iied
Managing Africa's Soils No. 22

What are the prospects for intensifying soil fertility management in the Sahel?

A case study from Sanmatenga, Burkina Faso

Sef van den Elshout, Bilfifou Sandwidi, Elisée Ouédraogo, Roger Kaboré and Grégoire Tapsoba

February 2001

This discussion paper series has been launched as part of the NUTNET project. NUTNET stands for *Networking on soil fertility management: improving soil fertility in Africa-Nutrient networks & stakeholder perceptions*. It brings together several research programmes working on soil fertility management in sub-Saharan Africa. Activities include research on farmer management of soil fertility and understanding of the perceptions of different stakeholders towards how best to improve soils management. This series will be continued under the INCO-concerted action programme *Enhancing soil fertility in Africa: from field to policy-maker* which builds on the work done by NUTNET and receives funding from the European Union.

The series encourages publication of recent research results on soil fertility management in Sub Saharan Africa in a discussion paper form. Emphasis will be on interdisciplinary research results which highlight a particular theme of wider relevance to development policy and practice. Themes include:

- Farmers' knowledge of soils and soil fertility management
- Socio-economic context of environmental change, including histories of soil management
- Nutrient budget analysis at farm and field level
- Examination of the policy context within which soil fertility is managed
- Discussion of methodological aspects and dilemmas when analysing soil fertility management at farm level
- Approaches towards on-farm trials and technology development with farmers.

For more information and submission of manuscripts please contact:
Thea Hilhorst, IIED-Drylands Programme
4 Hanover Street, EH2 2EN Edinburgh, United Kingdom
Tel: +44 131 624 7042; Fax: +44 131 624 7050
E-mail: thea.hilhorst@iied.org

Managing Africa's Soils working papers can be obtained from:
IIED-Drylands programme, 3 Endsleigh Street,
London WC1H ODD; United Kingdom
Tel: (+44 20) 7388 2117; Fax: (+44 20) 7388 2826
E-mail: drylands@iied.org
Or downloaded from internet: www.iied.org/drylands
click publications

ISSN 1560-3520

Managing Africa's Soils No. 22

What are the prospects for intensifying soil fertility management in the Sahel?

A case study from Sanmatenga, Burkina Faso

Sef van den Elshout, Bilfifou Sandwidi,
Elisée Ouédraogo, Roger Kaboré
and Grégoire Tapsoba

February 2001

About the authors

Sef van den Elshout, Bilfifou Sandwidi, and Roger Kaboré are all agronomists who have been working on the PEDI-IV project in Kaya, Burkina Faso.

Sef can be contacted at Oostmaasstraat 7ab, 3061 ZP Rotterdam, The Netherlands, and by e-mail at annemarie.sef@hetnet.nl; Bilifou and Roger can be contacted at s/c PEDI, BP 71, Kaya, Burkina Faso, and their respective e-mail addresses are pedikaya@fasonet.bf and eds@fasonet.bf

Elisée Ouédraogo is an agronomist and Grégoire Tapsoba an economist. They both worked for the Antenne Sahélienne, a collaborative initiative between the University of Ouagadougou in Burkina Faso and the University of Wageningen in The Netherlands, which ended in December 2000. Their respective e-mail addresses are oelisee@hotmail.com and antenne@fasonet.bf

About NUTNET

NUTNET is a network that aims to improve the management of soil fertility in Africa. It is a partnership of fifteen organisations from six African and two European countries: INERA, Burkina Faso; SOS Sahel, Ethiopia; KARI, KIOF & ETC East Africa, Kenya; IER, Mali; Environment Alert & University of Makerere, Uganda; IES, Zimbabwe; IIED & IDS, United Kingdom; and AB/DLO, LEI/DLO, SC/DLO, ETC & KIT, The Netherlands. NUTNET is funded by DGIS, the Ministry of Foreign Affairs in The Netherlands.

About *Enhancing soil fertility in Africa: from field to policy-maker*

This project builds on the work done by the NUTNET network, which has been extended to include the Swedish University of Agricultural Sciences (SLU), the Universidad Complutense de Madrid (UCM) and the National Agricultural Research Foundation (NAGREF) from Greece. It is funded by the International Co-operation for Development (INCO) programme of the European Union, which links ongoing research projects on soil fertility management in sub-Saharan Africa, focusing on the implications of diverse social, economic and environmental settings, and the differing perceptions held by stakeholders of research and policy design.

Acknowledgments

The authors wish to thank PEDI and the Antenne Sahélienne for their encouragement in writing this article, and Thea Hilhorst for her comments. We would also like to acknowledge the support provided by The Royal Netherlands Embassy in Burkina Faso, which financed the analysis of data on soil fertility management in Sanmatenga.

Design and production by Bridget Tisdall

Cover Illustration Christine Bass, based on Bogolan fabric patterns

Printed by Russell Press, Nottingham using Sovereign Silk, chlorine free

Summary

Conventional wisdom has linked declining soil fertility with increased population pressure, especially in areas with fragile ecosystems, such as the Sahel. On this basis, the government of Burkina Faso has developed a soil fertility action plan, which is currently in its pre-implementation phase. Lack of phosphorous and low organic matter content have been identified as the main problems affecting soils in Burkina, and the action plan therefore advocates the use of rock phosphate and organic manure, and encourages farmers to improve their crop management practices and grow crops that will give better economic returns.

This paper discusses the results of a soil fertility management programme that was part of an integrated rural development project, and carried out as part of the pre-implementation phase of the soil fertility action plan. It analyses the soil fertility management practices of a sample of 40 farming families that participated in project activities in 1998 and 1999. The study covered two zones with different population densities, and the families consequently used slightly different farming practices, depending on where they came from. All differed from the "average" household in Sanmatenga in that they were long-term participants in project activities.

The results of our study show that attitudes towards soil fertility management differ significantly between the two zones. More organic and mineral fertilisers are used in the south, where population density is much higher, and fields are continuously cultivated. In the north, households farm larger areas, and still practise fallowing. The differences between the two zones were particularily highlighted in the second year of the study, 1999, when the use of mineral fertiliser declined. In the south, this led to a slight increase in the area cultivated by each household, and a substantial upturn in the total amount of organic fertiliser applied, although the dose per hectare declined. In the north, there was a greater rise in the area cultivated, but while the total amount of organic fertiliser used also rose, this increase was less marked than in the south.

This raises the question of why farmers had not used all the organic fertilisers and arable land available in 1998; and why they seem to use mineral fertilisers as a substitute for organic fertiliser, instead of combining the two so that they complement each other. We suggest that the farmers in our sample focus on subsistence farming, rather than on maximising their output and selling off the surplus. If this is the case, mineral fertiliser could be used to reduce the labour needed to work the land and produce compost, which would lead to more intensive, but not necessarily market oriented, farming. Intensification of agriculture is thus not yet linked to increased commercialisation of farm produce.

French summary

Le gouvernement du Burkina Faso a développé un plan d'action pour la fertilité des sols qui est actuellement dans sa phase de pré-application. Le manque de matériaux phosphorés et le peu d'engrais organiques ont été identifiés comme les principaux problèmes pédologiques du Burkina Faso et le plan d'action conseille donc d'employer du phosphate minéral et de l'engrais organique. Il encourage les agriculteurs à améliorer leurs pratiques de gestion des cultures et de planter des espèces pouvant offrir de meilleurs bénéfices économiques.

Ce document présente les résultats d'un programme de gestion de la fertilité des sols qui faisait partie d'un projet intégré de développement rural et qui a été mené lors de la phase de pré-application du plan d'action pour la fertilité des sols. Il analyse les pratiques de gestion de la fertilité des sols dans un groupe-témoin de 40 familles agricoles qui ont participé aux activités du projet en 1998 et 1999. L'étude couvrait deux zones ayant des densités de population différentes et les familles avaient, en conséquence, des pratiques agricoles légèrement différentes. Toutes différaient du ménage "moyen" au Sanmatenga du fait qu'elles participaient à long terme aux activités du projet.

Les résultats de notre étude montrent que les attitudes à l'égard de la gestion de la fertilité des sols sont différentes dans les deux zones. Plus d'engrais organiques et inorganiques sont utilisés dans le sud, où la densité démographique est beaucoup plus élevée et où les champs sont continuellement cultivés. Dans le nord, les champs sont plus grands et les producteurs pratiquent encore la jachère. Les différences entre ces deux zones ont été notées en 1999, lorsque l'emploi d'engrais inorganiques a diminué. Dans le sud, cela a entraîné une légère augmentation de la surface cultivée par chaque ménage, et un accroissement substantiel de la quantité totale d'engrais organiques apportée, bien que la dose par hectare ait diminué. Dans le nord, on a constaté une augmentation plus importante de la surface cultivée mais alors que la quantité totale d'engrais organiques utilisés a également augmenté, cette augmentation a été moins marquée que dans le sud.

Cela pose la question de savoir pourquoi les agriculteurs n'ont pas utilisé tous les engrais organiques et toute la terre arable à leur disposition en 1998 ; et pourquoi ils ont utilisé des engrais inorganiques à la place d'engrais organiques, au lieu de combiner les deux qui se complètent les uns les autres. Nous pensons que les agriculteurs de notre groupe-témoin se préoccupent plus d'une agriculture de subsistance que de développer au maximum leurs rendements pour vendre leurs surplus. Si tel est le cas, les engrais inorganiques pourraient être utilisés pour réduire la main-d'œuvre nécessaire au travail de la terre et à la production de compost qui pourrait conduire à une agriculture plus intensive – mais pas nécessairement tournée vers les marchés. L'intensification de l'agriculture n'est alors pas (encore) liée à une commercialisation plus forte des produits agricoles.

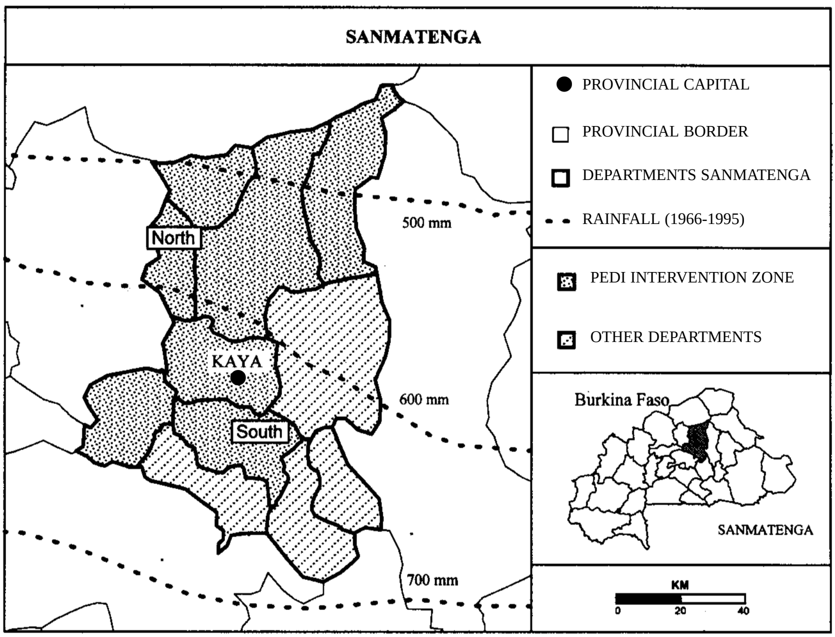
Une version en français de ce document de travail est disponible sur le site www.iied.org/drylands *cliquer* publications.

1 Introduction

Soil fertility management and sustainable farming practices are issues that preoccupy decision-makers across Africa. They are of particular concern in Burkina Faso, a Sahelian country that suffered severe droughts in the 1970s and 1980s, and where irregular rainfall still causes localised grain shortages.

This paper discusses the possibilities for intensifying soil fertility management in Sanmatenga province, in the semi-arid central region of Burkina Faso (see Figure 1). Since 1982, Sanmatenga has been the operational area for PEDI, an integrated rural development project.[1] For many years, agricultural activities centred on soil and water conservation (SWC), but when the fourth phase of the project began in 1996, attention shifted to a more intensive approach to agriculture, and the management of soil fertility.

Figure 1. Map of Sanmatenga



1 The *Programmation et Exécution du Développement Intégré* is financed by the government of The Netherlands. The fourth phase ended in December 2000, and a fifth phase was being discussed at the time of writing.

This paper begins with an overview of the national policies on soil fertility in Burkina Faso, before moving on to describe PEDI, and the soil fertility strategies used by farmers involved with the programme. The data on soil fertility management practices is then analysed, and we wind up with conclusions as to what may be done in future.

The United Nations Human Development Index identifies Burkina Faso as one of the poorest countries in the world. The south-western region has good agro-ecological potential and expanding industrial and service sectors, but the natural resource base in the semi-arid zones of the central plateau is limited. Population density is relatively high[2], and farming systems are traditional and oriented towards food self-sufficiency. PEDI works in the northern part of this central plateau.

Various authors have linked human poverty with the quality of the natural resource base, and the International Fertiliser Development Centre (IFDC) records that crop yields have declined as population levels increase. Marginal land is put under increasing pressure as farmers cultivate larger areas to maintain production, but do little to sustain soil nutrient levels and the productive capacity of the soil. The net result is that more and more rural people are being drawn into the heart of the poverty spiral (Mokwunye *et al*., 1996).

In 1993, Hoek *et al*. made similar observations about the PEDI area, noting that poverty is an enormous problem and that livelihoods are being endangered by the degraded ecosystem, which is placed under increasing pressure by the growing demand for available resources.

Evolution of agricultural policy

After Burkina Faso became independent in 1960, the government began promoting the production of cash crops. Cotton used to be an important crop on the central plateau, but very little is grown in Sanmatenga now, and the degradation of natural resources in the central plateau is partly attributed to the unsustainable methods used to cultivate it.

The early 1970s heralded a more integrated approach to rural development, and donors gave considerable financial support to projects such as PEDI, particularly after a second period of drought in the 1980s. Initiatives to improve agricultural activity focused on subsidising mineral fertilisers and implementing soil and water conservation measures, such as protecting watersheds, reforestation, the construction of stone lines and other anti-erosion works: activities that were mainly undertaken by farmer groups. When it became apparent that these technical interventions not only failed to have the expected impact, but also occasionally caused conflict between farmers, wards or villages, a more

2 According to CONAGESE (1999), the estimated agro-demographic carrying capacity in the central plateau of Burkina Faso is 40 people/km^2. The actual population is often between 80 to 120 people/ km^2.

participatory methodology was introduced, although the emphasis on collective action remained in place.

In the 1990s, the markets for inputs and farm produce were liberalised as part of a programme of structural adjustment for the agricultural sector (PASA).[3] The devaluation of the CFA franc in 1994 proved beneficial to exports of farm produce and livestock, but the dramatic increase it triggered in the price of mineral fertilisers forced many farmers to reduce their application rates.

There has been a wave of new policy initiatives over the last few years, some of which have been associated with PASA. Those most likely to have an impact on soil fertility management are the National Action Programme to Combat Desertification[4] and the National Action Plan on Integrated Soil Fertility Management or PAGIFS[5] (see Box 1).

Box 1. National Soils Action Plan for Burkina Faso

Soil fertility management has been the object of many initiatives in Burkina Faso. In 1995, concern in government and donor circles about soil fertility led to the decision to formulate a national strategy on soil fertility management, which was subsequently supported by the launch of the Soil Fertility Initiative (SFI) in 1996.

With support from several donors and the IFDC, a small Soil Fertility Management (SFM) Unit was created within the Ministry of Agriculture, and charged with promoting awareness of the extent and causes of declining soil fertility, developing a national strategy and action plan, and co-ordinating soil fertility-related initiatives at national level. Following an iterative process, the SFM unit organised a range of meetings with stakeholders to develop a common analysis of current practices, exchange new ideas and draw up a national strategy. The unit played a central role in getting the action plan developed and approved in 1998, backed up by technical assistance, personnel from IFDC and consistent long-term commitment from key people within government and donor agencies.

The national Soil Fertility Management strategy includes action plans for promoting soil amendments, particularly rock phosphate; for accompanying technologies, such as the production of organic fertiliser; and for strengthening the input and output markets. However, it has proved difficult to secure funding for these plans, and it is therefore still in the early phases of implementation. Efforts are now under way to ensure the integration of the soil fertility strategy with other national plans, such as the Poverty Reduction Strategy.

Source: Hilhorst and Toulmin (2000:49)

3 Programme d'Ajustement Structurel du Secteur Agricole (PASA).
4 Programme d'Action Nationale de Lutte Contre la Désertification, see CONAGES, 1999.
5 Plan d'Action de la Gestion Intégrée de la Fertilité des Sols (PAGIFS), see Ministère de l'Agriculture, 1999.

PAGIFS and rock phosphate

Some of the policy makers involved in formulating PAGIFS were simultaneously participating in the design of the fourth phase of PEDI, and the two initiatives consequently share similar points of departure. Both are based on the principle that investment in agriculture, and particularly in soil fertility, is needed to reverse poverty. It is argued that if farmers invest in their soils, they will obtain higher yields, producing enough to enable them to sell part of their harvest and use some of the income to maintain soil fertility.

Very low organic matter content and an overall deficit of phosphorous (P) had been identified as a key soil fertility problem in Burkina Faso, but previous attempts to promote locally mined rock phosphate as the 'national fertiliser' failed to impress farmers. Used to the rapid results obtained with 'cotton fertiliser', which contains NPK, many were disappointed by the more gradual effects of Burkina Phosphate (BP). Recognising that there is no point in trying to promote BP as an instant remedy, it is no longer endorsed as a fertiliser, but recommended as an amendment for improving the condition of soils, particularly in association with organic matter.

PAGIFS promotes an integrated package of BP, to be used in combination with organic and mineral fertilisers, on fields that are protected from erosion by soil and water conservation measures. To cover their costs, farmers are advised to use some of this package on cash crops. PAGIFS recommends an initial, subsidised,[6] application of 400 kg/ha of rock phosphate (equivalent to 40-45 kg P) to 'recapitalise' the stock of P in the soil. Thereafter, an annual dose of 100 kg/ha BP is suggested to maintain levels of phosphate.

Farming in Sanmatenga

The liberalisation of markets and devaluation of the CFA franc has had little impact on agriculture in Sanmatenga, where the subsistence-oriented farming systems use very few modern inputs or animal drawn implements (Hoek et al., 1993). The province averages 500 mm to 600 mm of rainfall each year, with one rainy season lasting 3-4 months. The south receives most rainfall. Population density ranges from 40 people/km^2 in the north to 100 people/km^2 in the south. Soils are mostly slightly acid (pH 5.5-6.5) sands or clayey/loamy sands, with low inherent fertility and a soil organic matter content of between 0.5% and 1.0%. Average cereal yields are 400-550 kg/ha. Soils in the inland valleys or *bas-fonds* are more fertile, but also more difficult to cultivate, and liable to flooding.

6 In view of its limited visible effect in the first years of application, PAGIFS proposes a subsidy to reduce the costs of BP. As none of the national subsidies have been put into effect yet, it fell to the projects involved in the pre-implementation phase to provide varying levels of subsidy for the farmers they worked with.

Every household – a group of people who farm and eat together – has a set of family or collective fields where grain is grown. The head of the household is responsible for their management, and every family member is expected to spend part of the day tending the collective crops. Wives and adult sons are also allocated small individual plots in or adjacent to the family field, where they grow food and cash crops for their own use.

The main crops are millet and sorghum, grown in association with legumes such as groundnut and cowpea, some of which are sold. Fallowing is only possible in the northern part of the province. Demanding species such as sorghum are generally grown the first season after a fallow period, followed by millet over the next few years (Mazzucato and Niemeijer, 2000). Annual crop rotation is relatively rare, and was practised on a third of the fields in our sample, although some farmers use partial rotation, moving small plots of 'pure' legumes within the family fields from one year to the next (Elshout, 2000a).

Although farming systems in the area have remained fairly static over the last few years, the economy of Sanmatenga is changing. Improvements to the infrastructure have made the zone less isolated, creating some opportunities for employment in the formal sector, and better access to education and healthcare. Money is raised to pay for these services through a variety of activities, such as crafts, agro-processing, gold mining, livestock rearing, market gardening and seasonal migration, either in Burkina Faso or abroad.

The relationship between farming and livestock

Livestock holdings vary considerably according to the financial status of the household, which is often, but not necessarily, related to its size and life-cycle. This life-cycle falls into three phases: young, fairly nuclear families; older extended families; and households headed by women, generally older widows caring for one or more children or grandchildren (Paassen et al., 2000). There are roughly the same numbers of old and young households in Sanmatenga, but very few that are headed by women. The average number of livestock and small stock owned by each type of family is shown in Table 1 below.

Table 1. Average number of livestock owned by each type of household in Sanmatenga

Type of household	*Cattle*		*Small stock*	
	North	*South*	*North*	*South*
"Young"	9	5	12	15
"Old"	15	9	21	19
Female headed	0	0	1	2

Fulbe households, which specialise in livestock production rather than arable agriculture, are a special case. Almost every agricultural village has at least one Fulbe family that takes care of herds belonging to other people, in addition to raising a limited number of their own stock in the village territory. Most of these families keep another, larger, herd in the pastoral zone further north, and also practise extensive cultivation on very small patches of land in the village. They do not seem to have compost pits, and apply very little manure from kraals to their fields.

The main source of organic fertiliser in arable agriculture is farmyard manure, which is either applied on its own or composted in pits with other organic material, such as crop residues, household refuse, human excreta, etc. Manure is more readily available in the south than in the north, despite the fact that there are fewer livestock in the south. This is because it is only possible to fatten animals in the south by stabling them and giving them supplementary feed. The manure deposited in the kraal is easily accessible, while in the north, where livestock are managed more extensively, it is mostly deposited in the bush, where the animals spend most of their time.

2 PEDI and soil fertility management activities

Changing approaches to soil fertility management

The year 1996 not only marked the beginning of the fourth phase of PEDI, but also a fundamental reorientation of its approach. After ten years focusing on communal soil and water conservation measures, it was argued that natural resource management is more likely to succeed if individual farmers feel that it is of direct interest to them. The Agro-Sylvo-Pastoral sub-programme (ASP) consequently switched from a communal to an individual approach, and instead of concentrating on the management of village lands, shifted the focus to fields belonging to individual farmers.[7] For example, the new approach gives greater priority to improving water infiltration in the field of a participating farmer than to installing SWC measures in a gully, which would require the co-operation of all farmers, whether interested or not. Rather than targeting a village or neighbourhood, extension is now aimed at core groups of interested farmers. PEDI has also developed a package of partially subsidised investments in soil fertility and farm equipment, which is available to every farming household participating in the programme.

The PEDI approach has always encouraged improved agricultural practices, such as soil and water conservation, and as part of its new soil fertility management strategy, PEDI IV concentrates on two core elements of the PAGIFS plan, encouraging the use of organic fertilisers and subsidised Burkina Phosphate. Demonstration fields and trials are used to promote cash crops and mineral fertilisers.

There are two reasons why subsidies play an important role in the PEDI approach. Firstly, recognising that individual farmers working under difficult agro-climatic conditions cannot be expected single-handedly to combat declining soil fertility, PAGIFS proposed that the direct costs of investing in soil fertility be shared by farmers, the State and, through development aid, the international community. The Convention to Combat Desertification (CCD) and the Soil Fertility Initiative are seen as evidence that this point of view is endorsed by the international community.

7 A second group of activities relates to investment in communal infrastructure, and involves literacy training centres, village stores, wells for drinking water, small water reservoirs for livestock, etc.

However, such support will only result in sustainable farming systems if agricultural production is profitable. For this reason, PEDI decided partially to subsidise investment in agricultural equipment, in order to help producers make the most of the time and resources they put into their farms. The aim is to demonstrate that these investments can be profitable in the long term, helping to break the poverty spiral and contributing to an intensification and commercialisation of agriculture. The promotion of commercial agriculture is one of the main priorities of the programme, as it is considered important for facilitating investment in agriculture and contributing to regional development. The plan is that the subsidies will eventually be phased out if a feasible package of measures (crops, extension, credit) is available. Farmers' contributions are already increasing, although there is as yet no proof that the poverty spiral can be reversed without the aid of subsidies.

The agro-sylvo-pastoral (ASP) programme

The ASP programme combines extension with research and development (R&D) activities and a series of investments.

Extension, research and development

The dominant extension approach in Burkina Faso is based on the Training & Visit (T&V) system developed by the World Bank. Recognising that T&V neither engages farmers directly nor responds to their problems, PEDI took a different, more participatory approach. During the first year of the fourth phase, the ASP technical support programme enabled farmers to draw up an inventory of their extension needs, which was used to identify priorities for the R&D programme, most of which was carried out in farmers' fields. Farmers were actively involved in R&D, themselves managing many of the trials, which also featured in demonstrations and as topics for discussion during exchange visits. The results were further used to make extension messages more relevant and accessible.

A series of participatory tools has been developed recently, aimed at facilitating the analysis of farm management and monitoring the dynamics of production and changes in soil fertility management practices.[8] The first of these tools is used during a village-level exercise, in which participants identify a number of criteria and use them to classify farmers into various groups, according to their soil fertility management practices and the type of soils cultivated. With symbols depicting crops and the various elements of the farm, participants then draw farm maps showing the flow of nutrients into, out of and within the farm: between the household, markets, fields, livestock pens, compost heaps, rubbish pits, etc. Once farmers have drawn their first resource flow map, showing the situation for a particular year, they can make a copy and add in information

8 The inspiration for this tool was a visit to the farming system team (ESPGRN) of the Institut d'Economie Rurale based in Sikasso, Mali (see Defoer et al., 1996).

about all their fields and crops. In this way they can develop a new farm map for each season, and monitor changes in their production system.

These participatory exercises enable farmers and extension workers to develop a common language for analysing problems and identifying well-targeted solutions; and in addition to providing information about various farming practices, the farm maps provide the basis for structured discussions about production strategies and facilitate dialogue with and between farmers. It was also hoped that this process would encourage farmers to exchange ideas and information, and to carry out their own experiments, making them less dependent on the extension services for innovative ideas.

PEDI programme staff have been exploring the potential for using the various maps and farmers' notebooks for monitoring purposes, and they have also carried out an internal evaluation of the participatory tools. This highlighted a number of issues, particularly the fact that the tools were too complicated for many farmers, most of whom are illiterate. However, those that did manage to understand the symbols, draw the farm maps and fill in the various monitoring forms were very enthusiastic about the process.[9] PEDI is in the process of revising and simplifying the tools, while bearing in mind the need to collect as much data as possible for monitoring. The notebook now forms part of a literacy training programme, and it is hoped that a number of farmers in each village will be able to handle the PEDI notebook and assist their colleagues.

The investment programme

In view of the fact that farmers may be keen to adopt some measures, but reluctant to use others, an integrated package was developed for the investment programme. This made it possible to combine the less popular Burkina Phosphate with sought-after resources such as carts and ploughs, and to encourage agricultural intensification by only offering subsidies for a limited area on each farm.

The package consists of the following elements, which are available to each farm involved in the project:

1. Soil and Water Conservation (SWC) measures. Everyone has the right to apply for a subsidy to install SWC measures on 1 hectare of the family field and 1 hectare of individual fields managed by wives or adult sons.
2. The provision of a four-year supply of BP for 1 hectare of a family field and for 1 ha of individual fields protected by measures to control erosion. Unprotected fields are not eligible. The supply follows national recommendations for a 'foundation' application of 400 kg/ha BP in the first year, followed by a yearly 'maintenance' dose of 100 kg/ha BP.

9 It is particularly used by a group of about 20 actively experimenting farmers known as 'the innovators'. This group has been supported by the 2nd phase of the Indigenous Soil and Water Conservation in Africa Programme (ISWC-2), co-ordinated by the Free University of Amsterdam and INERA in Burkina Faso.

3 Subsidy for lining a compost pit with cement
4 Subsidy for a cart and/or a plough.

Over time, PEDI has modified the package slightly. To stimulate the cultivation of legumes and cash crops, subsidised BP was made available for an additional hectare of the family field and one hectare of fields cultivated by individuals, provided that the specified crops were grown in these areas. In addition to this ‘package’ PEDI also supports investment in livestock and market gardening. This ‘integrated package’ programme took off well, although initially the only farmers able to meet the conditions of the programme were those that had benefited from the anti-erosion measures built collectively during the previous phases of PEDI.

Although there were more participants than expected, the total area covered was smaller than anticipated, and mostly limited to family fields, where subsistence crops are grown. In terms of the amount of land and number of plots involved, the fields cultivated by individuals hardly benefited from the subsidies. The main reason for this is that households prioritise work on the family field, on which they depend for survival. Moreover, most individuals lack the means to invest in their own fields, and are unable to provide the labour to construct the anti-erosion measures required to access other elements of the investment package. Another constraint on investment in these fields is the fact that they are controlled by the head of the household, who may reclaim them at any time. However, individuals may benefit indirectly from the package, given that the location of the cowpea and groundnut plots in the family fields changes over the years.

The terms of the programme stipulate that farmers who pay their contributions for at least the first two years will receive BP for four years. Between 1996 and 2000, a total of 4,800 participants applied for BP, using it on 4,400 hectares; and the package enabled smallholders to install anti-erosion measures on 2,500 hectares. The phosphate is sold in powdered form, which can be mixed with compost or directly applied to the field. Most farmers in Sanmatenga use the second method, as the scarcity of available organic matter and lack of water during the dry season make it difficult to produce enough compost.

The rising demand for BP indicates that some farmers are becoming more convinced about its efficacy as a soil amendment, and are not merely using it in order to qualify for a cart or plough. In 1999, 5% of participants used the investment programme to increase the area eligible for subsidies from one to two hectares, and some applied for more than the standard amount provided. However, despite an 80% subsidy on the real cost of BP, many farmers said that they could not afford to keep on using it. About 50% of participants received BP for only one or two years, either because they were unable to maintain their contributions, or because they had no means of transporting it to their fields or lacked the labour to work it into the soil, and consequently stopped using it.

3 Monitoring soil fertility management

PEDI has undertaken several studies to monitor the progress of its programme, one of which followed a sample of 40 farmers over a period of two years (1998 and 1999), recording the time spent working on family and individual fields (Tapsoba, 2000). The resulting data on soil fertility management has been analysed separately to identify existing practices and the extent to which PEDI recommendations have been adopted in the various intervention zones (Elshout, 2000a).

Methodology

All the farmers included in this study participate in the PEDI investment programme, following practices that may be considered relatively ‘advanced’, and they should not be seen as representative of the general farming population in Sanmatenga. Participating farmers were randomly chosen from the group involved in the PEDI programme, with half of the sample selected from the southern part of the project area, and the other half from the north. Population density in the south is 50-100 people/km^2, and 20-40 people/km^2 in the north. Access to land is easier in the north, where fallowing is still possible; while in the south, land is almost continuously cultivated, and farmers maintain soil fertility by constructing soil and water conservation measures, using planting pits or *zaï*, and composting manure, crop residues and household waste. Rainfall averages 650mm/year in the south, and 575mm/year in the north.[10]

All farmers were interviewed several times over the rainy season, and were present when their fields were measured immediately after sowing. At the beginning of the growing season, they were asked how many cartloads or kilos of manure and fertiliser they had applied while preparing their field for cultivation,[11] and the data were then used to calculate the application rates per hectare.[12]

The use, layout and total cultivated area of fields differ from one year to the next, partly in response to the labour available, and partly because the size of the farming family

10 Before 1970, the average rainfall in both zones was about 100 mm higher than these levels.
11 It is estimated that one cartload of manure weighs approximately 150 kg.
12 For some very small fields, measuring less than 0.1 ha, the calculated dose was enormous. These fields have not been included in the analysis because the practice is not representative for the zone; we have assumed that these farmers over-estimated the size of the field when calculating the application rate.

may change. A particular field may be divided into several plots, combined with another field, left partly fallow, or cultivated by another member of the family. We established that about 30% of the plots in the sample were used by the same person in 1998 and 1999, and have analysed the soil fertility management practices used to maintain them.

Applying fertilisers

The farmers in the sample used three types of fertiliser: organic fertiliser (OF), BP and mineral fertiliser (NPK). Table 2 gives an overview of the average application rates in 1998 and 1999. The most commonly used organic fertiliser was farmyard manure, which was applied in relatively large quantities of around 2.5 ton/ha, against an average for the zone of 1 ton/ha. These farmers seem to use a strategy noted in other parts of Sub-Saharan Africa (Hilhorst and Muchena, 2000), targeting certain parts of their fields. This indicates that PEDI extension workers are mistaken in assuming that farmers spread their fertility inputs over all their land in order to minimise risks.

In the sample, 17% of the area was left unfertilised for two years, 30% was given the same treatment in both years (OF or OF+BP), and 16% was only fertilised in one of the two years monitored. Each of the various alternative approaches used on the rest of the land was used by a very small percentage of farmers. The practice of alternating OF with BP, which could be regarded as a risk-avoiding strategy adopted by farmers with limited available OF, was only recorded in 1.8% of the fields.

Table 2. Average use of fertiliser on 40 farms in Sanmatenga, 1998 and 1999

	1998			*1999*		
	OF	*BP*	*NPK*	*OF*	*BP*	*NPK*
Average for all plots (kg/ha)	700	27	4	653	18	2
Average for plots with OF (kg/ha)	2320	156	31	1912	146	33
Average for plots with OF +BP (kg/ha)	2692	140	–	1705	151	–
Total application/farm (tons)	133	7.2	0.7	196	6.4	0.3
% Non-fertilised						
• Number of plots	51 %			35 %		
• Area	57 %			46 %		

The total cultivated area in our sample was larger in 1999 than in 1998. Table 2 shows that although there was an increase in the total amount of fertiliser used, the average dose per hectare declined. For OF, the observed amounts applied are less than half the recommended dose of 5 t/ha. The data on the average use of BP are less informative, as the recommended doses are 400 kg/ha in the first year and 100 kg/ha in subsequent years. On average, each applicant applied BP to 1.5 hectares of land, although it was supplied on the assumption that they would use it on 0.9 hectares. In 1998, 36 out of the 40 farmers in our sample used BP, but in 1999, 17 (or 47%) of the farmers using it the previous year stopped applying it.

Use of fertiliser on different types of soil

Table 3 shows the use of fertiliser on different types of soil. Over the two-year study period, 85% of fields with gravelly soils were fertilised, receiving significantly more organic inputs than other soil types. This is probably because most home fields are found near settlements, which are preferably located in slightly higher areas, which tend to have more gravelly soil. The home fields are kept well-fertilised, partly because they are nearest to the animal pens and waste heaps, and partly because they are used to grow early varieties of maize, which can be eaten while the main cereal crops are still ripening. The less intensively managed bush fields are located further away from the homestead, indicating that the location and use of a field are generally more decisive factors in soil fertility management strategies than soil type as such.

Sandy and loamy/clayey-sand soils rank second in terms of the amount of fertiliser applied. These soils are easy to work, and in areas with well-distributed rainfall they generally produce good millet yields. The main drawback is that they are fairly infertile, and consequently require inputs to improve nutrient levels and water holding capacity. Little fertiliser is applied to clay and waterlogged soils, which respectively cover 42% and 38% of the study area. These soils are already relatively fertile, and there is a risk that inputs will be lost if flooding occurs.

Table 3. Relationship between soil type and amount of fertiliser applied

Soil type (ha)	*Total*	*BP*			*OF*			*NPK*			*No fertiliser*	
		kg/ha	*N*	*Ha*	*kg/ha*	*N*	*Ha*	*Kg/ha*	*N*	*ha*	*Ha*	*% of total area*
Clay	90.1	203^{ab}	12	13.8	1490^{b}	28	28.1	23^{ab}	8	6.2	52.5	58
Sand	196.0	128^{b}	47	64.8	1889^{b}	93	95.9	29^{b}	32	24.2	66.0	34
Clayey-sand	112.4	140^{ab}	21	21.5	1879^{b}	55	56.0	53^{a}	10	5.6	44.7	40
Gravel	29.3	156^{ab}	13	12.7	3746^{a}	29	20.1	45^{ab}	4	2.2	4.6	16
Waterlogged	47.6	242^{a}	8	8.8	1772^{b}	6	5.8	19^{b}	7	6.2	29.6	62
Total	475.4		101	121.6		211	205.9		61	44.4	197.4	42

BP: Burkina Phosphate; OF: Organic fertiliser; NPK: Mineral fertiliser; N = Number of fields; a, b, & ab: no statistical significant difference between applications with the same letter (test LSD 95%).

We also analysed the relationship between the use of fertiliser and soil and water conservation measures, and found that 80% of unprotected land is left unfertilised. This is in accordance with extension recommendations, as PEDI advises that BP should only be used on fields where anti-erosion measures have been installed. However, some farmers do fertilise unprotected fields, generally applying more than the recommended doses.

Relationship between the type of crop and use of fertiliser

Table 4 presents the results of an analysis of the way that fertilisers are used on different crops. Most farmers intercrop with a wide variety of associations, hence the large 'other mixtures' category, which includes plots supporting three or more crops. There were very few pure stands of legume in our sample (5 out of 327 plots), although legumes should respond well to fertilisers containing phosphate. When supplies are short, BP and OF are frequently used on millet monoculture. This is mostly grown on fairly infertile sandy soils, while monocultures of sorghum, which is grown on relatively fertile soils that are subject to flooding, are generally left unfertilised. Although associations of cereals and legumes are frequently left unfertilised, the highest doses of BP were recorded on this type of plot, indicating that farmers are aware of the benefit of adding P to legumes, although this difference is statistically not significant.

Table 4. Relationship between crops and fertiliser

Crops	*No fertiliser Ha*	*BP*		*OF*		*BP+OF*		
		Ha	*kg/ha*	*Ha*	*kg/ha*	*Ha*	*FO kg/ha*	*BP kg/ha*
Pure millet or sorghum	27.4	10.3	100	30.2	2201	18.3	2254	102
Millet/ cowpea	35.6	5.7	187	6.9	1211	1.0	1515	202
Sorghum/ cowpea	56.7	11.3	238	16.5	3390	11.7	1894	170
Pure legumes	–	–	–	1.2	2345	1.1	5769	128
Other mixtures	78.8	16.2	115	67.5	1644	40.9	2071	143

BP: Burkina Phosphate; OF: Organic fertiliser; NPK: mineral fertiliser

Differences between the north and south of the zone

Fallowing is still practised in the north of the province, where the relatively low population density enables producers to farm extensively. Although agro-ecological conditions are less favourable in the north than in the south, households can compensate for the less productive land by cultivating slightly larger fields than those found in the south (see Table 5). In general, the area cultivated varies enormously from one farm to the next, partly reflecting the number of people in the household.

Table 5. Changes in the use of organic fertiliser (OF) and area cultivated in the northern and southern zones, 1998-1999

Zone	*Area/farm (ha)*		*Difference*	*Use of OF (ton/farm)*		*Difference*
	1998	*1999*		*1998*	*1999*	
North	4.6	7.2	2.6 VS	1	1.9	0.9 S
South	5.3	6.7	1.4 S	5.7	7.9	2.2 NS
Average	5	6.9	1.9 VS	3.4	4.9	1.5 S
Difference between north and south	0.7 NS	-0.5 NS		4.7 VS	6.0 VS	

NS: not significant; S: significant; VS: very significant (paired test-T)

The resources available to farmers vary each season, according to factors such as the timing of the rains and yield of the last harvest, which partly determine the area cultivated. Fields in both zones were significantly larger in 1999 than in 1998, while application rates for mineral inputs dropped, and a greater percentage of the area was left unfertilised in 1999. Table 5 shows that these differences were more pronounced in the north.

As most farmers aim to grow enough to be self-sufficient in food, we can assume that the total area of land cultivated will be influenced by the needs of the household and expected yields. Farmers may cultivate a smaller area if they expect to get good yields in the coming season, and it is possible that this is why less land was cultivated in Sanmatenga in 1998: they may have expected to get higher yields because they were using more BP and NPK. The next year, 1999, did not start very well as the rains were late, but because the investment package gave most farmers in our sample access to a donkey plough, they were able to prepare a larger area for sowing (Tapsoba, 2000).[13]

Unfertilised crops do not grow well in the south, where the land is continuously cultivated. In 1999, applications of mineral fertiliser dropped in both areas, with farmers

13 A rise in the number of donkey ploughs between 1998 and 1999 was mirrored by an increase in the number of hours spent ploughing.

in the south using less NPK, and those in the north using less NPK and BP. We are not sure whether this was because they could no longer afford to use these inputs, or because it was harder to obtain NPK. In the north, it is still possible to grow crops without fertiliser, which is why there is a significant difference in the area of unfertilised land under grain between 1998 and 1999. It should be noted that although more organic fertiliser is used in the south than in the north, there is little variation between the two areas in the dosage per fertilised hectare.

There are some remarkable differences in the use of BP in the north and the south. Although many farmers in the north stopped applying BP (out of 19 farmers using it in 1998, only 5 still applied it in 1999), application rates in the south remained fairly stable, as the dropouts were more or less compensated for by new farmers starting to use the input. Table 6 shows that application rates decreased dramatically in the north between 1998 and 1999,[14] but it is not clear whether this is because farmers were losing interest in BP as a soil amendment. Research has shown that it is more efficient to use a combination of BP and organic fertiliser on fields that are deficient in nitrogen and phosphorous (Elshout, 2000b), and that BP will have little effect when used on its own on such fields, as it was in the north.

Table 6. Use of fertilisers in the two zones in 1998 and 1999

		North		South		Average	
		1998	1999	1998	1999	1998	1999
Average fertiliser use for all plots (kg/ha)	BP	39	6	19	28	27	18
	OF	290	146	965	1060	700	653
Average use on fertilised plots (kg/ha)	BP	124	153	161	118	142	146
	OF	2244	2078	2806	1109	2320	1911
% of plots with BP + OF		5	3	12	13	9	8
% of plots with BP		20	3	3	4	10	3
% of plots without fertiliser		61	**81**	44	**38**	51	57
Households using BP		19	4	17	18	36	22
Households that stopped using BP (% shown in brackets)		15 (79 %)		2 (12 %)		17 (47 %)	

NB: Grey pairs indicate a significant difference (in a T-test or a Chi-square test). Underlined or bold figures also represent a significant difference between the horizontal pair .

14 The change in application rate can also be explained by the length of time farmers have been with the programme, as the dose during the first year is 4 times greater than that in subsequent years.

Finally, Tables 4 and 5 also show a significant negative correlation between the cultivated area and fertiliser application rates. When alternative sources of fertiliser are available, households can either cultivate a smaller area more intensively, or farm the same amount of land, using the new inputs instead of organic fertilisers. This could mean:

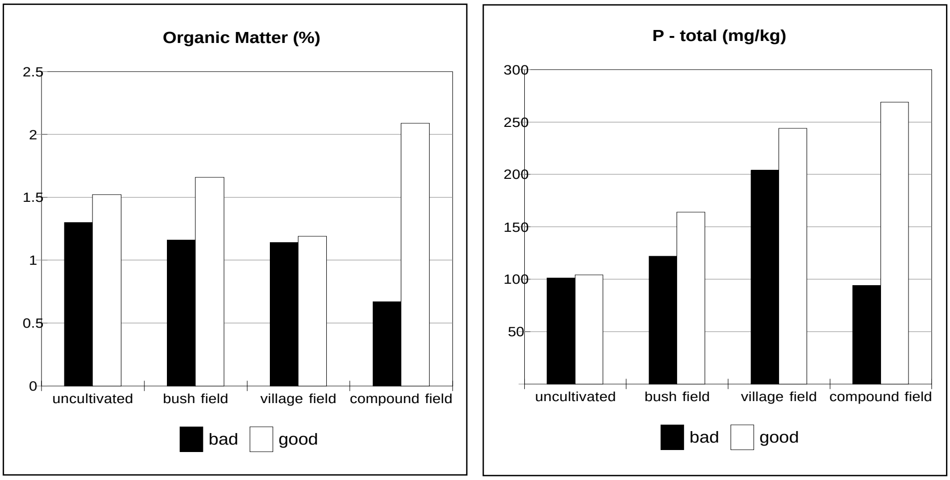
1. That an increase in the availability and accessibility of mineral fertilisers will lead to more intensive farming, as the total area cultivated will be reduced (thereby achieving one of the objectives of the PEDI programme); or,
2. That better access to fertiliser will not immediately lead to more intensive farming, in the sense of increasing total output, but it will reduce the amount of organic fertiliser and labour used.

If the second interpretation reflects what is happening in Sanmatenga, then farming is unlikely to become more commercial in the near future, given that the farmers in our sample have a more ‘advanced’ attitude to inputs than the most of the other smallholders in the province. The continued dominance of sorghum and millet in the cropping system seems to confirm this theory. Although cereals can be used to generate income, the large-scale sale of millet or sorghum is not socially acceptable in Sanmatenga, unless farmers have built up a large enough stock to cover their grain needs for several years.

4 Discussion and conclusions

Both PEDI and PAGIFS work on the assumption that increased population pressure is causing soil fertility in the Sahel to decline. However, despite the fact that the organic matter content of soils in Sanmatenga is only 0.5 to1.0%, it has been argued that this is not necessarily evidence of degradation. In their study of the Gourma, a less densely populated province near Sanmatenga, Mazzucato and Niemeijer (2000) found that for total phosphorous, the condition of soils in home fields was better than on uncultivated land, as the relatively immobile P accumulates in the soil (see Figure 2). They concluded that it is much more likely that the relatively low soil fertility is a natural state, rather than the result of extensive nutrient mining.

Figure 2. Soil conditions in Gourma[15]



Source: based on Mazzucato and Niemeijer (2000)

15 A group of farmers were asked to identify "good" and "bad" spots in their fields. Soil samples were then taken from these plots and analysed (Mazzucato and Niemeijer, 2000).

In 1995, Krogh developed a soil nutrient balance for a zone 50 km north of Sanmatenga, and came to the conclusion that extensive millet cultivation has been sustainable over the last ten years. Furthermore, when Scoones and Toulmin analysed the debate on declining soil fertility in 1999, they also concluded that there is no concrete proof that soils in the Sahel are generally becoming increasingly degraded.

In fact, it is difficult to see how soil nutrient mining is possible in extensive, subsistence-oriented farming systems, where no nutrients are exported from village lands.[16] In some parts of the northern zone of Sanmatenga province, soil fertility is not a constraint to farming, and does not prevent farmers from meeting their basic subsistence needs. However, farmers in the south are finding it increasingly difficult to maintain soil fertility. In the past, it could be sustained by fallowing and using the dung deposited by livestock as they grazed on crop residues, but it is no longer possible to achieve good yields without using additional inputs. Farmers now collect crop residues, make compost, and transport and spread organic fertiliser over their fields. They also dig planting pits (*zaï*) to make optimal use of scarce fertility inputs and soil moisture. It seems that soil fertility levels in the north are still adequate relative to the farmers' production objectives, while there is a discernible trend towards intensification in the south, where land is becoming increasingly scarce.

Since farming remains largely subsistence-oriented, farmers cannot use the harvest to recover the cost of external investments, and they therefore prefer to use organic fertilisers that require no cash outlay. Because they do not have to be purchased, extension agents and policy makers often regard organic fertilisers as a free nutrient input, despite the fact that a considerable amount of labour is required to produce, transport and apply them.

Farmers with other sources of income, such as livestock, use it to repay loans for equipment, and may purchase small amounts of mineral fertiliser. As we saw in the case study, mineral fertilisers are generally applied as a substitute for, rather than a complement to, organic fertiliser, and are used by farmers who want to maintain the production capacity of their soils, but can no longer make use of labour extensive methods such as fallow, or benefit from the dung deposited on their fields by cattle. It seems that farmers are interested in intensification because labour is scarce.

Experiences with the PEDI programme seem to indicate that soil fertility management is partly an issue of how to make the best use of the time that farming families invest in their land. As a group, farmers are not well integrated into the market for agricultural produce; consequently, most economic analysis of their production systems and debate

16 In 1998, nutrient balances were calculated for the southern zone of Sanmatenga, to evaluate the impact of soil and water conservation measures and fertiliser application. It was found that, when anti-erosion measures are in place, the nitrogen balance for a millet-legume association is in equilibrium (Stroosnijder and de Ridder, forthcoming).

about the level of subsidies required on BP, concentrate on the financial aspects. The fact that the labour required to produce OF can make it an expensive resource, has been largely ignored. Research by Sawadogo (2000) in a neighbouring province shows that soil fertility management in low external input systems is limited by the availability of labour and the time needed to handle manure and crop residues. Soil fertility is not only compromised by lack of phosphorous, but also by low levels of nitrogen and poor organic matter content. Rather than focusing on the exact dose of BP required to correct a deficit of phosphorous, and how much it will cost, it would be more productive to concentrate on developing efficient ways of producing organic fertiliser that can be enriched with BP.

This brings us to some of the assumptions made by PAGIFS and PEDI. PAGIFS assumes that farmers are aiming to increase agricultural output, and will therefore be ready to grow cash crops and use BP, mineral and organic fertilisers. PEDI presumes that they will eventually build up sustainable production systems. However, our results indicate that a large group of farmers in Sanmatenga have no interest in commercial farming, focusing instead on self-sufficiency. A feedback session to present the results of this study confirmed that agriculture is not seen as a potential source of revenue, and that if farmers have extra time, capital or other means of generating income, they will invest in livestock, agro-processing, migration or off-farm activities (Paassen et al., 2000).

This implies that the PEDI objective of promoting self-sufficiency in cereals reflects farmers' concerns, although this may not be the best strategy from an economic point of view. However, it also implies that, for the time being, the cash investments required of farmers will have to be generated by other activities, as it will take a long time for farmers to switch to cash crops. Investment in cash cropping will probably also be limited to small groups of younger producers, who are likely to be more open to the commercial potential of certain niche markets.

We would like to make two final points. Firstly, it seems that both PEDI and PAGIFS are too focused on soil fertility problems per se, and that farmers' views on this issue, or on the future of farming in our study site, only partially correspond with those of the policy makers involved in soil fertility initiatives. Secondly, even the relatively limited area of Sanmatenga displays a diverse range of soil fertility management practices. Farmers in the south manage their land more intensively than their counterparts in the north, and all the smallholders involved in the study adjust their use of fertilisers according to soil type, the location of the field (home or bush field) and the crop cultivated. With this in mind, it is important that extension messages reflect both regional conditions and the production objectives of target farmers. A single set of provincial recommendations will rarely produce the expected results, and national recommendations are even less likely to be universally appropriate or effective. One way of ensuring that extension messages respond to farmers' needs would be to move more towards a client-oriented extension system. It is therefore envisaged that in the next phase of PEDI, the focus will be on ‘extension on demand’, with farmers having to pay for extension support, although they will receive some kind of subsidy on the services provided.

Bibliography

CONAGESE, 1999. Programme d'Action National de Lutte Contre la Désertification. Ouagadougou.

Defoer, T., Kanté, S., Hilhorst, T. and Groote, H. de, 1996. Towards more sustainable soil fertility management. Agricultural Research and Extension Network (AgREN) Paper 63. ODI, London, UK.

Elshout, S. van den, 2000a. L'utilisation des fumures. Document de travail 3. PEDI-Kaya.

Elshout, S. van den, 2000b. La modélisation des récoltes. Document de travail 4. PEDI-Kaya.

Hilhorst, T. and Muchena, F.M. (Eds.) 2000. Nutrients on the move -Soil fertility dynamics in African farming systems. International Institute for Environment and Development, London.

Hilhorst T. and Toulmin C., 2000. Integrated soil fertility management. Policy and Best Practice Document 7, Ministry of Foreign Affairs, The Hague.

Hoek, R. van der, Groot, A., Hottinga, F., Kessler, J.J. and Peters, H., 1993. Perspectives pour le développement soutenu des systèmes de production agrosylvopastorale au Sanmatenga, Burkina Faso. Tropical Resource Management Papers, 3. Wageningen UR.

Krogh, L., 1995. Field and village nutrient balances in millet cultivation in Northern Burkina Faso: a village case study. SEREIN, working paper 4:1995. University of Copenhagen.

Mazzucato, V. and Niemeijer, D., 2000. Rethinking soil and water conservation in a changing society. A case study in eastern Burkina Faso. Tropical Resource Management Papers, 32. Wageningen UR.

Ministère de l'Agriculture, 1999. Stratégie Nationale et Plan d'Action de Gestion Intégrée de la Fertilité des Sols. Ouagadougou.

Mokwunye, A.U., Jager, A. de, and Smaling, E., (Eds.), 1996. Restoring and maintaining the productivity of West African soils: key to sustainable development. IFDC, Lomé.

Paassen, A. van, Sandwidi, B.M., Kaboré, R., Ouédraogo, B. and Abga, A., 2000. Commercialisation ? Le potentiel ASP théorique et réel dans le Sanmatenga. PEDI-Kaya.

Sawadogo, M., 2000. Crop residue management to sustainable land use. A case study in Burkina Faso. Documents sur la Gestion des Ressources Tropicales. Wageningen UR.

Scoones, I. and Toulmin, C., 1999. Policies for soil fertility management in Africa. IDS/IIED, London.

Tapsoba, G., 2000. L'effet de l'utilisation de la houe asine sur le mode de la production agricole. Antenne Sahélienne/PEDI-Kaya. Ouagadougou.

Working papers published in the series **Managing Africa's Soils**:

1 *Soil fertility management in its social context: a study of local perceptions and practices in Wolaita, Southern Ethiopia* by DATA Dea. September 1998

2 *Is soil fertility declining? Perspectives on environmental change in southern Ethiopia* by EYASU Elias September 1998

3 *Experiences in participatory diagnosis of soil nutrient management in Kenya* by D. Onduru, G.N. Gachini and S.M. Nandwa. September 1998 (**out of print**)

4 *Farmer responses to soil fertility decline in banana-based cropping systems of Uganda* by Mateete Bekunda. February 1999

5 *Experiences of farmer participation in soil fertility research in southern Zimbabwe* by Blasio Z. Mavedzenge, Felix Murimbarimba and Claxon Mudzivo. February 1999

6 *Soil nutrient balances: what use for policy?* by Ian Scoones and Camilla Toulmin. February 1999

7 *Integrated soil fertility management in Siaya district, Kenya* by Nelson A.R. Mango. August 1999

8 *Participatory research of compost and liquid manure in Kenya* by D.D. Onduru, G.N. Gachini, A. de Jager and J-M Diop. August 1999

9 *In the balance? Evaluating soil nutrient budgets for an agro-pastoral village of Southern Mali* by Joshua J. Ramisch. August 1999

10 *Farmers' knowledge of soil fertility and local management strategies in Tigray, Ethiopia* by Marc Corbeels, Abebe Shiferaw and Mitiku Haile. February 2000

11 *Towards integrated soil fertility management in Malawi: incorporating participatory approaches in agricultural research* by G. Kanyama-Phiri, S. Snapp, B. Kamanga and K. Wellard. February 2000

12 *Dynamics of irrigated rice farming in Mali* by Loes Kater, Ibrahim Dembélé, and Idrissa Dicko. February 2000

13 *Managing fragile soils: a case study from North Wollo, Ethiopia* by Eyasu Elias and Daniel Fantaye. April 2000

14 *Policies on the cultivation of vleis in Zimbabwe and local resistance to their enforcement: a case study of Mutoko and Chivi districts* by Billy B. Mukamuri and Terence Mavedzenge. April 2000

15 *Improving the management of manure in Zimbabwe* by Jean K. Nzuma and Herbert K. Murwira. April 2000

16 *Policy processes in Uganda and their impact on soil fertility* by Beatrice Egulu and Peter Ebanyat. July 2000.

17 *Stakeholder participation in policy processes in Ethiopia* by Worku Tessema. July 2000.

18 *Stakeholder perceptions of agricultural policies in Kenya* by Harry Kinyanjui, Stella Obanyi, Davies Onduru, Louis Gachimbi and Stephen Nandwa. July 2000

19 *Improving soil fertility management in South Africa: learning through participatory extension approaches* by J. Ramaru, Z. Mamabolo and J. Lekgoro November 2000

20 *Facilitating learning processes in agricultural extension: lessons from western Kenya* by Gerard Baltissen, Electine Wabwile, Margo Kooijman and Toon Defoer. November 2000

21 *Using local resources to improve soil fertility in Tanzania* by Juma M. Wickama and Jerimias G. Mowo. February 2001

22 *What are the prospects for intensifying soil fertility management in the Sahel? A case study from Sanmatenga, Burkina Faso* by Sef van den Elshout, Bilfifou Sandwidi, Elisée Ouédraogo, Roger Kaboré and Grégoire Tapsoba. February 2001

IIED publications

To order copies of these publications please contact
IIED Bookshop, 3 Endsleigh Street, London WC1H 0DD, UK
Tel: (+44 20) 7388 2117; Fax (+44 20) 7388 2826;
email: bookshop@iied.org; website: www.iied.org