and open discussion among themselves to review their understanding of PRA and confirm interest in proceeding with the programme.

3. Planning Meeting

If the PRA process is accepted, the PRA team, community leaders, and Village Coordinating Committee should organise a formal planning meeting in which all concerned parties will go over the details and workplan of the PRA exercise. This step initiates three processes:

(1) dialogue among the parties concerning all aspects of village problems and possible actions;

(2) full and dynamic community participation; and

(3) an integrated approach to development involving local residents and government extension personnel from several sectors.

At every step, the PRA team leader should keep local administrative officers and the community fully informed about progress of the PRA exercise.

Chapter IV
Data Gathering

Secondary Data about the Site

Preliminary data collection is critical in preparing an effective Village Resource Management Plan. Before beginning field work, it is helpful to gather whatever secondary data are already available from both published and unpublished sources, as well as from other project activities near the PRA site. The PRA team gathers and summarises the information before the field visit. The secondary data review need not be exhaustive and should not jeopardize or replace fieldwork.

Purpose

Secondary data provide an initial overview of the study area and yield general information on the resource base, land use, problems, opportunities, and past experiences in natural resource management. A basic understanding of the local conditions and overriding constraints enables the PRA team to address the specific needs and potential range of options available to the people.

What Sources

Easily available sources are utilised. Those used most commonly are annual reports, national censuses, project documents and maps, aerial photographs, and satellite imagery. The most useful information covers topography, drainage, vegetation, ecological zoning, production patterns, farm and agricultural resource management practices, population changes, marketing, infrastructure, and overall problems and opportunities. Information collected should be analysed and presented in simple graphs, tables, charts, and reports.

By Whom

The PRA team collects this information. The community and relevant external institutions may help identify sources.

How

The team should consult or visit technical officers, the public map office, and libraries, as well as donors, government ministries and agencies, universities, and international bodies. Maps and aerial photographs, though sometimes expensive, are helpful for data collection.

Field Data

Both Rapid Rural Appraisal (RRA) and PRA have been referred to as "data-economising" or "data-optimising" approaches; they can be used to collect limited data that produces useful results inexpensively and quickly. Their purposes are not scientific perfection, but flexible programme and project design. Data-gathering is intended, first, to encourage community residents to think systematically about their problems and possible solutions, and, second, to help the PRA team comprehend the region's conditions and circumstances, and to analyse problems and present options for addressing them.

The rapidity of the PRA approach does not lead to an incomplete or shallow collection of data, however. Unlike most conventional research methodologies, PRA uses a diversity of sources, including the assembled lore of the villagers themselves, to ensure that comprehensive information is collected. Investigating the community's situation through a variety of means makes it possible to cross-check the data and increases the accuracy of the analyses.

Several types of field data form the core of the PRA study, including spatial, time-related, and people-related information, as well as technical data (on, for instance, water potentials, tree species, and soil types). Each set of data expands the information base on local problems, needs, and opportunities—a compilation that forms the basis for preparing the Village Resource Management Plan.

Several techniques are utilised to collect each type of information. These include village maps, transects, and farm sketches for spatial information; time lines, trends, and seasonal calendars for time-related data; household interviews and institutional studies for people-related

information; and detailed sector specific studies for technical data. Each technique is designed to maximise local participation in data collection and analysis. Principal findings are presented in a simple visual form for rapid communication and comprehension to encourage lively discussions and debate.

Both PRA and RRA include a repertoire of more than 30 tools for collecting information and ensuring local participation. Some other common techniques include various ranking exercises, decision-making trees, resource profiles, production flow diagrams, and cartooning. In addition, combinations of spatial and time-related techniques, such as historical-transects and historical-seasonal calendars, have produced some interesting results. Some techniques are used to collect highly specific information (on, for instance, skin fold, height, weight, and other human characteristics, to determine the local health and nutrition situation). More techniques are being developed and adapted to focus on such issues as gender and age distinctions and inter-household variability in economic strategies.

To conduct the exercises and collect the data, the PRA team may work most effectively as a single unit or divided into several groups of two to three individuals with specific responsibilities. For example, in some circumstances it may be more constructive for only one group to prepare the necessary transects, while another prepares the seasonal calendar or other data table. In other circumstances, it may be better for two groups to work independently to prepare separate transects of the same area. The composition of these groups can vary from exercise to exercise or from day to day to facilitate team interaction. At the end of each day, the entire PRA team should gather together to present group findings, discuss inconsistencies, and identify information gaps for follow-up.

1. Spatial Data

Maps, transects, and farm sketches are powerful visual tools that provide, at a glance, a sense of location and differential relationships, and encourage the PRA team and the local people to view community problems and opportunities from a spatial perspective.

stress on behaviour and attitudes. The role of outsiders in the research process was reconceived as one of facilitator and catalyst rather than as director and analyst. PRA practitioners aim in principle to devolve the production of knowledge, its analysis and the generation of potential solutions onto those whose livelihoods formed the subject for research. As a result, local people are no longer seen as *clients* or *beneficiaries*, but as *partners* in a process of research and development set into motion by the PRA.

The methods of RRA, and lately of PRA, emerged in the 1980s, and now comprise a rich menu of visualisation, interviewing and group work methods (Box 3) that have proven valuable for understanding the local perceptions of the functional values of resources, the processes of agricultural innovation and the complexities of social processes and structures. PRA approaches, combining research and practice also offer opportunities for mobilising local people for joint action (Mascarenhas et al, 1991; Devavaram, 1991).

Box 3. Methodologies used in Participatory Rural Appraisal

- *Visualised Analyses*
  - Participatory mapping and modelling (resource and social maps)
  - Aerial photograph analyses
  - Seasonal calendars
  - Daily and activity profiles
  - Historical profiles and trend analyses
  - Time lines and chronologies
  - Matrix scoring
  - Preference ranking
  - Venn and network diagrams
  - Systems and flow diagrams
  - Pie diagrams
- *Interviewing and Sampling*
  - Semi-Structured Interviewing
  - Transect walks and group walks
  - Wealth ranking
  - Direct observation
  - Focus groups
  - Key informants
  - Ethnohistories and futures possible
  - Matrices
- *Group and Team Dynamics*
  - Team contracts
  - Buzz sessions and reviews
  - Rapid report writing
  - Work sharing (taking part in local activities)
  - Villager and shared presentations
  - Self-correcting notes and diaries

One of the key strengths of this approach is its emphasis on diagramming and visual sharing. In formal surveys, information is appropriated by the interviewer who converts what is said into words

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on a page. Diagramming enables control over the creation and analysis of the maps, models or diagrams to be shared, providing a source of information which can be discussed, modified and extended. Local categories, criteria and symbols are used in the diagramming techniques, which range from mapping and modelling, to comparative analyses of local perceptions of seasonal and historical trends and to diagrammatic representations of household and livelihood systems. Rather than answering questions which are directed by the values of the researcher, local people are encouraged to creatively explore their own versions of their worlds.

Table 3. Comparing the verbal and visual.

	Verbal (interview, conversation)	Visual (diagram, model, drama, play)
Outsider's mode and role	Probing investigator	Facilitating initiator and catalyst
Insider's mode and role	Reactive respondent	Creative analyst and presenter
Investigative style	Extractive	Performative
Insider's awareness of outsider	High	Low
Eye contact	High	Low
The medium and materials are those of:	Outsider	Insider
Detail influenced by:	Etic categories	Emic categories
Information flow	Sequential	Cumulative
Accessibility of information to others	Low Transient	High Semi-permanent
Initiative for cross-checking	Outsider	Insider
Ownership of information	Appropriated by outsider	Shared; can be owned by insider

Adapted from Chambers (1992)

Ranking and scoring exercises provide an opportunity to understand some of the complexities involved in decision-making. They are particularly valuable in the generation of locally appropriate, differentiated criteria for selecting and evaluating particular varieties or technologies. As such, they form an invaluable guide for agricultural researchers as to the requirements and preferences farmers have as regards varietal choice. Methods such as crop biographies, network and pathway diagramming (FARM-Africa 1991) and, more recently, systems diagramming (Guijt and Pretty 1992) have added to a repertoire of methods which can be effectively used in facilitating an interchange between research scientists and farmers.

Through a creative approach to the many different ways of knowing and through a challenging of biases and preconceptions about rural people's knowledge, PRA has the potential to instigate important changes in approach as it begins to be practised more widely.

Attachment C: Economic modelling by Steven Vosti, International Food and Development Policy Research Institute (IFPRI)

ANALYTICAL FRAMEWORK FOR FOREST MARGINS RESEARCH

"The following sketch of an analytical framework is presented to help focus attention on the types (and levels) of data needed to test a comprehensive set of hypotheses regarding the impacts of policy and technology changes on farm-level resource allocation decisions. Attention should be paid to subscripts, as they provide hints as to potential difficulties in data collection, site selection, and estimation".

I. Plot Level - "*i*" indexes plots

"*t*" indexes time

Note: All indexed by "*j*", the farm household.

A. Soil Parameters

$$SP_{i,t} = f_1(END_{i,t0}, CRP_{i,t0-t-1}, FAL_{i,t0-t-1}, BRN_{i,t0-t-1}, INV_{i,t-1})$$

where: $SP_{i,t}$ = Soil parameters of plot "*i*" at time *t*

$END_{i,t0}$ = Endowment of plot "*i*" at time zero

CRP_{t0-t-1} = Cropping pattern of plot "*i*" from settlement to time *t-1*

FAL_{t0-t1} = Total follow periods from settlement to time *t-1*

BRN_{t0-t-1} = Total number of burns of plot "*i*" from settlement to time *t-1*

INV_{t-1} = External investments of plot "*i*" in time *t-1*

B. Cropping Patterns*

$$CP_{i,t} = F_2(SP_{i,t}, \bar{P}_t, \bar{W}_t, TRANS_t, DIST, LAB_t, DEP_t, SETT_t, TEN)$$

where: $CP_{i,t}$ = Cropping pattern on plot "*i*" at time *t*

$\bar{P}_t$ = Vectors of output prices faced by farmer in time t

$\bar{W}_t$ = Vector of input prices faced by farmer in time t

$TRANS_t$ = Transport costs in time t

LAB_t = Labor available at time t (by age/gender, hired and family)

DEP_t = Household dependency ratio at time t

$SETT_t$ = Time since settlement

$DIST$ = Distance to market

TEN = Land tenure status

II. Household Level

A. Off-Farm Income -- indexed by "j", the farm household, and t

$$\%OFF_t = f_3(\bar{P}_t, \bar{W}_t\ TRANS_t, LAB_t, \%OFF_{t-1})$$

where: $\%\ OFF_t$ = Proportion of total farm income generated from off-farm sources at time t

B. Extractive Activities

$$EXT_t = f_4(FOR_t, \bar{P}_t, \tilde{W}_t)$$

where: EXT_t = Volume of extractive activities in time t

FOR_t = Amount of standing forest on farm

C. Migration** - indexed by "j", the farm, and "k", alternative site

$$MIG_t = f_5(\bar{P}, \bar{W}, PROD, HOSP, SCH, ORIGIN)$$

where: MIG_t = Decision to migrate (0/1)

$PROD$ = Trends in crop/animal productivity

$HOSP$ = Trends in provision of health services

SCH = Trends in provision of schools

$ORIGIN$ = Vector of factors in origin areas affecting migration decisions

III. Individual Level

"k" indexes individuals within households

$$BMI_{k,t} = f_6\ (CON_{k,t},\ HS_{k,t},\ Z_k)$$

where: $BMI_{k,t}$ = Body Mass Index (for adults) and an appropriate measure for children (perhaps weight-for-age), for individual "k" at time "t"

$CON_{k,t}$ = Family nutrient intake at time "t"

$HS_{k,t}$ = Health expenditures on individual "k" at time "t"

Z_k = Vector of individual characteristics, such as age, sex, ...

Endnotes;

* There is an underlying notion here that the choice set for cropping patterns (for technical and household survival reasons) is narrow to begin with, broadens, and then narrows again.

** Migration decision are based on expected trends in output price, input prices, crop/animal productivity, and the provision of public goods, vis-a-vis <u>needs</u> and <u>alternatives</u>.

Sections from Diane Rocheleau et al, Gordon Conway, and IDS Workshop, in Farmer First: Farmer Participation in Agriculture Research, by R. Chambers, A. Pacey, and LA Thrupp, Intermediate Technology Publications, London, 1988.

1.3 *Local knowledge for agroforestry and native plants*

DIANNE ROCHELEAU, KAMOJI WACHIRA, LUIS MALARET, BERNARD MUCHIRI WANJOHI

Local knowledge and research processes in Africa

Agroforestry has become popular in development and environmental circles throughout the world. It is now often invoked as a new solution to rural development needs. But the scientific community and development agencies have not invented agroforestry; this is merely a new word used to describe age-old land-use practices familiar to millions of farmers and herders in many parts of the world.

Agroforestry is defined formally as a holistic approach to land use, based on the combination of trees and shrubs with crops, pastures or animals on the same land unit, either in sequence or at the same time (Lundgren, 1982). In reality, most farmers cannot easily separate this from the integration of woody plants into agricultural and pastoral landscapes. Whereas formal agroforestry science is based on the systematic placement of trees relative to crops and pastures, rural people are often more concerned about the fit of the whole agroforestry practice, and trees in general, into the larger landscape. In many cases, farmers have longer experience and knowledge of 'agroforestry' practices than scientists.

In Eastern and Southern Africa, the trend of most agricultural development and settlement programmes has been toward the oversimplification of production systems and 'homogenization' of landscape; in addition, such programmes have often accelerated the twin processes of resource degradation and selective impoverishment of women, the poor, and/or ethnic minorities. Even most existing agroforestry programmes suffer from an imbalance of technical and social expertise and from lack of accountability to their rural clients.

Only recently have we begun to undertake successful agroforestry (AF) programmes which depart significantly from these patterns. These emphasize the priorities, knowledge, innovative capacities and full participation of local people in research and development. Key attributes are adaptability to local conditions, adoptability by farmers, and genetic diversity. Where farming communities are already well established, these AF programmes face choices about the use of residual woodlands, the conservation of local knowledge about plant species and their environments, and the domestication of valuable wild species into cropland, pasture and other niches. Land use and landscape planning for ecological and economic diversity are also involved. The challenge is to encourage, support and supplement rural people's own innovations in ways which combine these elements.

This is made more difficult by two characteristics of AF. The first is decisions which are committing. The choice between varieties of maize from research stations is simply compared with choices about land clearing, land use, tree planting and the management of woodlands. Farmers can change maize varieties after one season, but decisions about woody plant resources and the soil are not so readily reversible (Wilson 1987). Decisions in the present may determine resource conditions for generations to come.

The second difficulty with AF innovation is the enormous range of species and AF practices. Scientists lack proven packages for the diverse environments and circumstances of rural people in the region (Rocheleau and Raintree 1986). One response by AF researchers has been to choose a few practices and a short list of species and test them under a variety of circumstances, yet there is shortage of time and resources for such a trial-and-error approach to AF research.

For both practical and ethical reasons, the rural poor should predominate in these complex processes of technology and land use change. Practically, formal experiments have limited scope because trees require a lot of space and a fairly long time to grow. Only a few formal experiments can therefore be carried out, with few repetitions in space and time. Nor can formal testing be undertaken on a scale to fit the numerous, distinct environments which are commonly found. Great care is consequently needed in deciding what species and what AF practices to submit to formal experiments (Raintree 1983; Huxley and Wood 1984; Torres 1984). Moreover, the complexity and scope of the changes involved are beyond the capacity of formal research programmes under controlled conditions.

Rural people have here a comparative advantage: they know and use whole systems in all their diversity and variability; as clients they know what will meet their needs and they are well placed to adapt and adjust AF components over time. From an ethical point of view, also, it is right that the poor rural majority should direct any process which will transform the rural landscape and the biological basis of their livelihoods.

AF research and development workers in the field must therefore carefully mix existing local practice with the science of designing and testing new practices, involving themselves as consultants and catalysts in a process of research, extension and evaluation essentially 'owned' by rural people (Rocheleau and Weber 1987).

Rapid Rural Appraisal (RRA) and ecological methods for community-based AF research

The methods for agroforestry in general and community-based AF research in particular must constitute a radical departure from traditional agronomy and even from many of the farming systems research methods that have become established in formal scientific circles. Whether in formal or informal research programmes the approach should often be more ecological than agronomic, as befits the focus on the place of trees, woodlands and savannas in the habitat of farmers and herders. Within ecology, both qualitative and quantitative sampling and monitoring techniques have been developed to study whole systems and the complex relationships between organisms and their environments (Odum, 1984; Conway, 1985). Moreover, the theory and the methodology are well suited to a sliding scale of analysis from tree-soil interactions to regional land use systems (Odum, 1984; Rocheleau, 1983; Hart, 1985; Conway, 1985), whereas agronomy is firmly rooted in the plot.

The development of AF and woodland management systems for rural landscapes can benefit particularly from the convergence of methods in two sub-fields of ecology – ethnobotany and agroecology. While ethnobotany draws its methods from human ecology and ethnographic traditions in anthropology (Posey, 1981) and naturalist traditions in plant and animal ecology (Okafor, 1981), agroecology derives its research methods more from environmental management and systems ecology (Hart, 1981; Altieri, 1983; Conway, 1986). Ethnobotany and agroecology provide tools for studying existing 'natural' ecosystems, traditional AF systems and recent innovations by rural people. Their methods present ample scope for incorporating indigenous technical knowledge, indigenous capacity for innovation and indigenous capacity for experimentation into the identification of species for domestication and the design and testing of new AF and woodland management systems.

Rapid Rural Appraisal (RRA) techniques can combine readily with ethnoecological methods. However, it is the style rather than the speed of RRA which is most critical. For example, researchers can nest ethnoecological data and sample collection methods within a series of informal interviews with rural community groups of 15 to 30 people, followed by 'chains' of household level and individual interviews, mapping of farms and collection areas and participation in gathering trips, processing and other activities. During subsequent stages of research the same kinds of information-gathering activities can be used for monitoring and evaluation of experiments, whether formal or informal. This can apply whether the experiments are on-station, on-farm or in-the-forest, over a wide range of 'user'-and-'researcher' partnerships with respect to experimental design and management.

The possibilities range from research-designed experiments on-station to rural people's own on-site experiments that are simply 'discovered' and documented by research institutions. Most programmes are based on a more direct collaboration between the two groups, which includes a variety of roles for land users and formal research institutions in experimental design and management (Feldstein, Poats and Rocheleau, 1987).

Most of the immediate work in community-based AF research will focus on ecological adaptations of RRA combined with experimental situations where the user is also a researcher. However, the exact choice of methods and how to combine and apply them is still largely a matter of taste, style and available resources. For most professional researchers, first attempts with such an approach will be somewhat of a personal experiment to derive a coherent methodology from an eclectic collection of methods to answer research questions framed in response to local circumstances.

The two cases which follow are not models, but examples of such experiments. The emphasis is on lessons learned, and implications for follow-up.

An example from Kenya: trials, errors and hindsight

In exploratory on-farm research conducted by ICRAF in Mbiuni Location, Machakos District, Kenya, we tried out a combination of the methods described above. An earlier project in the area was based on the Diagnosis and Design (D&D) method (Vonk, 1984; ICRAF, 1983 a, b, Raintree, 1983) and involved a farm-level survey, on-farm AF trials and monitoring of local farms. In previous cycles of diagnosis and trials, farmers had identified priority problems for AF research to address: poor soil fertility, inadequate soil moisture, dry season fodder shortage and lack of building material and fuelwood. The proposed responses to these concerns included alley cropping with *Leucaena leucocephala* for mulch and fuelwood and rehabilitation of grazing lands through planting scattered multipurpose fodder trees in microcatchments. Ten farmers tried some combination of these in informal trials which were on-farm, researcher-designed and farmer managed (Rocheleau, 1985).

Later work at the community level and follow-up of the original ten farm trials provided a wealth of information and innovations based upon first, involvement of self-help groups in tree propagation and planting, second, participating farmers' reactions and proposed alternatives to the original technology trials and third, reaction of the group members to their own tree planting efforts on-farm and to the original ten trials (Rocheleau, 1985). The researchers joined self-help groups as participant-observers in weekly soil conservation sessions. The researchers proposed AF practices to supplement structures at gully and grazing land rehabilitation sites (Hoek, 1984; Rocheleau and Hoek, 1984), but participating farmers requested seedlings for on-farm planting rather than 'wasting' them on the conservation sites. At planting time project staff obtained seedlings from a government nursery and distributed 'sampler packages' of 13 exotic tree species to 120 active participating members of five collaborating self-help groups. Each participant had agreed to allow follow-up surveys and to observe and report on the performance of the trees. Other members of the community expressed interest in securing seedlings for the next planting season and within a few months six groups asked help to develop small nurseries and to grow their own seedlings (Rocheleau, 1985).

The new trials by group members were informal and exploratory and often incorporated either the function or the form of the alley cropping and grazing rehabilitation technologies, but rarely both. When group members were invited to visit and discuss some of the original on-farm trials as a group, they shared their very critical opinions about the 'package' in question, and also 'adopted' the process of AF development as a community enterprise.

By explaining to farmers the intentions and reasons for the trials researchers gave the participants a basis for assessing them constructively rather than simply accepting or rejecting them. During the course of the discussion participants raised several critical points about the trial technologies, which led others to pose alternative AF designs. For example, of the group representatives who visited the alley cropping site, one woman was struck by the attempt to improve soil fertility through the addition of plant biomass (mulching). Soon afterward she approached the local farmer-extensionist-researcher (and host of the alley-cropping trial) with her own practice of 'boma-mulching'. It consisted of applying large amounts of bulky plant biomass trimmed from living fences of *Euphorbia terucalli* to *bomas* (cattle pens), to be soaked with urine, trampled by cattle and baked into the underlying manure and soil. This produced instant compost.

As the boma mulching practice was discussed in group meetings, more people indicated some experience with the technique and many more showed an interest in trying it. Others reported having used *Terminalia brownii* and *Combretum* spp. leaves from large dispersed trees, and had been doing so for years. Within the year most farmers in the vicinity had tried this at least once after trimming their *Euphorbia* hedges. The next logical step seemed to be refinement of the technique in order to increase the nutrient content and to increase bulk without fouling the cattle pens.

Another woman who was present at the same discussion at the farm trial site planted three species of fruit trees in lines at 4m intervals in her cropland and a checkerboard pattern of *Leucaena* in her vegetable garden for wood and mulch. Yet another member who visited and discussed trials on the same farm, decided to plant a wood and timber lot on a degraded cropland plot, as well as living fences and timber on her property boundaries and a mix of fodder and timber trees in a small pasture near her home. Three others present at the same group discussion of the trials followed up by planting trees in cropland for fodder or for small poles.

The participating farmers saw themselves as choosing, mixing and matching from a selection of possible AF practices with some demonstrated feasibility. They were not adopting a proven package. The group participants began to request seeds and seedlings of particular species. As they gained more experience with tree propagation and planting *per se*, more farmers also began to come forward with experiences or interest or knowledge relating to indigenous trees. They also developed a keen sense of the vulnerability of some exotic tree species to drought, browsing, trampling and termites, which further fuelled their interest in indigenous trees.

Many of the group members expressed an interest in learning to grow local species. In one case women's group members asked for more plastic tubes for seedlings and researchers asked if farmers could provide local tree-seeds in exchange. This set off an animated discussion, since many of the participants had assumed that project researchers only dealt with exotic trees.

During the course of this group discussion two elder women recounted having tried to grow *Acacia tortilis* and *Balenites aegyptiaca* and having failed, which was determined to be from lack of seed treatment. The whole group welcomed the subsequent discussions and demonstrations of seed treatment for both indigenous and exotic species. The same group later collected their own seed of *Acacia polycacantha* from a tree on the group leader's property, treated the seed by two methods, and raised approximately 200 seedlings for planting by group members during the next rains.

As more species became available in projects and nurseries, some farmers began to trade and barter with trees. Observation of this trading activity, as well as the subsequent use of the seedlings, revealed a wealth of information about *who* wanted *what kind* of trees, for *what purposes* and *where* they were willing to put them.

As the follow-up and additional distribution programmes proceeded over the next two years, farmers became increasingly aware of the importance of termite and drought resistance. At the same time more and more trees, both indigenous and exotic, were being planted by farmers in their gardens, protected croplands, fencerows and close to the home compounds, as people developed awareness of the advatages of having trees in those areas.

There were many other examples of farmers' inveniveness, experimental successes and productive interactions with researcners through the use of these interactive research methods. The group level activities also resulted in a transfer of tree propagation and planting technology from the hands of a few skilled and relatively well-off men to mot farmers in the community, the majority being women. Their very involvement in these activities changed the species, spaces and processes whichemerged as part of the evolving research agenda.

Out of all the initiatives taken and questions posed, everal potential research directions emerged. The farmers' priority interests included the use of plant biomass for soil fertility, the use of leaf mulci from dispersed trees outside the cropland and multi-storey systems for lnd use intensification. They also adopted the process of AF development and domestication of trees, incorporated timber species from earlier rials and sought solutions to their own specific tree-planting problems. Thi list of priorities is distinct from the formal (or conventional) scientific seuence of:

- species selection and genetic improvement of plant maerial;
- development of prototype technology;
- adaptation of prototype to sites; and
- widespread extension of a fixed package.

By contrast, this experience argues for introduction of nany varieties or species and a few sample technologies with emphasis on principles and demonstration of some promising components – as effective approaches to help build sustainable R&D processes for resource-poor people.

Plant domestication: local knowledge and 'chain of interiews'

We were particularly interested in women's use of off-frm lands, which included the gathering of indigenous plants and the appearance of more and more 'incipient' home gardens. We also wanted o help develop alternatives that would serve women most dependent on products gathered off-farm. The project started with identification of speciesand spaces most important to women gatherers and investigating their intrest in domesticating favoured wild species on farms or in managing wodland systems. We focused primarily on food and medicinal plants ant secondarily on wood fuel and fodder plants.

We used several methods to describe the existing situaion with respect to the role of wild indigenous plants in land use systems and document traditional practice and local knowledge, identifying recent innovations in plant management. The effort relied heavily on informal surveys of groups, household and individuals among both the communiy at large and acknowledged local experts (Pope, 1986; Rocheleau et al,1985; Malaret & Ngoru, 1986). In particular, we developed the 'chain of interviews' method.

from earlier farm trials and group activities in soil conservation and tree planting. In these meetings, the purpose of the research and range of topics and specialists were identified. This led on to household interviews and lengthy talks with local specialists. These encounters in turn often led into participant observation on gathering trips, visits to sites of tree-planting or plant domestication and longer-distance travel to special collecting locations (Rocheleau et al, 1985; Wanjohi, 1987; Wachira, 1987). Researchers also conducted opportunistic interviews when they happened upon people herding animals or gathering food, medicine, or fuelwood. The residence of researchers in the area also provided opportunities for farmer-initiated interviews and information exchanges.

The group discussions normally lasted about an hour, with 15 to 30 people present. The early meetings entailed listing of plants gathered and places used for particular products. In later sessions the group discussed reasons for practices and preferences, problems with plants and source areas and ideas for improving the situation; eventually the group tackled decisions about which plants to domesticate and where and in what combinations. Interviews often ended with questions for participants to consider, followed in a few days by another session which gave people time to think and to confer with family and friends (J Kyengo, personal communication; Vonk, 1986; Rocheleau, 1985).

The household and individual interviews varied in time and in format, depending on the disposition of the persons involved. Both formal and informal approaches were used. One informal in-depth survey was based on a chain of informants from 'average' to expert; another was a more formal randomized sample of 63 households (5 per cent of population), which asked farmers to answer specific questions about the environment, collection, use and preferences of wild plants, etc. (Mutiso, 1986; Wanjohi, 1987; Munyao, 1987; Wachira, 1986; Rocheleau et al, 1985). The formal survey took three times as long and reproduced the same main results as the group interviews and chain of interviews, with less detail and coherence.

The surveys on women's use of off-farm lands and gathered plants yielded a list of 65 indigenous species used for food and 99 used for medicinal purposes, among them woody species, wild leafy vegetables and wild roots (Rocheleau et al, 1985). Most of the fruit-bearing woody species were also major sources of wood or fodder, uses which had received more attention in previous surveys of the farming system. In the formal survey 90 per cent of the 5 per cent sample group reported using gathered leafy vegetables to some extent, 10 per cent said they use wild greens year round and 70 per cent reported that they or their children eat wild fruits daily (or whenever available). Most of the respondents also used herbal remedies made from indigenous plants.

In many cases people noted that wild plants play a particularly critical role at some times of the year. Some of the wild greens, such as *Commelina africana* (Kikowe), are particularly important for late planters (ie, poor people who 'borrow' or rent oxen) since these greens fill the gap between the onset of the rains and the first harvest of cowpea leaves from the cropland. Likewise, some vegetables (*Solanum nigrum* and *Amaranthus* spp.) and fruits are especially important during the dry season, with over 25 species of fruits used by the sample group during that time (Wanjohi, 1987; Mutiso, 1987; Wachira, 1987).

Of all the species listed, farmers identified four species of leafy vegetables, nine fruit-bearing species and seven medicinal plants as good candidates for domestication on-farm. The criteria cited for choice of candidates and the suggested planting niches and plant combinations also helped to define useful criteria for subsequent screening of exotics and for design of AF practices with both indigenous and exotic species.

Most women surveyed were interested in alternatives to the current situation of gathering products in degraded and sometimes distant collection areas. They were receptive to the domestication of indigenous trees (including wild fruits) and wild leafy vegetables in gardens, small tree plots near the home and in-between spaces such as boundaries, gullies and along drainage and soil conservation structures (Rocheleau et al, 1986). Most participants were also eager to try exotic species to supplement indigenous fruits and vegetables or to sell as cash crops to urban consumers. There was an especially keen interest in exotic *Amaranthus* species for home use as leaf spinach (Wanjohi, 1987). Athough they acknowledged the production potential of managed woodlands and grazing land, the people surveyed were overwhelmingly pessimistic about woodland management except for those who actually own sizeable chunks of land with bush and woodland vegetation (Wanjohi, 1987; Wachira, 1987).

Throughout this cycle of surveys and plant collection the tree planting extension continued, with substantial informal feedback to the research effort through this activity, as well as through participant observation in group work sessions. Moreover, the surveys sparked new interests which in turn fed back into extension and informal trials. Similarly effective group methods and processes have been woven into CARE agroforestry projects in other parts of Kenya (Vonk, 1986; Buck, 1987).

In Kathama several farmers (all women) who had participated in interviews requested assistance with the design and establishment of small home gardens for plant domestication. They also requested help in procuring seed and cuttings of indigenous trees, vegetables, and vines, as well as exotics. Each of the farmers planned her own garden (Wanjohi, 1987; Wachira, 1987), chose her site and cleared, tilled and fenced her plot prior to planting time.

The factors which influenced selection of indigenous wild species for the gardens included abundance, ease of access, and palatability (for both fruits and vegetables). Also important as selection criteria for vegetables were preparation requirements (ie, whether they need to be fermented in milk, fried in oil or boiled) and whether they are used alone or mixed into staple dishes as a relish.

Of the seven garden trials established during this season, five 'succeeded'. Success, as defined by the farmers meant that gardens produced enough green vegetables for home consumption or at least enough to reduce vegetables that were more palatable and easier to prepare than the usual mix of gathered greens.

Fruit trees were considered to be a tentative success if they established well without serious damage by pests, diseases or drought. Another measure of success was the degree of interest expressed by self-help groups and individual farmers in these gardens. Their priority interests included: development of vegetable gardens in homesteads and group sites; homestead fruit trees; mixed tree nurseries; multi-storey home gardens. They did not express these interests in terms of a fixed 'package' but mentioned ways to use the principles and components involved.

Problems cited (in different degree) were mainly browsing by livestock, insect pests and drought, which mirrored many of the difficulties experienced in earlier alley cropping and grazing land trials. However, given the size and location of gardens, farmers found these problems much easier to address. The home garden also presents a lower risk environment for experiments and allows farmers to observe the entire system close at hand. Yet, even in this limited and well defined space, farmers must deal with many related innovations (such as effective fencing, pest control, intensive soil management and research and training in plant propagation techniques) that are necessary to support new plants and practices.

Eventually several principles and components from these garden 'trials' will likely find their way into cropland, grazing land and in-between spaces in the larger landscape.

Lessons and follow-up questions

Several lessons were learned from the studies. The substantial interest in domestication of indigenous wild plants (including trees, shrubs and herbaceous plants) warrants vigorous research and extension to follow-up on those species identified for domestication or for management in place. The experience points to the practical value of:

- choice by farmers of indigenous and exotic species for AF systems, according to criteria identified by them;
- identification of source areas and screening of germplasm for farmer-selected species;
- testing propagation techniques for selected indigenous and exotic species for AF systems;
- conducting 'social' experiments with different tenure arrangements, and
- testing different technology designs for 'interlocking' land uses by multiple users at shared sites.

One methodological question is how the surveys should differ in timing, format and/or content if they were done again. One need is a broader base of ecological information and careful identification of topics for separate treatment and for systems research. An important gap in information is a summary of indigenous knowledge and environmental perception. A general ecological survey would help at the start to provide better

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A METHOD FOR FARMER-PARTICIPATORY RESEARCH AND TECHNOLOGY TRANSFER: UPLAND SOIL CONSERVATION IN THE PHILIPPINES

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SUMMARY

Although viewed as important for on-farm adaptive research, farmer-participation has often been superficial and has not led to meaningful incorporation of farmer perspectives. This paper describes the use of a method involving the understanding of farmers' perceptions in determining priorities for research which integrates the different concerns and contributions of farmers and scientists with the transfer of technology from farmer to farmer.

Sam Fujisaka: *Un método para la investigación con la participación del agricultor y la transferencia de la tecnología: conservación del suelo de tierras altas en las Filipinas.*

RESUMEN

Aunque se considera importante para la investigación adaptiva realizada en la granja, con frecuencia la participación del agricultor ha sido superficial y no se ha llevado a la incorporación de las perspectivas del agricultor a nivel significativo. Este trabajo describe el uso de un método que supone el entender la comprensión del agricultor para determinar las prioridades para la investigación que integre los diversos intereses y aportes de agricultores y científicos con la transferencia de la tecnología de un agricultor a otro.

INTRODUCTION

Development of on-farm research methods (Zandstra *et al.*, 1981) was followed by case studies and methodological refinements (Shaner *et al.*, 1982). Farming systems research and technology transfer as practised, however, have most often involved site description; researcher identification and testing of components and patterns; demonstrations and farmer-managed trials to transfer information to farmers; and fixed technology packages for farmers to adopt.

With this method, technologies are assumed to be sound and when recommendations are not adopted this is considered a 'socio-economic' or farmer problem. Participation is said to be desirable, but is often limited to asking farmers what their problems are. Although the situation has been improving (Ashby *et al.*, 1987; Box, 1987; Johnson, 1972; Rhoades, 1987; Richards, 1985), on-farm research, overall, has attached little importance to farmers' technical knowledge and to the fact that farmers have always experimented, adapted and transferred technologies.

Social and biological scientists from the International Rice Research Institute (IRRI) and the Philippine Department of Agriculture (DA) are conducting research in the municipality of Claveria, Misamis Oriental in the Philippines. Site conditions are characteristic of most of the uplands of SE Asia which have strongly acidic soils with rice as a component crop. Their goals have been to address problems of low productivity and the possiblity that rice-based cropping systems may not be sustainable in such environments, and to develop methods for on-farm adaptive research that can be used by national agricultural research programmes.

The initial research was carried out on the flatter fields in the area and used standard on-farm research methodologies. More than half of the fields in Claveria, however, have a slope of more than 15%, and up to 47% are severely eroded (Bureau of Soils, 1985). Component and systems research in Claveria is now considering adapting the agroforestry technologies of contour hedgerows for erosion control and improved nutrient management.

Agroforestry systems combine woody plants and food or forage crops to control erosion (Young, 1986a) and maintain soil fertility (Sanchez, 1987). Erosion control and fertility maintenance are interdependent (Lundgren and Nair, 1985). To quote Young (1987) 'appropriate agroforestry systems control erosion, maintain soil organic matter and physical properties, and promote efficient nutrient cycling'. Technology involving the use of an A-frame for contour lay-out and bunded hedgerows is being developed in various countries (Young, 1986b) including the Philippines (World Neighbors, undated). It is appropriate for sloping land systems characterized by permanent plough-assisted agriculture, high and intensive rainfall and land scarcity.

This paper discusses farmer-to-farmer technology transfer and the participation of resource-poor farmers in the adaptation of agroforestry technologies, as well as a range of interlinked, mostly agronomic and biophysical, research issues. The lessons learned are contributing to the development of improved methods for on-farm research.

SITE DESCRIPTION

The research was done on volcanic plateau and alluvial plain sites with moderately well drained acidic clay soils of pH 3.9–5.2. Annual rainfall in the area is about 2200 mm, with maximum rainfall occurring between July and December. The first, wet, cropping season extends from May to October, and the second, dry, season from October to March. The rainfall during the second season is uncertain, resulting in extra, seasonal, fallow land (Fig. 1).

Although rice, maize, cassava and perennials are grown throughout the area, there are three distinct zones which correspond roughly to increasing altitude and rainfall. Upland rice–fallow rotations and cassava are the main cropping patterns in the lowest altitude area (400–500 m). Maize–maize and maize–fallow rotations predominate in the middle area (500–650 m). Maize, vegetables (especially tomato) and perennials dominate the upper area (650–950 m). The main crops reported by respondents in the initial survey were maize (grown by

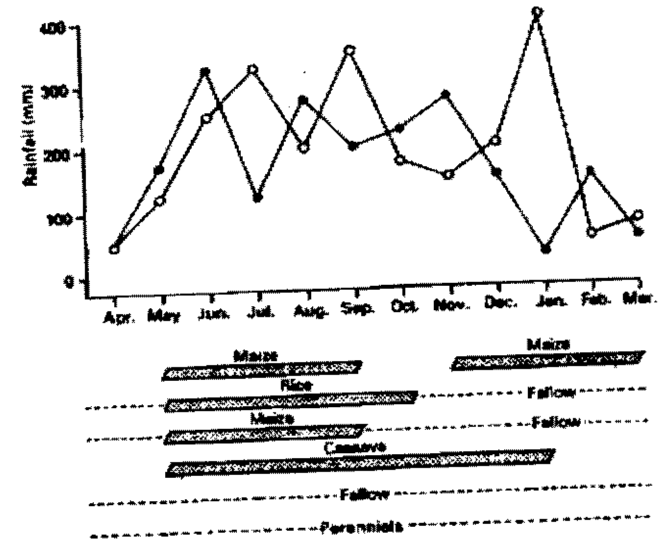

Fig. 1. Monthly rainfall distribution in the crop years 1985–86 (o– –o) and 1986–87 (•——•), and dominant farmers' cropping patterns, Claveria.

95%), rice (50%, mostly traditional cultivars), cassava (50%) and perennials such as coffee, cocoa and banana (25%). About 30% had started to plant hybrid maize and 20% had planted tomato within the previous three years.

Most farmers in Claveria had migrated from the Visayas region since the late 1940s. Farm sizes are small (up to 3 ha) and access to land has been limited to some extent by absentee-held pasture leases of up to 1000 ha. The small farmers comprise approximately equal numbers of owners, tenants and different types of agrarian reform beneficiaries. The latter are attempting to claim parts of the absentee-held large holdings, and there is a trend towards more land being managed by small owners, a factor that could promote improved resource management in future. The population of the municipality increased from 14 000 in 1960 to 29 000 in 1980 (NCSO, 1980) and the area of crops and grasslands is increasing at the expense of forested areas (Table 1).

METHODS

The interdisciplinary research involved scientists from IRRI and the DA. Efforts to incorporate a farmer perspective used methods from agricultural anthropology to understand farmers' practices, perceptions and technical knowledge, to link this to appropriate research into technology development and to incorporate both into farmer technology adaptation and dissemination.

Table 2. *Land and soil categories identified by Claveria farmers*

Soils	Lands
Undesirable characteristics	
Red	sloping
Poor	hilly
Exhausted	rocky
Acidic	washed out
Irregular fertility	
Disintegrates when held	
Desirable characteristics	
Fertile	flat
Black, dark	newly opened
Absorbs/holds water	low-lying area
Not easily dried	waterway/lowland
Friable	
Sandy or loamy	
Quite sticky	
Silty	
More neutral characteristics	
Crusty	gently sloping
Course	slash-and-burn area

While a few land owners had planted perennials on slopes, none had planted trees in strips or on the upper slopes. Some who thought they had adequate land left trees on fallowed areas. Others said tree planting was needed but that they lacked enough land.

Contour ploughing was virtually non-existent. Farmers generally cultivated hillsides up and down the slopes so that most furrows ran parallel and down the slopes. Some steep slopes were manually tilled to reduce erosion.

Farmers had tested different crop, cultivar and input combinations and calculated costs and returns. Fertilizers and lime were applied in greatest quantities to tomatoes because of the high returns possible, the assured benefits of residual phosphorus, and because the risks were usually shared with a financier. Lower levels of inputs were applied to hybrid maize because of the smaller potential gains. Inorganic fertilizers have recently been applied in small, experimental quantities to the improved upland rice, UPLRi5, but not to cassava, traditional maize or traditional rice.

Farmers had tested field fallows but found little nutrient regeneration because species succession no longer proceeded beyond the grasses (*Imperata cylindrica*, *Saccharum spontaneum* and *Paspalum* spp.). Fallow weeds and soils were analysed and the farmers' perceptions found to be largely correct, leading to experimental work on improved fallows.

Contour hedgerows were identified as one possible locally appropriate way to control soil erosion and a group of Claveria farmers were trained by farmers in Cebu. On their return, participants worked cooperatively to establish contour bunds, ditches and hedgerows on their parcels of land. Local sources of *Gliricidia sepium* and *Pennisetum purpureum* were located and planted. Other

farmers saw the work and joined the group, but an unusually heavy rainstorm damaged bunds and ditches and one new member became discouraged and dropped out. Others recalled the Cebuano farmers' warning that substantial maintenance work was needed for three years.

The group established almost 7000 m of contour hedgerows on 10 parcels of land with a mean size of 0.8 ha. The labour needed averaged 29 man days ha^{-1} (55% for shovelling) but was extremely variable. The amount of contour established varied from 673 to 1555 m ha^{-1} because of different slopes and farmer choice of distances between strips. Variable soil compaction and ground cover meant that each worker could establish 17 to 57 m of planted strip per day.

Farmers are testing different establishment methods and various hedgerow species and combinations, including other grasses (e.g. *Panicum maximum*), trees (indigenous *Cassia spectabilis*), cash perennials (coffee, cocoa, fruit), wild sunflower (*Helianthus anuus*) and even weeds that are otherwise serious crop pests such as *Digitaria longiflora* and *Paspalum conjugatum*.

They observed that terracing was faster and more effective if they used grasses rather than trees on the bunds. Some said they would leave the weed grasses for six or seven months before removal, but problems of root-feeding insects (root aphids, *Tetraneura nigriabdominalis* or *Rhophalosiphum rufiabdominalis*, and white grubs, *Holotrichia* spp. or *Leucopholis irrorata*) may be exacerbated by the use of grasses. This issue is being investigated at Claveria and in other upland rice areas (Litsinger *et al.*, 1987).

Researchers thought the napier grass used by the Cebuano farmers for goat fodder was inappropriate for Claveria because pasturage appeared to be adequate and because the grass is not a legume. Large pastures in the area, however, are not accessible to small farmers, and the farmers need fodder for their draught animals. Indeed, the napier grass hedgerows of one contour field were severely overgrazed.

Some farmers added further contour hedgerows between their initial strips. One researcher assumed that the motive was to increase biomass production, but the farmers said it was for faster, more effective terracing and erosion control. Researchers have responded by shifting from an almost exclusive emphasis on improved nutrient cycling to more research on soil erosion control.

Farmers saw that *G. sepium* on the down-slope side of the bund suffered from competition from napier grass planted above. A farmer's test of trees placed above the grass looks promising, and the arrangement is now being tested experimentally.

Gliricidia sepium cuttings suffered more than seedlings from termites and poor rooting. Farmers and researchers are working together on a small nursery to supply *G. sepium* and *C. spectabilis* seedlings. One researcher encountered very poor *C. spectabilis* seed germination, whereas one of the farmers had no trouble with germination. He described his methods but no obvious explanation

Table 1. *Land use change in Claveria, 1967–1985 (from Dapusala, 1986)*

	Area (ha) 1967	1985
Timberland/woodland	29 390	21 900
Grassland/pasture land	8 294	13 946
Croplands	9 106	11 244
Public Institutions	57	147

Initially, 55 farmers were selected at random and informally interviewed using open-ended, interactive and structured guide questions which had been selected after a period of exploratory research had determined some of the key issues facing farmers. Interviews were conducted in Visaya by the author and two field assistants from the research area who had farm backgrounds and university degrees in agronomy. None of the farmers interviewed had a history of involvement with research or development projects. Their fields were visited, and farmers discussed their crop and resource management. Farmers with sloping land reported poor and declining yields as a result of nutrient losses caused by soil erosion and depletion by continuous cropping.

World Neighbors, an organization working with upland farmers in Cebu (a nearby island with a high population and severely eroded uplands), has introduced contour ditches, bunds, and grass-legume tree hedgerows. Erosion has been used to form natural terraces between strips. A combination of technologies, farmer participation, group cooperation, and minimal project-to-farmer subsidies have contributed to the project's success.

From the discussions with farmers in Claveria about their ideas for technical solutions and from the author's experience with the Upland Development Working Group of the Philippines' Bureau of Forest Development (Fujisaka, 1986), the technology used in Cebu seemed to have potential for farmers in Claveria. Farmers from Cebu agreed to teach the technology to selected farmers in Claveria who had already attempted to resolve problems of soil erosion and nutrient depletion, and who were keen to avoid being forced by degraded land resources to migrate again to another area.

Six farmers and two site researchers went to one of the Cebu project areas during the pre-cropping dry season for 'hands-on' training. This involved using the A-frame for contour layout, bunding-ditching for strip establishment and erosion control, and the planting of hedgerows of fodder grasses (napier grass, *Pennisetum purpureum*) and legume trees (madre de cacao, *Gliricidia sepium*). The farmers then returned to Claveria and began to adapt the new technologies to local conditions. Farmer technology adaptation has been invaluable to the overall research process.

RESULTS

Of the 55 respondents in the survey, 95% said that soil erosion was a problem on their fields. All were aware of soil and nutrient erosion due to rainfall run-may be adopted by farmers in solving their problems or stimulate research leading to such technical alternatives.

Although a need for farmer participation has long been acknowledged (Farrington and Martin, 1987) many on-farm projects have lacked meaningful interactions with local people. Work in Claveria supports the idea that participation is a two-way process and that a participation 'paradigm' should progress from the obsolete view that 'the experts know best' to the increasingly fashionable concept that 'the local people know best' and on to the realistic and helpful idea that 'both experts and local people have unique areas of expertise which collectively provide a better basis for development than either alone' (Raintree and Hoskins, 1988).

Since farmers experiment, advantage should be taken of their technical knowledge and experiments in planning on-site systems research. Farmer evaluation of technical alternatives is of particular use in the identification of relevant research issues and in the adaptation of technologies to specific local circumstances.

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ecological relationships between different land-use systems and arrangements of trees.

Systems level experiments by and for land users are also crucial. The home garden and small grazing land plots are the two niches most often chosen by farmers for trials of complex interventions. The particulars of research designs and types of trials will vary, but need to be planned carefully.

In all the suggested follow-up activities, the role of local participants will be critical. To be effective, continuing research with land users must rest on shared information and understanding; success of follow-up will depend on the strength of the partnership between the community and the field research team.[3]

3.3 Farmers' groups and workshops

IDS WORKSHOP[1]

Overview of group methods: types, purposes and features

Group methods are increasingly used in agricultural research, extension, and other development activities (Kumar 1987). In Parts 1 and 2 (see 'groups' in index) we saw how group meetings can help in eliciting farmers' ideas and problems, in discovering and enhancing their knowledge and innovations and in trials and technology development. This section and those to follow (3.4, 3.5 and 3.6) present further experience.

'Farmer groups' refers to groups composed mainly of members of the rural community, along with one or more agricultural researchers and/or extensionists. There are many types, sizes and purposes of groups in agricultural research activities and developing a typology is difficult. Most groups have several functions. 'Workshop' is used for some groups usually to indicate one-off problem-solving or teaching/learning activity. 'Innovator workshops' (sections 3.4 and 3.5) usually involve a meeting to allow experimenting farmers to discuss their innovations with each other and with researchers.

Purposes of farmer groups can include:

- *building interaction and communication* between researchers and farmers, eliciting and exchanging information from farmer to farmer, from farmer to researcher and from researcher to farmer;
- *analysis* by farmers, with researcher support, of their problems and needs, reinforcing and fostering their own knowledge and capability;
- *R&D*, with the choice, design, conduct, monitoring and evaluation of experiments;
- *extension* from farmer-to-farmer, and the diffusion of innovations;
- *empowerment*, enabling farmers to organize for action or to share a resource.

Usually, any group serves several of these purposes. Some may be implicit functions rather than explicitly-stated aims. Nor are the purposes of a group static and inflexible; new aims and issues may emerge over time during the course of group meetings, especially as members desire changes. Seldom is it effective for researchers to establish rigid preconceived purposes prior to beginning group meetings.

Groups can serve as research/development methods in themselves or can be part of others. For example, diagramming, manual discriminant analysis, community appraisal, mapping and 'chains of interviews', can use groups.

Several issues related to the setting up and functioning of effective groups can be noted. Deciding on the appropriate size, membership and selection procedure also deserves careful consideration. One of the concerns is ensuring equality of composition and of dialogue, to promote constructive activities in which all group members feel free to participate and to avoid exclusion and jealousy of other community members. It is usually desirable to work with groups that are already established in an area, if they exist, as long as they have appropriate equitable composition and the group members are interested in participating in the new project. Obviously, timing and location of meetings should be planned mainly for the convenience of farmers, to ensure their full participation. Some groups can be effective for temporary activities; for instance, a single meeting may be sufficient to pass on ideas from farmers to researchers or to provide a forum for exchange of information, as described below in the cases of innovator workshops in Colombia and Bangladesh. Other groups convened at intervals can provide continuity in, for example, monitoring trials, discussing problems and progress, or carrying out self-sustaining project work. These and other points are illustrated in the following descriptions.

Groups in field hearings

Baker and Knipscheer (1987) describe groups participating in 'field hearings' in north-east Brazil. The conception was the use of farmer groups to evaluate and screen new technologies. The term 'hearings' was used to emphasize the importance of listening on the part of researchers and extensionists. (See also Knipscheer and Suradisastra, 1986 for regular research field hearings in Indonesia).

This work was carried out on a resettlement site where all farmers had the same amount of land with similar mixed crop and livestock enterprises. There were three project areas with 66 farmers in each. In one area, the researchers merely monitored the growth of farm livestock without making any other intervention. In another area, they provided a 'package' of veterinary interventions, but did not hold meetings or promote any group activities. In the third area, however, the same veterinary 'package' was accompanied by regular discussions between extensionists and farmers at 'field hearings', at which research or extension specialists also offered training in animal health, breeding or management.

As expected, the livestock in these latter areas did better than in the other two, as was shown by the rate at which they gained weight. Farmers' attitudes were also very positive in the area where field hearings were held and they showed greater willingness to pay for veterinary services.

Baker and Knipscheer conclude that the field hearings helped not only to inform farmers about the new technology, but also with farmer motivation. The farmers also 'provided important information and insights in the identification of the most limiting production constraints, and in the early stages of the project were instrumental in the choice of technologies which were tested' (Baker and Knipscheer, 1987:10).

One issue which needs to be considered when embarking on research with farmers' groups is whether to form new groups especially for research purposes, or whether to work with established groups. One consideration is whether there are appropriate common interests, and an equality of dialogue in the existing group. Where community leaders and the better-off farmers dominate meetings, it will usually be better to set up separate groups for non-leaders, women and/or resource-poor farmers. In some societies, however, it is unlikely to be politic just to form groups for the disadvantaged and it will be necessary for the needs and interests of better-off farmers to be addressed to some extent as well. Sometimes the necessary arrangements can be made by running some groups informally. For example, while men meet in a formal and official group, it may be possible to involve women in an informal group which meets at the same time.

In work with pastoralists rather than arable farmers, there may be few opportunities to use group methods for research except within the format of existing meetings. As Barrow (1987:6) comments in relation to Kenya, in the higher potential lands where people are settled and have title deeds, 'it is relatively easy to find and talk to farmers. But how is this done in the pastoral areas where people have to be mobile?'

> There is still a tendency to associate pastoralism with random wanderings, yet pastoralism and rangeland utilization is anything but random. The stock owners regularly meet to discuss grazing patterns, diseases, water access and utilization, the necessity for movement to better pastures and so on. This is an ideal starting point for discussion and learning since the people involved will usually be the leaders and elders. The place where they meet is usually a focal point in the area and is often centred near a watering point under a large shady tree (Barrow 1985).

Discussion at such a forum, sensitively approached, can give researchers a good insight into the people's knowledge of their area and a perspective on their problems and aspirations. However, Barrow (1987) warns that care is needed in interpreting what is discussed. Issues such as schools, cattle dips and wells may be mentioned merely because they are topical and 'real issues' will only emerge after the researcher has been accepted by the group. It is also important to hold discussions with other groups throughout a region, because 'problems and what people know will vary in different areas and with the different groups of people (in particular the men and women)'.

Farmers' groups and field days

One particularly fruitful form of group activity connected with on-farm research is the farmer field-day, usually conducted in or near fields where trials are in progress. Sometimes the aim is for farmers with trials on their own land to make comparisons with similar trials on somebody else's so that problems can be discussed. Sometimes the field-day is an occasion for researchers to listen as farmers evaluate the crop varieties under trial during the growth season (Ashby et al, section 3.4). Sometimes a promising technology has been introduced and the field-day is a stimulus for farmer-to-farmer extension (Norman et al, 3.6).

Discussions of farmers' groups in two different provinces of Zambia, both with some emphasis on field-days, have been provided independently by Kean (1987) and Edwards (1987b). Both describe evolving situations in which researcher-managed trials on farmers' fields have gradually become more interactive and responsive to farmers' views. The extent of evolution in terms of the size of the on-farm programme can be seen from figures for Luapula Province, where 17 farmers participated in only four trials in 1982–3, but where numbers had increased to 60 farmers and 13 trials in 1985–6 (Kean, 1987:5).

In both provinces, the selection of farmers to participate in on-farm trials has been a major issue. In Luapula Province, it is felt that after five years, 'the team has still not found the best method of farmer selection' and there has been a tendency to end up with 'relatively more wealthy, male, progressive farmers' (ibid:12). In both provinces, farmers who are selected tend to be clustered geographically in relatively small areas. In Lusaka Province, transport difficulties have made it necessary to select farmers whose fields are within walking distance of trial assistants' homes. However, within these fairly tight clusters, it is possible to select a representative group by recruiting farmers according to criteria concerning 'access to resources' and gender. 'It was intended that both those with and without easy access to resources would be recruited' and a percentage of the farm households selected are female-headed, 'based on their actual representation within the community' (Edwards, 1987b:6). After a selection based on these criteria has been made, the soil scientist checks that the resulting pattern is adequately representative of different soil types.

There has also been an evolution in the type of trial planned in both provinces. In Luapula, all trials were originally described as 'researcher-managed', but now about a quarter are 'farmer-managed' (Kean, 1987:5). Maize and cassava varieties have both been the subject of trials and so has the cultivation of the areas with persistent soil moisture in the dry season known as dambos. Kean comments on a 'maize/bean intercrop trial' carried out because of its possible relevance to improving the nutritional status of small-scale commercial farmers. The idea arose from discussions in which commercial farmers reported that they were no longer intercropping, whilst subsistence farmers still continued this practice.

The significance of farmers' field-days becomes clear when it is realized that they initially provided the principal opportunities for farmers involved in these Zambian on-farm trials to meet as a group. In addition, they are occasions when farmers meet scientists from the experiment stations. When on-farm research began, the occasional field-day seems to have been almost the only meeting held for participant farmers, but after two seasons, an end-of-season meeting was introduced in Luapula Province to discuss the results of trials and to elicit farmers suggestions for the next year's programme (ibid:8).

Explaining how field-days have evolved, Kean says that during the first two seasons, the researchers made most of the arrangements and did most of the talking and 'the farmers felt rather intimidated'. In the third year, the trials assistants did all the explaining while the researchers stayed in the background, but the farmers still did not participate very actively. Further changes then included the holding of smaller, local field-days at which the farmers themselves explained the trials which had taken place on their land. Then a second, larger meeting was held in a primary school, attended by community leaders and other farmers. The aim here was 'to encourage farmers from the different groups to voice their opinions about the trials (and) about how the trials could be improved'. The local extension officer made a record of the discussions and researchers were pleased by the level of participation of farmers and the useful comments received (ibid:7–8).

In Lusaka Province, field-days also evolved in the direction of smaller, local meetings, each based on a cluster of trial sites. These were held during the period prior to harvest to discuss progress with the trials up to that date. In one instance, farmers came and went during the meeting but an attendance of about fifteen was estimated, including some half-dozen women. This was more rewarding than larger and more formal events. All the farmers came from the adjacent area and had seen the trials during the season (but not all had trials on their land) and some lively debate ensued. Encouraged by feedback from the farmers, who liked the new sorghum and maize cultivars introduced in the experiment, the trials assistant was able to persuade the local cooperative marketing depot that they should stock these cultivars. Attempts to encourage this from the top through the marketing agencies had previously been unsuccessful (Edwards, 1987b:12).

Edwards reports that another useful result from this meeting is that information on how cassava was being managed in the area was obtained for commodity specialists at the experiment station. When the question was raised, there was again a lively debate, and Edwards makes a comment which provides a final indication of the value of farmers' groups. The very liveliness of the meeting (which would not have occurred where local headmen were present in a formal capacity) gave 'greater confidence in the information ... about what was happening to cassava'. Farmers were not just repeating the standard explanation of what they thought the researchers wanted to hear (ibid).

2.5 *Diagrams for farmers*

GORDON R CONWAY

Diagrams for communication

A diagram or, expressed more fully, a diagrammatic model, is any simple, schematic device which presents information in a readily understandable visual form. Diagrams can radically simplify complex information, making it easier to communicate and analyse. Until recently, it has been widely assumed by professionals that rural people, especially when illiterate, would not be able to construct or understand diagrams. A mounting body of evidence, including that accumulated through agro-ecosystems analysis (Conway 1985; Conway et al 1987; Pretty, ed, 1988; McCracken et al

1988; McCracken 1988), indicates that not only can they often draw and understand diagrams, but that they take pleasure in doing so. We have found that diagrams can be an effective and efficient means whereby farmers' knowledge can be made explicit, either through diagrams they construct, or through their guiding and informing researchers so that they can make diagrams.

Diagramming in these ways has three major advantages over most other modes of investigation:

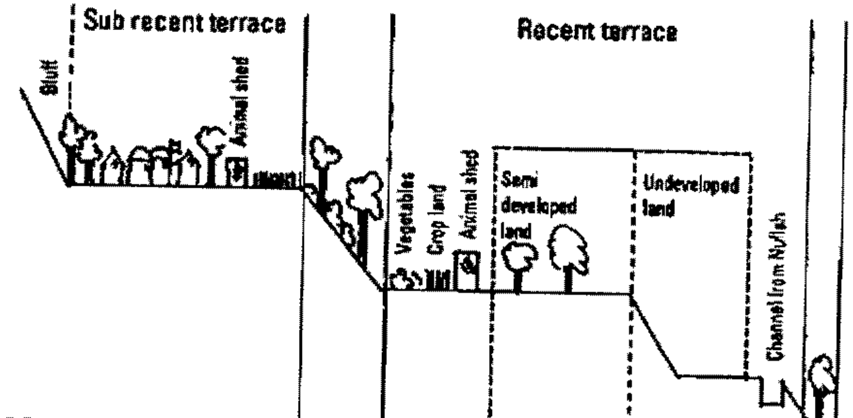
- the questioning and responses are more open-ended than in, for example, questionnaire surveys. In diagramming, the general subject area may be preset, but the detail has to be filled in by respondents, giving primacy to their knowledge and perceptions;
- diagrams can capture and present information which would be less precise, less clear, and much less succinct if expressed in words. This makes practical analysis easier;
- diagrams are shared information which can be checked, discussed and amended. If diagrams are drawn up by researchers during interviews, respondents can examine what has been recorded on the basis of what they have said, and confirm or qualify it.

Our emphasis is on the use of diagrams derived mainly from local knowledge as a tool for communication and analysis for agricultural research. Five types of diagrams will be described.

Maps are an obvious and simple type of diagram. Their primary use by farmers is in communicating with development specialists, particularly about the location of different parts of a farm, their relationship to basic resources, such as water, and to the major land forms.

To most westerners, maps are readily comprehensible but may be foreign to some cultures. In that case, techniques of map construction need to be tailored to local perceptions. The best approach may be to ask people to draw their village and then build on the conventions for representing its layout which they adopt. Obviously, the western convention of always having north at the top of the map may be a hindrance to understanding in some circumstances. Joint map making with researchers and farmers needs to begin with one or two commonly agreed reference points, the remainder of the map being constructed on these. In Pakistan our practice has been to construct sketch maps from a high vantage point, using this approach. Other uses of mapping methods by farmers are discussed in section 2.6.

Transects (see figure 2.1) have greater practical utility than maps, in our experience. They can focus attention on the different zones or micro-environments in a watershed, village or farm. In agroecosystems analysis, they are drawn up by researchers who walk from the highest to the lowest point in an environment, accompanied by local people, consulting people in each zone. The main purpose of transects is to identify the major problems and opportunities in the agroecosystem, and where they are located. Transects need to be simple, indicating the major topographical



Soil	Loam	Stony large boulders	Sandy loam	Stony sand	Stony sand	
Crops	Wheat - Maize, Mash Wheat- Fallow Vegetables Potatoes	Bushes trees	As for recent terrace	Willow Poplar Russian Olive Thorny Bushes	Scattered trees	
Livestock	Ruminants Free grazing in winter	Grazing	Free Grazing	Grazing		
Problems	Pod borer in mash Water flooding from can Water shortages	Poor soil	Serious water shortages	Poor soil	Flooding	
Opportunities	Pest control Extend canals-irrigation and water control		Improve grazing, extend canals	More trees	Alfalfa irrigation	

Figure 2.1: *Transect of a village in northern Pakistan*

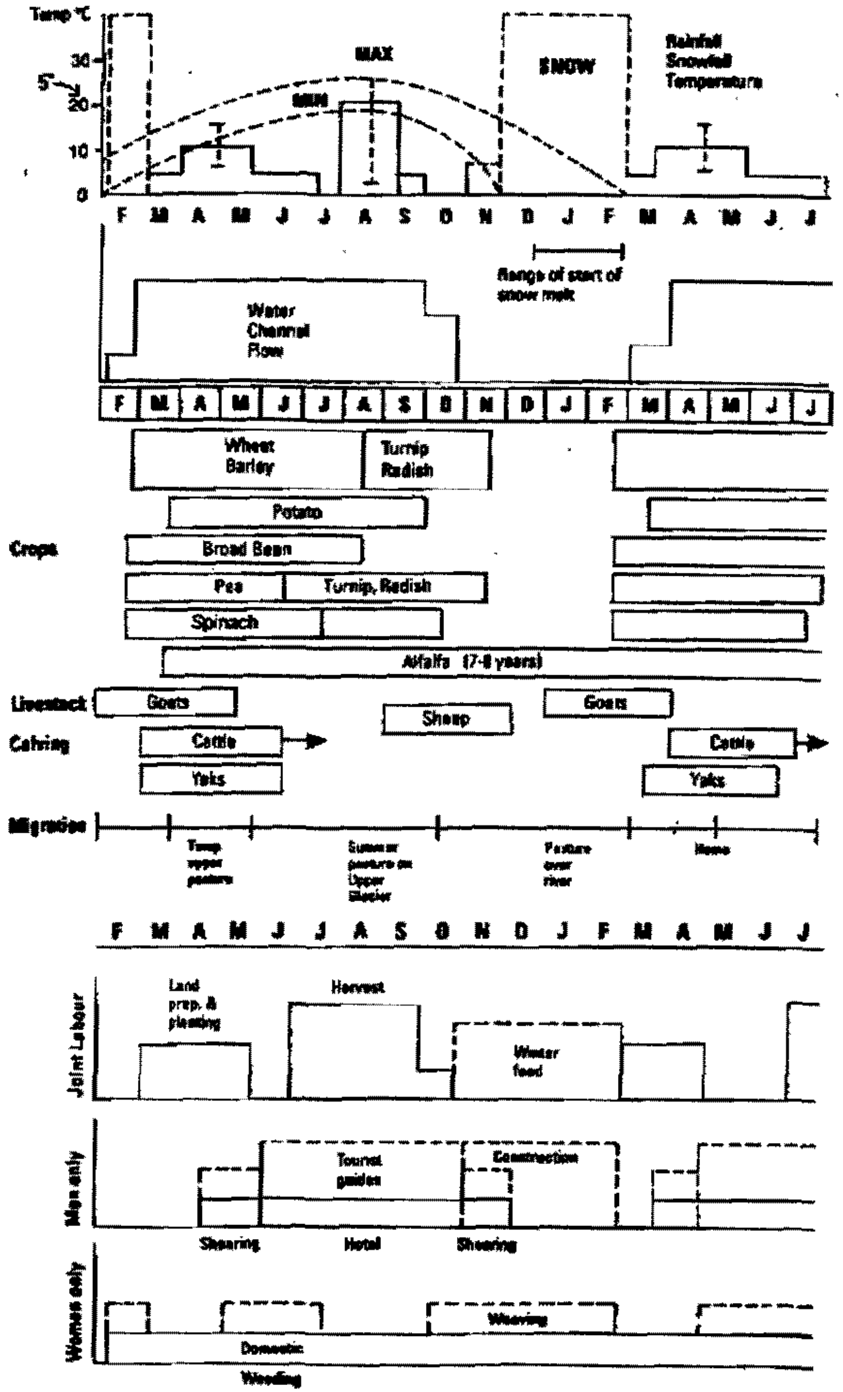


Figure 2.2: *Seasonal calendar for a village in northern Pakistan*

features, with associated lists of the crops, livestock, problems and opportunities (as in figure 2.1). If soils are included they should be referred to by some feature such as texture or water holding capacity. As with the maps they do not need to be cartographically accurate. Each transect should be a schematic idealization, not even necessarily following a real straight line. Although they have some similarity with botanical or soil survey transects they are different in form and purpose.

Calendars (see figure 2.2) are diagrams to indicate seasonal features and changes. Where possible, they should be based on the local calendar. They are useful to enable farmers to identify critical times in, for example, the annual crop cycle. Calendars have long been used in Farming Systems Research. They can be used to cover all the major events and changes that occur within the rural year. The most obvious and important dimensions are climate, cropping patterns, livestock (sources of forage and key events such as calving, sales and migration), labour demand, diet and nutrition, diseases and prices for crops, livestock and other produce and for food.

Climatic data may often be available from official records, but farmers' own perceptions can be valid as well as indicating the view of conditions on the basis of which they make farm decisions. In northern Pakistan, where rainfall data is largely absent, we found that semi-structured interviews can give relative rainfalls. Questioning goes approximately as follows: Which is the wettest month? Which is the next wettest? and so on, followed by: Which is the driest? Which is the next driest?, together with comparisons of months: Which is the wetter (or drier) of these two? Relative amounts can be roughly gauged by asking comparisons of wetness, whether one month is three-quarters, a half or a quarter as wet as the wettest month. Relative amounts are adequate for initial diagnostic purposes, showing the pattern into which crops have to fit. It may be enough simply to construct a seasonal calendar around major events such as the beginning of the rains, period of drought, first frosts or the level of irrigation canal flow.

Rural people's knowledge of climatic events can be detailed. In an interview in Wollo in Northern Ethiopia (ERC 1988), two farmers recalled the number of days of rainfall in each month for the previous five years. Their recall probably picked up rainfall which was agriculturally significant and may therefore have had an agricultural validity superior to that of normal rainfall records. In any case, their achievement shows the value of assuming that rural people have detailed knowledge and asking them about it.

Agricultural labour demand for women and for men can be elicited in a similar manner, asking first about the busiest and the next busiest months and so on, then the least busy, and so on. In West Bengal, the resulting histograms for women and men have been drawn on the ground, provoking a debate about the different labour peaks for women and men and the continuous labour demand, pointed out by the women, of their domestic chores.

Visually, 18 month calendars are better than 12 month calendars for

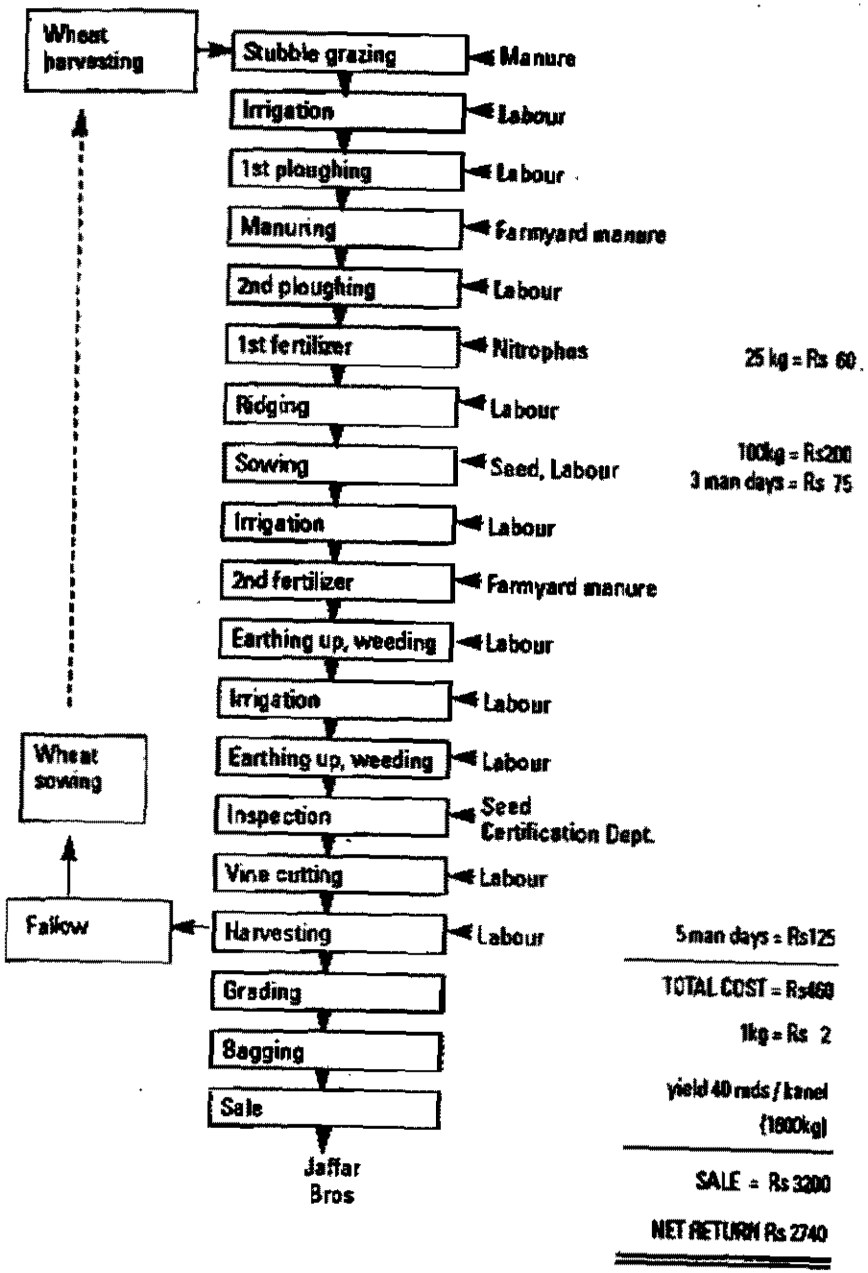


Figure 2.3: *Production cycle for seed potatoes*

revealing seasonal patterns. Conventional Western calendars begin in January, but the local calendar may start at some other time, or it may be better to start with a key event like the start of the rains.

Flow diagrams (see figure 2.3) can elicit and present sequences such as the cycle of production and marketing. Key aspects can be noted alongside the flow, for example labour requirements and monetary costs. These then become simple production accounts.

Venn Diagrams can also be used, for example for understanding institutional relationships within a village. Even in quite small villages the number of different institutions and actions involved in decision-making can be considerable. These can be identified and diagrammed at a meeting of villagers or of a particular group. Venn diagrams, known in Pakistan as 'chapati diagrams', use touching or overlapping circles of various sizes. Each circle represents an individual or institution and the size of the circle indicates importance (which can be discussed by the group undertaking the exercise). The circles can be used to indicate the degree of contact or overlap in terms of arriving at decisions. Overlap occurs if one institution or individual asks another to do something, or if they have to cooperate in some way, according to the following convention:

- separate circles mean no contact;
- touching circles indicate that information is exchanged;
- small overlaps point to some cooperation in decisions;
- large overlaps mean considerable cooperation.

Diagrams to aid analysis

Beyond their use to elicit information, diagrams can be used by and with rural people as an aid to analysis (see also pp 93–100). Most of those described are general purpose tools for identifying problems, constraints, solutions and opportunities. Most of them have been used in group discussions by teams of researchers or extension specialists or combinations of these (Conway 1986) but have recently been extended more to aid analysis by rural people themselves, as the following examples illustrate.

Seasonal diagramming can focus attention on key seasonal constraints. In one village in Pakistan, for example, systematic seasonal diagramming revealed that the period when dysentery was rife was also the time of harvesting, posing a problem with an agricultural as well as a human aspect. Similarly, seasonal diagramming in South Wollo in Ethiopia found that the peak month for malaria was also the month of highest male labour requirement, for land preparation. More positively, the analysis of seasonal diagrams can point to opportunities, such as when new crops can be grown.

Venn diagrams for village institutions can similarly be used to generate and focus analysis. We have found that they can be constructed very easily by cutting out paper circles of different sizes, labelling them with the names of the institution or individual and then arranging them on a table in a pattern that emerges from the discussion and experience of the participants. Once arranged to everyone's satisfaction, the circles can be stapled into position and used to identify needs for improved links, better overlap, or the positioning of new institutions.

The power and utility of diagramming can, finally, be illustrated from a workshop carried out in the Philippines which focused on a small dam at the outlet of Lake Buhi in Bicol province (Conway and Sajise, 1986). Following construction of the dam a number of severe problems arose, primarily affecting the lakeside dwellers and inhabitants of the municipality of Buhi. Those adversely affected became understandably angry, to the point that the future of the project was in jeopardy.

In order to try and tackle the problem a team from the University of the Philippines undertook a brief survey of the area, interviewing farmers and summarizing these interviews, together with secondary data and direct observations, in a series of diagrams similar to those discussed above. A four-day workshop was then convened which brought together some 70 people representing not only the aid agencies and the central and provincial government agencies, but also local politicians and representative farmers and fishermen. The workshop was aimed at conflict resolution, using a procedure for the analysis of diagrams. This worked extremely well and one of the most satisfying memories of the workshop was of intensive but productive arguments between small groups of aid and government officials and farmers and fishermen, focused on a particular diagram (figure 2.4).

It turned out that one of the key diagrams was a seasonal calendar which helped resolve the central water scheduling issue. Fishermen above the dam were complaining of their fish cages drying out and lakeside farmers of their rice fields suffering drought, in order to provide water for the downstream farmers. Construction of the seasonal calendar pinpointed the key constraints to the timing of agricultural and fishery operations, namely the occurrence of typhoons and sulphur upwellings, but also demonstrated that retaining the water in the lake above a critical level until the end of May could satisfy the upstream farmers and fishermen without severely affecting those downstream.

Many of the examples cited earlier, however, refer to work being undertaken by the Aga Khan Rural Support Programme (AKRSP) in northern Pakistan (Conway et al, 1987). This programme aims at rapid development in several hundred villages primarily through the efforts of the villagers themselves. However, it remains to be seen how far diagrams will be used by village organizations. One suggestion is that valley-wide groups may use agro-ecosystem zoning for planning, and the mapping of agro-ecosystems already done has been very illuminating.

Traditional land-use capability classification and agro-ecological zoning tend to be data-hungry, requiring extensive field surveys and information on climate, soils, vegetation, etc. By contrast, the method used in northern Pakistan is meant to be rapid and iterative. In 1987, a trial zoning exercise was under way in the Hunza valley, with a first rapid survey

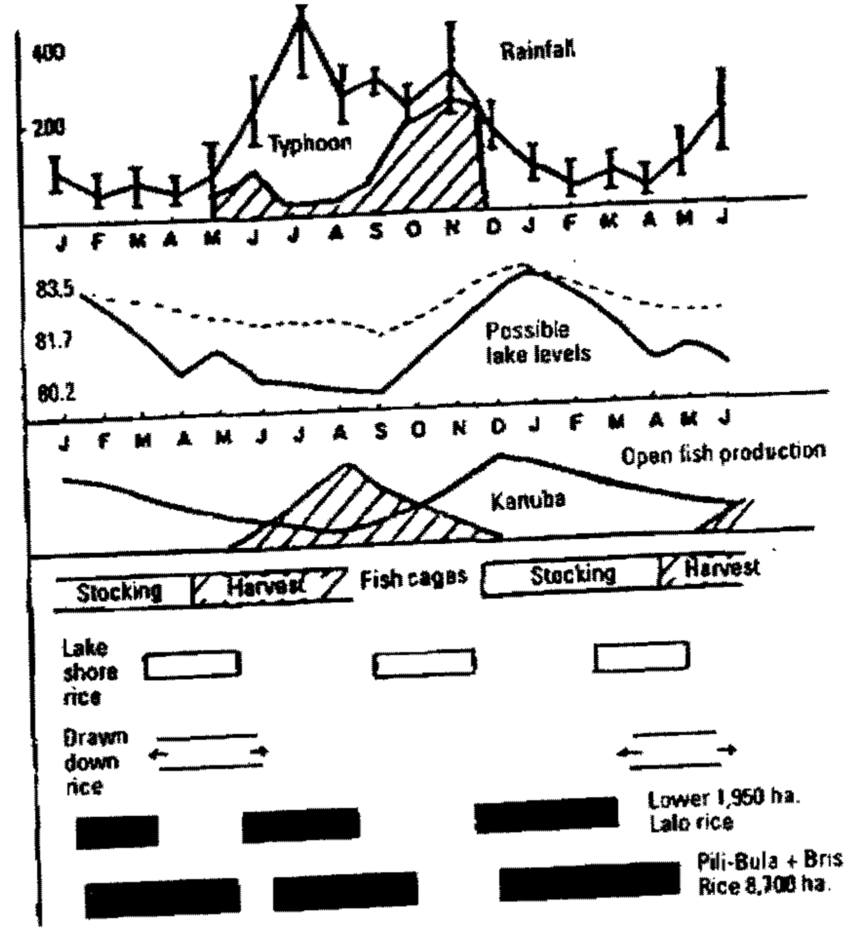


Figure 2.4: *Seasonal calendar for the Lake Buhi project*

covering biophysical features. An iteration emphasizing socio-economic features was to follow and it was assumed that boundaries would be revised as more information was gathered in subsequent iterations. Biophysical zones were characterized by the growing period for crops, which varies with altitude from 190 to 330 days. Calculations were made from secondary data, but then interviews with farmers were used to alter and refine the initial boundaries. Farmers were well aware of the major differences we were mapping along the valley and could give us accurate estimates of growing periods in their own and neighbouring villages.

A second technique under development is sustainability analysis. This is a group exercise which can be used to investigate either a particular production and marketing flow or a development process or project. The aim is to identify problems and threats that are likely to arise and to think of solutions. The exercise begins by construction of a flow diagram. The groups sit round a very large sheet of paper on which the flow diagram is marked out in black. Then participants use coloured pens to mark in problems that they know or guess will arise (in blue), stresses or shocks that may occur (in red) and suggested preventive measures or solutions (in green). Finally, points in the production cycle are marked in yellow where checks (or monitoring) seem advisable to see if problems are developing. It is hoped that village groups will find it useful to analyse sustainability of key production processes this way.

Conclusion

The potential of diagrams for eliciting the knowledge of rural people and for analysis by and with them, is only just beginning to be realized. Professionals concerned with rural development have tended to suppose that rural people, especially if they are illiterate, will not be able to understand or use diagrams. Our own experience has been that their capabilities almost always exceed the expectations of outsiders. The best rule of thumb seems to be to assume that they can understand and use diagrams until proved otherwise.

For the future, there is scope for much inventiveness, by rural people and by outsiders, in devising and using these and other diagrams, exploiting the advantages they have over more conventional methods of investigation and analysis.

2.6 Maps drawn by farmers and extensionists

ANIL K. GUPTA AND IDS WORKSHOP

Different views of reality

Mapping can be viewed as one specific type of diagramming method, as noted by Gordon Conway in section 2.5. It might appear surprising to

include maps as part of this discussion of innovative methods, since mapping is a conventional technique which has been used for decades as a part of formal agronomic and geographical research, land-use planning, and a guide to many other activities, and it is undoubtedly a vital tool for many purposes. However, while recognizing the importance of mapping in its conventional forms, our discussion instead stresses new approaches.

Reality mapping is a method we have used in several contexts, most recently in India[1] in July 1987, as an attempt to understand the way poor people perceive their environment. What we do is give coloured pens and paper to individual men or women on an occasion when they are meeting as a group, for example, in a women's workshop. Very often, these are people who have never handled a pen before. We then ask them to draw their village or any aspect of it which they see as important to their survival. Not infrequently, at least among women, the result is only a colourful pattern or design without any recognizable figure or shape. However, many do draw trees and plants and, almost without fail, a temple. It is instructive to study which species they draw and what plants they feel most comfortable about drawing.

We have tried this exercise with Indian Administrative Service officers in India and scientists in Bangladesh as well as with poor women and farmers. Several differences reflecting social background and sex have emerged. Women tend to draw very small forms, often centred on a temple and rarely showing any means of transport. Men, by contrast, rarely omit transport. Moreover, in the case of a dry village in Maharashtra where a student named Mandavkar tried it, it was noticeable that while many poor people drew only their immediate neighbours and fields, the richer people drew in far more detail covering the whole village.

We are still analysing what may be gained in understanding people's cognitive maps through drawing, and we do not claim much at present. However, we can recommend its use as an 'unfreezing device' at the beginning of farmers' or scientists' workshops. It can generate tremendous creativity in group sessions, as happened at a session at Bangladesh Agricultural Research Institute (BARI). There paintings done by groups were bold and satirical, in contrast to the more restrained individual ones. What we hope to do, however, is to refine the technique so as to help us understand how people relate to their resource environment.

Topographical maps by pastoralists

In some places, village people have been encouraged to draw maps of a more strictly topographical kind. One agency in Mexico regularly asks people to draw maps of their own villages. An instance in West Africa relates to Jeremy Swift's work with Wodaabe Fulani pastoralists in Niger (Chambers 1983:99). The research team asked some herders to draw maps, which they did without difficulty. The maps differentiated areas according to their ecological characteristics, as might have been expected, but also indicated several special zones. These were areas where the herders' cattle got night blindness from vitamin A deficiency in the dry season, for which

TSBF

TROPICAL SOIL BIOLOGY AND FERTILITY PROGRAMME

(2)

21 Dec 1992

TO: Participants in Slash and Burn Consortium
FROM: Cheryl Palm

While reading the following discusion paper on the biophysical aspects of site characterization please include any comments and addittions. I have tried to emphasize measurements that are not as common. At the same time I have prbably shown the TSBF bias on biological measurements so I would appreciate help from those of your with other biases. Keep in mind several issues, coordination with other networks, national, regional and international and the measurements and methods they promote; the role of GIS and how to interact from the beginning; current models of use to the Slash and Burn Project; quality control and the need for any central laboratories. In particular, we need to plan what site characterization and training activities the biophysical group considers most important for the workshop. In discussions with Dennis Garrity and Mike Swift with thought exercises in biomass measurements (above and belowground), meteorological measurements, and experiemtnal design and plot layout could be important. In your response please include other factors or exercises you think important.

STANDARDIZED MEASUREMENTS AND METHODS FOR SITE CHARACTERIZATION AND MONITORING OF BIOPHYSICAL PARAMETERS FOR THE SLASH AND BURN PROJECT

Cheryl Palm, TSBF, Box 30677, Nairobi

The specific objectives of the biophysical research agenda for the Slash and Burn Project fall into three general activities; 1) Characterization of the biophysical environment of key deforestation areas, including regional GIS data bases which together will provide the environmental framework where research will be conducted and have potential impact. 2) Evaluation of existing land-use systems and newly developed technologies with respect to their species composition and interactions, productivity, nutrients cycling and budgets and other aspects of sustainability. 3) Quantification of the contribution of slash and burn agriculture and proposed alternative land-use systems to components of global change, particularly green house gas emissions and soil depletion and amelioration. Each of these three activities requires extensive measurements, some of them overlapping between the activities but others are quite specific to a particular objective. We must be certain that the list of required measurements contains those that are essential to meeting the objectives but at the same time the list must not be overwhelming so as to discourage complete compliance by the participants. Methods used for the measurements must be standardized to provide compatible data for synthesis and comparisons of relative productivity and sustainability of alternative land use systems and for extrapolation of the more promising alternative land use practices.

Several questions must be addressed when selecting which variables to measure and what methods to use:

1. Where are the measurements to be made, or in other words, what is the site?
2. Is the measurement for site characterization or for monitoring?
3. What are the types of experiments to be conducted at each site?
4. What is the reason for making a particular measurement? Is the measurement useful for understanding the productivity and sustainability of the systems?
5. What is the cost and time effectiveness of the measurements relative to the information gained? Can the measurement be estimated other parameters?
6. What methods are the majority of the laboratories already using for the specified measurements?

With regard to the first question, research proposed for the Slash and Burn project occurs at several levels or scales, from the experimental plot to a global framework. Research will be focussed around the 8 benchmark sites. Each benchmark site is comprised by a primary research station and possibily some related substations within the same country. The benchmark sites and substations will represent the basic agroecological-socioeconomic zones in which slash and burn agricuture is a pressing land use problem. These benchmark sites and stations will be characterized in a general sense with respect to climate, vegetation, soils, and land-use practice and this information applied to georeferenced datasets. The actual experiments will be conducted both on on-station and on-farm plots. A more detailed site characterization will be required for the on-station experimental plots than the general description for the benchmark sites but by the nature of on-farm experimentation less detail will be required. For the proposed work to be relevant both at the small and larger scale it is essential that the areas or sites, at each level, are representative and that there are key links between the different levels. The data collected or required at each level is quite different but the data obtained at one level must be relevant and sufficient to feed necessary information into the next level.

It is also important to know if the measurement is for site characterization or for long-term monitoring of changes in experimental plots under various treatments. Site characterization usually includes those parameters which define the general environment in terms of location, climate, soils, vegetation, and even land-use history. These parameters set the conditions for the potential productivity of the slash and burn systems. Long-term monitoring involves repeated measurements of variables referred to as the response variables, and includes the physical, chemical and biological variables of the vegetation and soils which change as a result of changes in land use. The response can be fast for some of the variables such as change in vegetation biomass but much slower in others such as soil organic matter; therefore the frequency for measuring the variables will vary according to the systems under study and the response times for the different variables. Some of the parameters that define the site characteristics in a general sense are also response variables which must be measured in greater detail with time. Another type of measurement can be called the driving variables or those that cause changes in the response variables. Driving variables are considered to be external to the system, causing changes within the system, and are often associated with land-use changes and management. For the purposes of slash-and-burn agriculture examples would include clearing and burning the vegetation, fertilization and tillage.

No specific experiments have been proposed yet for any of the Slash and Burn sites therefore it is difficult to recommend specific measurements. The types of experiments envisioned cover a broad spectrum and would include crop variety and tree provenance trials; component interactions, such as crop-tree and crop-weed; nutrient cycling and nutrient budgets. The discussion paper includes a rather comprehensive list of measurements that could apply to many different types of experiments. It is not expected that all measurements be made at all sites but that subsets of data be taken depending on the objectives of each particular experiment.

There must be sufficient reason for choosing a particular measurement to be included for site characterization or monitoring studies. The reason for site characterization are more straightforward and relate to the climate, soil, and vegetation features that are relevant to the production potential of an area. Variables to measure for monitoring studies are not so obvious because of the diversity and complexity of the studies. A guideline to follow when choosing measurements could be biophysical aspects of sustainability, namely production trends and environmental impact. Examples for the production side would be trends in crop production, soil fertility, weed biomass and composition, and nutrient budgets. From the environmental context, examples would include emission of greenhouse gases, loss of soil organic matter as CO_2 and other forms of nutrient loss from the system, including erosion and leaching.

Given the above considerations this discussion paper presents a recommended list of measurements according to two critera: where they are to be taken - benchmark areas, on-station or on-farm experimental plots and whether they are for site characterization or monitoring studies, or both. Not all measurements are relevant to all experiments.

Specific methods are proposed for these measurements. The details of the methods are not included in this paper, they will be provided once the suite of measurements has been decided. Many of the methods are familiar to agronomic research and are already used by many of the national laboratories and research centers; details for these methods can be found in the American Society of Agronomy publications - Methods of Soil Analysis, Parts 1 and 2 or the Tropical Soil Biology and Fertility Handbook of Methods. Other methods, however, are derived more from ecological research and may not be as widely known or utilized. More detail of these methodolgies and a rationale for their selection will be presented for those that are not so widely used. The TSBF Handbook has been used as a guideline for the measurements and should be consulted for background information and the details of the methods.

Particular emphasis has been placed on the soil and vegetation varilables. It is important these variables fall into two categories: pools (standing stocks) and processes (fluxes in and out of the system and between the pools). Both site characterization and monitoring include both pool and process variables. Monitoring studies which follow the changes in pool sizes with time provide valuable information about changes in the systems. Studies which also measure the changes in processes provide a better understanding of why the system is changing. To illustrate the distinction, a monitoring study that measures the pool of soil organic matter will indicate if the content is changing or remaining the same. If this information is coupled with process variables such as decompostion rates and litterfall or residue applications we will be understand more about why it is changing. This process information provides the basis for the design of more efficient management of systems. Some of the fluxes that are important in slash and burn systems are presented in Table 1, methods for measuring some of them will be discussed in the following text.

It is our intent to present the measurements and methods as a starting point for discussion, we hope to reach on consensus in the following drafts and workshops. A comprehensive list of measurements is presented below in separate categories of location, climate, land-use, soils, and vegetation. Those variables which are considered requisites for site characterization at the benchmark area, on-station, or on-farm sites are highlighted. Additional mearsurements that are important for characterizing and monitoring specific components of experiments are also presented.

LOCATION

The exact location of a site, with respect to longitude, latitude and altitude, is important for providing information for geographically referenced data banks. Additional information such as landscape position (alluvial terrace, lowland, hillside or ridge), slope, aspect and geology or parent material are important for defining the site. The benchmark areas would ideally provide information of the percent of the area they represent that is in the different landscape position, slope categories (0-5, 5-10, 10-20, 20-40% and above), and geological zones. The actual area to be represented by the characterization of these benchmark sites must be decided and coordinated with the georeferenced information. For both on-station and on-farm plots it is important to record all the information in Table 1 for site characterization purposes.

Table 1. Variables required for site characterization of the benchmark areas, on-station and on-farm plots.

Location Variable	Benchmark Area	On-station and on-farm plots
Latitude and longitude	general area represented by the site	Exact location, (Global position locators (GPL, eg. Loran, Magellan)
Altitude	percent of area in various altitude categories	Altimeter
Landscape position	percent of area in different landscape categories	Description
Slope	percent of area in different slope categories	Inclinometer (%)
Geology/ Parent Material	percent of area in different geological zones	Description of geology/parent material of exact site

CLIMATE VARIABLES

The climatic data required for site characterization and monitoring and the methods for obtaining them are provided in great detail in the TSBF Handbook, p. 8, and the IBSRAM Technical Notes No. 1 on Site Selection and Characterization, p. 53-88, and are based on the WMO guidelines. The measurements are features of most agrometerological stations. Many experimental stations are already equipped with meterorlogical stations, for those that are not we would recommend recording stations with data loggers.

The measurements, methods, purpose (site characterization or monitoring) and location (benchmark area, on-station plots, on-farm plots) are presented in Table 2. For the benchmark areas longterm data on mean monthly rainfall, and maximum and minimum daily air temperature should be compiled for the site characterization. The number of years the records cover should be reported and is preferrably more than 10 years. More detailed daily monitoring of rainfall, temperature (air and soil), evaporation, radiation, wind and humidity are necessary for on-station experiments. The measurements should be taken as near to the experimental plots as possible and if it suspected that rainfall is different at the plots then additional gauges should be installed near the plots. Most of the data obtained on-station can be used for the on-farm experimental sites, but again it is recommended that daily rainfall be measured for the on-farm plots.

Table 2. Method, location, and frequency of measurement of climatic variables.

Climatic Variable	Method	Benchmark Area	On-station Plots	On-farm plots
Rainfall	collected daily, receptive area of gauge should be 200 cm^2	longterm records, mean monthly precip (mm/mo)	daily, mm	daily, mm
Temperature	daily max and min, measured 1.2-2.0 m above the ground	longterm records, mean monthly max and min (°C)	daily max and min	- - -
Soil Temp	daily max/min at 0.10 m depth	- - - - -	for specific studies in relevant treatments	- - -
Radiation	Campbell sunshine recorder	- - - - -	daily	- - -
Evaporation	Class A pan	- - - - -	daily	- - -
Wind	cup anemometer	- - - - -	daily	- - -
Humidity	Assmann psychrometer	- - - - -	daily	- - -

LAND-USE

A fairly detailed description of the land-use of the area under study is important for determining potential points of intervention for improving the productivity and sustainability of the current agricultural system. One must distinquish between a general description of the land use of the area being studied and the actual land-use of the experiemental site. Both are important but provide different types of information. The former is for characterization of land use patterns in the bench mark areas and provides information the percentage of the area under different land-use management. The latter, past land use of a site used for experimental purposes, is important for understanding the immediate factors, or driving variables, that will had an impact on the current status of the vegetataion and soil. Current land use could be considered the experimental treatments that are installed.

The type of information needed is presented in Table 3. Much of the data for site characterization of the benchmark area will be obtained from interview surveys and others secondary information available and will overlap with the information requested by the socioeconomic survey. Quantification of as many of the driving variables, such as fertilizer use, stocking rates and crop and fallow length, rather than a qualitative description, is most useful and will aid in understanding and predicting the magnitude of the response variables.

Of particular importance for determining the productivity of areas under different land use and the impact of areas in slash-and burn agriculture to the emission of greenhouse gases is an indication of the amount and age of the vegetation cleared and the frequency of clearing a single area. For example, is an area cleared once and then abandoned to forest or put to another use or is the land cropped or used until it is degraded? Other important factors influencing the maintenance or decline of productivity of slash and burn practice in the area are the length of the cropping cycle and subsequent fallow period, and an indication if the fallow period is decreasing and/or cropping period increasing.

Table 3. The different aspects of land use that are important for area and site characterization. (adapted from the TSBF Handbook, p. 20)

Land use Variable	INFORMATION REQUIRED	AREA (AC) OR SITE CHARACTERIZATION (SC)
Type of land-use: pastures, crops, plantations	% area in each category or class (TSBF Handbook, p.20)	AC
Clearing and burning	*Area cleared per year, type of land cleared (undisturbed forest, fallow (age), grassland *Clearing and burning method	AC
Management, type of use (crops, pastures, plantations, etc)	*crop/fallow ratio (years) *crop and tree varieties and plant spacing, *rotations and intercropping *ground covers *weeds and weed control *tillage, irrigation *animals, stocking rates *pastures, plant composition	AC and SC
Inputs	*types (fertilizers, manures, prunings, mulches) *quantities *timing and method of application	AC and SC
Outputs	*harvest products (fruits, grains, straw, etc.)	AC and SC

SOIL VARIABLES

<u>Site Characterization</u> - There are several soil variables that are essential for site characterization for most types of experiments envisioned. The soil chemical and physical properties, along with the climate, will dictate the appropriate crop varieties and tree provenances for the area by setting the fertility and hydrologic potential and constraints for growth and production. We recommend that the 2 or 3 dominant soil types for the benchmark area be classified according to Soil Taxonomy, to the family level.

Soil classification according to Soil Taxonomy is quite detailed and involves some chemical and mineralogical procedures not available to most laboratories. The Soil Management Support Services (SMSS) of US AID can often assist in the analysis and classification of soils. Some of the sites have undoubtedly been analyzed and classified accordingly.

It is not necessary to classify the soils of the experimental plots but it can usually be ascertained from the information of the soils in the benchmark areas. There are, however, several variables that are important for site characterization of the on-station and on-farm plots (Tables 4A, 4B). These include particle size analysis (texture), soil available water, from the physical aspects; and pH, ECEC (effective cation exchange capacity), %base saturation, N mineralization potential as measured by anaerobic mineralization, and P-fixation, measured via P sorption isotherms, from the chemical aspects.

Another measurement that could be added to the list that is not normally considered part of site characterization could be a test for the limiting nutrient(s) to production. Many experiments will look at various treatments for maintaining or improving crop yields and soil fertility, knowing the limiting nutrient aids in selecting treatments and understanding results.

Measurements for monitoring fertility, nutrient and carbon dynamics

In addition to site characterization there are varibles that are important for longterm monitoring studies (Tables 4A, 4B). This section presents some of those measurements. The depth and frequency of sampling depends on the measurement and experiment. Bulk density must also be sampled for experiments concerned with changes in the total stocks of nutrients in the system. All of these factors should be discussed as they apply to different types of studies.

Nitrogen, as well as, phosphorus are the primary limiting nutrients in tropical soils. Whereas laboratory methods for evaluating the available nutrient supply and fertility status for the basic cations are quite reliable, there is no widely accepted method for estimating nitrogen and phosphorus availability. Total N and P are generally large pools that do not change significantly even over a few years. Inorganic N levels are extremely variable spatially and temporally and are not ususally correlated with crop productuction except perhaps under fertilized conditions. Certain methods for measuring available P do provide a guide for critical levels for some crops, but does not work for tree production. Obviously, some measure of the more readily available portions of soil N and P are needed. Even though there is still no concensus we recommend in situ N mineralization and the

Hedley et al. (1982) P fractionation scheme, for means of assessing changes in N and P availabilities.

N-mineralization Mineralization is the process by which soil organic matter and added organic materials decompose and release inorganic N. The rate depends on many factors including, rainfall and temperature, the total soil N content as well as its composition. The amount and type of organic materials added to the soil will also alter the net mineralization rate and pattern. Several methods have been proposed for estimating mineralization and they all have particular problems (see TSBF Handbook p 162-165) but they can provide relative indices for nitrogen availability.

The TSBF group adopted the in-situ undisturbed core method outlined by Raison et al (1987). Paired pvc tubes are driven into the topsoil; the soil from one tube is extracted immediately for inorganic N while the other tube is left, covered, in the soil for 14 days to one month before removing and extracting for inorganic N. The difference in inorganic N between the two times is considered to be net mineralization. In the wetter sites, the method is not as reliable as in the dries areas, partially due to the spatial variability of the process but also due to methodological problems of compaction and water saturation. Despite these problems we encourage further attempts at estimating in situ mineralization by use of tubes with a larger diameter to avoid compaction and by sampling intensively in a small area.

Intensive sequential sampling for mineralization can provide an estimate for the amount of N made available to plants during the course of crop growth or during the year. This however is extremely time consuming and not very practical; ideally mineralization rates from soil organic matter could be modelled with information on the effect of soil temperature and moisture, such an exercise could be important for determining the inherent mineralization rates of the various soil-climate zones representative of the slash and burn areas. Simulataneous anearobic or aerobic incubations carried out in the lab would help to establish a relationship for the field and lab measurements at different sites.

Another use of intensive sampling of mineralization is to determine the nitrogen availablity patterns following applications of organic materials of varying chemical characteristics and decompositions rates. Coupled with information on changes in the light fraction (see below) could aid in the selection of materials and timing of application to synchronize nutrient availability with plant demand and minimizes losses of nutrients from the system.

Phosphorus fractionation - Estimating phosphorus availability in tropical soils is problematic partially because of the high P-fixation capacity of many of the soils with high Fe and Al oxide or allophane contents. Much of the P in weathered tropical soils exists in recalcitrant pools and this P is generally considered to be unavailable. Recent studies have shown that much of that recalcitrant P is utilized and that most of the P utilized comes from organic pools, rather than inorganic pools as in less weathered soils. Soil test data for P can show little or no change with time despite crop harvest removals and continued tree and crop growth, this also indicates that the available P is being replenished from the other pools. Certain pools of P that are not measured in most soil tests are apparently a readily available source of Pi for plant uptake.

A scheme developed by Hedley et al (1982) separates P into different fractions using sequential extractants: resin, bicarbonate, NaOH, sonication with NaOH, HCl, and a residual P extracted by H_2SO_4 and H_2O_2. The different fractions are also separated into inorganic and organic P. While this fractionation method is laborious and time consuming we believe it merits further consideration. By looking at the changes in the different pools with time in different land use practices we may be able to better understand P dynamics and the controls on P availablity in different soils. It may be that only certain pools in the fractionation scheme will be crucial for assessing changes in P availability. The dependence on organic inputs in slash and burn agriculture stresses the importance of investigating this pool more thoroughly.

Other candidate methods for looking at changes in soil P would be separating total soil P into inorganic and organic forms or more by a two step extraction, acid followed by base, detailed by Bowman (1989). Another method that has been developed in New Zealand that appears promising for a soil test for trees is cumulative P extracted by consequetive extractions with bicarbonate.

Soil organic matter: C, N, and P

In recent years there has been renewed interest in soil organic matter research because 1) the importance of soil organic matter in maintaining the productivity of low-input agricultural systems such as slash and burn agriculture, and 2) the contribution of the loss of soil organic matter to carbon dioxide and other greenhouse gas emissions. Despite its importance, there is no 'soil test' for looking at soil organic matter as it affects productivity. Current efforts are being made to measure more active or labile fractions of soil organic C, N, and to some extent P, and to see if there is a correlation with productivity.

Microbial biomass (C, N, and P), soluble C, and anaerobic N mineralization are suggested as estimates for a fast turnover pool that would be relevant to nutrient availability. There is not yet conclusive evidence showing a general relationship with any of these measurements and productivity. Part of the reason is that the correct types of experiment have not been conducted; much of the time has been spent on methods development. The Slash and Burn project will provide the types of experiments needed to test the value of the various measurements.

Microbial biomass The method recommended for microbial biomass C and N is the chloroform fumigation-direct extraction method of Vance et al. (1987). This method works better on acid soils than the original fumigation incubation procedure and it is not sensitive to recent organic additions. The method is best used when comparing different treatments on the same soil but is probably not good for comparing microbial biomass on drastically different soils, although the trends may be similar. The fumigation time may vary with soils, sandy soils probably only require one day of fumigation whereas clayey or wet soils may require three to five days (this should be checked at each site). Fumigated and unfumigated soils are extracted with K_2SO_4 and the extract analyzed for C and N (TSBF HANDBOOK). The amount extracted from the unfumigated soil can be considered an estimate of soluble C and N and the difference between the amount extracted from the fumigated and unfumigated soils is related to the microbial C and N, factors have been calculated to convert the values to biomass. There is evidence that short-term changes in microbial biomass reflect long-term trends in soil organic matter content.

Light fraction The light fraction consists of the soil organic matter that is not bound to clay minerals and can makeup 5 to 50% of the soil organic matter. It is basically undecomposed or partially decomposed organic material in the soil and is therefore distinctively different from the clay bound, humified soil organic matter. Knowing the % of the total soil organic matter that is in this light fraction may serve as a means of breaking down the total into functionally pools. Preliminary studies indicate that the light fraction may represent a pool of slower turnover time than microbial biomass. Measuring the changes in light fraction over time with changes in land use and management may provide a some correlation to production trends and ultimately lead to a soil test parameter.

Several methods have been proposed for measuring the light fraction; these methods cover a broad range in technical detail and equiupment, from simply swirling the soil in water and collecting the material that floats to more complicated sonication and density fractionation procedures. The method we recommend involves sieving the soil through a 2mm sieve, and them dispersing the soil in dilute (0.5M) sodium hexametaphosphate for 16 hours and then filtering through a 0.53um sieve. The material trapped on the sieve is oven-dried and can be analysed for C and N, the fraction cannot be analyzed for P because the dispersant contains P. Perhaps by modifying the method and dispersing with NaOH P can also be measured. The light fraction must be ashed to correct for the amount of the mineral soil adhered. This method may not work for well aggregated soils, so sonication for a specified time may be required.

SOIL FAUNA

Soil fauna are important for forming and maintaining soil structure and also in the decomposition and mineralization of organic inputs and soil organic matter. Despite these important functions there has been little emphasis on characterizing soil fauna. Changes in land use result in drastic reductions in the number and types of soil fauna which can have an impact on both soil structure and fertility. Methods for collection, separating, and classifying soil fauna are presented in the TSBF Handbook. Experiments proposed by the slash and burn should place emphasis on the characterization and function of soil fauna. It may be necessary to assign a group of experts to coordinate this task given the speciality of the subject matter.

VEGETATION VARIABLES

Measurement of the standing stocks and rates of accumulation of biomass and nutrients of the vegetation, both above and belowground; and the amount, chemical composition, and decomposition rates of organic inputs are important for understanding the initial stocks of the site and the vegetation dynamics and nutrient fluxes of the system and for following the production and nutrient accumulation of the replacement systems. The methods described below are used for both site characterization and monitoring of vegetation, the measurements will not be required for all type of experiments (Table 5).

BIOMASS AND NUTRIENT CONTENT Quantification of the biomass and nutrient content of the vegetation that is cleared for slash-and-burn agriculture is necessary for understanding

TABLE 4A. A comprehensive list of soil variables for site characterization and monitoring studies and the recommended methods. Depth of sampling should be done according to horizons but not all horizons need be sampled for all measurements. Frequency of sampling will vary with the type of measurement and its importance to each experiment.

SOIL VARIABLE	METHOD	UNITS	NOTES
CLASSIFICATION			
Soil Taxonomy, family level	on representative pedons for Benchmark sites; perhaps coordinated with SMSS	na	
PHYSICAL PROPERTIES			
Particle Size	Hydrometer, 40s, 5hr readings (TSBF Handbook,p 34; ASAI, p.405).	%sand, silt, clay	use __ NaOH as dispersant in well aggregated soils with high Fe and Al oxide content (EMBRAPA)
Bulk density	Depends on soil type, stoniness (TSBF Handbook, p.51-53)	g/cm^3	
Infiltration	Double ring (TSBF, p53)	cm/hr	
Plant available water	water held between field capacity *in situ* (TSBF Handbook, p.50) and permanent wilting point (1500kPa, pressure plate TSBF p 50; ASA1 p.405), summed for all horizons in the rooting zone	mm of water	
Soil moisture			
CHEMICAL PROPERTIES			
pH	1:2.5 water (TSBF p.33)	na	
CARBON - Total	Complete oxidation or Walkley Black with correction factor (TSBF p. 35)	%	
Light fraction	Soil organic material between 53um and 2mm. Soil dispersed with dilute hexametaphosphate,(Cambardella and Elliott, 1992)	mgC/g soil	dilute hexametaphosphate may not work for well aggregate soils
Microbial biomass and soluble C	Fumigation-direct extraction (Vance et al, 1987)	ugC/gsoil	
NITROGEN - Total	H_2SO_4/H_2O_2 Se digestion	%	
Light fraction	see light fraction above	mg	
N mineralization potential	Anaerobic incubation (TSBF p, 83; ASA2 p.727)	ugN/gsoil	
N mineralization	*In situ* undisturbed cores (TSBF, p 84)	ugN/gsoil /day	use larger diameter tubes for wet soils to avoid compaction and possible anaerobic conditions
PHOSPHORUS - Total	H_2SO_4/H_2O_2 Se digestion	%	
Available	Bicarbonate extractable pH 8.5 (TSBF p. 38; ASA2 p 421)	ug/g	this extractant appears best for a broad range of soil pH
Fractionation	Hedley et al, (1982)		
Isotherms	Fox and Kamprath (1970)		An indication of P-fixation capacity; necessary only for clayey, red soils or soils with volcanic influence and pH in NaF >10.
EXCHANGEABLE CATIONS: Ca, Mg, K	extracted with ammonium acetate at ph 7 (TSBF p.36) or Ca, Mg by 1N KCl and K by bicarbonate	meq/100g	ammonium acetate at pH 7 gives an overestimate of exchangeable H and Al
Exchangeable acidity (Al^{3+} and H^+)	extracted in 1N KCl (TSBF p. 37)	meq/100g	must not use ex acidity estimate by ammonium acetate pH 7
Effective cation exchange capacity (ECEC)	exCa+exMg+exK+exAL+exH	meq/100g	must not use the CEC determined by ammonium acetate at pH 7
%base saturation; %Al sat	(exCa+exMg+exK/ECEC)*100; (exAl/ECEC)*100	%	
LIMITING NUTRIENT			
SOIL FAUNA	20x20x20cm monoliths, fauna separated into functional groups	no. and g/m^2 soil	

the potential productivity of the suceeding system as well as the loss of carbon and nutrients from the system. The burn converts many of the nutrients stored in the biomass to plant available form in the ash but the burn also converts most of the carbon and nitrogen to gaseous form, particularly CO_2 and NO_x, which are greenhouse gases. Other nutrients can be lost by subsequent leaching. The actual amount of the nutrients in the biomass that are supplied by the burn can be estimated by measuring the ash content on the soil surface shortly
after the burn (see section belos for the method). The amount lost either by gaseous emission or leaching can be estimated by the difference in the total nutrient content of the vegetation before the burn and the amount of ash produced. However the difference method does not specify how the nutrients were lost, so it is recommended that attempts be made to measure the largest losses (methods described in Synthesis section).

Measurements of the biomass and nutrients of the area cleared should be characterized for longterm experiments concerned with productivity and nutrient cycling and is particularly important for sites that are monitored jointly with GCTE for the emission of greenhouse gases. The actual measurements should be confined to the experimental plots for on-station research. In terms of site characterization for the benchmark areas, it would be desirable to have estimates for the biomass of the majority of the areas cleared for slash and burn agriculture (or some rough indication, such as x% of the areas cleared are from primary forest of 300 t/ha and y% from fallows of 75 t/ha), although the methods for doing so are not currently reliable. For on-farm experiments, when possible the biomass and nutrients of the cleared vegetation should be measured for experiments concerned with crop productivity, at the very least the amount of ash added to the topsoil should be measured and analyzed for nutrients.

Table 4B. The soil variables in Table 4A listed according to site characterization (SC) or monitoring (M). Not all measurements are relevant to all experiments.

	BENCHMARK AREA	ON-STATION PLOTS	ON-FARM PLOTS
CLASSIFICATION			
Soil Taxonomy, family level	SC, 2 or 3 of the main soils of the area		
PHYSICAL PROPERTIES			
Particle Size	SC	SC	SC
Bulk density	SC	M	--
Infiltration	--	M	--
Plant available water	SC	SC	--
Soil moisture	--	M	--
CHEMICAL PROPERTIES			
pH	SC	SC, M	SC, M
CARBON - Total	SC	SC, M	M
Light fraction	--	M	--
Microbial biomass and soluble C	--	M	--
NITROGEN - Total	--	SC, M	SC, M
Light fraction	--	M	--
N mineralization potential	--	SC	--
N mineralization	--	M	--
PHOSPHORUS - Total	--	M	--
Extractable	--	SC, M	M
Fractionation	--	M	--
Isotherms	--	SC	--
EXCHANGEABLE CATIONS: Ca, Mg, K	SC	SC, M	SC, M
Exchangeable acidity	SC	SC, M	SC, M
Effective cation exchange capacity (ECEC)	SC	SC, M	SC, M
%base saturation; %Al sat	SC	SC, M	SC, M
LIMITING NUTRIENT	--	SC	--
SOIL FAUNA	--	M	--

Aboveground biomass Methods used for measuring biomass differ for woody or herbaceous vegetation.

Measurements of woody biomass and nutrient content are labor and time consuming but are crucial for ascertaining the initial nutrient content of the forest or fallow vegetation that is cleared. The aboveground biomass of a secondary or primary forest can be estimated by destructive sampling of a minimum of 5% of the area. All vegetation within quadrats of transects is harvested and weighed fresh in the field. Subsamples are then oven dried, wieghed for conversion to dry matter basis, and analyzed for nutrient concentration. Carbon is assumed to be 0.5*biomass. The vegetation should be separated into the leaf, branch, and stem components throughout the sampling and nutrient analysis stages.

Woody biomass can also be estimated by using allometric equations. Allometric equations take a parameter that is easily measured such as diameter and height to calculate biomass, which is not so easily measured. The equations can be developed on site, by the destructive harvest method, or by equations developed by Brown, Gillespie, and Lugo (1988). They have provided separate equations for different forest types (these equations are supplied in the TSBF Handbook). The equations require the diameter of individual trees, so they can also be used to estimate the biomass of individual trees or the summed biomass of the trees in a particular area. A few problems could be encountered using these equations. The first is that the equation were developed for primary forests so may not be applicable for young secondary forests and forest fallows. The information also does not give the nutrient content of the vegetation.

The biomass of the replacement land-use system also must be measured; if the system is characterized by trees then the biomass and nutrient changes should be estimated on a yearly basis. This can again be done by use of allometric equations but it is best that the equations be developed for the particular species planted in the experiment. Such equations are also useful following biomass production in provenance trials.

Herbaceous vegetation consisting of grasslands, crops, weeds, and cover crops can all basically be measured in a similar manner by harvesting the vegetation in a number of small quadrats. The size of the quadrats will depend on the type and distribution, or plant spacing, but is usually 0.5x0.5m or 1.0x1.0m. The number of quadrats sampled should be around 20-30 (TSBF Handbook). The total biomass can be measured or the amount represented by different vegetation types; e.g. weeds or crops.

<u>Belowground vegetation</u> Estimations of root biomass may be as essential for characterizing the site in terms of the nutrients made available upon clearing and burning; although the roots generally do not burn, they will contribute nutrients as they decompose with time. The roots become more important as the biomass of the aboveground vegetation is smaller and may contribute over half of the biomass in grassland systems.

Methods for estimating roots are difficult because of the varialblity of roots but also because the nature of sampling in the soils and extracting the roots from the mineral soil for weighing and nutrient analysis. Roots are sampled by coring techniques that are described in the TSBF Handbook, and the biomass of roots is reported on a per gram of soil basis. Again this measurement is important primarily for longterm studies of nutrient cycling and budgets and should be restricted to on-station plots cleared for experiments.

Perhaps more important than root biomass for many studies, particularly for compenent trials and component interaction studies, is root distribution. Distribution patterns provide a good indicator of the zones of nutrient and water uptake and therefore potential competition among plant types. Root patterns will vary with plant type, soil types, and climates. Root distribution patterns are best studied by looking at trench profiles that are made next to the plants of interest. Details are again provided in the TSBF Handbook. The number of root hairs occurring in a particular depth interval are counted and recorded as a percentage of the total number of roots sampled to a defined depth.

ORGANIC INPUTS, QUALITY (CHEMICAL COMPOSITION), AND DECOMPOSITION

The soil organic matter content is determined by the amount of inputs to the soil (above and belowground) and the rates of decomposition of the materials. The decomposition rates are determined by the temperature and moisture of the specific environment where the organic material is located and also by the chemical composition of the materials. The loss of soil organic matter results in a loss in soil fertility and the release of CO2 to the atmosphere, therefore, it is important to maintain soil organic matter. The loss can be determined simply by measuring the changes in carbon with time, as indicated by successive measurements. In order to understand the reasons for losses or maintenance of soil organic matter it is necessary to measure the organic inputs and their decomposition rates, and compare them between different systems. Such comparisons will lead to an understanding of the controls of soil organic matter and point to management techniques that will maintain soil organic matter and fertility. These measurements would not be required at all sites but would be considered important for sites investigating improvements in crop and soil management with the use of mulches and manures or for sites studying the losses or storage of soil organic matter and the relation to global change (sites where GCTE is collaborating).

Organic Inputs The organic inputs to the soil can be from within the system (internal cycling) via crop residue returns, litterfall, and live mulches. The amount of internal inputs is determined by the productivity of the system, and can come from above or belowground. Inputs can also be supplied from offsite (external inputs) as manures and mulches and residues, among others. The amount of inputs from external sources can be managed more than those from internal cycling because it is not dependent on the productivity of the system. The inputs from internal cycling can come from above- and belowground sources. The amount of inputs, whether from internal or external sources, should be measured on a per area basis. If the inputs consist of various types and plant parts they should be reported according to the amount of each type and even broken down into the amount of leaves and branches if the case arises. The fate of the inputs and the resulting changes in soil organic matter content and fertility depend not only on the amount and rate of decomposition but also the method of application; therefore it is important to report if the material is surface applied or incorporated.

Ash The ash produced from burning the aboveground vegetation determines the amount of nutrients available to the subsequent crops and vegetation; so although it is not truely an organic input it is important to measure the amount and nutrient content of the ash. The ash is normally collected in metal trays (0.5x0.5 m) placed on the soil surface, underneath the litter layer before the burn. Twenty to thirty trays should be placed randonly per hectare. After the burn the ash is collected in bags, oven dried and weighed. If there is unburned material it shoul be separated from the ash and can also be weighed to give an indication of how much material did not burn. The ash is also analyzed for nutrient content and if necessary corrections must be made for contamination by the mineral soil.

Organic input quality and decomposition The decomposition of organic materials also provides nutrients for plant growth, the rate of release of nutrients particulary N and P varies with the decomposition rate of the material. Knowing these release patterns and how they vary with the quality of the organic inputs may help in determining the timing of application of mulches, manures, and crop residues to crops in order to ensure the nutrients are available at a time when the crop demands the nutrients, this would also decrease nutrient losses from the system.

Quality refers to the rate of decomposition of the material and depends on many factors, among them, N concentration and lignin are the most important and methods for measuring them are in the TSBF Handbook (N by Kjeldahl, lignin by acid-detergent fiber).

In general, the higher the N concentration the higher the rate of decomposition and the higher the lignin concentration the slower the decomposition. Leguminous materials are generally high in N concentration and the rate of decomposition is apparently influenced by the polyphenolic content. Measuring polyphenolic poses a problem because of the variety of compounds that are included and the methods for extracting them. The methods are worth discussing, as well as the type of polyphenlic compound that would be of interest in analyzing, eg, condensed vs hydrolysable or tannin vs nontannin. Other variables which could be important in influencing the decomposition rate include the other nutrient cations and aluminum concentration.

Decomposition of the organic inputs, including the roots, is measured using the litterbag technique. The decomposition of the inputs must be followed in the appropriate context, i.e., if the material is incorporated the plant materials (litterbags) must also be incorporated. When possible standardized litterbags (size and mesh size) and methods should be used; however, one's judgement must be used to ensure that the materials and methods are correct for the given situation. For surface applied materials it is perhaps easier to use the litterbags as an envelope placed on the soil surface but for incorporated materials to use the litterbags as vertical cylinders, as described in the TSBF Handbook. The decision as to which method is used must also take into account the size of the mesh relative to size of the organic inputs, if the inputs are small and likely to fall through the mesh then it would be better to use the bags as cylinders or to place a smaller mesh size on the bottom of the bag.

The litterbags must be collected at crucial times to provide the nutrient release curves, including any immobilization phase. The collection times will depend both on the quality of the material but also on the rainfall and temperature during the course of the decomposition. We recommend collecting at 1, 2, 4, 8, 16, and 32 weeks in warm, humid climates and doubling or tripling those times for drier climates. The decision must be made based on the investigators' knowledge of the system and materials under study. At each collection time the dry mass remaining and the N, P, and other nutrients, in the tissue should be determined to give the nutrient release patterns.

SYNTHESES AND CONCLUSIONS

The measurements recommended above have been done so in isolation of any specific objectives or experiments and it may be difficult to understand the reason for certain measurements. At the same time there are many other measurements that have been omitted or overlooked. Some of the measurements can stand alone if they pertain to components but some must be considered in conjunction with others if the system or certain aspects of the systems are the area of interest. As mentioned earlier, some of the measurements are of pools and other of processes, integrating the two types of measurements is important in understanding the changes in the system and designing improved alternatives. Combining informating on the changes in nutrient stocks in the various pools, with nutrient inputs and outputs, give the nutrient budget and balance of the systems; if the balance is negative there is a net loss of nutrients and the system is degrading. Table 6 provides a synthesis of many of the fluxes that should be considered in slash and burn systems. Some of the measurements have not been mentioned previously. The decision as to which of the variables should be measured should consider the relative sizes of the fluxes and the relative ease of measurement.

Models can also help in defining the measurements to be taken; therefore the Slash and Burn group needs to consider models that have been developed by other groups, for cropping systems and ecosystems alike. As an international group concerned with a global problem, we need to coordinate as much as possible with other networks and groups working in both agricultural and environmental issues relevant to slash and burn agriculture and its sustainable alternatives.

Table 5. Methods for sampling vegetation pools and fluxes.

	METHOD	NOTES
ABOVEGROUND		
Tree Biomass: Forest, Forest Fallow, and individual tree components	Destructive harvest or allometric equations (TSBF p. 13)	
Herbaceous biomass: Grasslands, crops, weeds, cover crops	Vegetation harvest by small quadrats	
Litter standing stock	Collection of material on soil surface in small quadrats (TSBF HANDBOOK p. 58)	Must be sampled at maximum and minimum littermass times to obtain the yearly average,if needed
Nutrient content	Individual plant components (leaves, trees, stems, litter) analyzed for the nutrients in question (usually N, P, Ca, Mg, K). Carbon assumed to be 0.5*biomass.	Is a standardized method necessary for plant anaylsis? Or is use of a control sample or unknown sufficient?
Aboveground Inputs Litterfall and residues	Littertraps in the case of litterfall in forest or agroforestry/plantation systems (TSBF Handbook p. 57; bulk measurement for residues, manures and mulches applied on area basis (TSBF Handbook, p 58, 59).	
Chemical composition (quality)	Nutrient content of the material (N,P, Ca,Mg,K), lignin (acid detergent fiber, TSBF p.45), polyphenolics	polyphenolics are recommended for legumes
Decomposition	Litterbag method, standardized litterbags (TSBF, p.80)	Mesh size should be altered when studying material of small sizes; collection times will depend on material and season; biomass and nutrient contents must be corrected for contamination by ashing
Ash	20-30 0.5X0.5m metal trays per hectare	trays placed under the litter layer on the soil surface
BELOWGROUND		
Biomass	Root cores, to depth which encompasses 70-80% of root biomass (TSBF Handbook p. 61-64.)	Can be separated into size classes, usually fine roots, <2mm and coarse roots >2mm; live and dead roots; and according to plant type.
Nutrients	Nutrient content of the root material analyzed as for plant samples but the data must be corrected for the mineral soil contamination by ashing.	
Distribution	Trench profiles (TSBF p. 60), roots counted and distribution reported by 10 cm depth increments	
Inputs	For tree based and perennial systems, root coring combined with rhizotrons (TSBF p. 66-67); for crop or annual systems by root biomass at harvest or anthesis.	

Table 6. Inputs, losses, and internal cycling important for slash and burn sytems.

VARIABLE	Note on relative size of flux.	Relative ease of methodolgy: 1 = easy 2 = possible but requires special equipment 3 = difficult and should be done by specialized group
EXTERNAL INPUTS		
Precipitation (nutrients)	small	1
Fertilizers	depends on amount added	1
Mulches, manures: as nutrients or carbon (from outside plots)	large	1
SYSTEMS LOSSES		
Harvest material removed	large	1
Runoff, erosion	depends on slope and land use	2
Leaching, below rooting zone	usually small but can be large if a lot of nutrients are added to the system	2
Gaseous	small as total % of nutrients but important exceptions such as burn events; also important if greenhouse gases	3
INTERNAL CYCLING		
Ash	large but depends on biomass	1
Litterfall, crop residue, prunings	large	1
Decomposition	medium to large, depends on inputs to system	2
Mineralization	medium to large	2
Plant uptake	large	1,2

3

A database of research activities for the Slash and Burn Project.

Richard Coe
ICRAF, Nairobi
16 December, 1992

1. The Need.

The Global Alternatives to Slash and Burn initiative is a proposed global research activity. Current plans are for substantial field research to be conducted at 8 sites in 3 continents. Research will also take place at satellite sites, as well as at other centres concentrating on regional and global synthesis of results. Currently some 17 collaborating institutes have been identified.

If this research effort is really to be a coordinated global project and not a series of isolated research activities, there has to be a well established system for information exchange between all interested groups. Participants in the project worldwide need to be kept informed of what is happening, what data has been generated and is available and what the key results are.

One way of achieving this is through a computer based database. There are many possible structures for such a database. This paper outlines one structure, summarising the output needs it could satisfy, the input requirements and some of the steps needed for implementation. Some alternative database structures are also described. This paper is not a technical specification for any database.

2. Inputs, Outputs and Constraints

Outputs

The nature of outputs which must be available from the database can be described by listing example requirements of typical users, Table 1.

Table 1

Typical User	Example Output required
Field researcher	New initiatives at other sites. Modifications to design and methods at other sites. Key results from all locations.
New Collaborator	What is going on where in his field (e.g. nutrient cycling, economic surveys..).
Donor	List of research activities and major achievements without technical details.
Reviewer	Activities and results in the area being reviewed (geographical or subject based).

The outputs required will range from brief summaries (Where is improved fallow research going on? What fruit tree species are being studied?) to the highly technical (Are the same isotope techniques being used for P work everywhere?).

Inputs

The outputs described above will be obtainable if the data input consists of a list of research activities, with such details as:

Project name
Location (with biophysical and socio-economic characterisation)
People/Institutes involved.
Reasons for the research (where does it fit in the whole framework)
Objectives
Methods
Data generated
Results.

Constraints

The two major constraints which make the database potentially difficult to set up and maintain are the geographical distribution of both users and sources of data, and the need for continuous updating, as new activities are initiated and results generated.

The database will only be useful if it provides a user friendly way for information to be exchanged between the 17 collaborating institutes. Each institute will generate information that must be incorporated into the database, and each institute will need to access information originating at other centres.

The value of information in the database goes down quickly with its age. f it is not kept up to date it soon becomes worthless. One of the functions of the database will be to keep collaborators informed of latest developments. For this reason it is essential to structure the database so it can be continuously updated.

3. A possible structure

The structure outlined below is based on ICRAF's database of research activities, which is still being developed.

Data flow and updating

Figure 1 shows the flow of data.

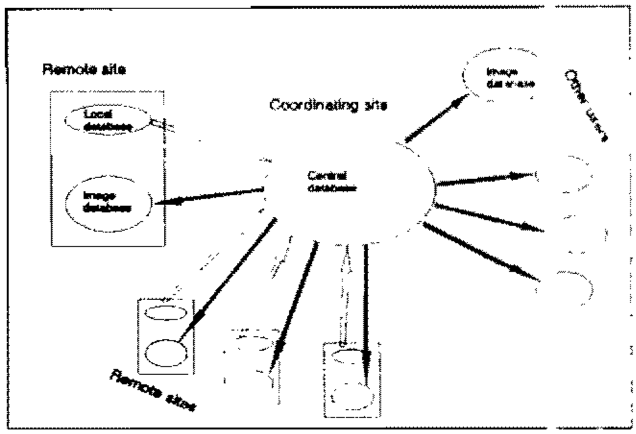


Figure 1 Structure of database

Each site at which information is generated (i.e. where research activities are planned and carried out) has a copy of the data capture software. Information on research is entered, building up a local database which describes activities at that site. The format and structure of the information is controlled to ensure uniformity between sites.

A copy of the local database is then sent to the coordinating site. The local databases from all sites are compiled into a central database, which will contain information on all Slash and Burn project research activities. The compilation process will ensure that information from different sites is compatible.

A copy or image of the central database can then be distributed to anyone who needs access to the information. This will include all research sites that are generating data as well as other interested parties, such as project coordinators, donors and potential new collaborators. The image database can be searched and the necessary output reports produced by each user.

The database has to be kept up to date. This can not be done by individual users modifying the data in their image database as this would result in different users having different versions. The data in the image therefore can not be modified by users. Instead users update their local database. The new local database is sent to the coordinating site, where it is compiled and a new image produced The new image is then distributed to all users. The frequency with which this needs doing depends on how rapidly new initiatives, changes in design and methods and important results are generated. At the start and end of each growing season would be reasonable.

These transfers of data between the coordinating and remote sites could in principle be done by electronic data transfer (E-mail) and even done automatically. The problem of telecommunications with some sites and the large volumes of data involved are likely to make transfer by diskette more practical.

Data items

Within the database there are records of several types. One type is "Experiment", containing fields that describe such things as the location, objectives, methods, design, measurements etc. Another record type is "Location". The fields of this record type give the characterisation of the research locations (climate, soils, land use etc.). This site characterisation component of the data base is valuable itself, giving a description of all sites in which the Slash and Burn Project is operating. The power of this structure lies in the link between the two types of records. A user of the database needs to know the characteristics of the site at which an activity is going on. However a researcher entering information does not want to have to enter the same characteristics data for each experiment at that location. By having linked records of characteristics and experiments, soil and climate data is tied to details of each experiment, yet only has to be input once per site.

Other record types can be defined according to range of outputs needed from the database. The ICRAF database, for example, has tree species as a record type. Each experiment is linked to one or more tree species records. Defining tree species as a record type allows characteristics of the species to be entered into the database without repeating them for every experiment in which that species occurs. It also allows us to link with the MPTS database. In the Slash and Burn research database it might be appropriate to define 'Method' as record type. If, for example, a standard method of tree root sampling and measurement is established, the description of an experiment would just be linked to method record. In this way, the method does not need fully describing for every experiment in which it is used, yet a full description of the method is available for every experiment.

Research activities other than experiments, such as surveys, modelling exercises and bibliographic research can all be entered into the database. A systematic way of describing them has to be found.

4. Development

Developing the database system requires:

- Definition of the data to be input, both content and structure.
- Preparation of software to capture that data.

- Definition of the structure of the central database and the method of compiling local databases.

- Preparation of software for users to search the image database and produce reports.

The resources needed to do this depend largely on the exact nature of the data to be input. If it is much the same scope as that in ICRAF's research database (i.e. details of field research activities: surveys, on-farm and on station experiments), with a similar level of detail, software developed by ICRAF could be used as a starting point. However ICRAF still has considerable development work to do. Increasing the scope of the database by including a broader range of research types and/or more detail would increase the development costs.

Whatever decisions are made on structure there will be some software development required. A professional development programmer will be needed and recent experience at ICRAF suggests this is not likely to be available in Kenya. Suitable hardware and software licences would also be required.

5. *Maintenance*

Maintenance of the system is required at both remote sites and the coordinating site. At remote sites, scientists have to keep their local database up to date. This need not be time consuming - each time an activity is initiated or amended the details have to be entered, as do summaries of results. Such maintenance of research records is something experimenters should be doing anyway. The software provided will mean this information is easily caught by the database.

Maintenance of the central database involves regular receipt of local databases, compilation into an updated central database and generation and distribution of new images. Maintenance costs at the coordinating site include a database manager, suitable hardware, running costs and secretarial support, plus resources for installation and training of users.

6. *Alternative structures*

Existing Databases

A rapid survey of other research organisations revealed no existing databases that would satisfy the requirements outlined above. Several CG centres have databases of research activities aimed more at management that scientific data exchange. These databases contain information, for example, on budgeting and expenditure, but little scientific detail. Some technical databases exist, for example in breeding programmes, but these are too narrow in scope for the Slash and Burn Project.

Several research organisations concerned with multipurpose trees have developed research databases, for example CATIE (MIRA) and F/Fred (MPTSys). MPTSys is probably most comprehensive, and contains linked records of locations, experimental details and raw data, together with analysis and modelling software. However it is limited to simple growth trials of multipurpose trees. It would be difficult or impossible to include descriptions of, or raw data from, agroforestry trials and surveys, particulary those related to process oriented research.

A single central database

An alternative mode of operating a database of research activities would be a single central database which is accessed by all users, both those supplying and those retrieving information. Such a scheme requires email connections from all sites to the centre. While that is feasible, and possibly in place already, most of the these connections use standard telephone circuits. On-line work on a remote computer is therefore very expensive. The situation is not likely to change during the lifetime of this project.

Complexity of the database

There is a wide spectrum of possible contents of the database. Simpler definitions would have less technical detail on each research activity. More complex definitions could encompass a wider range of research types and include raw data. In general the value or utility of the database will increase with increasing complexity, but with diminishing returns. The cost of development and maintenance will go up exponentially.

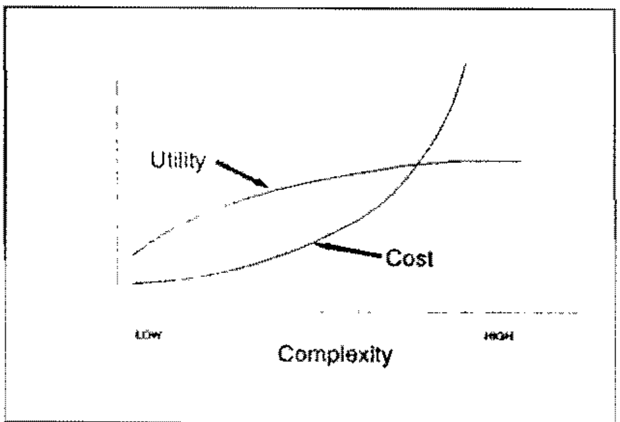


Figure 2 Cost effectiveness of database.

As an example, consider the problem of including raw data in the database. The added value of that information arises because it means researchers working on regional or global synthesis of results have easy access to it. While such data exchange is essential for synthesis, the number of people who need access to raw data is limited. Most can get required results from summaries. However the cost of including raw data in the database is very high, because of the complexity and data volume it adds.

Including raw data in the database also brings up the sensitive issue of access to data. Many field scientists worry about data which has been painstakingly collected being 'stolen' by others. Preventing this is difficult if such data is included in the database and widely distributed. An alternative, planned to be adopted by ICRAF, is to include in the database:

1. Summary findings.

2. Published results.

3. Information on what raw data has been collected and who to contact for access to it. Individual agreements on access can then be arranged as needed.

The level of complexity adopted will have to depend on the outputs required, resources available and cost effectiveness.