INSTITUTO NACIONAL DE INVESTIGAÇÃO AGRONÓMICA

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METHODOLOGY FOR PARTICIPATORY SOIL SURVEY AND LAND EVALUATION

(First Draft)

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1. GENERAL INTRODUCTION

Soon after independence (1975), Mozambique adopted a centrally planned economic system. In the area of agriculture, government efforts were concentrated on large state farms. Much of the rural population was grouped in new villages (aldeias comunais). This movement, known as aldeiamento, was prompted by a number of reasons, among which easier supply of essential services to the rural population (schools, dispensaries etc.), easier protection against guerilla attacks during the civil war and, in certain cases, protection against floods. As far as land use is concerned, the aldeiamento has led to an excessive concentration of agricultural activities around the new "mega-villages", separated by large nearly abandoned areas. Hence an unsustainable situation and declining yields, due to the shortening of fallow periods. Civil strife, nearly since independence until 1992, has ruined the infrastructure, disorganized the commercial network, strongly reduced the cattle population and disrupted governmental assistance to the rural population.

The recent peace situation made it possible for farmers to return to the lands they occupied before the aldeiamento, thus making it possible to increase the duration of fallow. The commercial network is beginning to function, thus improving the supply of goods to farmers and providing opportunities for them to market excess production. The adoption of a decentralized free market economic system has generated new attitudes towards agricultural development. The focus is now on the ***family sector*** and on ***people's participation*** though the commercial sector, producer of exportable commodities such as cotton, and foreign investment are also strongly encouraged.

The family sector which represents about 90% of the rural population consists of small-scale farmers disposing of small holdings averaging about 1.5 ha, usually in several scattered plots. Land is primarily used for rainfed crop production with little or no inputs, except planting material and labour. Production is mainly for subsistence but surplus crops are marketed. Most urgently required assistance by the family sector is in providing marketing outlets for excess production, supply of seeds, implements, cattle for animal traction, and rehabilitation of the infrastructure (drainage systems, roads etc.). Once these emergency requirements are met, further progress will depend on well integrated farming systems research, extension and land use planning programmes.

The purpose of this report is to propose a participatory soil survey and land evaluation methodology that provides an information base for land use planning, extension and farming systems research. The proposed methodology, in which farmers' knowledge and participation are key factors, was elaborated and first tested during the land resources appraisal of the district of Xai-Xai (province of Gaza), then further refined and tested in the districts of Pemba-Metuge (province of Cabo-Delgado) and Mocuba (province of Zambezia) and in the posto administrativo of Namialo (district of Meconta, province of Nampula).

2. MAIN PURPOSES OF SOIL SURVEY AND LAND EVALUATION IN THE MOZAMBICAN CONTEXT

The important changes that are taking place in the national economy lead to a ***high instability in the pattern of land use*** and to a ***strong increase in the volume of land transactions***. Institutional operators such as ministers, governors and district administrators have to make many decisions on the affectation of lands to new uses. Serious and often irremediable errors may occur in the decision making process if it is not based on adequate information. For example highly erodible land may be allocated to mechanized cotton production or highly valuable agricultural land may be allocated to urban development while equally suitable land of lesser agricultural value is available. Private investors also have to select the most suitable land, crops and land management practices for large-scale farming enterprises and therefore require land-related information.

It appears clearly from the above that good information on the land[1] resource base would greatly facilitate the land use decision making process of ***institutional and commercial operators***. Institutional land use planning decisions have an impact on all users, farmers and urban dwellers, family sector peasants and commercial farmers alike. Moreover, institutional decision makers often have to arbitrate land use conflicts.

The characteristics of the land determine the potential for agricultural production. It is therefore important for the farming systems research specialist, the extensionist and the land use planner to know:

- what are the characteristics of the various lands that occur in a particular area (**land characterization**)?

- where does a given type of land occur and how extensive it is (**land distribution**)? This information will allow, for example, the FSR specialist and the extensionist to determine what are representative lands to locate field trials.

- what kind of land use a given land is most suitable for (**potential land use**)? e.g. arable farming, grazing, forestry, wild life etc.

- what crops, either locally known or not, could grow on a given land (**crop selection**)? This allows the selection of crops for testing in the local environment.

- what yield level could be achieved for a particular crop on a given land (**crop performance**)?

- what measures could be taken to increase production or sustainability or both (**land management**)? These may be for example, fertilization or land reclamation measures, such as

[1] Land basically includes soil, geology, landforms, climate, hydrology, plant cover and fauna. Except for the fauna, all other aspects of land are usually covered to some extent in soil surveys.

drainage, leaching of salts, sub-soiling, erosion control etc...

Community-level rural development workers have to interact with farmers. Therefore the land resources specialists must make available to them land information in a format that they can themselves understand and that allows them to communicate with farmers. Adequate **terminology** is therefore an important requirement for land resources information.

3. WHAT ARE SOIL SURVEY AND LAND EVALUATION ?

3.1 Introduction

The core of most land resources appraisals carried out for agriculture purposes includes essentially **soil survey** and **land evaluation.**

Soil survey investigates the nature and the spatial distribution of soils while **land evaluation** determines their potential for various uses, among which only agriculture, extensive grazing and forestry are considered in this report.

As Dent and Young (1981) put it, "Land evaluation is the process of estimating the ***potential*** of land for alternative kinds of land uses." Therefore, the objects of land evaluation are pairs of entities, each one consisting of a land type[2] (LT) and a land utilization type (**LUT**).

In this context, the term potential is a composite one as it includes five basic components:

- the productive potential, that is the capacity of a given land to deliver under a certain **LUT**, given outputs (produces and/or services) in given **quantities** and/or **qualities.**

- the implementation potential, that is the degree of difficulty that would be encountered to implement the technologies required by a given **LUT** on a particular land. For example, a given tree species may produce more timber on steep highlands due to favourable climate, however access may be so poor that timber exploitation is not feasible. Similarly, the ease of implementation of irrigation or mechanization are not necessarily related to yield potential. Mechanized maize production may be more difficult to implement on sloping land than on flat land though maize yield may be similar or even higher.

- the conservation potential, that is the capacity of a given land, under a particular **LUT**, to conserve its' own productive potential and the quality of the environment at large.

- the economic potential, that is the degree of efficiency of resource mobilization, including capital and labour, as compared with the outputs generated by the pair (**LT; LUT**). This comparison

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[2] The term map unit is not used here because a given land type can be described for subsequent evaluation without involving a mapping exercise.

is not necessarily in monetary terms.

- the social potential, that is the capacity of a given land under a particular **LUT**, to contribute positively to the social aspirations of the land users.

It appears from the above that the global suitability rating is therefore the result of **trade-offs** between productive, implementation, conservation, economic and social suitabilities.

Land suitability can be assessed either qualitatively or **quantitatively**.

3.2 Qualitative land evaluation

It estimates the potential of a given land for a given land use in broad terms such as highly suitable, moderately suitable or unsuitable. No attempt is made to quantify achievable crop yields, although yield considerations are a factor in determining the suitability rating. The land capability classification system (Klingebiel and Montgomery, 1961) of the American Soil Conservation Service is one type of qualitative land evaluation system for broad land use types, namely arable farming, grazing, forestry and wildlife.

3.3 Quantitative land evaluation

In practice quantitative land evaluation exercises are split in two: A **physical evaluation** phase, which includes the estimation of both achievable yields at given input levels, and a **socio-economic** phase which analyses the results of the first phase to determine the economic and social suitabilities. This process is called by FAO (1976) the **two-stage approach**. Very often, quantitative evaluation is only done in physical terms.

3.4 How is land evaluation done

Land evaluation in general can be done for the present situation or for a potential situation, for example after specific land reclamation measures have been implemented and/or new crops or technologies have been introduced. All land evaluation exercises involve 7 basic steps:

- defining the objectives
- selecting the type of land evaluation to be carried out
- setting the suitability classification structure and combination rules
- identifying relevant land utilization types (**LUTs**) and determining their land requirements
- gathering information on the attributes of each land type (**LT**)
- matching the requirements of each land utilization type (**LUT**) with the attributes of each land type (**LT**)
- reporting and dissemination of results

3.4.1 Defining the Objectives

Unless he is given other specific objectives, the land evaluator has to provide answers to the following questions that are usually asked by land use planners, extensionists and farming systems specialists:

- what kind of land use a given land is most suitable for? (**potential land use**)

- what crops could be grown on a given land? (**crop selection**)

- what are achievable yields for a particular crop on a given land? (**crop performance**)

- what measures could be taken to increase/maintain production or sustainability or both? (**land management**)

The land evaluator has to include always an additional objective which is the **analysis of present land use**, which must be done before selecting the LUTs to be evaluated.

3.4.2 Selection of the Type of Land Evaluation

3.4.2.1 For potential land use

The objective in this case is to identify the land suitability for broad land use types such as arable farming, mechanized rainfed farming, animal traction based rainfed farming, irrigated farming, grazing, forestry etc.

The land capability classification system (Klingebiel and Montgomery, USDA-SCS, 1961) has been used extensively in the United States and elsewhere, including Mozambique, for this type of evaluation. This system has two main limitations:

- It was developed for mechanized agriculture and does not take into account animal traction and hand tools cultivation which are dominant in Mozambique.

- It assumes, indirectly, that arable farming requires the best soils while grazing, forestry and wildlife can be practised on increasingly poorer soils. This assumption is strongly biased toward arable farming.

When we tried to adapt the land capability system to the Mozambican conditions, we have found it very difficult to combine the requirements of mechanized farming with those of animal traction and hand tools. Also, the bias towards arable farming is built in the system itself. Given the current wide availability of computers, which facilitate greatly the manipulation of large datasets, it is better to determine the suitability separately for each broad land utilization type. Thus in the Xai-Xai land evaluation exercise we have built 8 different computer (ALES) models to determine the suitability for the following land use types:

- mechanized (surface) irrigation farming

- mechanized irrigated rice production
- mechanized rainfed farming
- animal traction-based rainfed farming
- hand tools-based rainfed farming
- traditional wetland farming
- extensive grazing
- forestry

The models take into account the potential for production, implementation (e.g. of mechanization, irrigation) and for conservation. Together they constitute a land capability system.

After the 8 suitabilities were determined for all map units, the latter were grouped into **management units**, having similar suitabilities and requiring similar management. Though the suitabilities were determined only in qualitative terms, this zonation into management units proved very useful for the land use plan of the district of Xai-Xai.

The above mentioned models require the inclusion of soil depth, gravel content and rockiness, which were not relevant in Xai-Xai, and further validation, to be useable throughout the country. + climate

3.4.2.2 Crop selection

In order to recommend crops that may be grown in a given area, the land evaluator compares the crop requirements of a large number of crops with the land characteristics of a particular study area. Given the necessity of processing a large volume of data, some computer databases have been written to do just that. The most comprehensive such computer crop database is presently FAO's **ECOCOCROP1**.

ECOCROP1 gives climatic and soil requirements as well as potential uses for 1200 plants, including crops, fruit trees, forage species, timber and fuelwood tree species etc. Once the programme user enters land information, a list of suitable crops is automatically generated upon request.

We have used ECOCROP1 in the Xai-Xai case study and found it quite useful. It has, however, some limitations that could be remedied in the future. One serious limitation is that the programme subroutine which generates the lists of selected crops does not work properly. We therefore have had to export the whole database to a spreadsheet where the sorting was done iteratively field by field. Another serious limitation is that the soil crop requirements are often too vague and the classes of the land characteristics are often too broad and different from the standard ones, e.g. those of the FAO guidelines for profile description. It must be noted that ECOCROP1 does not estimate achievable yields. However, ECOCROP1 gives full and **optimal** ranges for most land characteristics, thus it may help to get some broad indication of crop performance.

One may also use the literature to select crops. There are various crop monographs which include information on crop land requirements. It is also common practice to use crop suitability look-up tables, some of the better known are those in FAO and Prof Sys' land evaluation manuals, Booker Tropical Soil Manual and the Agriculture Compendium. A very serious limitation of those tables is that they are compilations of published, very often secondary, data. The source data is seldom of an experimental nature especially for land characteristics such as soil depth, rock fragment etc. We have found also that these publications tend to quote each other.

3.4.2.3 Crop performance

Here the objective is to forecast the performance of specific crops, either qualitatively or more or less quantitatively. Land suitability can only be assessed if a "set of decision procedures", which together constitute a model, is available to determine crop performance from the degree of severity of land characteristics and input levels. There are basically three types of such models:

- mechanistic models are mathematical models which attempt to simulate crop growth as a function of climate, available nutrients etc. This type of model, such as FAO's AEZ, performs reasonably well at small-scale because then climate is the main variable and the influence of climate on biomass production is relatively well known. However, at large scale, soil factors become important and their influence on yield is much less known. The complexity of agro-ecosystems, the numerous interactions between crop growth factors, the ever increasing number of crop species, varieties and cultivars complicate the modelling process. Model validation must be repeated for each variety as the physical performance often vary more between two varieties of the same crop than for the same variety on two different soils. The common practice of intercropping further complicates building quantitative models in Mozambique.

Most existing mechanistic models are at best semi-quantitative and science is still far from being able to develop a fully quantitative model sufficiently accurate for planners and decision makers.

- statistical models are mathematical models derived from the statistical analysis of large numbers of yield data. They are mostly used in global crop production forecasting, such as global agriculture warning systems. They are seldom used for land evaluation because the original yield data records usually do not include detailed soil data.

- expert systems are models which consist of decision trees based on the judgment of one or more "experts" who are persons having an extensive experience in the contemplated land use. They may be farmers, crop researchers, foresters, drainage engineers etc. The model builder must elicit from the "experts" a **knowledge base** which he will use to construct decision trees.

There are commercial computer programmes, such as **ALES** which is in use in INIA's land and water department, that facilitate the construction of land evaluation expert systems. It must be noted that expert systems can be used for qualitative as well as quantitative land evaluation.

An expert system need not be computerized and simple look-up tables which allow to link crop performance to land characteristics are also expert systems.

There are also hybrid models, such as those in **PLANTGRO**, that are partly mechanistic models and partly expert systems. This Australian software allows presently to make coarse yield predictions for about 16 crops, although this number can be increased if the user can supply relevant crop data. This type of software is certainly a good compromise and should be tested in the Mozambican conditions.

Whatever the type of land evaluation models, they all require a lot of good quality data for their elaboration and/or their validation. Good quality experimental data useable for land evaluation is scarce in Mozambique because the country has been at war nearly since independence. Hence, the refinement and validation of the existing or future quantitative land evaluation models would necessitate several years. However, the on-going development activities cannot await the conclusion of the validation process.

It is also felt that if a proper soil characterization is done, farming systems research can provide a much more realistic (on-farm trials) and cost-effective yield estimation than modelization. Especially these trials would take into account the global production environment and not only the physical one. Also, in the conditions of the family sector in Mozambique, farmers give priority to risk minimising and therefore potential crop yield estimation is not a high priority.

During the Xai-Xai land resources appraisal, it appeared to us that farmers can contribute tremendously to evaluate crop performance, though mostly in qualitative terms. We started asking farmers to rank the soils of their area according to their productivity for various local crops. The methodology is fully explained in **chapter 5** of this publication.

Land suitability as predicted by farmers is extremely valuable because it is the result of the accumulated experience of many generations. However, it covers only locally known crops, grown with the techniques that are locally known. Therefore it must be seen as a complement to conventional land evaluation techniques. Farmers land suitability rating can also be used to fine-tune conventional land evaluation expert systems. The rules for the latter being elicited from farmers, from the observation of local crops behaviour and from available secondary information. Participatory rural appraisal techniques (J. A. McCracken et al. 1988) are convenient tools to elicit farmers' knowledge and make them contribute to the land evaluation process.

The interviews showed also that conventional concepts in land evaluation must be handled with care in the conditions of subsistence agriculture as shown by this extract from an interview:

<u>Question</u> Which soil do you prefer to have, a **Giho** (upland sandy soil) or a **T'Sovo** (periodically flooded depression soil having permanent available moisture due to the presence of a water table below the plough layer)?

<u>Answer</u> After refusing to choose the farmer ended up saying: When it

rains a lot I get a good crop in **Giho** and I get nothing in the **T'Sovo**, and vice-versa when there is a lack of rain.

We then tried to have the farmer consider statistics of dry years as opposed to excessively wet years to decide which soil is better. He said that when there is a flood he harvests the sweet potato and the cassava, sells most tubers before they rot and uses the stems to plant in the upland soils which are then guarantied of good moisture supply. When there is a drought he plants more in the depression soils.

The two types of soils complement each other and are both essential to his risk minimising strategy. Saying that 70% of the time the weather is droughty then the **T'Sovo** is preferable may make sense in commercial agriculture, it does not in the context of subsistence agriculture as the farmer cannot eat 7 years and starve 3 others!

It appeared indeed that farmers, instead of putting the emphasis on the fact that some lands are better than others for given crops, rather tend to stress the complementarity between the various types of land.

3.4.3 Selecting the Suitability Structure and Combination Rules

3.4.3.1 The suitability structure

Most evaluations follow the FAO Framework for Land Evaluation (FAO, 1976) which defines:

- **suitability orders** reflecting kinds of suitability, namely **S** which is suitable, and **N** which is unsuitable.

- **suitability classes**, reflecting degrees of suitability within orders. Usually, but not necessarily, 4 which are S1, S2, S3 and N[3]. However, it appeared in the case studies that it would be better to have at least one more class in the order S. Indeed most authors, such as Dent and Young (1981), place the limit between S3 and N at 20% of optimal yield[4], which for example would correspond for maize (optimal yield of at least 5 tons in Xai-Xai) to about 1 ton. This is still about the double of what subsistence farmers consider acceptable yields. We therefore suggest to define the classes as shown in the table below.

- **suitability subclasses** reflecting kinds of limitation, or main kinds of improvement measures required, within classes. For example in S2**d**, d means require drainage.

- **land suitability units** reflecting minor differences in required management within subclasses.

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[3] Here we do not distinguish between N1 and N2 as no economic evaluation is contemplated at this stage.

[4] The yield that would be obtained if all soil conditions were optimal.

Proposed Suitability Classes
(modified from Dent and Young 1981)

Suitability Classes	Definition in terms of yields (*)
S1 highly suitable	80 to 100 percent of optimal yield
S2 moderately suitable	40 to 80 percent of optimal yield
S3 marginally suitable	20 to 40 percent of optimal yield
S4 very marginally suitable	10 to 20 percent of optimal yield
N unsuitable	less than 10 percent of optimal yield

(*) these yield ranges are only indicative.

3.4.3.2 The suitability combination rules

In determining land suitability for a particular LUT, one must first compute the suitability rating of each land quality, then combine the ratings of all the relevant land qualities. Combining ratings is very difficult as there are interactions between land qualities that are difficult to account for.

Unless dealing with mechanistic models, there are basically two ways to deal with the problem, either by weighing each land quality rating (parametric method) or applying Liebig's "law of minimum" (maximum limitation method) which states that the most limiting factor determines yield. Determining the coefficients in the parametric method is both difficult and arbitrary, we therefore recommend the maximum limitation method as it is easier to apply.

3.4.4 Identifying Relevant LUTs and their Requirements

3.4.4.1 Identifying relevant LUTs

The first step in identifying relevant land utilization types is to analyze and describe the present land use in the study area. Indeed, present LUTs may be included in the land evaluation to see to what degree they are adapted to the lands of the study area. Farmers interviews will help the land evaluator collect information about land use.

As long as the land evaluator gets to know better the study area, he should select some potential LUTs that could make use of the local opportunities. Here again the interviews with farmers may help identify the population needs and aspirations which could be satisfied by relevant LUTs.

The LUTs need to be described in more or less detail depending on the scale and the type of the land evaluation. Dent and Young (1981) suggest that an LUT description should include the following information:

- <u>Produce</u>: goods or services produced, e.g. crops, timber, recreation, wildlife conservation etc...

- Market orientation: subsistence, commercial etc.

- Capital intensity: level of capital investment.

- Labour intensity: level of labour time involved.

- Technical knowledge and attitudes: level of technicity of the farmers.

- Power and implements: Source of power, such as human labour, animal traction, machinery and types of implements such as hoes, wooden/metallic ploughs etc...

- Size and configuration of land holding: range of areas and shapes of typical holdings.

- Land tenure: private, communal or state ownership, or tenancy.

3.4.4.2 Identifying the requirements of LUTs

In most cases the land evaluator uses published material such as look-up tables, technical monographs, research reports. Very seldom if ever, is the required original data is collected specifically for land evaluation purposes. In this situation the land evaluator has no alternative but use secondary sources. However, he should check them by direct observation, whenever possible, and consult specialists for each LUT when available.

It is necessary that DTA starts a specific nationwide programme to collect crop requirements data. The activities would include experiments, direct observation and interviews of key informants, such as agronomists, irrigation and drainage engineers, foresters, range management specialists etc., and farmers.

A specific format for collecting crop requirements data should be prepared.

3.4.5 Identifying the Land Types Attributes

It is necessary to collect information on the characteristics of the various lands that occur in the study area and, if possible, their distribution. One may obtain this information through field surveys and/or from existing published data. It is however better for the land evaluator to carry out himself a field survey as he will have the opportunity to make many direct observations. Also, it is very rare that published routine soil surveys include all the required information.

Given the small-size and scattering of individual plots of the family sector, a soil map that would provide farm-level information, would have to be done at a fairly large scale, the cost of which would be prohibitive. Also, in small-scale agriculture, most development work is done at community level and communities generally know well their natural resources and their location. Therefore, in this situation, detailed mapping is not required, unless important infrastructure works, such as irrigation or drainage, are contemplated.

It was found that to gather global soil information on the districts and to produce a zonation into land management units (i.e. portions of the landscape that have similar productive potential and limitations), reconnaissance soil surveys at scale 1:50,000 to 1:100,000 are sufficient. This work follows a morpho-pedological (land systems) approach in order to speed-up the execution while ensuring a good technical standard. The photo-interpretation is done on 1:50,000 or 1:100,000 scale SPOT or LandSat imagery and aerial photographs (whenever available), and the ground truthing is carried out by transecting.

During the transecting, a number of routine (short-duration) interviews are made with farmers that are encountered. The purpose is to elicit the local soil classification, to include it in the map legend.

The observations and profiles are described in SDB forms but special care must be taken to include as many notes and drawings as possible. While the descriptions of the typical profiles should be entered in the computer database soonest upon completion of field work to be used for reporting, those of routine observations could be entered later-on when the staff is available.

One set of soil maps is drawn at scale 1:50,000 or 1:100,000 for immediate use. Another set will later be reduced and published as a regular soil map at scale 1:250.000. A report including soil descriptions, photographs, analyses and management recommendations is also prepared.

3.4.6 Matching **LUTs** Requirements with **LTs** Attributes

The matching consists in comparing the land requirements of each LUT with the land characteristics and assigning a suitability rating. This straight forward but quite tedious task is usually done with computers using specialized software such as ALES.

3.4.7 Reporting and Dissemination of Results

It is felt that maps and reports fail to ensure adequate soil information transfer to community level development workers. The first reason is that they have difficulty to locate in the field with maps. The second is that the soil map legends are written in technical jargon that is not easily understood by them. Therefore adequate format and transfer of information must be dealt with during the planning of the land resources assessment.

Besides maps and reports which are required to record and present soil information, it is proposed to organize practical training for development workers in order to enable them to recognize the main soil types of their district, know their distribution and their management limitations and opportunities. For this purpose it is necessary to hold a 2 days seminar followed by 3 to 5 days field excursion. We have successfully held one such seminar in the district of Xai-Xai for government and NGOs extensionists.

4. PROPOSED SEQUENCE OF ACTIVITIES

The following sequence of activities is proposed to carry out land resources appraisal:

- analysis of secondary data, including existing maps and reports

- acquisition of aerial photographs, satellite imagery (Spot or LandSat) and topographic maps

- general field reconnaissance of the study area during one or a few days, depending on extent

- routine transecting, including short farmers' interviews. Typical pedons are described, photographed and sampled. Photographs are also taken of the current land use. At this level a tentative map legend, including the local soil classification, and a broad zonation of the area are drafted.

- detailed farmers' and key informants interviews

- finalization of the soil maps once the soil analyses are available and production of soil maps through GIS

- processing and compilation of interviews including evaluation matrices. The land evaluation matrices will produce at this stage a land evaluation for the main crop species grown in the study area.

- selection and description of relevant LUTs to be considered in the formal land evaluation

- land suitability evaluation using ALES "land capability models"[5] and production of a land suitability map for each LUT through GIS

- grouping of map units into management units and production of a zonation map for each LUT through GIS

- generation of a list of potentially suitable crops using ECOCROP1

- elaboration of management recommendations, whenever possible with the assistance of the soil fertility and hydrology sections of DTA

- writing up and publication of a "land resources appraisal report" for the study area, including all the above information as well as background information on climate, geology etc.

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[5] Actually the ALES models for broad land uses which together constitute a land capability system as explained in section 3.4.2

5. INFORMAL INTERVIEWS

5.1 Introduction

The policy of the Mozambican government is to encourage peoples' participation in all decisions and processes having an impact on their lives. This healthy attitude has become popular in many countries and in international aid agencies.

Indigenous knowledge has long been ignored by formal science. However, the winds of change are blowing and indigenous knowledge finds every day more applications in social and environmental sciences. In agriculture, farming systems researchers have developed during the eighties "rapid rural appraisal techniques" to elicit farmers knowledge. The term "rapid" was eventually dropped and replaced by "participatory" to put the emphasis on the importance of people analyzing their own situation and proposing solutions, with the outsiders merely serving as facilitators and "consultants" on particular technical issues.

During the multi-disciplinary rapid rural appraisal of the district of Xai-Xai (November 1993 and February 1994), where the author participated as land resources specialist, it became evident that farmers have and can contribute considerable information about soils and their management. It was therefore decided to adapt rural appraisal techniques to soil survey and land evaluation.

The work started in Xai-Xai and continued later in the provinces of Cabo-Delgado, Zambezia and Nampula. The experience acquired during the 4 case studies showed that indigenous knowledge is an **indispensable complement** to formal soil survey and land evaluation techniques. Some of the benefits are:

- Elicit **farmers' soil classification system.** This allows to make better map units (groupings of soils) and to prepare a map legend using both local and scientific nomenclatures, hence facilitating communication between outsiders, such as extensionists, and farmers. Knowing the farmers' soil classification system is also indispensable if the land evaluator is going to ask them to evaluate soils for crop production.

- **Make the farmers evaluate the suitability of each type of soil** for several crops, hence using their generations-long farming experience. Of course, they can only evaluate for the crops that they grow under the farming techniques that they know, nonetheless their evaluations remain extremely useful.

- Elicit **soil management information** on fertility, land degradation, land preparation etc. Hence one can understand the reasons behind sometimes apparently strange land use habits.

- **Understand farmers subsistence strategy and how land management fits** in the community's life in order to explore ways of reinforcing it and avoid introducing disturbing innovations.

- Have farmers participate fully in the land evaluation exercise.

Indeed, land evaluation is a tool for decision making about land use, therefore it must produce proposals which are meaningful for local people.

Semi-structured interviews and ranking techniques are the backbone of the adopted methodology. Every effort is made to facilitate cross-checking between these methods and field observation as well as with formal scientific investigation techniques.

We used two types of interviews, namely comprehensive and routine ones. While doing the exploratory soil survey, we took every opportunity to interview rapidly, about soil classification and management, any farmer passing by. After completion of the soil survey, we usually conducted in-depth interviews where all relevant types of questions were asked.

In the following sections we will explore first how semi-structured interviews were conducted then look more closely at ranking techniques. It must be noted that ranking techniques are part of the interview and should be looked at as special tools for the latter.

5.2 Semi-structured Interviews

Semi-structured interviewing consists in asking the interviewee(s) questions, sometimes with the help of a checklist but never with a formal questionnaire. It is an interactive process in which the nature of the questions and their sequence depend on previous answers. Questions included in the checklist may prove irrelevant in the context of a particular interview and new ones may be incorporated. However, our experience shows that given the very specialized objectives of our interviews, there are core questions that need to be nearly always asked.

In order to be successful the interviewing process must consider carefully:

- who should make the interview
- who should be interviewed
- how is the actual sampling to be done
- where and when should the interview take place
- how should the interview be carried out
- how should the results be used

5.2.1 Who makes the interview

For the interviewees to feel more comfortable it is preferable to limit the number of interviewers to 2-3 persons. The one person leading the interview must be an experienced land evaluator with a good agriculture background in order to be able to evaluate the technical soundness of the answers and formulate relevant questions according to context. He must also have a good interviewing experience because he has the heavy task of guiding the interview, ensuring that the questions are relevant and that the answers are reliable.

Whenever possible, it is good to have an agronomist or extensionist to contribute in the interview provided they do not diverge from its' main purpose which is land evaluation. Our experience in the rapid rural appraisal carried out in Xai-Xai showed that multidisciplinary interviews are very tiring for both the interviewees and the interviewers as they have to change constantly of subject. Indeed, one would ask about soil issues, another about crop diseases and another about household consumption etc... We have found, in Mocuba and Namialo, that it is better to carry out separate thematic interviews that are integrated at a later stage. Daily discussions between the various specialists carrying out the thematic interviews allow them to take into account each other results to feed in the next interviews.

It is better that at least one of the interviewers speaks the local language because linguistic nuances may have important interpretative value and if ignored may lead to false conclusions. In Xai-Xai and Namialo the interviews were carried out respectively in Shangana and Macua whereas in Mocuba and Pemba-Metuge they were in portuguese. Even in the case that the interviewees speak portuguese it is very good that one of the interviewers understands the local language to be able to follow up the dynamics of the discussions and arguments between the interviewees. These arguments are important for instance to determine where there is a consensus and what are conflictual opinions.

When an interpreter is used, it is better to use someone whom the group has already known for at least a few days, in order to ensure that he is honest and that he understands the issues that will be raised during the interviews. In Namialo we used one of the labourers who worked with us during the soil survey that preceded the interviews.

5.2.2 Who should be interviewed

One may carry out either individual or group interviews. When the object of the interview is to elicit special knowledge, the individual who is interviewed is called a key informant. A group of key informants that are interviewed simultaneously on the same subject is called a focus group.

In Namialo we have interviewed a key informant, who was a tractor driver, because we wanted specific information about mechanised land preparation for cotton. An example of focus group may be a group of community leaders that are interviewed about community leadership.

Individual interviews have the advantage that the interviewee is not inhibited by group or hierarchical pressure, thus more information can be elicited from a specific individual. However, more time is consumed per unit information and this is not always possible. Group interviews on the other hand offer the possibility of using simultaneously several sources of information, hence saving time, and more importantly, allow to create a group dynamic that may reveal aspects that individual interviews do not show. A serious limitation of group interviews is they are sometimes dominated by one or two individuals who inhibit the other participants. It takes experienced interviewers to be able to keep such situations under control. The best group interviews that we did involved 2 to 6 individuals.

Gender is an important factor which must be carefully considered while selecting the interviewees. Persons involved in crop production were mainly women in all four districts where we tested the methodology, especially in the south of the country. Women generally proved more knowledgeable than men about soil issues. One should therefore try to have at least as many women as men in group interviews. Whenever possible, the interviewer should interview women separately from men to avoid the frequently observed passive attitude of the formers when male community members are present.

In-depth interviews should only be carried out with adult community members who have accumulated experience on land issues. One should avoid however very old people because they often have reduced intellectual capacities and get quickly tired. The ideal age is between 30 and 60 years though we sometimes had very good information from much younger persons. Older persons may be interviewed, as briefly as possible, when a historical perspective is required, especially to identify possible land use or climatic changes.

5.2.3 How to do the actual sampling

Once the type of interviewees has been selected, it is necessary to proceed to the actual selection and arrange appointments. One has the choice between acting through local governmental or non governmental channels and direct and random contact with relevant farmers/key informants.

One may for instance request the district administrator or the extension service to make appointments with individuals or groups that fulfil certain conditions[6]. The extension service would generally select contact farmers with whom they are used to deal. This practice is acceptable if the interviewers want key informants on technology introduced by the extension service. For example it may be interesting to interview contact farmers who have adopted land conservation methods to evaluate their efficiency. However, contact through official channels involves the risk of getting non representative individuals. In our experience the sampling process is better done as follows:

- the land evaluators first transect the study area and make many short interviews with farmers randomly encountered in the field. This phase will serve to produce a **zonation of the study area** into agroecological and land use zones and identify the local soil nomenclature. It will also allow to identify, through the short interviews, knowledgeable farmers that would accept further in-depth interviewing.

- select in each agroecological zone a few farmers, identified in the first phase, who, if required, may help contact additional farmers. Appointments are subsequently made with them.

[6] Occupation type, age group, gender, geographic location etc...

5.2.4 When and where the interview takes place

Interviews should not interfere with farmers peak activities, such as land preparation, and should preferably be made out of their working time. When the interview is the object of an appointment, the farmers should be asked to indicate a suitable date and time. If the interview is made without appointment, the interviewer(s) should choose the time when field activities have been completed. The best time is generally when the sun starts to get strong, at about 9-10 a.m. In case the interviewer has overwhelming reasons for interviewing the farmers during a busy period, he may offer them an adequate compensation, preferably in goods rather than money.

The interview should take in a place which is representative and where the participants feel comfortable, e.g. a shaded place if the whether is hot. In a well differentiated landscape it is better to choose a place where several soils occur, for example a toposequence. This is important because both the interviewer(s) and the interviewees can visualise the soils that they will be talking about.

The district of Xai-Xai is a good example of a strongly differentiated landscape where soil changes over short distances. In this district good locations were alluvial levees and risers linking the valley to the Serra. In the crystalline areas of Mocuba and Namialo however, the landscape is relatively flat and homogeneous, therefore the interviews took place mostly near the houses of the interviewees.

5.2.5 How to carry out the interview

The interviewers should decide beforehand who would be the team leader/principal interviewer, who will take notes[7] and who will be the interpreter. Experienced interviewers should brief the novice ones and the interpreter on how to behave during the interview.

The following guidelines should be respected by all members of the interviewing team:

- avoid attitudes that may shock the interviewees

- speak calmly to avoid nervousness among the assistance

- do not argue but rather repeat your question formulated in a different way

- be humble, do not try to show the participants that you know better

- do not interrupt unnecessarily, however if the interviewer is drifting away from the question, you may interrupt him gently without showing anger, thank him for the information given and ask him again the original question

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[7] It is preferable that all interviewers take notes and combine them subsequently. In the case an interpreter is used, the main interviewer can write down questions and answers while the interpreter and the interviewees are discussing. The notes should be complete and include drawings whenever necessary. The notes should be written clearly because others may have to use them.

- ask questions in an impersonal way, e.g. instead of asking a farmer "what maize yield do you get on this type of soil" ask him "what maize yield do the farmers of this area usually get on this type of soil"

- do not ask leading questions e.g. if you ask "don't you think sol A is better than soil B for maize?" the answer you will get is likely to be yes out of respect for your. It is much better to ask "which among soils A and B is better for maize?"

- do not help the interviewees to give an answer

- if you get an answer that you think doubtful don't show your opinion which may be considered insulting, but rather try to reformulate your question in a different way or ask another one that may help cross-check the questioned answer

- leave sensitive issues e.g. land tenure at the end of the interview because they may block the interview

- avoid showing that you are tired otherwise you would accelerate the tiredness of others

- try not to conceive explanatory theories at an early stage, because you will have a tendency to lead interviewers to confirm them and to ignore facts that contradict them

- try to formulate questions in such a way that they cross-check each other

- start the interview by referring to something visible, e.g "what is the name of this soil?"

The translator is most often by necessity someone who is involved in agriculture, and therefore has his own views on the issues raised in the interviews, which he would tend to impose. The work of an interpreter is a difficult one, it especially tiring as he must translate the questions and the answers and for this he must memorise them before translation. He therefore has the tendency to reduce the translated parts to what he thinks covers the essential. These are major problems that can be tackled as follows:

- never ask the interpreter to give you beforehand his opinions on the issues to be raised in the interviews, otherwise he may distort the answers of the interviewees to save face

- try at an early stage to learn key words in the local language, this will help you grasp what the discussion between the interpreter and the interviewees is about. Examples of such key words are: yes, no, better, worst, soil, water, names of main crops, colours, to plough, to sow, to harvest etc...

- the duration of the discussion between the interpreter and the interviewees should be monitored and compared with that of the translated version. We sometimes had situations where the discussion would last 5-10 minutes and the translated version was just yes or no!

- the questions should be formulated in a concise manner and as much as possible in the same words, hence the interpreter does not have to make the effort of understanding them at each interview

- the interpreter should translate the answers of the interviewees by portions and not to wait until the end. However, he should not interrupt the interviewees too often otherwise they may get nervous and loose track of their line of thought

The principal interviewer should:

- start the interview by explaining to the interviewees what are the objectives emphasising the fact that the interviewing team wants to learn from them

- state before asking questions that the interviewees may express different opinions and that this is normal because everyone's experience is unique

- encourage the interviewees to discuss before giving an answer to controversial issues. More information may be obtained from the discussion than from the answers

- monitor the reactions and attitudes of the participants and propose a break to allow them to rest and relax whenever they get tired. One very popular activity during breaks was in our experience to distribute cigarettes to the participants and exchange informal views about some (funny) subject not directly related with the interview

- make sure that the interview does not exceed 1 hour for an individual and 2-3 hours for groups. The duration may be longer or shorter according to the degree of tiredness and willingness of the participants

- not make more than 4 hours of interviewing per day. This means also not plan more than 2 group interviews per day

- not hesitate to terminate an interview which is not successful. Once we had to interrupt an interview with an old lady who got very rapidly very tired and could not understand the questions any more. Another unique case was with a group among which there were 2 men who were very hostile because they thought that we came to take their lands. The situation got so tense that in order to avoid conflicts we preferred to terminate the interview, though several of the participants were willing to continue

- prepare a checklist of questions to be asked, partly based on observation during the soil survey phase and on pre-existing checklist

- structure the questions in blocks according to the types of issues to be raised, but be flexible and allow divergence from the pre-established sequence whenever the information provided is interesting. At the end of each block of questions, he should ask the other interviewers if they have other questions before going to the next block of questions

- keys questions that are not sensitive should be asked in the beginning to make sure they are answered before the participants get tired

5.2.6 Typical interview sequence

The interviewers greet the group of interviewees then explain the objective of the interview. While the participants get in place, the person taking notes, writes down the date, name of place, location coordinates as determined with the GPS, interviewees numbers, gender and approximate age. Then the principal interviewer starts asking questions by blocs of information related to particular aspects.

5.2.6.1 Local soil classification

The main objective is to elicit the local soil classification system. This is essential for the remainder of the interview in order to avoid ambiguity and facilitate dialogue. In our experience the usual questions were:

. what is this soil?
. what are the other soils that occur in this area?
. do you known other soils that do not occur in this area?
. can you define/describe all the soils that you mentioned?

The interviewers must identify clearly the type of soil which corresponds to each name mentioned by the interviewees, including the range of variation in its' characteristics. This may be done directly by doing augerings in representative sites indicated by the interviewees or later by comparing with the zonation/soil map, using the GPS coordinates of the location.

One must keep in mind that farmers' soil classification is mostly based on the **colour**, **texture** and **cohesion** characteristics of the topsoil, on the soil's **moisture regime** and **position** in the landscape. Farmers also make no difference between soil and soil layer. For example, in Mocuba and Namialo, Kotokwa designates a red soil, but if you dig in front of them another soil and show them a red subsurface horizon, they would tell you "this soil has kotokwa below". This is why one should always try to elicit from what are the different sequences of layers that occur in their area and how they name them.

As soil scientists do, farmers use intergrades which they name generally by saying "this soil is soil A mixed[8] with soil B". However, they sometimes use specific names for certain intergrades. For example in Namialo, Nipati is an intergrade between Outhako (light coloured sandy soil) and N'diba (fine-textured very dark soil).

5.2.6.2 List of local crops

The objective is just to list the crops grown in the area and know their local names. This step is important for the next activity which

[8] When there is a layer A over a layer B, some farmers also say layer A mixed with layer B. It is very important to understand the exact meaning of "mixed" in a given context.

will be to elicit a land evaluation matrix.

5.2.6.3 Land evaluation matrix

The objective is to evaluate soil suitability for the main crops. The interviewees are requested to compare in turn for each crop the productivity of all the soils existing in the area. Typical questions are:

. which soils are unsuitable for this crop
. which soil give the highest yield
. among soils A and B, which one gives the best yield, B and C, A and C etc...

The information, including any comments that the interviewees may make, is carefully noted in a matrix according to the techniques shown in **appendix** I. An example of such an evaluation matrix is given on the next page.

It is important to limit the questions to the soils and to the crops that the interviewees do actually know and to start with the most important crops.

5.2.6.4 Crop resistance to drought

Most of Mozambique is semiarid, hence resistance to drought is a major crop characteristic that will determine its' success and the degree to which it can contribute to food security. We thought therefore interesting to ask farmers to rank the main crops according to their resistance to drought.

Crop resistance may vary with the physiological development stage and soil moisture supply would also vary with position in the landscape. It is therefore important to compare plants at similar development stage and moisture regime. We had for example cases where the interviewees were comparing sweet potato, planted in water receiving lowlands with crops sown on uplands!

The interviewees are requested to tell for each pair of crops which one would survive longer when an unexpected and protracted drought occurs.

5.2.6.5 Soil fertility

An evaluation matrix of the natural fertility of the main soils is first prepared by asking the interviewees to tell for each pair of soils which one will have its' fertility exhausted first under agricultural use. The interviewees are subsequently asked to indicate for each soil how many years it is cultivated and how many years it is left under fallow.

Example of a land evaluation matrix

CROPS	SOILS								COMMENTS
	Outhako	Nipati	N'diba	Kotokwa yulupalé	Kotokwa ikani	N'toku	Vamasorro sorrone	Nawawa	
Cassava	5	2	3	1	4	9	9	9	very small tubers in outhako
Sweet potato	6	3	2	1	5	4	9	9	only on ridges in n'toku
Pigeonpea	9	1	3	2	4	9	9	9	dies in outhako
Cowpea	9	1	3	2	4	9	9	9	
Groundnut	3	1	4	9	2	9	9	9	
Maize	7	2	4	1	3	5	9	6	remains small in outhako, only on ridges in n'toku
Rice	2	4	3	9	9	1	9	9	only in places where water stagnates
Sorghum	9	2	3	1	4	9	9	9	
Pearl millet	4	2	1	9	3	9	9	9	
Sugar Cane	6	2	3	4	5	1	9	9	only in depressions
Pineapple	5	1	3	2	4	9	9	9	remains small in outhako
Banana	9	2	4	1	5	3	9	9	
Papaya	6	3	2	1	5	4	9	9	
Watermelon	5	3	2	1	4	9	9	9	
Coconut	2	1	9	9	9	9	9	9	
cotton	9	2	3	1	4	9	9	5	
Tobacco	9	1	2	3	5	4	9	9	
Pumpkin	9	2	3	1	4	9	9	9	in outhako it is only grown on termites mounds
Cucumber	9	2	3	1	4	9	9	9	
Tomato	9	2	3	1	5	4	9	9	in outhako it is only grown on termites mounds

9= unsuitable; 1-7= ranks

<u>Example of a matrix of evaluation of crop resistance to drought</u>

Cas	Pot	Sor	Mil	Mai	Pig	Cow	Gro		Score	Rank
	pot	sor	cas	cas	pig	cas	gro	Cas	3	5^{th}
		pot	pot	pot	pot	pot	pot	Pot	7	1^{st}
			sor	sor	sor	sor	gro	Sor	5	3^{rd}
				mil	pig	mil	gro	Mil	2	6^{th}
					pig	cow	gro	Mai	0	8^{th}
						pig	gro	pig	4	4^{th}
							gro	Cow	1	7^{th}
								Gro	6	2^{nd}

Cas= cassava; Pot= sweet potato; Sor= sorghum; Mil= millet;
Mai= maize; Pig = pigeon pea; Cow = cowpea; Gro = groundnut

It was found that the ratio:

(duration of cultivation)/(duration of fallow)

gives a good indication of natural fertility and can be used to complement and cross-check the natural fertility evaluation matrix.

In the interview where the natural soil fertility evaluation matrix shown in the next page was elicited, the following answers were also obtained about the duration of cultivation and fallow periods:

Outhako	cultivation 3 years, fallow 6 ----> ratio 0.5
Nipati	cultivation 6 years, fallow 2-3 years ----> ratio 3-2
N'diba	cultivation 6 years, fallow 2-3 years ----> ratio 3-2
Kotokwa yulupalé	does not need fallow
Kotokwa ikani	cultivation 3 years, fallow 4 years ----> ratio 0.75
N'toku	does not need fallow
Nawawa	cultivation 1 year, fallow 6 years -----> ratio 0.17 (remark: During the first 3 years of fallow even wild grasses do not grow).
Vamasorro sorrone	cultivation 1 year, fallow 6 years -----> ratio 0.17

Hence the global ranking according to ratios is:

1) kotokwa yulupalé and n'toku which do not need fallow (respectively classified first and second in the evaluation matrix)

2) nipati and n'diba which have a ratio of 2 to 3 (respectively classified third and forth in the matrix)

3) kotokwa ikani which has a ratio of 0.75 (classified fifth in the matrix)

4) outhako which has a ratio of 0.5 (classified eightieth in the matrix after nawawa and vamasorro sorrone)

5) nawawa and vamasorro sorrone which both have a ratio of 0.17 (respectively classified sixth and seventh in the matrix)

Therefore the only real difference between the two ranking methods in this particular case is in the inversion of the rank of outhako with that of nawawa and vamasorro sorrone.

Example of an evaluation matrix of natural soil fertility

Outhako	Nipati	N'diba	Kotokwa yulupalé	Kotokwa ikani	N'toku	Nawawa	Vamasorro sorrone		Score	Rank
	nipati	n'diba	kotokwa yulupalé	Kotokwa ikani	n'toku	nawawa	vamasorro sorrone	Outhako	0	8^{th}
		nipati	kotokwa yulupalé	nipati	n'toku	nipati	nipati	Nipati	5	3^{rd}
			kotokwa yulupalé	n'diba	n'toku	n'diba	n'diba	N'diba	4	4^{th}
				Kotokwa yulupalé	kotokwa yulupalé	kotokwa yulupalé	kotokwa yulupalé	Kotokwa yulupalé	7	1^{st}
					n'toku	kotokwa ikani	kotokwa ikani	Kotokwa ikani	3	5^{th}
						n'toku	n'toku	N'toku	6	2^{nd}
							nawawa	Nawawa	2	6^{th}
								Vamasorro sorrone	1	7^{th}

Note: what is marked in each cell of the matrix is the name of the soil which takes longer to exhaust its' natural fertility.

Once the matrix is elicited and the duration of cultivation and fallow periods are known, one can proceed with other fertility related questions such as:

- do you use fertilizers (chemical, mineral or organic), with which crops, in which quantities how and when?
- where do you get the fertilisers, against what?
- do you know of any plant that enhances the growth of crops that are sown/planted in association or in rotation with it?
- what do you do with crop residues, with weeds?
- if you burn crop residues and weeds, do crops grow better in the spot where the ashes are located?
- if yes, how long does this positive effect last?
- what plants indicate low soil fertility?
- what plants indicate good soil fertility?

5.2.6.6 Land preparation

Typical questions are:

- when and how do you prepare the land for sowing/planting?
- why do use this technique/instrument for land preparation?
- how long does it take to prepare this way one unit area of each type of soil?
- when the soil is wet, how many days does it take to be dry enough for land preparation to be feasible?

5.2.6.7 Land degradation aspects

The objective is to understand farmers perception of land degradation and identify any remedial measures they might be using. Typical questions are:

- in the time of your father, the land produce more, as much or less than now?
- why?
- is rainfall as it used to be or not?
- is there soil loss when there is wind?
- is there soil loss when it rains?
- what type of soils are affected?
- what are the soils that are moist affected?
- under which crops is there more soil loss?
- do you consider the soil loss as detrimental?
- if yes, what do you do to prevent it?
- do you know of any other measure that may prevent soil loss?

5.2.6.8 Access to land

The objective is to identify the key soil resources, availability of land and the conditions of access to land. Typical questions are:

- do you know which are the key soils without which a farmer cannot achieve food security?
- how important is it to have access to termites mounds?
- how important is it to have access to a wetland?
- does everybody have access to the keys soils?
- if a community member needs land, to whom should he put the request?
- are there land conflicts?
- who has the responsibility to solve land conflicts?
- is there a shortage of land in general?
- is there a shortage of a given land type?
- do you sell land between community members?
- do lend or rent land?
- for how long and for how much?

5.2.6.9 How to use the results

The results of all the interviews are analyzed and a synthesis is prepared by bloc of information. The different evaluation matrices are combined, each kind separately as shown below. For each crop, the original ranking obtained in each interview (the three lower rows in the sample matrix shown below) is marked in a global land evaluation matrix . Thus the reader can make an idea of the variability of opinions among the informants.

In the sample matrix shown on next page, only soils A, B and C were evaluated for cassava in all three interviews giving ranks that are apparently different. However, in reality in terms of ranking, 5-4-2, 3-2-1 and 4-3-1 are identical because the sequence is the same i.e all 3 interviews considered soil C better than soil B better than soil A.

Sample Evaluation Matrix

Crops	Interviews	Soils						
		A	B	C	D	E	F	G
Cassava	Final	**6**	**4**	**2**	**3**	**5**	**1**	**9**
	Average	4	3	1.3	2	3.5	1	9
	#1	5	4	2		3	1	9
	#2	3	2	1		4		9
	#3	4	3	1	2			

9= unsuitable; 1-8= ranks

The average score between the different interviews is calculated for each soil and put in the matrix. Lastly the average scores are ranked hence giving the final evaluation result.

6. CONCLUSIONS

Farmers' knowledge and participation have seldom been used systematically in the past for the purpose of soil survey and land evaluation. In the conditions of subsistence agriculture, farmers' lives depend on delicate land use systems that must be well understood to avoid introducing disturbing innovations.

The proposed methodology makes use of farmers indigenous **as well as** conventional land resources appraisal techniques, to produce a diagnostic of the situation and management proposals that take into account farmers' experience and vital needs. Farmers by no means know everything about their lands and the information they provide is sometimes confused and requires careful consideration by experienced land resources specialists who can interpret it and put it in context. We realized also during the case studies that farmers interviews are an absolute necessity when dealing with subsistence agriculture because in this context, conventional concepts in land evaluation need to be handled with care.

The methodology is fast and cheap and therefore particularly adapted to Mozambique which is a very large country presently with limited financial resources.

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Appendix I. RANKING TECHNIQUES

The techniques of ranking allow to find out the priorities and preferences of the interviewee(s). Ranking a set of objects or issues consists of placing them in a hierarchical order according to given criteria. Ranking is very useful because it is generally easier for an informant to make comparisons in relative terms than in absolute ones.

We have used extensively the pairwise ranking technique which consists in comparing successively, two by two, all the objects in a given set in order to elicit an overall hierarchy. The ranking must be done for a single criterion at a time. The sequence of operations is as follows:

1. Choose the type of objects to be ranked e.g. soils, plants etc...

2. Ask the interviewee to list the most important (preferably not more than 6-7) items to be ranked.

3. Organize the listed items in a two entries matrix where each item is listed once horizontally and once vertically as shown below:

A	B	C	D	E	
					A
					B
					C
					D
					E

4. Ask the interviewee to compare in turn all the items and note the name or the code of the preferred item in the intersection of the column and row where they occur. If the interviewee find two items to be similar write =

A	B	C	D	E	
	A	A	=	A	A
		B	D	B	B
			D	E	C
				D	D
					E

5. The scoring is done by attributing 1 point for each time an item is given preference, 0.5 point if it is considered equal to another item and 0 point if it is considered inferior. The scores are summed up for each item then ranked, the first being the item having more points.

A	B	C	D	E	
	A	A	=	A	A
		B	D	B	B
			D	E	C
				D	D
					E

Score	Rank
3.5	1st
2	2nd
0	4th
3.5	1st
1	3th

However, the interviewer must also apply elementary rules of logic such as associativity[9] to test the consistency of the ranking that the scoring may not highlight. The example below illustrates this technique:

A	B	C	D	E	
	A	A	=	A	A
		B	D	B	B
			C***	E**	C
				D*	D
					E

Score	Rank
3.5	1st
2	3rd
1	4th
2.5	2nd
1	4th

We have* D > E. We also have ** E > C and *** C > D which lead to E > D, which is incompatible with D >E. The scoring did not show this contradiction which invalidates the whole ranking process. Consistency tests should be done during the interview in order to ask the interviewee to repeat the ranking wherever mistakes occur.

The pairwise ranking technique, as shown above, was successfully used in land resources appraisals of Xai-Xai, Mocuba and Namialo, to elicit local experience on soil fertility and the resistance of various crops to drought.

Pairwise ranking was also applied in a slightly different way to evaluate soil suitability for individual crops. As shown below, the

[9] the associativity rule is as follow: if A>B and B>C then A>C

main difference is in the presentation of results and each line represents a full pairwise ranking of soils A to F for the production of a given crop X, Y, etc... Therefore each line is a summary of a full pairwise ranking matrix.

CROPS	SOILS						COMMENTS
	A	B	C	D	E	F	
X	5	2	3	1	4	9	
Y	6	3	2	1	5	4	

9= unsuitable; 1-6= ranks