Dryland Networks Programme

ISSUE PAPER

How farmers classify and manage their land: Implications for research and development activities

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IIED
INTERNATIONAL INSTITUTE FOR ENVIRONMENT AND DEVELOPMENT

Paper No. 51
July 1994

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BACKGROUND TO THE STUDY

This paper deals with classification of land by farmers in the Minianka region of the Siwaa in southern Mali. The study was conducted as part of the activities of the ESP/GRN (Production systems/natural resource management) team in Sikasso, in collaboration with the Sotuba Soil Laboratory in Bamako. The team comprises agronomists, agro-economists, rural technicians, sociologists and animal husbandry specialists. Its primary role is to identify the technical and socio-economic constraints on production and natural resource management, to introduce a farmer-centred approach to all specific research programmes, taking account of users' real concerns and facilitating communication between farmers, extension workers and researchers. The final aim is to develop extension messages appropriate to the real situation on the ground.

ABSTRACT

In order to understand the traditional system of soil classification, to apprehend the criteria forming the basis of this classification and to determine the farmers' strategies of soil management, a study was done in the Minianka region, in southern Mali.

The results of this study show that there exist 2 levels of classification: the superior and the inferior level. The principle criteria for the soil classification of the superior level are: the topography and the presence of large size elements, while for the inferior level, soils are classified according to their constraints and potentialities.

The aptitude of soils to be tilled after the first rains and their sensibility to excess of water in terms of adhesion that can delay the tillage, are the principal factors for the soil classification.

The analysis of the farmers' management practices of constraints and soil potentialities helps to direct research and the development activities in the field of soil management.

SUMMARY

A study was conducted in the Minianka region of Southern Mali with a view to understanding the traditional soil classification system, grasp the criteria on which it is based and identify peasant land management strategies.

The results of this study show that farmers classify land into two levels: a higher level based on topography and the presence of coarse elements, and a lower level based on soil constraints and potential. The main factors which form the basis of soil classification are the suitability of the soils for tillage after the first rains of the season and their sensitivity to excess water, which can delay working the soil.

Analysis of the strategies adopted by farmers to manage different types of soil can improve the focus of research and development activities.

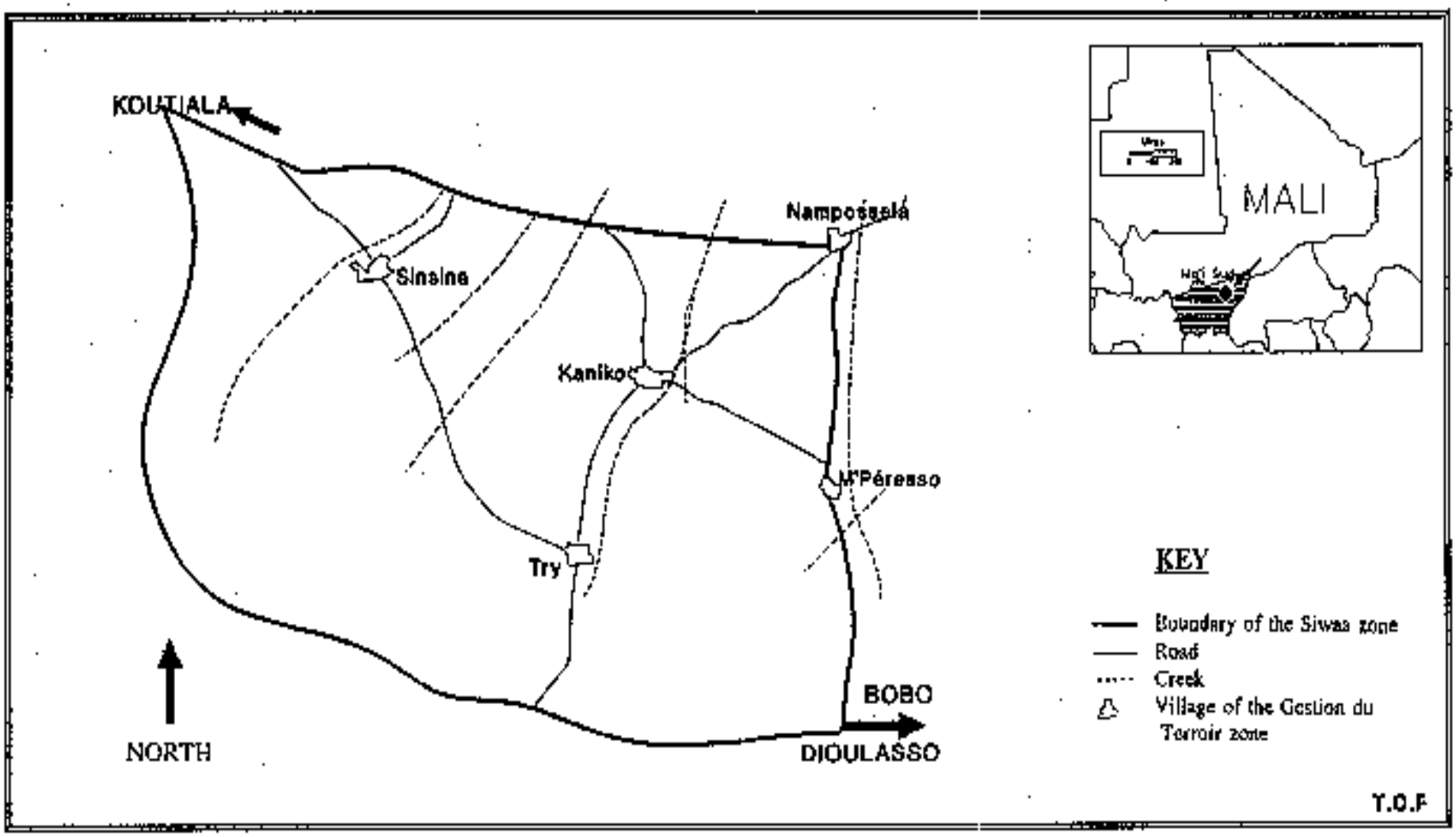
1. INTRODUCTION

Unlike comprehensive systems which try to generalize and are not normally developed by users, local classification systems are specific to local production conditions. Traditional classification systems reflect distinctions and priorities which are relevant to users, such as the production capacity or potential of resources. Factors which limit yields often provide the basis for this classification. (Tabor 1993, Pawluck et al., 1992).

Knowledge of farmers' perception of the potential and constraints of the various types of land should make it possible to come up with more responsive research and extension activities with regard to soil management and conservation. To this end, a study of traditional land classification was conducted by the Sikasso section of the DRSPR in co-operation with the Sotuba soil laboratory in Bamako. The specific aims of this study were to:

- Understand the structure of the farmers' land classification system and grasp the criteria on which it is based;
- Understand farmers' strategies to manage the constraints and potential of the land;
- Determine the results of these strategies in terms of crop yield from each type of land;
- Help to guide research and development activities aimed at more effective land use management.

MAP 1: THE SIWAA ZONE (KOUTIALA)



2. DESCRIPTION OF THE STUDY AREA

The study of traditional land classification was conducted in Southern Mali in the circle of Koutiala, specifically in the Siwaa area[1] (see Map 1).

In this area, attempts have been made to get across many extension messages about maintaining and protecting the soil, following the degradation caused by humans and accentuated by lower rainfall over the last few decades. Formerly 700 to 1050 mm, annual rainfall over the last 10 years has been of the order of 500 to 800 mm (Veldkamp et al., 1991).

3. METHODOLOGY

Individual discussions using an interview guide were conducted in the fields of 22 farmers. Those whose farms have been the subject of permanent monitoring since 1990 were given priority. Discussion arising from a group visit to each village helped to clarify some points in the interview guide about which farmers' opinions were divided.

As part of its permanent monitoring and evaluation programme (PME), the DRSPR/Sikasso has been collecting data since 1990 from 30 farms within the Siwaa. This study draws on the data collected in respect of crop yield and fertilization on different types of land.

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[1] The Siwaa is an inter-village organisation covering six villages which have some 6,500 inhabitants, all of them agro-pastoralists, the majority of whom belong to the Minianka ethnic group, with a total area of 16,605 hectares (Touré et al., 1992).

4. FINDINGS AND DISCUSSIONS

4.1 Local classification units

Farmers establish classifications on the basis of a set of criteria, the most important of which often gives its name to the type of land. The Minianka farmers of the Siwaa use two levels of classification (higher and lower).

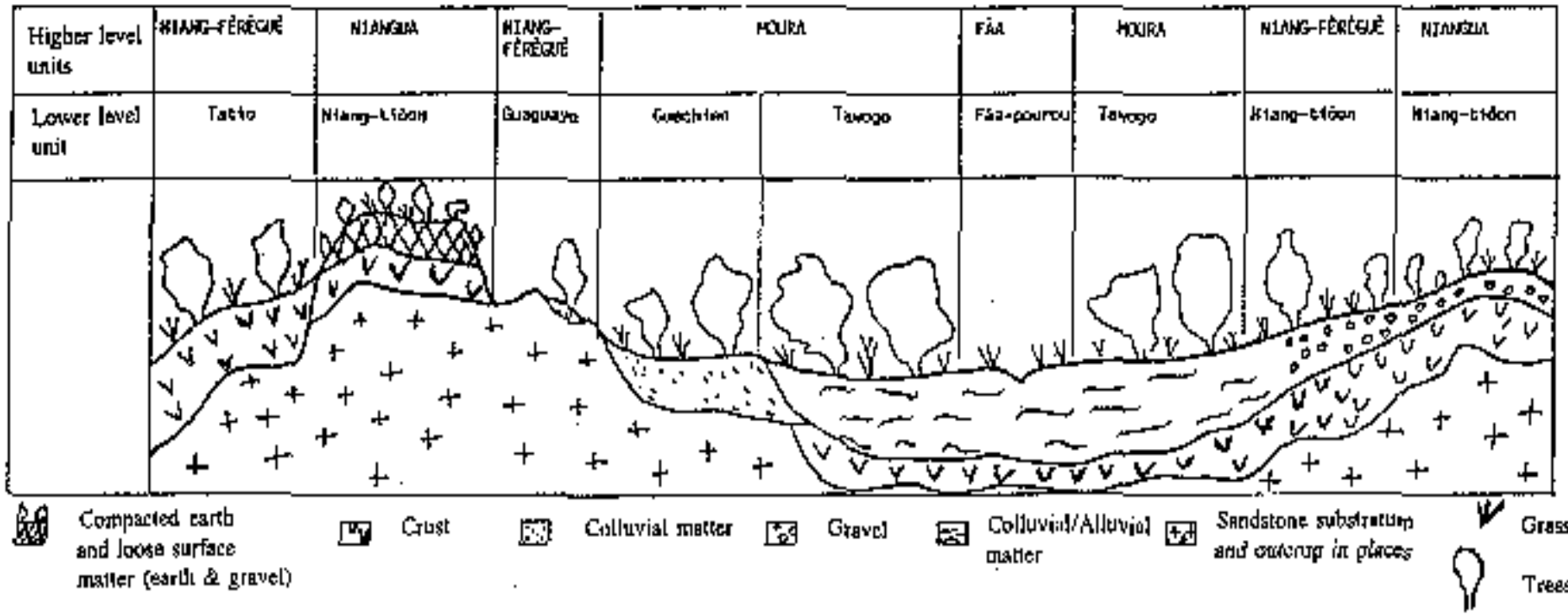
Higher level units

Classification criteria. Units at this level are mainly differentiated on the basis of two criteria: (1) topography/geomorphology and (2) the presence or otherwise of coarse elements. Higher level units come one after another in an orderly sequence following the contour lines (topography/geomorphology). In the sequence of higher level units, *Moura* is thus always found lower down than *Niangua* and *Niang-férégué* in a given topographical sequence. The presence and size of coarse elements are also key criteria in distinguishing higher level units. Some less decisive criteria such as flooding and colour are used in distinguishing units at this level.

Types of terrain. The higher level units are: *Niangua (Niang-pou), Niang-férégué, Moura, Faa* and *Dou-férégué* (see Diagram 1).

The *Niangua* is characterized by gravelly soil scattered with stones or blocks of compacted earth. The soil is not generally deep. The top of the Niangua is called Niang-pou. Certain plant species may dominate in the Niangua, such as *Combretum glutinosum, Detarium microcarpum, Burkea africana*, etc. In the

DIAGRAM 1: FARMERS' SOIL CLASSIFICATION IN THE SIWAA (KOUTIALA)



SOTUBA SOIL LABORATORY (DRSPR)

past, when rainfall was good and animal traction was not available, the Niangua was used for agriculture (sorghum), despite the presence of blocks of compacted earth.

The *Niang-férégué* soil is gravelly with a few stones and blocks of compacted earth. The trees and shrubs found on the *Niang* are also present on the *Niang-férégué*. Demographic pressure has meant that the *Niang-férégué* is increasingly being brought under cultivation.

The main characteristic of the *Moura* is the lack of gravel, blocks of compacted earth or sandstone. Large specimens of *Vitellaria paradoxa, Parkia biglobosa* and *Daniellia Oliveri* are found here. The *Moura* is now the main agricultural area.

In topographical terms, the *Faa* corresponds to lowlands which are subject to flooding. Its surroundings are rich in hydrophilous plants such as *Terminalia macroptera, Mitragyna inermis, Daniellia oliveri, Piliostigma reticulata, Sarcocephalus esculennus etc.* The *Faa* is heavily used for field, tree and horticultural crops.

The *Dou-férégué* often acts as a transitional zone between the *Moura* and *Dougou* (creek), being the banks of the latter. Most *Dou-férégués* in the area are degraded with sparse vegetation cover.

Lower level units

The lower level units correspond to the types of soil found on the higher level units. They are differentiated according to constraints on their cultivation and their underlying potential.

Criteria relating to constraints. Whether land is fit to be worked after the first rains of the season is a key criterion in farmers' classification of land in the Siwaa area. The texture of the topsoil is often used to differentiate between land types. In this way, sand gives its name to the sandy soils *(Guechiens)* and clay to clayey soils (*Tiogo*). The degree of soil adhesion can be a hindrance and is to a large extent dependent on texture. Starting to cultivate heavy soils which have a good deal of coarse elements (gravel plus blocks of compacted earth) is only possible when the land is wet enough and may also require the removal of stones. The presence of a shallow impermeable layer may indicate a likelihood of temporary water-logging or insufficient moisture. Erosion, although not often mentioned as a classification criterion, often comes up as a constraint in land management.

Criteria relating to fertility. Colour is an indication of the potential of the soil. The main colours used are black (*wo, woyogo*), red (*gnié, gnigua*) and white (*fien*). Any blackish areas may be known as *Tawogo* and any reddish area as *Tagnigua* (*ta* = part). Black land is considered by farmers to be the most fertile. The abundance of vegetation and the height and species of trees and grasses may act as indicators of moisture levels or soil fertility. Conversely, almost total absence of vegetation is a characteristic of degraded (or uncultivated) land or land which is becoming degraded. Land with a flat

surface or which crunches under the feet (loose silty soils) is often considered to be fertile.

Types of soil. The main types of soil on lower level units are: *Guechien, Niang-Tioon, Tawogo and Tatio, Faa-pouro, Niang-guaguaye, N'Guingué, Guaguayé* and *Lodini (Lodimaho)* are other types which are neither common nor much used in the Siwaa area. This document concentrates on the four main types.

Guechien are permeable soils characterized mainly by their sandy surface texture and their suitability for tillage just after rain. Work in the fields very often begins on the *Guechien.* The constraints relate to low fertility, large numbers of ephemeral streams (*Logogo*), capping after heavy rainfall and waterlogging in rainy years. The *Guechien* is sub-divided into *Guechien gnié* (red sand) and *Guechien wo* (black sand) according to fertility.

Niang-Tioon designates fine gravel mixed with fine earth. The main constraint is low moisture retention due to the high gravel content and shallowness of the soil, and the high degree of run-off. Crop flattening (as a result of superficial rooting) and rapid wearing out of farm implements must also be borne in mind. However, *Niang-Tioon* has the advantage of requiring less weeding due to its low level of fertility.

Tatio is usually found high up on the slope and appears when the top soil has been stripped away. It is characterized by its red colour, high clay content and considerable degree of adhesion when wet. The soil is deep, clayey and compact. Infiltration is poor. Such land is quite sensitive to water erosion and

numerous surface streams develop. Plants on the *Tatio* are affected to a greater degree than those on the *Guechien* by any temporary breaks in the rains.

Tawogo is usually deep soil characterized by its dark or black colour. The farmers consider *Tawogo* to be the best soil from the point of view of potential (development of trees and shrubs). These soils are heavier in texture than the *Guechiens* and must reach a certain level of humidity before they can be worked. However, excess water causes stickiness and clogging at a superficial or deeper level. Excessive weed growth on *Tawogo* constitutes a major constraint.

4.2 Land use strategy

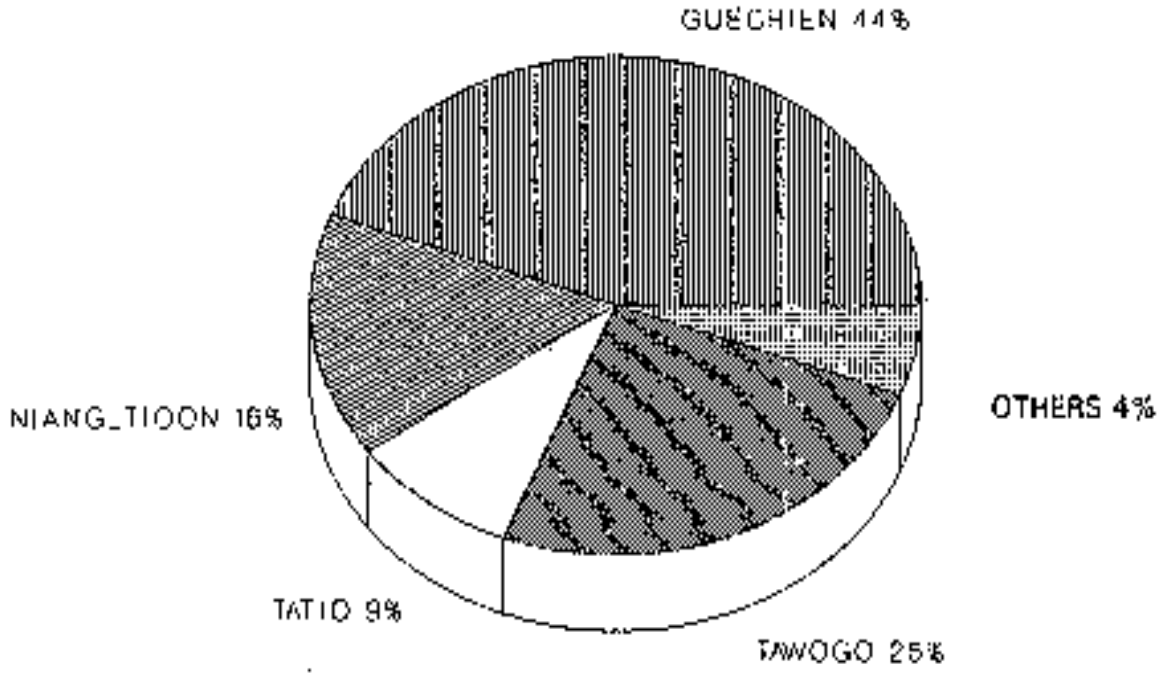
Use of different types of land

The various types of land are not used to the same degree of intensity. *Niang-tioon* comes in third place as far as use is concerned, followed by *Tatio* (Figure 1).

This uneven use of different types of land is not only due to the nature of the bedrock, but is also influenced by the varying degrees of potential. With lower rainfall over the last 20 years, sensitivity to inadequate moisture has become an important criterion in judging soil potential. *Guechien* is less fertile but, as it retains moisture quite well under present rainfall conditions, it is becoming more and more popular and is cultivated by many more farmers than is *Tawogo*. (Figure 1)

Soils such as Niang-tioon and Tatio have been brought under cultivation more recently than *Guechien* and *Tawogo* which have been cultivated on average for

FIGURE 1. SIZE OF AREA CULTIVATED BY TYPE OF LAND



N.B. PERCENTAGE AREA/TOTAL AREA

more than 25 years. As demographic pressure increases, the availability of uncultivated *Guechien* and *Tawogo* is restricted, leading to an extension of the cultivated area on *Niang-tioon* soils.

Preferences per type of crop

Crop rotation on *Niang-tioon* mainly involves cereals. Sorghum is grown in 97% of rotations, millet in 86% and cotton in only 20%. Sorghum-sorghum-sorghum-millet is the most common rotation (29%), followed by sorghum-millet-millet-sorghum (17%). There are virtually no rotations involving the cultivation of cotton every two years on these soils. On *Guechien* and *Tawogo*, cotton and sorghum figure in 80% of rotations, against 60% for millet and 30% for maize. The main rotations on *Guechien* and *Tawogo* are two-yearly: cotton-sorghum, cotton-millet and cotton-maize. The fact that cotton and, to a lesser extent, maize are cash crops may explain their prevalence on soils with naturally high fertility.

Farmers' management of the constraints and potential of land

Generally speaking, all types of land are worked in much the same way, but the order in which work is undertaken at the beginning of the season depends on rainfall and the type of land. After light rain at the beginning of the agricultural season, *Guechien* is the first to be tilled, followed by *Tawogo*. *Tatio*, and *Niang-tioon* are tilled last because they dry out quickly and retain little moisture. After heavy rain, soils not subject to adhesion (*Guechien*, *Niang-tioon*) are the first to be worked and those subject to a degree of adhesion come last (*Tawogo*, *Tatio*). *Guechien* can be sown dry without tillage whereas *Tawogo* requires preparation of the seed bed.

According to the farmers, if no organic matter is added, land degradation (erosion and falling yields) will occur within 7 years on *Tawogo*, 4 years on *Guechien*, 3 years on *Niang-Tioon* and 4.5 years on Tatio, on average. Erosion-control measures which have been promoted over the last few years seem at first sight to be applied equally to the different types of soil. However, farmers prefer to set protective bunds on *Tatio* rather than *Guechien*, perhaps because bunds on sandy soils are not resistant to water.

Farmers' fertilizer use strategy

The use of fertilizer depends greatly on the economic importance of the crop (e.g. cotton). Generally speaking, farmers do not seek to maximize yields. However, one of the basic principles of fertilization strategy is a concern to guarantee acceptable yields from all the various types of land cultivated. In managing fertilizer use, farmers take the potential of the land into account. As they are aware that fertilizer does not have the same effect on all types of land, most farmers give priority to poor soils. Thus *Tawogo*, which is recognized as less fertile, receives more fertilizer than *Guechien* (Table 1). *Tawogo* is also fertilized to a lesser extent in order to minimize the possible risks of burning in the event of low rainfall. Thick weed growth is also a constraint on *Tawogo* which would only be exacerbated by fertilizing the latter.

TABLE 1: FERTILIZATION OF COTTON BY TYPE OF LAND

Type of land	Np	% of plots fertilized with organic fertilizer		Mineral fertilizer - average dose Kg/ha		
		Waste	M & T	Area	Cotton-complex	PNT
Guechien	16	75	69	48	132	300
Tawogo	11	45	45	31	95	0
Niang-tioon	2	50	50	34	118	0
Tatio	3	67	0	42	141	100

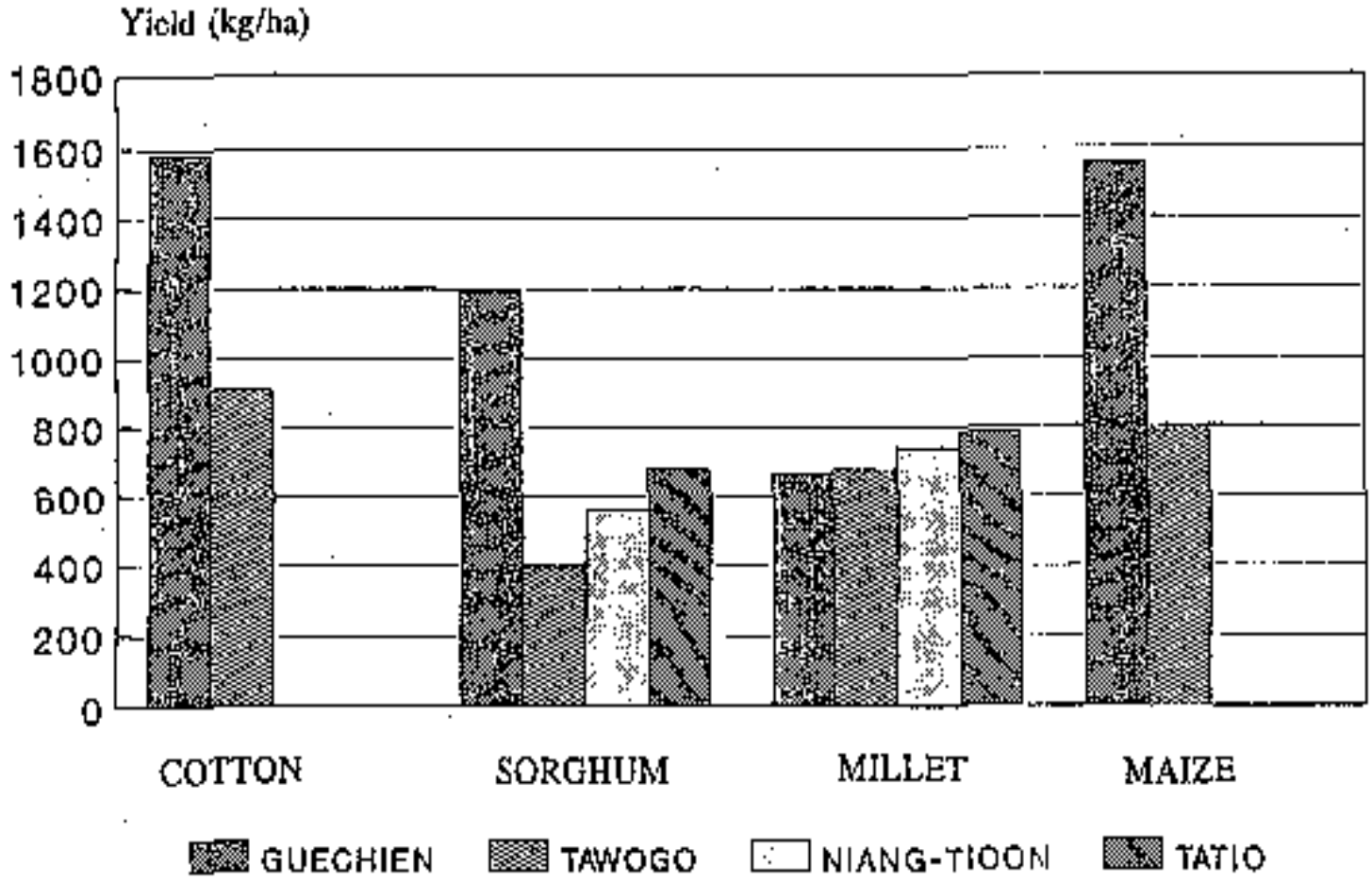
NB: Results shown are from data collected by PME project.
Np = number of plots of cotton/type of land
M + T = Manure and stalks

Crops receiving the most fertilizer are cotton and maize, but sorghum and even millet may be treated with mineral fertilizer when sowing is late, or with organic fertilizer when sown on very poor soil.

Crop yields per type of land

Yields of cotton, sorghum, groundnuts and maize are higher on *Guechien* than *Tawogo* (Figure 2) despite the fact that the latter is potentially more fertile than the former. This is probably due to the fact that *Guechien* receives more fertilizer than *Tawogo* (Table 1), there is more room for manoeuvre in tillage of sandy soils than heavy (black) soils in current rainfall conditions and the thick weed growth is less controllable on *Tawogo* than on *Guechien*. Millet yields do not vary greatly from one type of soil to another. This may be due to the fact that this crop, apart from being resistant to inadequate moisture and unfavourable edaphic conditions, benefits little from the after-effects of fertilization.

FIGURE 2: CROP YIELD/TYPE OF LAND



NB: The number of cases (repeat) on *Niang-Tioon* and *Tatio* is < 4 for cotton and maize, and they have not been shown here.

5. CONCLUSIONS

Soil classification by Minianka farmers distinguishes a higher and a lower level, the first corresponding to the type of land and the second to the type of soil. Land potential is assessed using indicators such as colour and the presence and development of grasses and trees on a flat surface. In classifying land, farmers take account of current rainfall, as the best lands in a rainy year are not necessarily the best in a year when there is insufficient moisture. Land which can be worked at the beginning of the rainy season and just after rain and which is not subject to clogging is highly rated.

Farmers manage fertilizer on the basis of the opportunities or risk associated with its use. Less fertile land which responds well to fertilizer thus receives higher doses than land considered to be rich. So farmers maximize profit by fertilizing the less fertile *Guechien* to a greater extent than *Tawogo*. This means that yields of all crops except millet are higher on *Guechien*. Since farmers adjust recommended fertilizer doses to the type of soil, alternatives to standard recommendations are needed in order to make more effective use of nutrients on the two main types of land (*Guechien* and *Tawogo*).

In view of the growing use of *Niang-Tioon* despite all the constraints, research into production systems appropriate for such soil is urgently needed. These soils are rapidly becoming exhausted as a result of the almost total absence of cotton on this type of soil and the abundance of subsistence crops which are not fertilized. The use of fertilizer on subsistence crops such as millet and sorghum cannot be justified in Mali's current economic circumstances. In seeking to achieve sustainability in production systems which are mainly based on subsistence crops, the development of agro-forestry systems seems most appropriate for these types of land. Improved clearance techniques (Kaya et

al., 1993) could thus be a specific extension topic in connection with the cultivation of *Niang-tloon*. Research in this field must deal not only with technical aspects, but also with socio-economic and institutional aspects, if it is to be successful.

This study shows that farmers are aware that different soils are susceptible in varying degrees to erosion, and that erosion-control techniques will need to differ depending on the type of soil. However, extension workers do not generally recommend specific control measures for different kinds of soil. An in-depth study of how farmers have adapted the various recommended techniques would lead to better targeting of research and extension activities in erosion control.

Identification and analysis of the physical and chemical properties of these soils are essential to examine the basis for local soil classification. Further comparison of farmer classification systems and those of conventional soil science would help improve communication between researchers, extension workers and small farmers

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