Farmers' Perceptions and Sustainable Land Use in the Atacora, Benin

A. Adegbidi, K. Burger,
E. Gandonou and I. Mulder

Working Paper No 22

February 1999

The Authors

Anselme Adegbidi is Head, and Esaie Gandonou is assistant researcher, at the Department of Rural Economics and Sociology, University of Benin. They may be contacted at

Faculté des Sciences Agronomiques
Université Nationale du Bénin
BP 526
Cotonou
Benin

Tel: 229 324 023
Fax: 229 300 276
Email: A. Anselm: adegbidi@syfed.bj.refer.org E, Gandonou: gesaie@syfed.bj.refer.org

Kees Burger is Associate Professor and Ingrid Mulder is Assistant Researcher at the Faculty of Economic Sciences, Vrije Universiteit. They may be contacted at:

Section Economics and Development Economics
Faculty of Economic Sciences, Business Administration
and Econometrics
Vrije Universiteit
De Boeleaan 1105
1081 HV Amsterdam
THE NETHERLANDS

Tel:	I. Mulder:	31 20 444 6142	K Burger	31 20 444 6086
Fax:		31 20 444 6004		31 20 444 6004
Email:		imulder@econ.vu.nl		kburger@econ.vu.nl

The programme of Collaborative Research in the Economics of Environment and Development (CREED) was established in 1993 as a joint initiative of the International Institute for Environment and Development (IIED), London, and the Institute for Environmental Studies (IVM), Amsterdam. The Secretariat for CREED is based at IIED in London. A Steering Committee is responsible for overall management and coordination of the CREED Programme.

Environmental Economics Programme, IIED

IIED is an independent, non-profit organisation which seeks to promote sustainable patterns of world development through research, training, policy studies, consensus building and public information. The Environmental Economics Programme is one of seven major programmes of IIED; it conducts economic research and policy analysis for improved management of natural resources and sustainable economic growth in the developing world.

Environmental Economics Programme
IIED, 3 Endsleigh Street
London WC1H 0DD, UK
Tel +44 (0)171 388 2117; Fax +44 (0)171 388 2826
e-mail: Jacqueline.Saunders@iied.org

Institute for Environmental Studies, (IVM)

IVM is a non-profit research institute, based at Vrije Universiteit, Amsterdam. The Institute's primary objective is to carry out multi- and interdisciplinary research on environmental issues, based on cross-fertilisation of monodisciplinary sciences. Environment and the Third World is one of eight major IVM research programmes.

IVM, Vrije Universiteit
De Boelelaan 1115
1081 HV Amsterdam
The Netherlands
Tel: +31 20 444 9555; Fax: +31 20 444 9553
e-mail:secr@ivm.vu.nl

Abstracts of CREED publications and details of all CREED projects
are available on the Internet. Visit the CREED Web site at:

http://www.iied.org/creed

Abstract

This paper examines farmers' opinons on soil fertility decline and techniques for improvement in the Atacora, north-west Benin. These are linked to household composition and endowments, as well as farmers' own actions. The study highlights farmers' awareness of the impact of their farming practices on soil fertility, particularly in areas of high pressure on the land.

Traditional fallow is still the most frequently used technique to combat fertility loss in the Atacora. However, the share of land in fallow decreases as difficulties with accessing new land increases. Here farmers are more willing to invest in other soil fertility measures compared to other areas, particularly chemical fertiliser and parking of animals, but actual adoption rates are lower because of smaller net crop sales and lack of animals. Farmers in these areas do tend to use more labour intensive techniques, although man-land ratios are not significantly higher than elsewhere in the region.

Resumen

Esta monografía documenta la opinión de los agricultores en cuanto a la caída en la fertilidad de su tierra y las técnicas para mejorarla en Atacora, en el noroeste de Benin. Dichas técnicas están relacionadas con la composición de los hogares, sus activos y las acciones de los agricultores. El estudio pone de relieve el hecho de que los agricultores son conscientes del impacto negativo que sus prácticas tienen en la fertilidad de la tierra, en particular en las zonas de uso intensivo.

El barbecho o descanso en el cultivo de la tierra es aún el método más frecuente para combatir la pérdida de fertilidad del suelo en Atacora. Sin embargo, a medida que disminuye la disponibilidad de nuevas tierras cultivables disminuye también la proporción de tierra en barbecho. En este caso, los agricultores prefieren invertir en otros métodos, en especial fertilizantes químicos y la no rotación de los animales. La adopción de esta práctica es aún muy baja debido a la escasa venta de los productos de la cosecha y a la falta de animales. Los agricultores en esta zona tienden a utilizar técnicas de mano de obra intensiva a pesar de que la razón entre el número de hombres y el área cultivada no es significativamente más alta que en otras partes de la región.

Ce document traite des opinions des agriculteurs de l'Atacora (dans le nord-ouest du Bénin) quant au déclin de la fertilité du sol et aux techniques de lutte contre ce phénomène. Ces prises de position sont examinées en fonction de la composition des ménages et des biens dont ils disposent, ainsi qu'à la lumière de ce que font les paysans eux-mêmes à ce sujet. L'étude fait apparaître leur conscience de l'impact des pratiques agricoles sur la fertilité pédologique, en particulier dans les zones où la terre subit une forte pression.

Dans l'Atacora, la jachère traditionnelle demeure la technique la plus fréquemment employée pour combattre la perte de fertilité du sol. Néanmoins, la proportion des terres mise en jachère diminue au fur et à mesure que s'accroissent les difficultés d'accès à des terres nouvelles. Ici, par rapport à d'autres régions, les paysans sont plus que désireux d'investir dans d'autres mesures d'amélioration de la fertilité pédologique, en particulier les engrais chimiques et le parcage d'animaux, mais les degrés réels d'adoption de ces mesures sont inférieurs parce que les recettes nettes de leurs ventes de récoltes sont moindres et parce qu'ils manquent d'animaux. Dans ces zones, les paysans ont tendance à employer des techniques où la main d'œuvre tient une plus grande place, encore que les ratios hommes/terre n'y soient pas significativement plus élevés qu'ailleurs dans la

Contents

Introduction

Farming in fragile environments inherently involves the risk of land degradation. This may take a variety of forms. In this paper we focus on soil fertility decline. Loss of fertility may be caused by soil erosion through wind or water, or depletion of soil nutrients as a result of agricultural cultivation. Sustainable agriculture in such environments is only possible if sufficient precautions are taken. In areas of land abundance, the risk of nutrient depletion may be reduced through long fallow periods which help restore fertility, although this does not necessarily prevent erosion. In areas of land scarcity fallow periods tend to be shorter and cultivation periods longer. Farmers may be unaware of the problem, or lack the means or knowledge to prevent or offset nutrient depletion. Alternatively they may develop strategies to cope with degradation, such as seasonal migration. This paper presents some evidence on soil fertility decline together with an evaluation of farmers' perceptions on this topic. Indeed, the evidence indicates that farmers are aware of the problem and of methods to maintain soil fertility, but time and money constraints prevent many farmers from apply them.

This paper forms part of a study of the farming systems in Atacora, Benin, which aims to contribute to decision making about appropriate environmental policies for the area. It examines how farmers themselves perceive their situation and the consequences of their actions. We therefore focus on farmers' own opinions about soil degradation, its causes and required responses. This approach will provide a better understanding of the rationality of farmers' behaviour and, in turn, the basis for formulating appropriate policies to improve the situation. It is beyond the scope of the study to provide a description of all (indigenous) fertilisation systems used in the Atacora. Rather, it focuses on rural people's knowledge of *specific* fertilisation techniques, and addresses the following questions:

- what do farmers know of their present situation and causes of land degradation
- what is their attitude towards further degradation
- which practices do they adopt to maintain soil fertility
- what are the constraints to the adoption of soil conservation measures?

The paper consists of 11 sections. In the next section a survey of the study area is given; this is followed by a short description of the survey used (Section 3). Section 4 provides descriptive evidence of soil degradation in the area. This is followed by a discussion of the principal causes of land degradation as seen by the farmers, and then their response to a (further) reduction in soil fertility. An overview of the practices adopted for maintaining or ameliorating soil fertility is presented in Section 7, while Sections 8 and 9 assess the main reasons for respectively adopting or discarding certain methods. In Section 10 we discuss the ranking of the best performing soil conservation techniques by farmers. The final section gives a synthesis.

The Survey Area

The Atacora region, situated in the north-west of Benin, covers almost one third of the surface of the country (see Figure 1). The region is characterised by the Atacora mountain chain, with altitudes varying from 400 m in the south to 650 m in the north. These mountains are the source of many rivers and water-basins, which makes the region suitable for the production of rice in certain shallows. However, the mountainous region is very vulnerable to erosion; moreover, the region is largely inaccessible and roads are very difficult to maintain.

The climate in the Atacora is semi-arid. There is one rainy season (mid-April to mid-October), and annual precipitation varies from 1,200-1,300 mm in the south and centre, to 900-1,000 mm in the north and the east.

With only 21 inhabitants per km^2, the Atacora is the most sparsely populated region in Benin after the Borgou. Its population is largely agricultural (92%). In 1992, 77,289 agricultural households were registered with an average of 7.6 persons per household (INSAE, 1994). On average, 4 workers are available per farm. Around 47% of the total area is suitable for agriculture. Per agricultural household this amounts to 19 ha of arable land (MDR, 1993) of which no more than 2.37 ha are cultivated (MDR/DAPS, 1995). There are large differences in population density within the Atacora.

According to climate, soil and cropping practices, four agro-ecological zones may be distinguished (CARDER-Atacora, 1993)[1]. The north-west zone roughly coincides with the administrative districts of Boukombé, Tanguiéta, Matéri and Cobly. The climate is of the Sudan type with a precipitation of between 800 and 1,100 mm per year. The shallow, ferruginous soils have a low water holding capacity and low natural soil fertility. The zone is linked by the mountain range and is rather densely populated (emigration zone), especially the district of Boukombé. Maize, sorghum, yam and beans are the principal crops and mechanisation is rarely used.

The north-east zone coincides with the administrative districts of Kérou, Kouandé and Péhunco. It has a Sudan-Guinean climate and an annual rainfall of between 1100 and 1200 mm. The tropical ferruginous soil has a sandy subsoil. The soils are still rather deep and fertile. Vegetation consists of savannah shrubs, dominated by *Acacia siébériana* and *Butyrospernum parkii* (Shea, or karité). Climatic and soil conditions, combined with the widely used oxen-plough, favour a range of annual crops. Cotton production is well developed and maize is gradually replacing millet. Land availability is still good.

The central zone consists of Copargo, Ouaké, Toucountouna, Natitingou and a part of Djougou. The climate is Sudanian with an annual rainfall of between 1,200 and 1,300 mm. The tropical ferruginous soils are often pebbly but profound and have a moderate fertility. The soils are sensitive to leaching. The ecosystem in this region is one of tree savannah evolving into a bush savannah. The main crops grown are yam, sorghum and millet.

[1] In 1995 the Ministère du Developpement Rural (MDR) created a new division of agro-ecological zones However, we have used the old division.

The fourth, south zone, comprises the district of Bassila and the south of Djougou. The climate is Sudan-Guinean with rainfall varying between 1,100 and 1,200 mm per year. The ferruginous soils on a sandy base are profound and fertile. There is a savannah vegetation with shrubs and trees. While the zone comprises large areas of listed forests, they are intensively exploited. Groundnuts, maize and beans are the main cultivated crops.

Figure 1. The Atacora Province in Benin

Survey Overview

The selection of the households in the survey was based on an earlier survey held in the second half of 1993 by the Ministry of Rural Development of Benin (CARDER-Atacora, 1994). The results of that survey were available for the current study. The 1993 survey was held among 600 farmers within the framework of the Second Project of Rural Development in the Atacora. A two-stage sample design was used, first selecting villages and subsequently selecting households. During the first stage a sample of 60 villages was chosen and stratified on the basis of sub-prefecture. In each sub-prefecture a number of villages was randomly chosen in proportion to the total population of the sub-prefecture. The sample frame used for the choice of the 60 villages was based on the preliminary results of the 1992 population census (INSEA, 1994). In the second stage of the sampling, 10 households were chosen in each village at a local meeting organised by the enumerator assigned to each selected village.

The field survey used in this paper was undertaken by the Université Nationale du Bénin and the Vrije Universiteit Amsterdam, assisted by the CARDER-Atacora, from June to August 1995. The households of the 1993 survey were revisited, without replacing the households that were not present. The 1995 survey was held among 539 agricultural households namely:

- 131 farmers from the ‘south’ zone
- 146 farmers from the ‘centre’ zone
- 160 farmers from the ‘north-west’ zone
- 102 farmers from the ‘north-east’ zone

Farmers were interviewed on their farms in the crop year 1995/96 using a semi-structured questionnaire. This included a household-type survey with additional sections on soil conservation and fertilisation. The survey focused on rural people’s knowledge of specific fertilisation techniques rather than all (indigenous) fertilisation systems used in the Atacora, namely those that are widely used and those introduced by extension services. For the former, interviews were held with village chiefs, NGOs and other resource persons, whereas CARDER provided information on the latter.

Although farmers were asked to report on any other fertilisation techniques they knew or used, a comprehensive description of their soil management behaviour cannot be expected to arise from this methodology. This requires a more in-depth survey with open ended questions. Additional information was collected through interviews with CARDER Atacora, village leaders, NGOs and other resource persons.

Soil Fertility in the Atacora

Soil fertility decline over time at plot level is inherent to fallow based agricultural systems. The soil is cultivated without the use of other types of fertilisation, and after a relatively short period, the land is put to fallow to allow soil fertility to recover. In a sustainable system, differences in soil fertility between plots at different stages in a cycle should even out at the village level or even at the household level. In addition to differences in soil fertility over time at plot level, there are also inherent differences related to soil type, which makes comparison between farmers difficult. We have seen in section 2 that the north-east and the south have a higher initial soil fertility. However, this study is more concerned with decline over the long-term.

It is difficult to demonstrate that a long term decline in soil fertility is taking place in the Atacora. Although this study included a soil survey, it reflects a specific interval, and there is little available data on earlier years to facilitate a comparison. Yet, while inherent soil fertility differs across zones, we have reason to believe that the overall differences are due to other factors. In a morpho-pedological study carried out in 1977, Faure (1977) suggests that in the area south of the road connecting Birni, Natitingou and Porga, nutrient depletion had occurred on a large scale due to over-exploitation of the soil. This was the most densely populated part of the area, which included all districts of the Atacora situated to the north of Copargo and Djougou. In addition Faure (ibid) concludes that the Atacora mountain chain and the area between Boukombé and Tanguiéta are very vulnerable to erosion.

A similar study of the Djougou-Ouaké area in 1977 and repeated in 1996 (Faure, 1977 and CENAP, 1997) reveals that in the 20 year period soil characteristics deteriorated for the three different types of soils in the study. The clay content had decreased, the acidity had increased and the ratio of organic carbon to nitrogen has decreased in all three types of soil. In two out of three soils the organic matter content had decreased. The quality had improved in only one soil type, and then only for the organic matter content (Gandonou, 1998).

Although population density in the Atacora is relatively low, in some areas access to land has become difficult and fallow periods have decreased. While there is little available data on the length of past fallow periods, there is reason to believe that in most parts of the Atacora fallow is insufficient for soil fertility recovery, given the limited use of other fertilisation techniques. It is also difficult to determine the required ratio of fallow to cropping periods to ensure soil recovery, since this depends on area and climate. However, for the Borgou province with similar agro-ecological conditions, de Haan (1992) argues for a minimum of 5 years fallow to restore soil fertility, while cultivation periods should not exceed 5 years.

The average duration of the *most recent* fallow period in the Atacora is 4.6 years. For the plots *currently* in fallow (1994/1995), farmers indicated that the total fallow period would be, on average, 4.2 years ie, shorter than the most recent period. The modal fallow period was 3 years.

The average duration of the cropping period for plots *currently in fallow* (1994/95) is 4.2 years (mode = 3 years). This is equivalent to the planned fallow period for the same plots. When we look at all plots that were *cultivated* in 1994/1995, the average period was 5.3 years on average (mode = 3 years).[2] Since this figure is based on all plots cultivated in 1994/1995, and we do not know how long the farmer would continue cropping, it may be the case that the actual cropping period may be higher.

Fallow periods are particularly under pressure in areas where access to land is difficult. The share of land in fallow, which is an indicator for the length of the fallow periods compared to cultivation periods, is smaller when access to land is difficult. This correlation is significant. The fallow periods in the Atacora are often shorter than 5 years, whereas the cropping periods are longer on average. A fallow period shorter than 5 years cannot restore the soil's original fertility (Hoefsloot et al, 1993). In the survey (1994/95), only a small proportion of the fallow had improved, amounting to 11 plots with a total area of 9 hectares.

We may conclude that the use of fallow in the Atacora is not sufficient to maintain long term fertility and additional methods have become necessary. More evidence on soil fertility decline and a description of the results of the soil samples taken during the Atacora survey may be found in Gandonou (1998).

[2] The maximum cropping period has been set at 15 years including all plots that are indicated as: 'always been

Farmers'Perceptions of Soil Fertility

Are farmers aware of soil fertility decline and its causes? When we asked farmers whether there was soil degradation in their village (where soil degradation was defined as a fall in soil fertility), only 3 percent indicated that there was none. We also asked about the causes of soil degradation in the village. When asked "What, according to you, are the main causes of soil degradation in your village?" each household could offer more than one response. For the whole of the Atacora, three principal causes emerge: deforestation was mentioned by 59% of the households, over-exploitation of the land by 55% and bush fires also by 55% (see Table 1). Although these three are perceived to be the prominent causes, in the south over-exploitation is ranked first by 58% of the households mentioning this cause (see Annex 1). In the north-west where land degradation is most severe, bush fires are ranked first (69%). Other important causes mentioned by households are lack of fertiliser, demographic pressure, erosion and climate.

Table 1. Principal causes of soil degradation according to Atacora farmers

Cause	number	%
No soil degradation	16	3
Deforestation	317	59
Over-exploitation	299	55
Bush fires	298	55
Lack of fertiliser	226	42
Climate	172	32
Erosion	164	30
Demographic pressure	124	23
Overgrazing	118	22
Cotton cultivation	45	8
Other	50	9
Don't know/no answer	16	3

Source: Survey VU-UNB (1995).

N.B: Each farmer could give more than one answer. Percentages are taken with respect to total number of households, not the numbers of answers given.

Climatic factors are beyond the control of the farmer or households. However, deforestation, over-exploitation and demographic pressure are not, while bush fires are often (accidentally) started by the farmers themselves. We would like to see how farmers' behaviour corresponds to these causes given.

Box 1

Bernard Co, 39, lives with his younger brother, his parents and five children of a deceased older brother in the Copargo district. Besides being a farmer he is a priest in the village's catholic church. He recalls that in his youth there were many more trees: "There were even large animals like elephants. In those days the villagers burned the fields before cultivating. One day the forest was gone and the large animals had moved as well. About ten years ago the CARDER taught us that burning was not good for the land, and we have learned. Now we burn more carefully. We burn early in the year, then the fire damages less. Before burning we carefully clear a strip of land around the field and around each tree to stop the fire. In this way we prevent the fire to spread to other fields and to burn the trees. Nevertheless our fields are sometimes unintentionally burned because of bush fires. Children sometimes put fire to the bush when they are hunting for animals.

It would be good when more Shea-trees and Cashew trees were growing here, they are good for the soil fertility and the fruits can be processed and sold. Animal dung is used on a very small scale, and only around the houses. There is very little dung and it is difficult to transport it to the remote fields. When you have a Peulh friend you can invite him with his cattle on your farm. Depending on the day he arrived he will stay for 3 months or less. During this period his cows fertilise your soil, but all that time you have to feed the Peulh and his family.

A number of new techniques have been introduced in our village. Two ways of using crop residues are applied in the village, though on a very small surface only. The crop residues are raked into the soil or they are collected and stored in a pit to decay.[3] We prefer to use maize residues because they decay much faster than sorghum residues. Since 1992 we are also experimenting with improved fallow in our village, although on a very small scale. Mucuna is grown and Cajanus cajan, which is often grown around the fields. This year we have started growing Istris. It improves the soil and can be used as fodder for the animals, but the seeds are very expensive.

Despite these improvements many farmers, especially the younger generation, have decided to look for work outside the village. This migration often helps the family that stays behind, because the migrant sends money to the family that stayed behind. However, it is not good for the village. With the migration of the younger people, village life has become less colourful. Moreover, it has become more difficult for farmers to get the agricultural work done. In former days, the elderly people or the farmers without a son could call upon the village youth, but many young people have now moved away.

Another source of labour that has disappeared is the help of your daughter's fiancé, who used to help his prospective father in-law. This is no longer a custom in our village. In our village, the importance of wage labour is increasing. Formerly, a farmer could invite other villagers to work on his field. The workers were not paid but food and drinks were served. Nowadays, with the increasing importance of money, the villagers prefer to be paid in cash."

Farmers attribute an important role to trees in maintaining soil fertility, since deforestation received a high score for contributing soil degradation (see also Box 1). Apart from clearing land for agricultural production, bush fires are another reason for trees disappearing. Often these two coincide, as bush fires are often accidentally started by farmers when they

[3] Author's note: the first technique is referred to in this research as *green manuring* and the second as *composting*.

use burning to clear the land. Farmers also complain about bush fires started by children when they are hunting (see Box 1). Deforestation and bush fires are often mentioned together as a cause of soil degradation. These causes were mentioned together by 47% of the farmers; 18% of the farmers mentioned neither and 35% mentioned one of the two.

There are no clear differences in burning and planting behaviour between farmers mentioning deforestation or bush fires as a major reason for soil degradation and those who do not. Planting trees is widespread (see also Box 2), and the proportion of farmers who plant trees is not significantly larger for farmers who report deforestation as a cause (68%) compared to those farmers who do not (65%). As we would expect, the number of trees planted by farmers who indicate deforestation as a major cause (107 trees) is larger than those who do not (86 trees), although the difference is not significant. This number of trees includes all trees planted in the past by the household head.

Box 2

Isifou Kparai, 56, is the Imam of a village in the centre. He has a wife and three daughters. Two are married and live with their husbands and the other works as a servant in Nigeria. Besides Imam he is a farmer. It is difficult for him to get all the work done in the field, not only because he is alone with his wife, but also because he recently underwent an operation and his health is still delicate. He often asks for a helping hand from the younger people in the village. He pays them when he has some money.

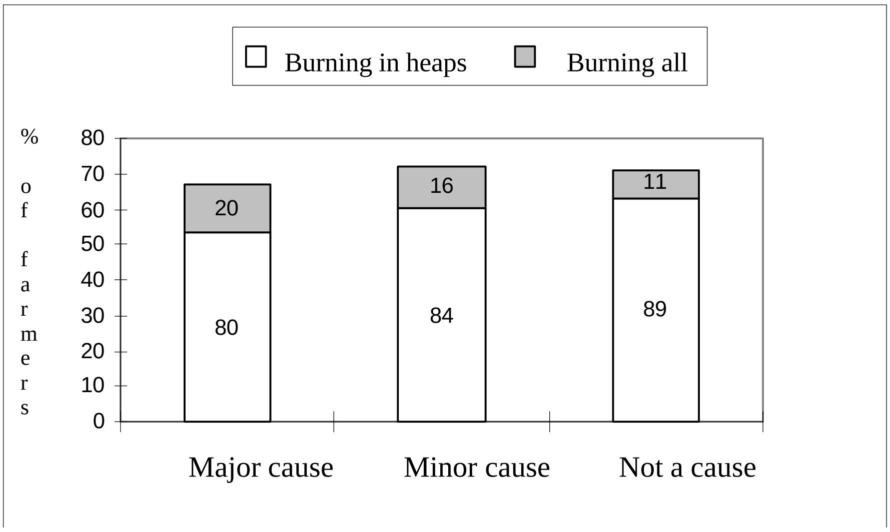
Isifou recounts his youth: “At that time there was still a large forest around the village. The village grew larger and larger, and all the villagers burned trees to grow their crops. These trees were important to fertilise the soil. About 40 years ago the last part of the forest was cleared in the neighbourhood.”

Isifou reports that nowadays the villagers are planting trees for several purposes, particularly construction. “An example is the *Eucalyptus* tree. *Eucalyptus* decays slowly. This is good for construction, but not for agriculture. Besides that it has very few leaves to fertilise the soil.” According to Isifou the planting of trees is not sufficient: “We need chemical fertiliser to be able to maintain

Soil fertility is an important problem in the village. However, the health of the villagers worries Isifou even more: “Farmers need to be in a good health to be able to produce!”

Bush fires are often accidentally started by farmers when clearing land for cultivation. Burning the grass requires much less labour than weeding and/or ploughing. Two methods of burning may be identified: one involves the collection of grasses and other material in heaps to burn it, the other is to set fire to the standing grasses and allow the whole field to burn. The latter methods is likely to be less controllable. The extension service in Benin discourages both types, but particularly the latter as the high temperatures consume not only the weeds, but also much of the life in the top soil, which affects fertility. Although we would expect those farmers concerned with bush fires to use better burning practices than those who do not, there was little evidence of any difference between the two groups. Figure 2 shows that most farmers use burning to clear land. The farmers who identified bush fires as a major cause of land degradation adopt this method only slightly less often - 67% -compared to 72% for the rest. This difference is not significant.

Figure 2. Burning for land clearing by method and extent of environmental concern



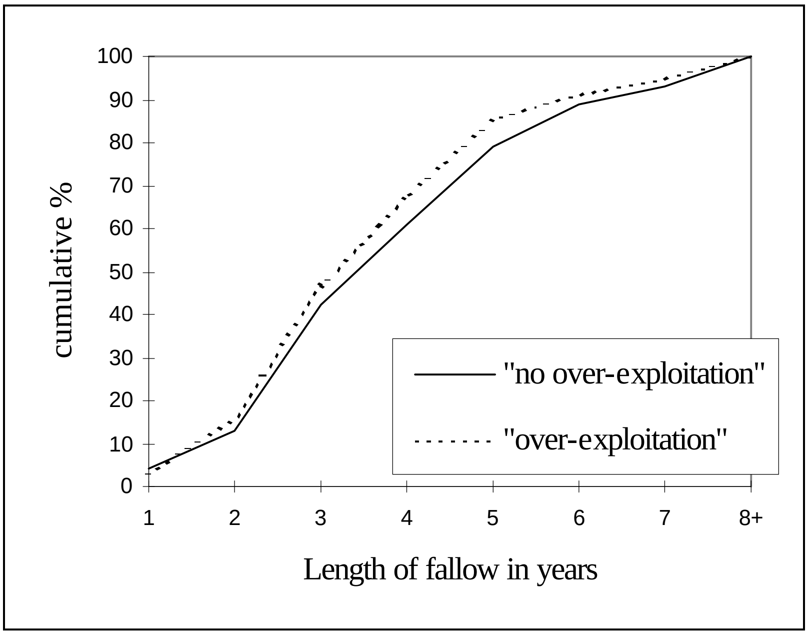
Note: numbers in bars represent percentage of farmers in that category.
Source: Survey VU-UNB (1995)

The third major cause given by farmers for soil degradation is over-exploitation, or over intensive use of the soil. This is also a direct result of farmers' behaviour. As mentioned in the introduction, over-exploitation is often associated with a reduction in fallow periods. Is this also the case here? We would expect farmers who live in areas where the pressure on land is higher to be forced to reduce fallow as well as witness the effects of over-exploitation. We therefore expect farmers who indicated over-exploitation as a main cause of soil degradation to use shorter fallow periods and longer cropping periods than average. Because we are particularly interested in the most recent fallow, we looked at plots that are currently in fallow. We asked farmers how many years each plot had been and would be kept in fallow. The lengths of the fallow periods differed slightly between the groups: there are indications of reducing the fallow period and extending cropping periods by those that indicated over-exploitation causes land degradation.

Figure 3 shows the sharpest division possible between those reporting over-exploitation as the major cause, and those that do not. The cumulative distribution of years in fallow for the farmers that report over-exploitation is located above that of the other farmers, implying fallow periods are shorter for farmers indicating over-exploitation as a cause. The average fallow periods are 4.4 years without over-exploitation and 4.0 years with over-exploitation. The difference is significant at the 10% level. Both fallow periods are shorter than the minimum fallow period required (5 years).

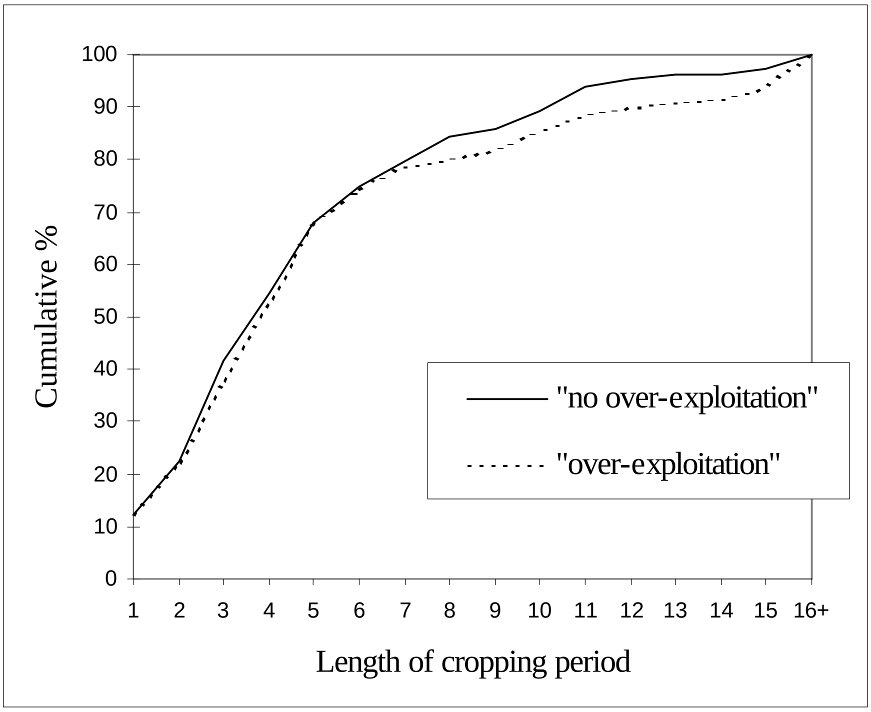
Similarly, the length of the cropping period for plots currently cultivated is 5.5 years for those farmers reporting over-exploitation and 5.2 years for other farmers (see Figure 4). The difference is significant at the 10% level. This is an average for the period under cultivation for all plots that are currently cultivated. This means it is not an average of the total cropping period, because for the majority of plots used in the calculation the cropping period has not yet ended. Farmers who indicate over-exploitation as a major cause of soil fertility decline are cultivating during longer periods on the same land, followed by a shorter fallow period than others. This means that although they are aware that over-exploitation leads to reduced soil fertility, they have chosen to use a shorter fallow period and a longer cultivation period (see also Box 3).

Figure 3. Total duration of fallow for plots currently in fallow



Source: Survey VU-UNB (1995)

Figure 4. Length of cropping period for plots currently cultivated



Source: Survey VU-UNB (1995)

Box 3

Bantara Orou, 45, lives with his three wives in a village in the central zone. He has 15 children between the ages of eight months to 26 years. Three of his daughters are married and live with their husbands, one daughter is a servant in Nigeria and one son is in the Borgou, trying to find good land. Four of his children attend the local school.

Bantara talks about cultivation practices in his village: “In former days the most important rotation scheme was yam-sorghum-sorghum. After three years of cultivation the land was put to fallow for about 6 years. Nowadays, after yam, sorghum or maize is grown followed by a two or three year fallow period. Sometimes groundnut is grown as a third crop after sorghum. Groundnut is usually grown last in the rotation, although some farmers end with cassava. The large early yam is grown in the river banks, mixed with rice.

Beans are grown together with sorghum or cassava, and occasionally pure. The yield of beans is very low when mixed with sorghum or cassava. Mixing with beans is done for three reasons. Mixing gives a better occupation of the land. Besides that, food security is increased because at least one of the two crops will give something. Finally, growing beans gives a little fertility to a bad soil. Some farmers have even started experimenting with growing pure beans, sometimes even two years in a row, to control *striga*. *Striga* is a harmful weed that grows near the roots of sorghum and reduces yields drastically. Growing beans reduces the growth of *striga* considerably. Not every farmer in the village has seen this. Unfortunately we do not eat much beans and there is not really a market for beans either. To avoid overproduction, the farmers in the region do not grow beans every year. It has become a tradition that once every three years no beans are grown in the region, also to prevent parasites from spreading.”

Difficult access to fertiliser is particularly important for households in the two most degraded areas (centre and north-west), and was mentioned by 53% of the farmers in each areas. The benefits that fertiliser can bring are apparently well understood by these farmers. However, the lack of fertiliser is likely to be due to insufficient funds, although availability and market distance may also be contributory factors (See Boxes 2 and 4).

Erosion is another important cause for those households in the centre zone (40%) (see also Box 4). This is also the area with the largest share of plots with a sloping surface (see Figure 5), although the share of plots with a *steep* slope is small (5%). In this zone, population pressure and overgrazing (49% and 48% respectively) were identified as the major factors. It is not surprising that demographic pressure is often mentioned, since the centre is the most densely populated zone. Although this is not a major livestock-zone, livestock is also seen as a threat to agriculture. While population density is much lower and land availability is still good in the north-east zone, population and overgrazing are also highlighted by farmers there (29%). This is probably because the area is currently a major immigration zone, and more cattle can be found here than in the other zones. It is interesting to note that cotton cultivation is explicitly given as a major cause, particularly in the north-east (28%), where it is expanding. In other zones this plays only a minor role (7% or less, cf. Annex 1).

In order to gain some understanding of how farmers respond to soil degradation, we next assess what they would do in the case of further fertility decline.

Box 4

Moussa Takpara, 32, and **Alassa Sayo,** 38, are young farmers living in the central zone. Moussa is married and has three children from ages four to seven. Alassa is married and father of four children from three to seven. Moussa and Alassa talk about their problems with agriculture:

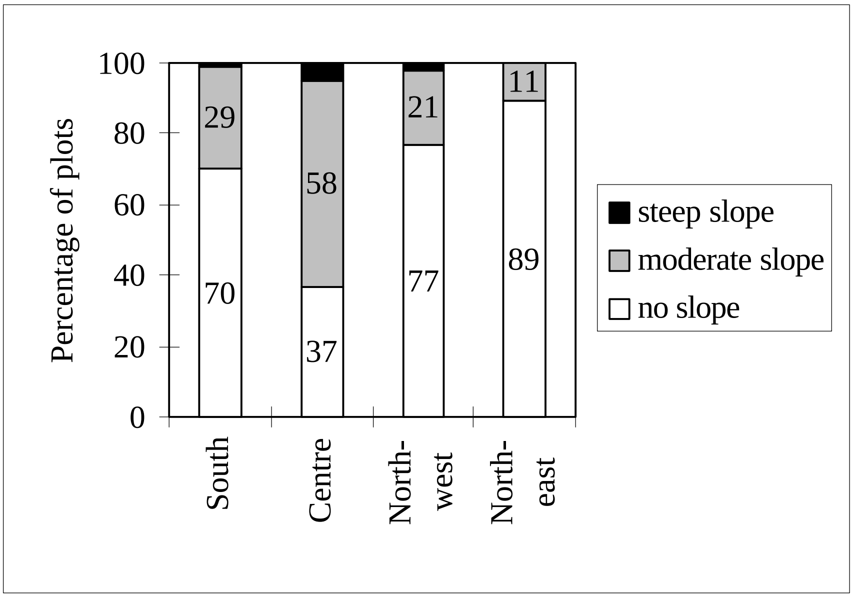
“Erosion is a problem in the village, but a more important problem is that the soil is tired. We use a two or three year fallow to improve the soil. Sometimes we even use an improved fallow. The CARDER has taught us to do this. We plant Cashew trees and African Locust trees and we do not burn the field. The results are good but it is not sufficient.

We use crop residues of maize to make compost, the residues of sorghum decay much slower. We also grow beans and groundnuts to improve the soil a bit. Groundnuts are always grown third and last in the rotation. When groundnuts would be grown before the other crops, the latter would not grow very well.

Seven years ago we started using chemical fertiliser on groundnuts in our village. Groundnuts need a different type of chemical fertiliser than cotton, and this fertiliser is not always available in the village. The first three years it was available from the CARDER, the following two years it was not. Last year it was available again. Unfortunately this year it is not.

Alassa and Moussa worry most about the health situation in the village. After health, soil fertility is the largest problem in the village: “When the soil continues to deteriorate we will not be able to survive here. Above all we want to continue here as farmers, although many young people will leave the village and will try to find a living elsewhere. To guarantee our future some things need to change in the village. We should use more chemical fertiliser and we should stop burning the vegetation. Moreover, plant residues should be collected at the end of the season, this can be used to enrich the soil. We need oxen for tillage and for their manure. Finally, we should plant more trees. Chemical fertiliser alone is not sufficient, because erosion would then become a problem.”

Figure 5. Percentage of plots with slope



Source: Survey VU-UNB (1995)

Farmers'Responses to Soil Fertility Decline

Faced with a possible further decline in soil fertility, farmers ranked their replies as follows: putting more land under fallow was the first option, with 29% of the farmers ranking this answer first; investment (20%) and expansion (16%) were also ranked first frequently. For each of these options the second and third ranked options were also analysed (Table 2). The importance of putting more land under fallow is illustrated by its high ranking both as a first and a second option (49% of those who ranked investment first, and 36% of those who ranked expansion first). Other possible responses mentioned by farmers included a change in cropping pattern towards less demanding crops, migration (especially in the centre and north-west) and the re-use of old fallow land. Table 2 and Annex 2 provide details.

Table 2. Farmers' responses to further declines in fertility of their cultivated land

First option	Second option	No of farmers	Third option	No of farmers
Put under fallow n=175	Re-use fallow	63 (36)	Invest	42 (24)
	Invest	57 (33)	Re-use fallow	26 (15)
	Expand	22 (13)	Less demanding crops	15 (9)
Invest n=121	Put under fallow	59 (49)	Re-use fallow	26 (21)
	Less demanding crops	14 (12)	Put under fallow	14 (12)
	Re-use fallow	13 (11)	Less demanding crops	10 (8)
Expand n=93	Put under fallow	33 (36)	Re-use fallow	23 (25)
	Invest	19 (20)	Put under fallow	13 (14)
	Migrate	9 (10)	Invest	12 (13)

Source: Survey VU-UNB (1995).
NB: The figures in parentheses are the percentages of the farmers in the first column.

Faced with a (further) decline in soil fertility, farmers in the Atacora may be expected to respond in one of four ways: i) put more land under fallow; ii) re-cultivate old fallow land, iii) extend the farm by bringing more land under cultivation or iv) invest in recovery by bringing in more fertiliser, grow crops as green manure or by land restructuring etc. Of these options, three are located on-farm and one off-farm. The use of more inputs, or the growing of less demanding crops (and leaving land fallow as an extremely undemanding 'crop'), as well the reuse of former fallow land may all be considered as on-farm solutions, whereas expansion through bringing more land into cultivation requires availability of land and impacts on that availability to other farmers.

We would expect that individual choice of options would depend on the resources available to the household. If much land is under fallow, option 3 is viable; if money and labour are available, more intensive cultivation would be an option; if not, more fallow and less demanding crops would be the rational response.

Table 3 presents the responses to questions regarding land availability. Most farmers have easy access to additional land. The answer 'almost impossible' was given quite frequently by farmers in the area of Boukombé in the north-west (39%) and the capital Natitingou in the centre (15%).[4]

Table 3. Access to new land (finding new land is…(row percentages))

	easy	moderate	difficult	almost impossible	do not know	total
Atacora	49	15	26	9	1	N=539
South	67	9	22	2	0	N=131
Centre	36	21	34	8	1	N=146
North-west	36	14	29	20	1	N=160
North-east	68	17	13	2	0	N=102

Source: Survey VU-UNB (1995)

Tables 2 and 3 illustrate the contribution of land scarcity. Putting land under fallow is a preferred option under all land access situations (32% of farmers rank this option first). However, this is especially so under moderate land access (39% rank putting land to fallow first) followed by easy access (33% rank putting land to fallow first). Under easy land access, expansion is relatively important (25% rank this option first), but less viable in the case of moderate (11% rank expansion first) and difficult and almost impossible access (9% rank expansion first).

The option to reclaim old fallow does not differ much between farmers with different land access. For some it may not be needed because land is in ample supply. Or, as one farmer with easy access to land put it: "when I leave a plot, I leave it forever". For farmers with difficult access, the pressure on land may be so high that even old fallow land is not easily available. For these farmers, investment is a more important option (29% ranked first) compared to those farmers with moderate (10% rank investment first) or easy access (11% rank investment first).[5]

When we examine household endowments, we see that putting land under fallow is favoured by households with smaller labour supply. Households that rank 'putting land to fallow' first have significantly smaller household size (on average 9.6 persons) and labour force (6.8 persons) than those households who do not. Households that rank investment first have a significantly higher household size (on average 12.5 persons), labour force (9 persons) and man-land ratio (2.8 persons per ha) than those who do not. Farmers who opt for 'expansion' as their first option, have a significantly smaller man-land ratio (1.8 persons per ha) than those who do not. As we have seen above, a high availability of land favours this option. The re-use of old fallow reflects a medium size labour force (8 persons), household size (11.4 persons) and man-land ratios (1.9 persons per ha). Farmers who favour growing less demanding crops show a significantly smaller household size (8.3 persons), labour force (5.7 persons) and man-land ratio (1.7 persons per ha), although they show a significantly lower net revenue from crop

[4] These figures cannot be found in the table.
[5] These figures cannot be found in the table.

sales than those who do not. A significantly lower net revenue from crop sales is also found among those farmers who opt for other sources of revenues or migration.[6]

In sum, the choices appear to be:

1. expansion (new land) which is favoured by availability of land and low man land ratios;

2. intensification by investments or more fertiliser, favoured by limited access to land, larger households, high man land ratios and more cash income;

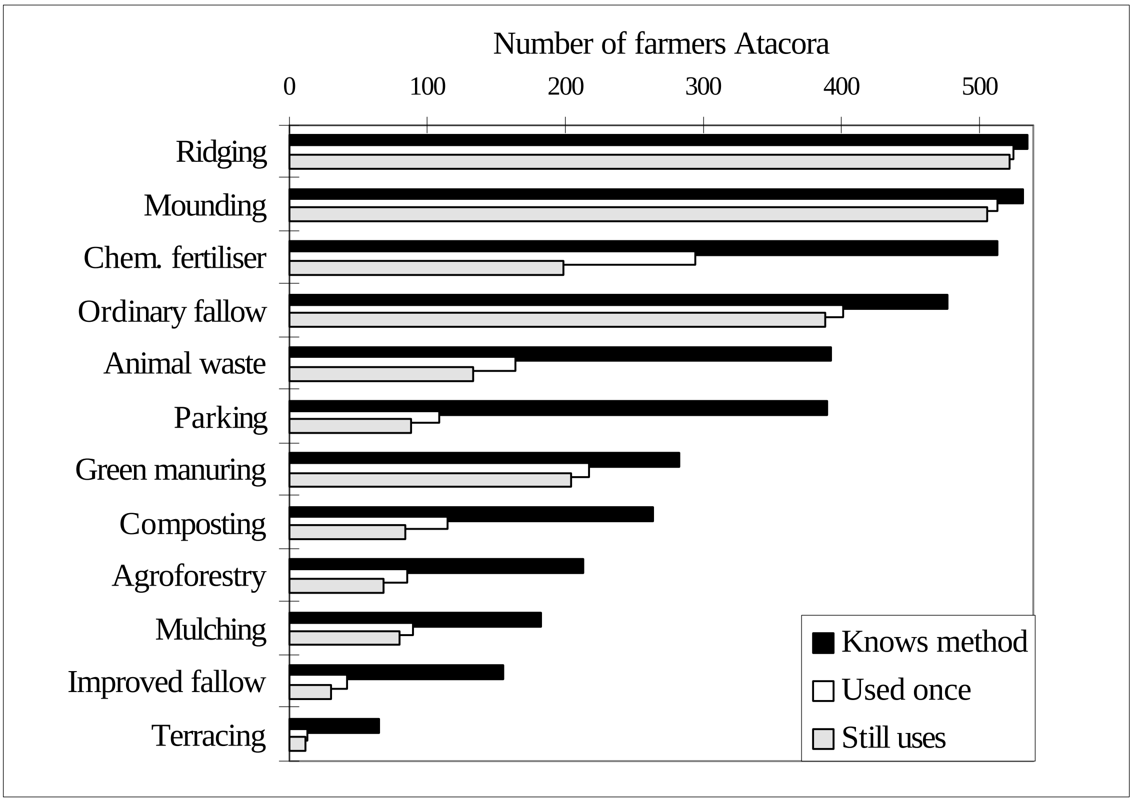
3. reduction through migration or the growing of less demanding crops or more fallow land, favoured by relatively small households; for these cash incomes make the difference: with high incomes more fallow is preferred, without such sales, less demanding crops or a search for other revenues and migration.

[6] All significant differences mentioned are significant at the 5% level.

Farmers'Knowledge and Adoption of Fertilisation Methods

Six methods to combat soil degradation are known to the majority of farmers of our sample (see Figure 6). The best known are ridging (89%), mounding (88%), mineral fertilisation (85%) and ordinary fallow (79%) followed by the use of animal waste (66%) and the parking of animals in the field for the night (65%).

Figure 6. Knowledge and adoption of methods to maintain or improve soil fertility



Source: Survey VU-UNB (1995)
Note: The total number of farmers is 539.

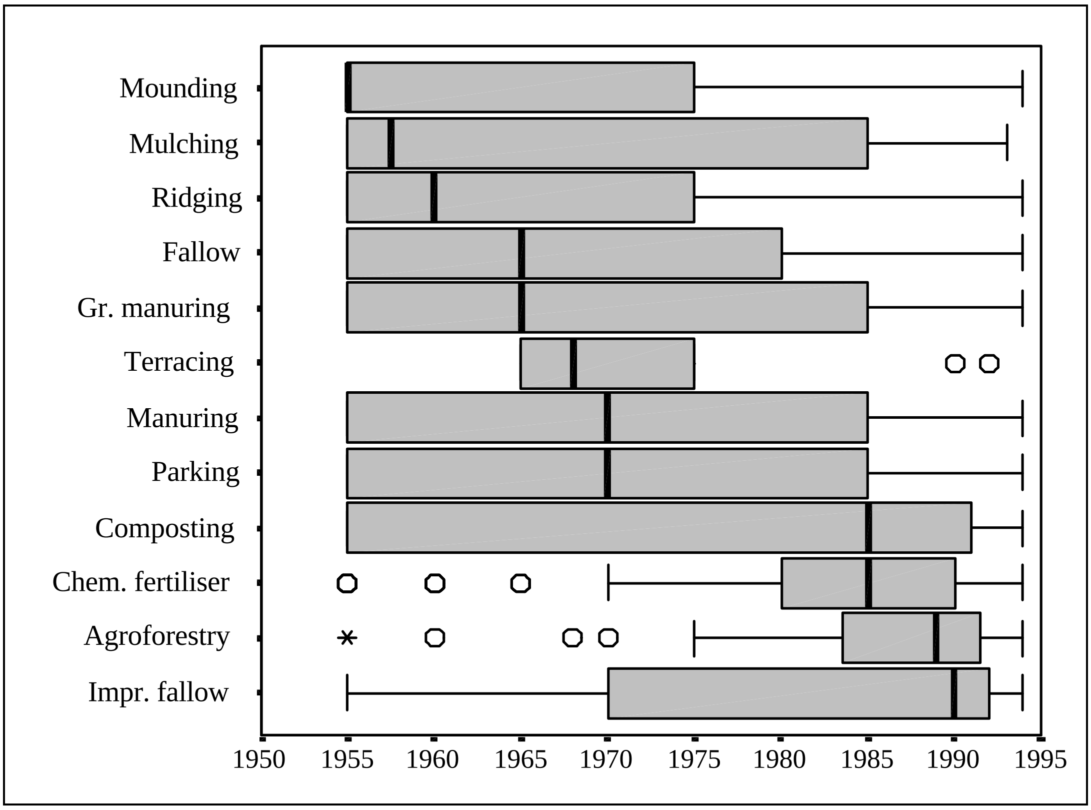
In addition to these techniques, many farmers are aware of green manuring (49%)[7], composting (45%), agroforestry (36%), mulching (31%) and improved fallow (30%). A number of farmers (10%) highlighted terracing as a method for maintaining soil fertility, especially those located in the centre zone (21%) (c.f. Annex 3). Of the farmers that have used a technique at least once, ridging is most frequently adopted (applied at least once by 98% of those that know the method). This is followed by mounding (96%), ordinary fallow (82%), green manuring (72%) and mineral fertiliser (56%). Adoption rates are also high for mulching (49%), composting (42%), the use of animal waste (41%) and agroforestry (40%). Parking animals in the field and improved fallow are practised less frequently. The adoption rate is particularly low for terracing (21%), even in the north-west where this technique is

[7] Although the term green manuring is generally applied to techniques where nitrogen fixing plants are used to fertilize the soil, farmers in the Atacora generally use the term for the practice of mincing plant residues and raking it into the top-soil.

mostly applied. Of the farmers who adopted terracing, 75% are located in the north-west (cf. Figure 6 and Annex 3).

In reality, almost all farmers in the sample applied at least two of the methods mentioned above. Many techniques have been used for a long time, as illustrated by the box-plot of adoption years (Figure 7). A box-plot can give us information on quartiles and outliers. The boxes indicate the interquartile range (the box-length) containing 50% of the observations with the 25th percentile and 75th percentile (lower and upper bound of the box) and the median (bold line). The circles indicate outliers, all values between 1.5 and 3 box lengths away from the lower or upper bound of the box.

Figure 7. Duration of method used to maintain and improve soil fertility (in years)



Source: Survey VU-UNB (1995).
Note: The maximum number of years in use was set to 40 years (1955).

Extremes are values that are more than 3 box lengths away from the upper or lower bound of the box and are depicted by an asterix. Finally it indicates the smallest and largest values that are no outliers (thin lines).

However, not all farmers who have used a particular method have continued to the present day. Many techniques have lost their importance as they have been abandoned. The techniques still in use are (ranked top-down) ridging (mentioned by 86% of the sample), mounding (83%) and ordinary fallow (62%). These are old practices used for more than three decades by a large majority of the households (see Figures 6 and 7, and Annex 4).

In addition, three other methods take an intermediate position: the use of green manuring (practised by 33%), chemical fertiliser (32%) and animal waste (22%). The use of chemical fertiliser is relatively recent and most started using it within the last ten years (by 64%), primarily on farms where cotton is grown. 46% of those practising green manuring (an older technique) had adopted this method within the last 25 years, the remainder having done so prior to this time. Similarly, in the case of animal waste, almost half of the users claim that the method was adopted in the last 25 years, while the rest say it dates from an earlier time. Of course not all the respondents had been farming this long.

Little used methods in the Atacora are parking of animals (15%), composting (14%), mulching (13%) and agroforestry (11%). The latter is a particularly recent introduction with 77% claiming that it dates from the last decade, against 52, 29 and 22%, respectively for composting, parking of animals and mulching. The latter two of these had (according the half the number of users), already been n use for more than 25 years.

Some farmers (5%) have introduced the improved fallow in their farming systems, notably in the last ten years. Finally, only 10 households (2% of the sample), of which 9 were in the north-west, made use of terraces (cf. Figure 6 and Annex 3).

In the central zone, where land degradation is greatest, the use of green manuring and composting is highest, with rates of 49% and 21% of the sample in this zone. In the north-west, which is also affected by degradation, the farmers make more use of animal waste (31%) and parking of animals (21%), which reflects the higher rate of cattle raising activities there. In the north-east considerable amounts of chemical fertiliser are used, associated with extensive cotton growing there.

Reasons for Adopting Specific Soil Improvement Methods

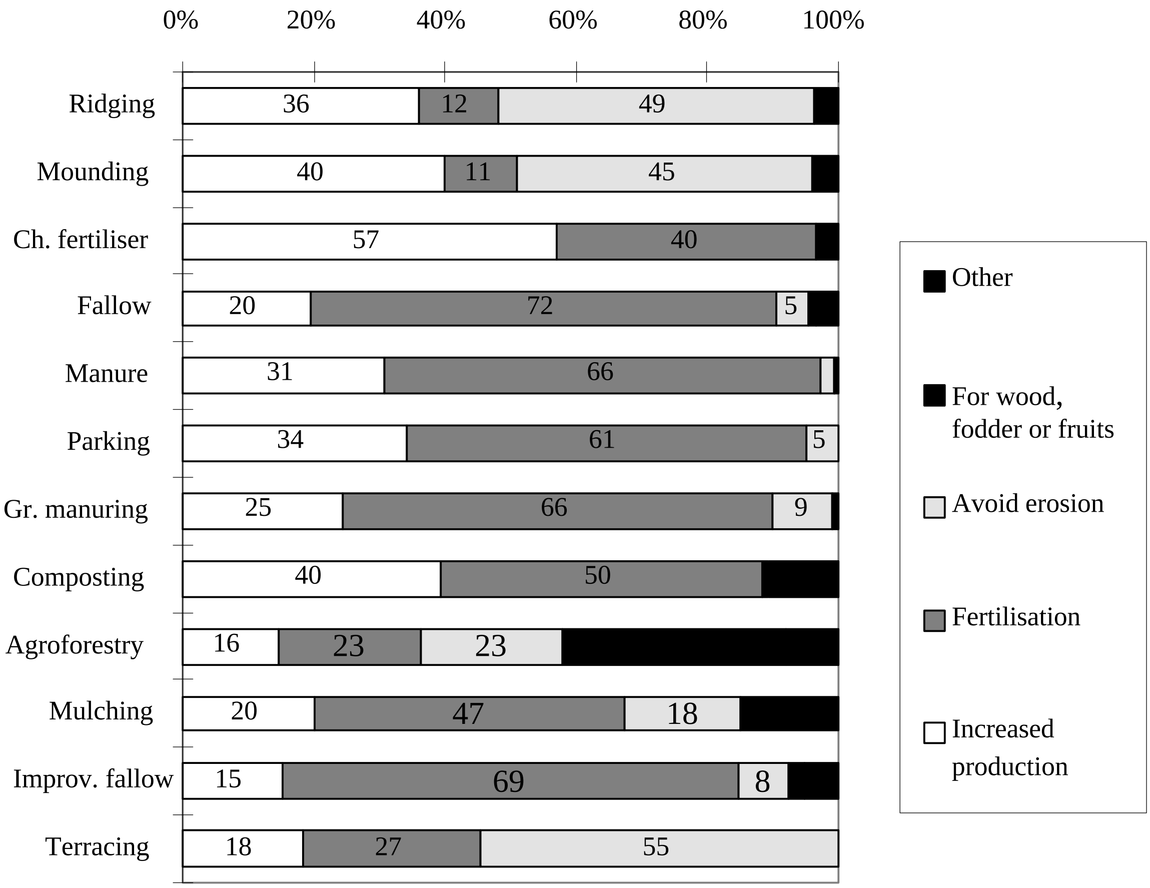
Farmers use various soil improvement methods simultaneously because, in their view, each method has its own specific merits. A number of techniques are most often used because of their ability to improve soil fertility (see Figure 8): ordinary fallow (72%), improved fallow (69%), animal waste (66%), green manuring (66%), parking of animals (61%), composting (50%) and mulching (47%). Improved production is ranked second for all these techniques and avoiding erosion takes third place. Mulching is relatively important for avoiding erosion (18%).

Combatting erosion is the main reason for farmers adopting terracing, ridging and mounding according to the farmers (55%, 49% and 45% respectively of the relevant households). Increased production follows closely for ridging and mounding (36% and 40%), which is also adopted, to a lesser extent, for improving fertility (12% and 11%). On the other hand, terracing is more important for improving soil fertility (27%) rather than increasing production (18%).

Directly increasing productivity is the main reason for the use of chemical fertiliser (57%), whereas improving soil fertility comes at a second place (40%).

Finally, agroforestry is mainly used for production of wood and fruits or fodder (37%). It is used to a lesser extent to avoid erosion (23%), improve soil fertility (23%), or to increase production (16%). A relatively large group do so to combat erosion (23%). This group is particularly numerous in the south and the north-west (cf. Annex 5).

Figure 8. Reasons for adopting the methods actually used by farmers in the Atacora



Source: Survey VU-UNB (1995).
N.B.: percentages of those that use the method (c.f. Figure 6).
* For mulching, main other reasons are: covering the soil and water conservation

The number of farmers that actually used the methods would have been much higher had many of the farmers not abandoned them. The reasons for doing so are discussed in the next section.

Abandonment of Soil Improvement Techniques

The methods most frequently abandoned appear to be those recommended by extension services to stop land degradation. Three of these have particularly high abandonment rates: use of mineral fertiliser (abandoned by 34% of the adopters), improved fallow (29%) and composting (27%). Four additional methods have met with a similar fate: agroforestry (21%), use of animal waste (19%), parking of animals (19%) and terracing (15%). Lowest rates of abandonment are recorded for the oldest techniques, ie. mulching (11%), use of green manuring (6%), ordinary fallow (3%), mounding (1%) and ridging (0.4%) (cf. Table 4). Although it is not widespread, terracing has relatively low rates of abandonment; importantly, in the north-west, no adopter of terracing has abandoned this practice.

The two zones most affected by degradation (centre and north-west) have witnessed the highest rates of abandonment. For example, the rate of abandonment of chemical fertiliser in the centre was 59%, while that for agroforestry in the north-west stands at 47% (see Annex 3). These figures indicate that farmers in these zones are continually searching for and testing methods of sustainable land use but are often discouraged.

Table 4. Abandonment of methods to maintain or restore soil fertility by farmers

Method	Abandonment (no of farmers)	As a percentage of those using the method at least once
chemical fertiliser	94	34
improved fallow	12	29
composting	31	27
agroforestry	18	21
animal waste	31	19
parking of animals	20	19
terracing	2	15
mulching	10	11
green manuring	12	6
ordinary fallow	12	3
mounding	6	1
ridging	2	0.4

Source: Survey VU-UNB (1995).

The reasons for abandonment vary according to the method. However, we are not only interested in why farmers abandon techniques, but also why they do not adopt methods they are aware of. We asked each farmer to indicate why he does not use (anymore) any method of which he is aware. The results are provided in Tables 5 a-c. These tables are divided into different types of techniques: anti-erosion (Table 5a), land intensive techniques (Table 5b) and manuring techniques (Table 5c) (see also Annex 6).

Mounding and ridging are not included in this analysis because of the very low numbers of non-users (<25). Nearly all farmers are familiar with these techniques and have continued to use them, given the high adoption and low abandonment rates (see Figure 6). The few farmers who do not use these techniques are exceptional and are omitted from the analysis.

Table 5a. Reasons for not using/abandoning anti-erosion techniques (column %)

	Mulching	Terracing
Not suited for land	14	60
Too much work	59	20
No advantage	23	16
Other	4	4
N=	97	31
Non response %	6	11

Source: Survey VU-UNB (1995).

Table 5b. Reasons for not using/abandoning land intensive techniques (column %)

	Fallow	Improved fallow	Agroforestry
Too much work	4	39	40
Not enough land	51	3	2
Too expensive	0	40	15
No advantage	21	5	11
Not suited for land	6	2	8
Lack of plants	0	3	8
Enough land	8	1	1
Borrowed land	4	1	3
Just learned	0	0	6
Molestation by animals	0	4	0
Other	6	3	8
N=	79	114	137
Non-response %	10	21	9

Source: Survey VU-UNB (1995)

Table 5c. Reasons for not using/abandoning fertilising techniques (column %)

	Manuring	Parking	Composting	Green manuring	Chemical fertiliser
Too much work	53	15	66	62	1
Too expensive	2	12	3	8	95
Lack of animals	33	66	6	0	0
No advantage	3	2	5	9	1
Not suited for land	2	0	4	6	1
Just learned	0	0	7	5	0
Difficult	0	0	5	5	0
Transport problems	4	1	1	0	0
Theft animals	0	1	0	0	0
Other	1	2	4	6	1

N=	231	279	161	68	283
Non-response %	11	8	13	20	10

Source: Survey VU-UNB (1995)

Clearly, each soil conservation technique require inputs. Some are very land intensive, such as agroforestry, improved fallow and ordinary fallow; others require the use of manure and/or animals, like composting, the use of animal waste and parking of animals; chemical fertilisers on the other hand require a lot of money. Almost all techniques require labour; agroforestry, green manuring, mulching, composting, terracing and the collection of animal waste are particularly labour intensive. As indicated by Tables 5a-c, farmers often abandon a certain technique because of the demands on labour or funds. We would like to know for each soil conservation technique what type of farmers decide against it. We have seen in Section 6 that household endowments influence the kind of technique chosen by a farmer in the event of a (further) drop in soil fertility. Do the answers we find in Tables 5 correspond with household characteristics and can we say what kind of farmer is more likely to adopt a certain technique?

For each technique we compared average endowments of farmers who are still using the technique and for those who are not (see Table 6). We looked at household size (total number of persons), labour force (number worker-equivalents depending on the ages of the members), farm size (total land area including fallow land), the ratio of the two latter and the net crop sales of the household (in FCFA). In addition, we looked at a village specific variable: the access variable. The variable 'access' measures the difficulty of finding new land for the farmers in that village, and is rated on a scale from 1 to 4, with 4 indicating almost impossible to access new land. Although farm size decreases with the difficulty of accessing new land as we would expect, household size decreases in the same direction.[8] This decrease in household size is probably a result of differences in household composition between ethnic groups and the fact that ethnic groups are not evenly distributed over the Atacora. As a result there is no significant correlation between land access and labour force per hectare and a high labour force per hectare does not necessarily mean access to land is difficult. We have added the access variable to make interpretation easier.

We also made a similar comparison between farmers who still use the method and the group of non-users who do not use it because it requires too much labour, or in the case of ordinary fallow, too much land, and in case of chemical fertiliser, too much money. The results can be found in Tables 6a and 6b.

[8] Both significant at the 5% level.

Table 6a. Household characteristics for different user groups of soil conservation techniques

Method	Endowment	Still use method		No longer use method		No longer use main reason:	
						insufficient land	
Ordinary fallow	HH. size	**386**	10.7	**87**	9.9	**39**	***8.0
	Labour force		7.6		6.8		***5.6
	Total area		4.7		*4.1		*3.7
	Labour force/area		2.0		*2.7		1.9
	Access		1.9		**2.2		***2.8
	Net crop sales (FCFA)		56,210		*154,650		**5.641
						Too expensive	
Chemical fertiliser	HH. size	**196**	11.7	**312**	***9.8	**267**	***9.8
	Labour force		8.0		**7.0		**6.9
	Total area		5.2		***4.1		***4.1
	Labour force/area		2.0		2.3		2.2
	Access		1.9		**2.1		***2.1
	Net crop sales (FCFA)		139,400		***31,850		***31,000

* = significant at the 10% level, ** = significant at the 5% level, *** = significant at the 1% level.
Significance indicates there is a significant difference with the figure in the third column (users).
N.B.: The figures in bold are numbers of observations
Source: Survey VU-UNB (1995)

6b Household characteristics for different user groups of soil conservation techniques

Method	Endowment	Still use method		No longer use method		No longer use: too much work	
Green manuring	HH. size	**204**	11.0	**76**	10.2	**40**	11.75
	Labour force		7.7		7.3		8.4
	Total area		4.7		**3.9		4.1
	Labour force/area		1.9		*2.6		*2.4
	Access		2.1		**1.9		***1.7
	Net crop sales (FCFA)		68,070		53,790		68,240
Animal waste	HH. size	**132**	11.2	**256**	10.1	**123**	10.3
	Labour force		7.9		7.1		7.4
	Total area		4.7		4.3		4.4
	Labour force/area		2.0		2.2		2.1
	Access		2.3		***2.1		***1.9
	Net crop sales (FCFA)		21,960		***76,420		69,930
Parking of animals	HH. size	**88**	11.2	**298**	10.2	**41**	9.7
	Labour force		7.8		7.2		7.3
	Total area		4.8		4.3		4.7
	Labour force/area		2.1		2.1		2.2
	Access		2.0		2.1		2.0
	Net crop sales (FCFA)		77.080		57,580		20,035
Composting	HH. size	**84**	11.9	**179**	**9.9	**106**	**10.0
	Labour force		8.9		***6.7		***6.9
	Total area		4.7		4.2		4.6
	Labour force/area		2.2		2.2		2.0
	Access		2.1		2.0		*1.9
	Net crop sales (FCFA)		35,830		76,560		*104,010
Mulching	HH. size	**78**	11.6	**103**	11.0	**57**	10.5
	Labour force		8.1		7.8		7.6
	Total area		5.1		*4.2		**4.1
	Labour force/area		1.8		*2.2		**2.3
	Access		1.8		2.0		**2.1
	Net crop sales (FCFA)		115,980		*28,660		*23,440
Agroforestry	HH. size	**67**	11.7	**144**	11.5	**55**	11.1
	Labour force		8.1		8.0		7.6
	Total area		5.0		4.6		4.4
	Labour force/area		2.2		2.3		2.0
	Access		1.7		**1.9		***2.1
	Net crop sales (FCFA)		103,110		115,540		*56,319
Improved fallow	HH. size	29	10.9	**125**	11.2	**46**	9.6
	Labour force		7.7		7.9		6.8
	Total area		4.4		4.2		4.1
	Labour force/area		2.1		2.6		2.3
	Access		1.9		1.9		1.9
	Net crop sales (FCFA)		67,630		93,290		*23,437
Terraces	HH. size	**11**	7.9	**54**	9.8	**10**	*11.2
	Labour force		5.3		**7.2		**8.7
	Total area		4.4		4.0		4.7
	Labour force/area		1.4		**2.8		*2.3
	Access		3.2		***1.9		***1.8
	Net crop sales (FCFA)		16,030		109,900		68,440

* = significant at the 10% level, ** = significant at the 5% level, *** = significant at the 1% level.

Significance indicates there is a significant difference with the figure in the third column (users).
N.B.: The figures in bold are numbers of observations
Source: Survey VU-UNB (1995)

Terracing and mulching were not often used because they were unsuitable for the land, or farmers do not see their advantage (see Tables 5). This is not surprising, given that the majority of the land has no sloping surface (Figure 5). Terracing is used by farmers with a significantly smaller available labour force and with a relatively low labour force per hectare, even compared with the (small) group not using terracing because it requires too much labour. Labour shortage does not seem to be an important reason for not to use terracing. For the users of terracing, access to new land is significantly more difficult. It is likely that these farmers are forced to use land that is less suitable for cultivation, the land with a slope. The need for terracing appears to be very site specific. In some areas especially in the north-west many farmers use steeply sloping land that is very vulnerable to erosion. In these areas the non users who know the method is low. In other areas, where erosion is less threatening non-use is much higher.

Although both techniques are rather labour intensive, only mulching is not often used for that reason. We would expect households not using mulching to have a smaller labour force and a smaller labour force per hectare compared to users. From Table 6b we can see that farmers who do not use mulching have a lower labour force and household size than those still using mulching (not significant). Nevertheless, farm area is significantly smaller as well, resulting in a significantly larger work force per hectare for non-users, unlike we would expect. The results are even stronger for those farmers reporting that they do not use mulching because it is too much work. Mulching is not used by households with relatively large labour endowments and difficult access to land. Users have significantly higher net crop sales. Perhaps farmers with low incomes have a higher preference for activities that increase productivity in the short term, whereas the effects of mulching on production are realised in the longer term.

When we look at the more land intensive techniques - fallow, improved fallow and agroforestry, it is surprising to see that lack of land is *only* an important reason for non-use in the case of ordinary fallow (see Table 5b). It is not surprising that for this technique, which requires no other inputs, lack of land is the main reason for non-use. Those farmers that do not use fallow (anymore) are farmers with a significantly smaller farm size, especially those that give lack of land as the main reason for non-use. At the same time, the latter have a significantly smaller household and labour force size, resulting in a labour force per hectare that is not significantly different from the group of fallow users, whereas we would expect a larger labour force per ha. However, we do see that access to new land is more difficult for the non-users, especially for those that are not using fallow for that reason.

Some farmers say that ordinary fallow has no advantage, perhaps because the fallow period has already become too short to be useful. However, this answer is given particularly often in areas where land is easily available (south, north-east). A reason may be that farmers do not consider using fallow because they do not plan to come back to this land. In this way fallow is no longer a land use decision within the farm. This could also explain why some farmers say they do not use fallow when there is enough land. Apparently, fallow land is not always considered part of the farm. For these farmers, net crop sales are significantly higher than for the farmers still using fallow, whereas farmers who indicate there is not enough land to use fallow have significantly smaller net crop sales than users. There is also a small group of farmers that lives in an area where access to land is still very good and who are relatively well off. They do not consider themselves users of fallow where in fact they are. We have to keep in mind that the non-use of fallow is relatively low and these situations are exceptional. It is not only important that fallow is used or not, fallow should be used *sufficiently*. The share of land in fallow is an indicator for the quality of the fallow. There is a significant (5% level) negative correlation between difficulty in access to land and share of land in fallow. This means that in situations of difficult access to land, the quality of the fallow has deteriorated.

The non-use of improved fallow and agroforestry is much higher than the non-use of ordinary fallow. According to the farmers, this is mainly a result of the high labour and capital requirements for the growing and handling of trees or other plants and *not* the lack of land. Nevertheless we do see that non-users of agroforestry have more difficulties with access to new land. The farm size of users is larger than farm-size of non-users, but not significantly. At the same time labour endowments are not significantly smaller for the non-users, even for those farmers who indicate the techniques require too much work. Net crop sales of farmers using the techniques is not significantly higher than for those not using improved fallow or agroforestry. Only for the subgroup of farmers who say they do not use improved fallow or agroforestry because it requires too much *labour* are the net crop sales significantly smaller.

The remaining techniques are all manuring techniques: animal manure, parking of animals, composting, green manuring and chemical fertiliser. For chemical fertiliser, 95% of the farmers state that expenses were the main reason for non use. We can see that lack of money is indeed a reason for not using chemical fertilisers. The farmers still using chemical fertiliser are those whose net cash income from agricultural production is significantly higher than those not using chemical fertiliser. This is what we would expect. It is interesting to see that the farmers who are still using chemical fertiliser, use more land than those not using fertiliser and access to land is easier for users. At the same time the household size and work force are larger, resulting in a labour force per hectare that is not significantly different from the non-users.

Some manuring techniques require access to animal waste (parking, animal manure and composting), which is much easier for someone who keeps cattle. Traditionally, the livestock owned by farmers was taken care of by the (semi-) nomadic Peulh cattle raisers. For their services, the Peulh could keep part of the offspring and they could use the manure. Farmers would generally not keep livestock in their own village. Only relatively recently, with the introduction of the oxen-plough, have farmers sometimes kept (part of) their own livestock on their own farms. When a farmer wants to use animal manure on a field and he does not have animals at his farm, he can invite a Peulh family to park a herd (not necessarily his own) on his land during the night. The Peulh will be paid in cash or in kind for this service (see Box 1 and de Haan, 1992). The main reason not to use parking of animals is lack of livestock, also an important reason for not using animal manure. Other important reasons for not using parking of animals are the amount of work (for guarding the animals) and the costs when Peulh cattle raisers have to be paid for their services (see Table 5c). In Table 6b we can see that parking is used by farmers with higher net crop sales (not significant).

Instead of bringing animals directly to the field, manure may also be collected and transported. However this is very time consuming and transportation is sometimes difficult. This explains why the main reason for not using animal manure is that it is too labour intensive and, as expected, the availability of livestock is very important for the decision to use manure intensive techniques. The techniques that are manure intensive are used by 64% of the farmers that say cattle raising is one of their main activities and by only 25% of the other farmers, a substantial difference.

The main reason given for not using composting, green manuring and animal manure is the amount of work required. The labour endowments of the non-users are smaller on average than those of the users of these three techniques (significant only for composting). However, those households which indicated they did not use these technqiues because they required too much labour possessed higher labour endowment than those households who did not use these techniques for other reasons. For each technique, the labour force per hectare for the group of non-users as a whole was at least as high, or higher, than for the users (significant for green manuring only). The labour force per hectare for the group of farmers who do not use these techniques because they require too much labour assumes an intermediate position, except for composting where it is the group with the lowest labour force per hectoare (not signifcant). Therefore, labour force and labour per hectore do not seem to provide an adequate explanation of the adoption of these techniques. Indeed, the availability of new land seems to offer a better explanation for household adoption of these techniques. The use of these three techniques seems to be confined to farmers with difficult access to new land. Farmers with easy access probably prefer to use their labour for other income generating activities rather than soil improvement, provided that they have the necessary resources, such as access to new land for fallow and net cash income for chemcial fertiliser and parking.

We could also compare the use of land intensive techniques to the availability of new land in the village as seen by the farmer. This is done in Table 7, where the same is done for manure intensive techniques. Table 7 shows that in areas where land is easy or moderately easy to obtain, land intensive techniques are more often used. The opposite can be concluded for manure-intensive techniques that are more often used in land scarce environments.

Table 7: Use of land- or manure- intensive techniques and difficulty access to new land

Getting new land is…	Land intensive techniques		Manure intensive techniques	
	Users	Non-users	Users	Non-users
Easy	58.35	41.65	29.95	70.05
Moderate	58.99	41.01	27.06	72.94
Difficult	55.35	44.65	26.13	73.87
Almost impossible	45.00	55.00	40.35	59.65

Source: Survey VU-UNB (1995)
Note: Figures are row percentages, users and non-users add up to 100%

Summarising we can say that the use of most techniques are favoured by a larger household size and a larger labour force (although this is only significant for composting). Although limited access to new land seems to explain the use of many techniques, this is not always reflected in a larger labour force per hectare because at the same time, users generally have a larger farm size than those that are not using the technique. This is not exactly what we would expect, given the results in Section 6, where investment in soil conservation was favoured by large households and limited access to land, but also by a high labour force per hectare.

When access to new land is easy, land intensive techniques are favoured. Net crop sales are positively correlated with easy access (significant at the 5% level), probably because it is easier for farmers to grow cash crops in addition to their own crops when land access is easy. Easy access to land therefore favours land intensive techniques as traditional fallow and agroforestry, as well as techniques that require net cash income (chemical fertiliser and agroforestry). Mulching also seems to be favoured by large farms with high incomes. Although traditional fallow is still the most often used technique (after mounding and ridging) we have also seen that the quality of the fallow (the share of land in fallow) decreases with increasing difficulties in accessing new land.

Difficult access to new land increases the use of manure intensive techniques (other than chemical fertiliser); it favours the use of green manuring, composting and animal manure. Terracing is used by farmers with very difficult access to land since they are forced to use land which is sloping.

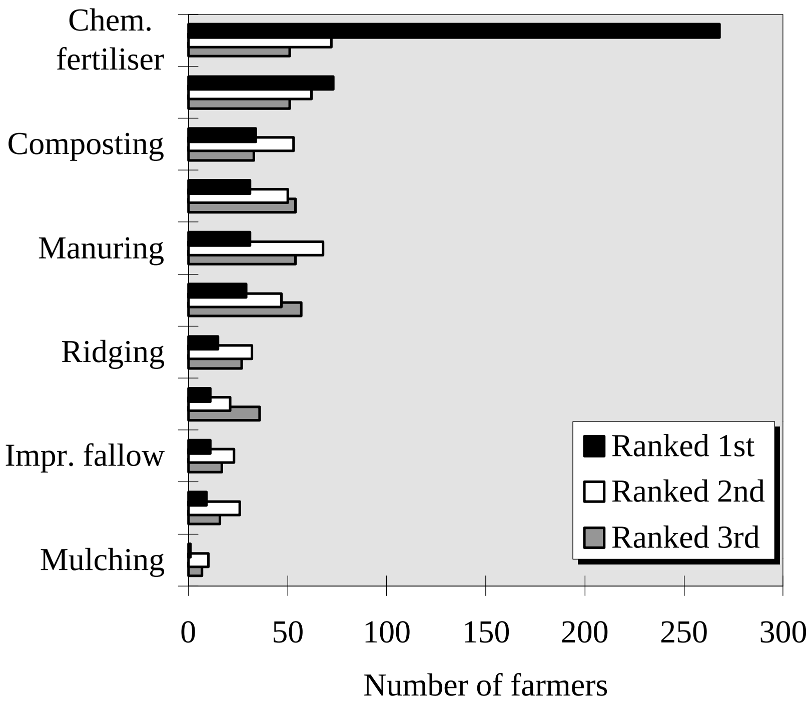
The use of parking seems to be favoured by the ownership of cattle as we would expect. However, parking is also favoured by larger net crop sales, which are needed to pay cattle raisers for their services. The effects of difficult access to new land on the use of parking and improved fallow is not clear.

After all these observations, it is interesting to obtain information on which of the above methods is considered best suited for maintaining and restoring soil fertility. We asked farmers to rank three methods and the results are presented in the next section.

Farmers'Perceptions
of Soil Fertility Performance

The majority of farmers in the Atacora (62%) mentioned chemical fertilisers among the three best methods for maintaining or restoring the soil, and for more than 2/3 of these, it was ranked first (Figure 9). These figures are especially high in the north-east where the technique is widely used. Although chemical fertiliser is highly ranked, five other methods are considered particularly useful, namely parking of animals in the fields at night (25%), use of animal waste (24%), green manuring (22%), composting (20%) and ordinary fallow (19%). Parking of animals is highly appreciated in the north-west where it is well known. Moreover, it is ranked frequently (40%) in first, or in second (75%) place (Figure 9).

Figure 9. Farmers' perceptions of best performing methods for soil fertility



Source: Survey VU-UNB (1995).
N.B.: Terracing was ranked only once, in third place.

A final group of methods considered useful by some farmers is ridging (13%), mounding (12%), improved fallow (9%) and agroforestry (9%). In over 3 out of 4 cases, these techniques are ranked in second or third place. Only 10% of the farmers indicated mounding and ridging among the best methods, even though almost all use these methods. The explanation here could be that these are mostly considered as anti-erosion measures rather than soil fertility improving methods (Figure 8).

On the whole, the method that farmers in the Atacora would most readily adopt, given the means (ie, money and time), is chemical fertiliser, followed at some distance by parking of animals, use of animal waste, green manuring, composting and ordinary fallow.

Summary and Conclusions

This study has highlighted two important aspects of soil degradation in the Atacora: the extent to which farmers are aware of the degradation and the measures they consider to be adequate. Linking their perceptions to actions actually undertaken is not straightforward. Measures considered best generally show lower adoption rates. Reasons for this must be sought in constraints to use these techniques.

In line with the more objective evidence of soil fertility decline in the Atacora, nearly all farmers are aware that an overall decline is taking place. Most farmers have thought about causes and possible solutions. In the areas where pressure on land is high (centre and parts of the north-west) farmers realise that this is a result of their own (collective) action, of deforestation, over-exploitation and bush fires. Nevertheless, especially in these areas, farmers feel they are forced to shorten fallow periods and increase cropping periods and to use more land on the hill-sides.

Faced with a further decline in soil fertility, it is quite likely that the Atacora farmer would do one of four things: put land under fallow, invest to restore fertility, re-use old fallow land or increase farm size. It may well be that in this case more land, rather than less, is actually used. Investment may help to facilitate this change which would otherwise worsen rather than ameliorate the situation. The responses of farmers to a further fall in soil fertility is very much dependent on land availability. Investment seems to be considered only in case of difficult access to land, and especially so by families with large labour endowments. The farmers in the centre seem most willing to make investments. Those farmers in areas with difficult access to new land realise that traditional methods of fallow are no longer sufficient.

Many farmers consider the use of chemical fertiliser and parking of animals superior to fallow. Chemical fertiliser is preferred by a majority of farmers; this also highlights the fact that most farmers prefer methods that increase production in the short term.

Even though farmers in areas of difficult access to land are more willing to invest, they show a lower actual use of the most preferred methods (chemical fertiliser followed at distance by parking of animals). Farmers in these areas do not have the means, money or cattle, to use these methods. Net crop sales are significantly smaller in areas of difficult access to new land, which makes the purchase of chemical fertiliser more difficult. Farmers do use parking in the north-west where more farmers keep their own cattle and do not have to pay cattle raisers for their services.

Use of methods other than chemical fertiliser, fallow and parking is relatively high in the centre and the north-west. The use of labour or manure intensive techniques (animal waste, green manuring and composting) is higher in these areas. Other responses of farmers in these areas include growing less demanding crops or migration. Migration is taking place although very few farmers are willing to do so or to shift to non-agricultural activities.

By analysing household characteristics we aimed to provide a profile of the use of different methods. The use of chemical fertiliser is constrained by lack of money from crop sales, which confirms the farmers opinions. Land intensive techniques are found to be used more in households where farmers perceive land as easily available, while manure intensive techniques are more often used in land scarce environments and by cattle raisers. Labour intensive techniques seem to be used by larger households as we would expect. However, users of these techniques seem to have larger farms as well and, as a result, the labour force per hectare is not higher for these farmers. This is noteworthy, and raises questions about the opinions of non-users that these methods require too much time. Use of these techniques seem to depend more on difficulties with access to new land, which is not significantly correlated with man-land ratios. Apparently, farmers in areas of difficult access think the returns on labour spent on these activities is higher than farmers who live in areas with easy access. The latter prefer to use land intensive techniques and they have more means to use chemical fertiliser.

References

CARDER-Atacora. 1993. *Sondage Diagnostic du Departement de l'Atacora.* Centre d'Action Régionale pour le Développement Rural Atacora, Natitingou, Benin.

CARDER-Atacora. 1994. *Enquete de Reference: Deuxieme Projet de Developpement Rural dans l'Atacora*. Centre d'Action Régionale pour le Développement Rural Atacora, Natitingou, Benin

CENAP (1997). *Carte Pedologique de Reconnaissance de la République du Bénin*, Paris.

Faure, P. 1977. *Carte Pedologique de Reconnaissance de la République Populaire du Bénin*. ORSTOM, Paris.

Gandonou, E. 1998. *Impacts De L'histoire De L'utilisation Des Terres Agricoles Sur La Qualité Des Sols: Une Tentative D'évaluation Quantitive Dans l'Atacora (Nord-Ouest Du Bénin)*. Working paper. FSA-UNB, Cotonou, Benin.

de Haan, L. J. 1992. *Rapports Entre Agriculteurs et Eléveurs au Nord Bénin: Ecologie et* . Commission des Communautées Européennes/Université d'Amsterdam, Amsterdam.

Hoefsloot, H., Van der Pol, F., and Roeleveld, L. 1993. *Jachères Améliorées: Options pour le Développement des Systèmes de Production en Afrique de L'Ouest*. Royal Tropical Institute, Amsterdam.

INSAE. 1994. *Deuxième Recensement Général de la Population et de l'Habitation - Février 1992 - la Population de l'Atacora*. Institut National de la Statistique et de l'Analyse Economique, Cotonou, Benin.

MDR. 1992. *Cartes de Sécurité Alimentaire du Bénin.* Ministère du Développement Rural, Cotonou, Benin.

MDR. 1993. *Compendium des Statistiques Agricoles et Alimentaires* (1970-1992). Ministère du Développement Rural, Cotonou, Benin.

MDR/DAPS. 1995. *Document of the Round Table on the Rural Sector*: Ministère du Développement Rural, Cotonou, Benin.

Annexes

Annex 1 Principal causes of soil degradation according to the Atacora farmers per zone

Causes	Number of farmers SOUTH (N=131)		CENTRE (N-146)		NORTH-WEST (N=160)		NORTH-EAST (N=102)	
No soil degradation	12	(9)	2	(1)	0	(0)	2	(2)
Deforestation	59	(45)	96	(66)	108	(68)	54	(53)
Over-exploitation	76	(58)	77	(53)	92	(58)	54	(53)
Bush fires	51	(39)	94	(64)	110	(69)	43	(42)
Lack of fertiliser	40	(31)	77	(53)	84	(53)	25	(25)
Climate	34	(26)	53	(36)	62	(39)	23	(23)
Erosion	27	(21)	58	(40)	51	(32)	28	(27)
Demographic pressure	16	(12)	49	(34)	30	(19)	29	(28)
Overgrazing	11	(8)	48	(33)	30	(19)	29	(28)
Cotton cultivation	1	(1)	10	(7)	7	(4)	27	(26)
Other	3	(2)	8	(5)	28	(18)	11	(11)
Don’t know/no answer	5	(4)	7	(5)	3	(2)	1	(1)

Source: Survey VU-UNB (1995)
N.B.: One farmer could give more than one answer. Percentages are taken with respect to total number of households, not the numbers of answers given.

Annex 2. Farmers' decisions in the Atacora in the event of a (further) decline in soil fertility of their cultivated land.

2a: South (N=131)

First option	Second option	Number of farmers		Third option	Number of farmers	
Put under fallow n=41	Re-use fallow Invest	20 15	(49) (37)	Invest Less demanding crops Reuse fallow	10 8 2	(24) (20) (5)
Expand n=33	Invest Put under fallow Others	11 3 2	(33) (9) (6)	Invest Reuse fallow Put under fallow	4 4 3	(12) (12) (9)
Invest n=30	Put under fallow Reuse fallow	8 8 5	(27) (27) (17)	Reuse fallow Put under fallow Extension	3 2 1	(10) (7) (3)

Source: Survey VU-UNB (1995).
NB: The figures in parentheses are the percentages of the farmers of the first column.

2b: Centre (N=146)

First option	Second option	Number of farmers		Third options	Number of farmers	
Put under fallow n=47	Invest Re-use fallow Migration Extension	22 12 5 5	(47) (26) (11) (11)	Invest Re-use fallow Migration	16 8 4	(34) (17) (19)
Invest n=44	Put under fallow Less demanding crops Expand	30 5 2	(68) (11) (5)	Re-use fallow Less demanding crops Put under fallow	12 7 3	(12) (16) (7)
Expand n=19	Put under fallow Invest Other	11 3 2	(58) (16) (11)	Invest Put under fallow Re-use fallow	5 3 3	(26) (16) (16)

Source: Survey VU-UNB (1995).
NB: The figures in parentheses are the percentages of the farmers in the first column.

2c: North West (N=160)

First option	Second option	Number of farmers		Third option	Number of farmers	
Put under fallow n=58	Re-use fallow Migration Extension	21 11 11	(36) (19) (19)	Re-use fallow Invest Migration Extend Less demanding crops	11 8 4 3 3	(19) (14) (9) (5) (5)
Invest n=28	Put under fallow Less demanding crops Re-use fallow Expand	10 7 2 2	(36) (25) (7) (7)	Re-use fallow Extend Put under fallow	5 5 4	(18) (18) (14)
Expand n=19	Put under fallow Invest Re-use fallow	7 4 4	(37) (21) (21)	Put under fallow Re-use fallow Invest	5 5 3	(26) (26) (16)

Source: Survey VU-UNB (1995)
NB The figures in parentheses are the percentages of the farmers in the first column.

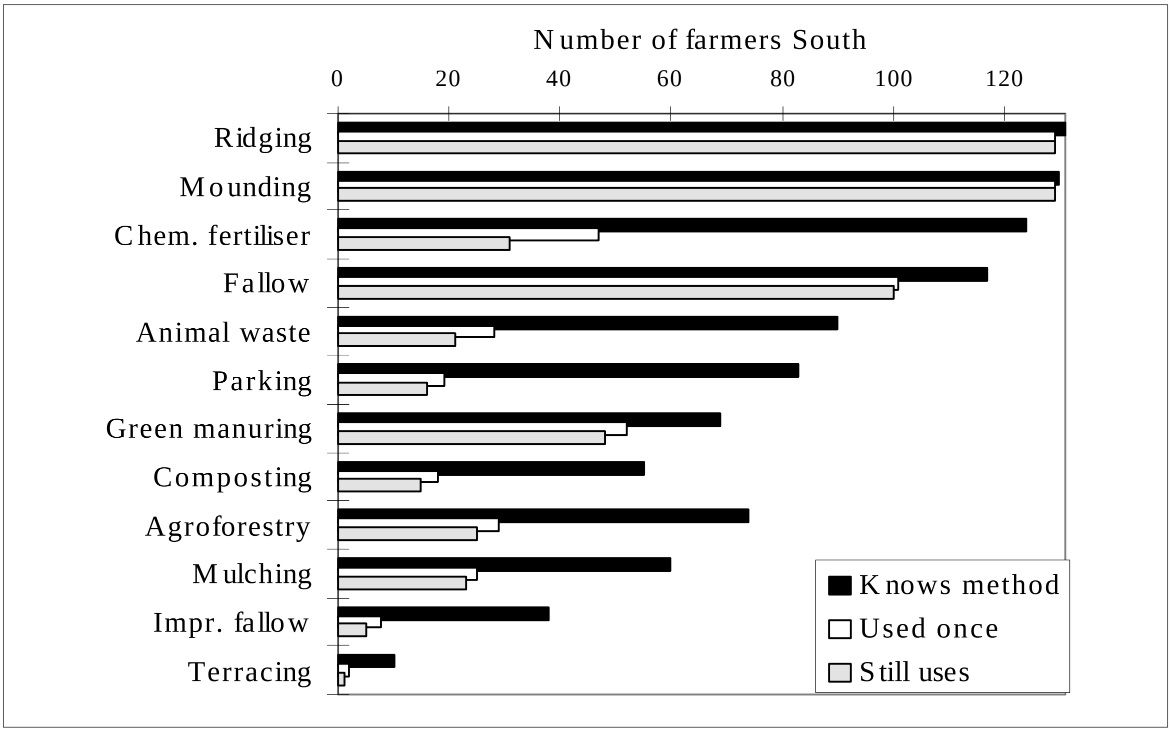
2d: North East (N=102)

First option	Second option	Number of farmers		Third option	Number of farmers	
Put under fallow n=29	Re-use fallow	10	(34)	Invest	8	(28)
	Invest	9	(31)	Reuse fallow	5	(17)
	Extension	5	(17)			
Expand n=22	Put under fallow	12	(41)	Reuse fallow	11	(50)
	Migration	9	(36)	Extension	2	(9)
				Put under fallow	2	(9)
Invest n=20	Put under fallow	11	(55)	Reuse fallow	6	(30)
	Reuse fallow	3	(15)	Put under fallow	5	(25)

Source: Survey VU-UNB (1995).
NB: The figures in parentheses are the percentages of the farmers in the first column.

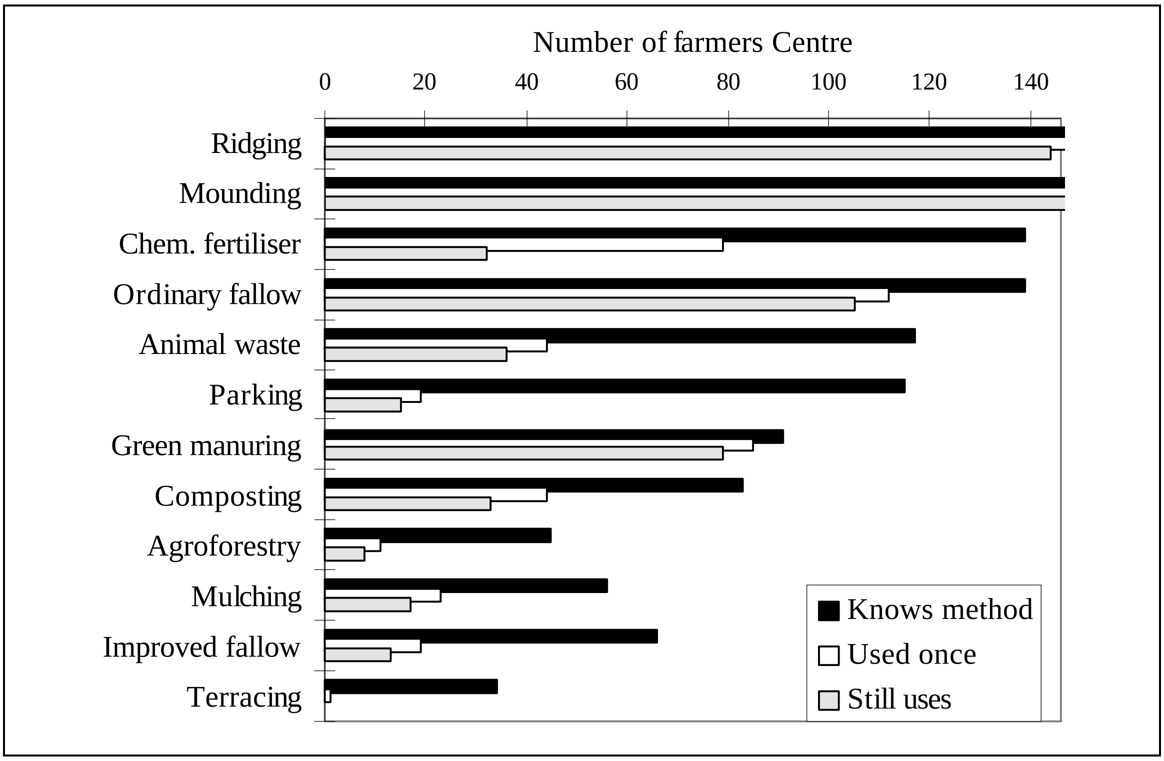
Annex 3. Farmers' knowledge and adoption of methods to maintain or improve soil fertility in the Atacora.

3a: South (N=131)



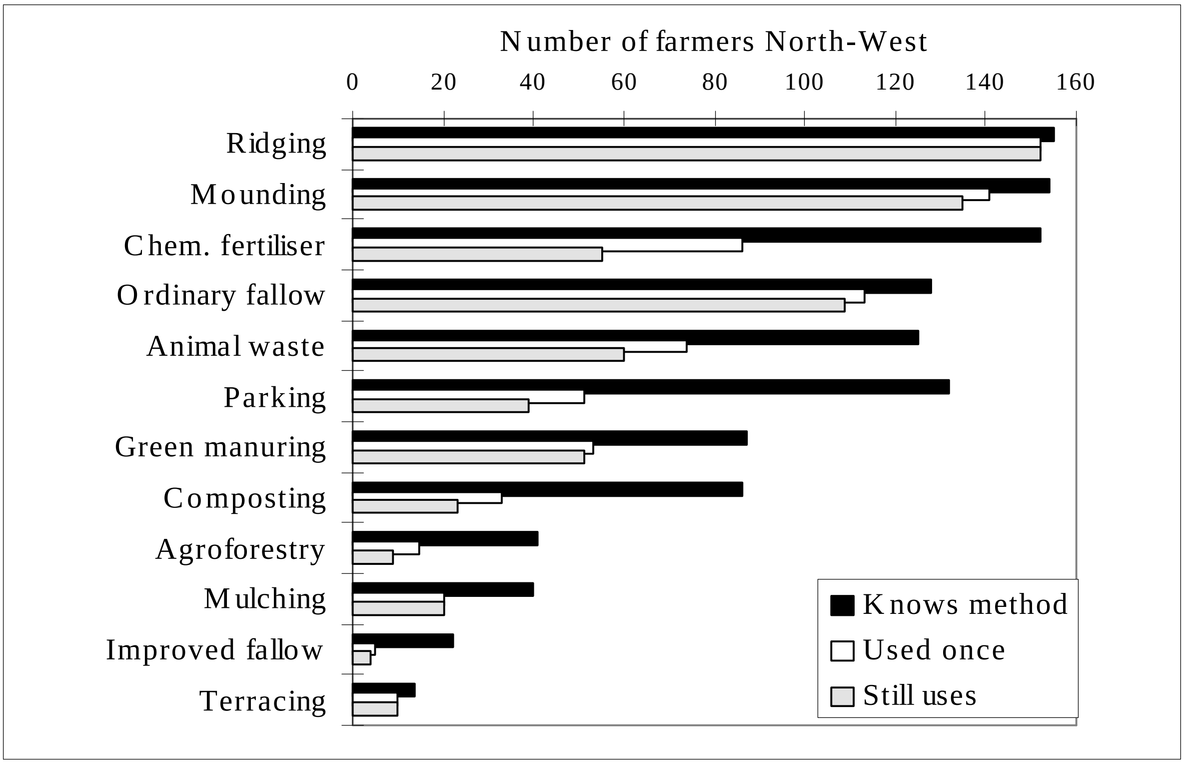
Source: Survey VU-UNB (1995)

3b Centre (N=146)



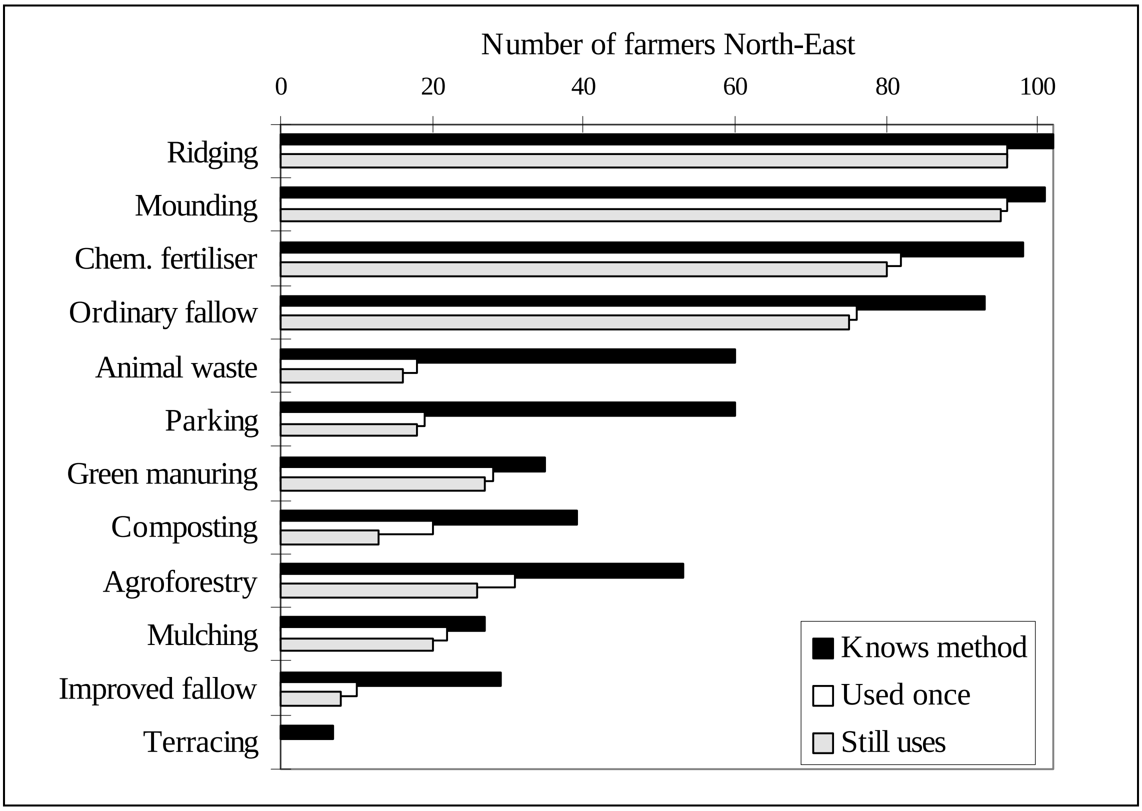
Source: Survey VU-UNB (1995)

3c North West (N=160)



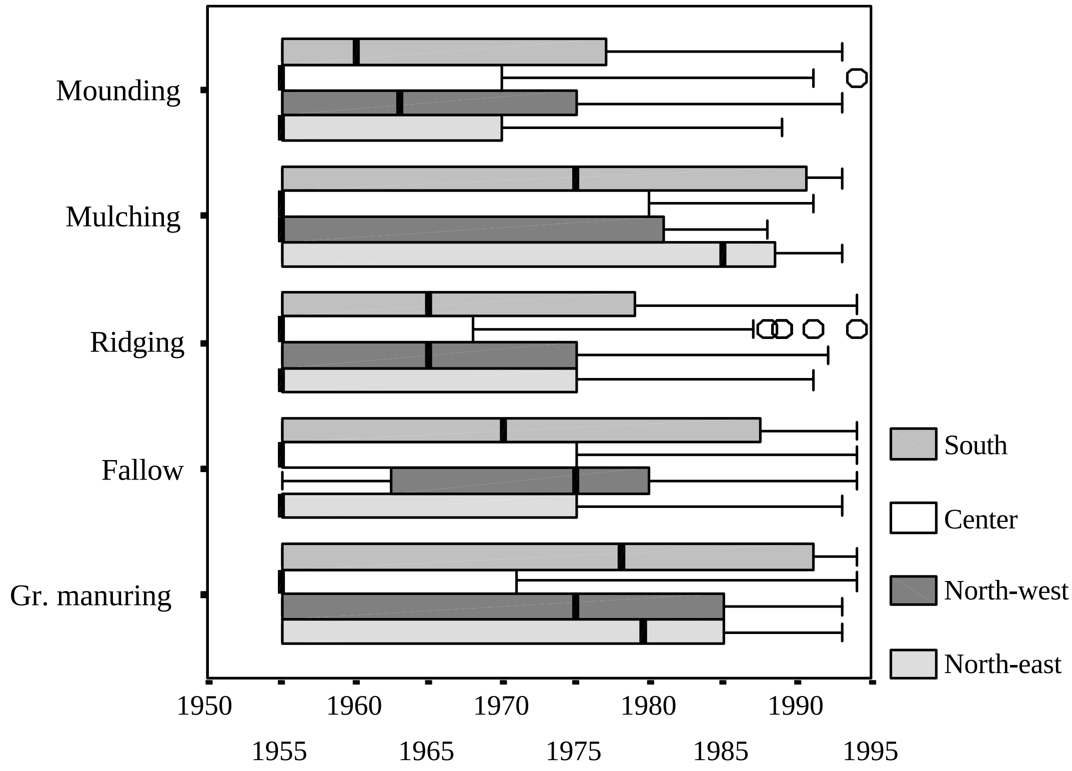
Source: Survey VU-UNB (1995).

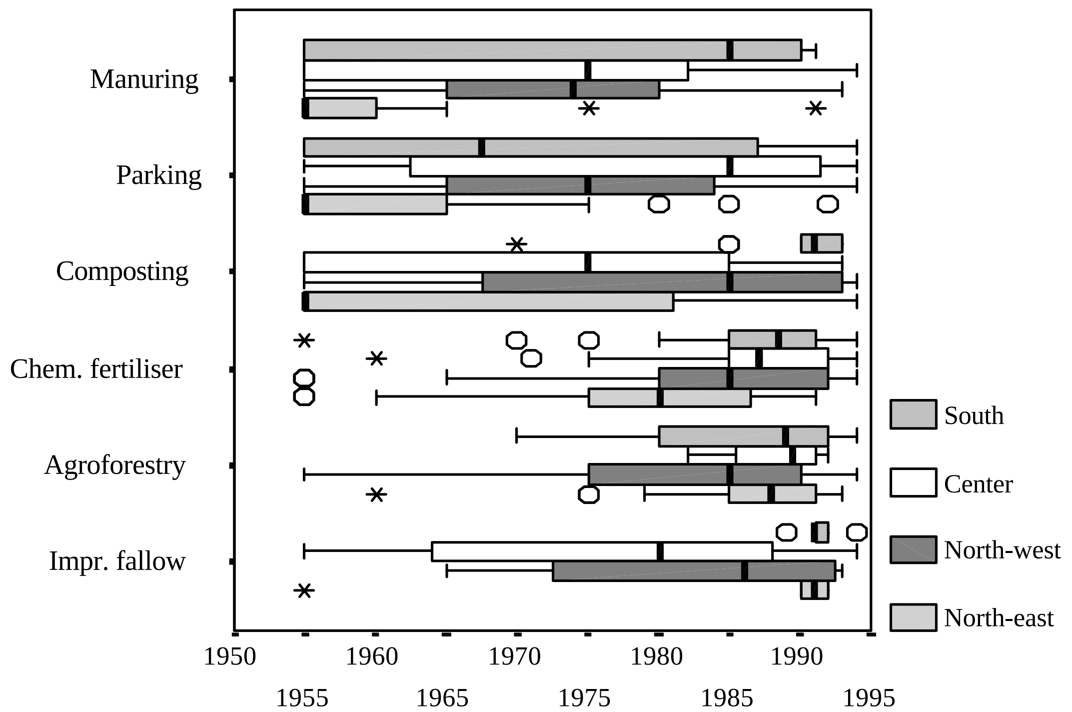
3d. North East (N=102)



Source: Survey VU-UNB (1995)

Annex 4. Years of use of methods to maintain and improve soil fertility





Source: Survey VU-UNB (1995)

Annex 5. Reasons for adopting methods used by farmers in the Atacora (row percentages)

5a. South

Reason --------------- **Method**	**Increased production**	**Fertilisation**	**Avoid erosion**	**For wood/ fodder/fruits**	**Other**	***Obs. N=**
Ridging	39	9	56	0	0	122
Mounding	41	8	54	0	1	123
Ch. Fertiliser	49	49	0	0	2	45
Fallow	16	64	14	5	4	95
Manure	40	50	10	0	0	20
Parking	6	67	28	0	0	18
Gr. Manuring	20	65	14	2	0	49
Composting	41	53	0	6	12	17
Agroforestry	14	21	41	34	7	29
Mulching	17	54	13	0	17	24
Impr. Fallow	50	50	0	0	0	6
Terracing	0	100	0	0	0	1

Source: Survey VU-UNB (1995)
N.B.: Percentages of those that use or have used the method.
* Number of farmers who have responded to the question.

5b. Centre

Reason --------------- **Method**	**Increased production**	**Fertilisation**	**Avoid erosion**	**For wood/ fodder/fruits**	**Other**	***Obs. N=**
Ridging	29	14	50	0	7	139
Mounding	33	16	43	0	8	143
Ch. Fertiliser	63	33	0	0	4	70
Fallow	23	69	2	0	6	104
Manure	37	58	2	0	2	43
Parking	50	50	0	0	0	18
Gr. Manuring	23	62	13	1	0	82
Composting	44	53	0	0	2	43
Agroforestry	20	30	20	30	0	10
Mulching	32	27	14	0	27	22
Impr. Fallow	11	74	16	0	0	19
Terracing	0	0	100	0	0	1

Source: Survey VU-UNB (1995)
N.B.: Percentages of those that use or have used the method.
* Number of farmers who have responded to the question.

5c: North West

Reason -------------- Method	Increased production	Fertilisation	Avoid erosion	For wood/ fodder/fruits	Other	*Obs. N=
Ridging	33	15	49	0	4	131
Mounding	43	10	43	0	3	115
Ch. Fertiliser	62	33	0	0	5	76
Fallow	21	77	1	0	1	96
Manure	31	69	0	0	0	67
Parking	46	54	0	0	0	48
Gr. Manuring	35	65	0	0	0	43
Composting	48	41	0	0	11	27
Agroforestry	23	23	23	8	31	13
Mulching	20	45	25	0	10	20
Impr. Fallow	0	80	0	0	20	5
Terracing	22	22	56	0	0	9

Source: Survey VU-UNB (1995)
N.B.: Percentages of those that use or have used the method.
* Number of farmers who have responded to the question.

5d. North East

Reason -------------- Method	Increased production	Fertilisation	Avoid erosion	For wood/ fodder/fruits	Other	*Obs. N=
Ridging	51	9	36	0	4	85
Mounding	51	7	38	0	4	81
Ch. Fertiliser	51	47	0	0	1	74
Fallow	18	79	2	0	2	66
Manure	0	100	0	0	0	16
Parking	13	88	0	0	0	16
Gr. Manuring	19	81	0	0	0	26
Composting	13	53	0	0	33	15
Agroforestry	14	24	7	55	3	29
Mulching	11	63	21	0	5	19
Impr. Fallow	11	67	0	11	11	9
Terracing	-	-	-	-	-	0

Source: Survey VU-UNB (1995)
N.B.: Percentages of those that use or have used the method.
* Number of farmers who have to responded the question.

Annex 6a. Reasons for not using land intensive and anti-erosion techniques (column %)

	Agroforestry	Impr. Fallow	Fallow	Mulching	Terracing
South					
Too much work	44	38	7	34	38
Not enough land	5	0	7	0	0
Too expensive	9	38	0	0	0
No advantage	12	0	7	49	13
Not suited for my land	14	3	7	17	50
Lack of plants	5	0	0	0	0
Enough land	0	3	43	0	0
Borrowed terrain	5	0	7	0	0
Just starting	2	0	7	0	0
Destruction by straying cattle	0	14	0	0	0
Other	5	3	14	0	0
n	51	45	17	37	9
No-response %	16	36	18	5	11
Centre					
Too much work	41	41	6	89	19
Not enough land	0	4	77	0	0
Too expensive	5	39	0	0	0
No advantage	14	6	6	3	13
Not suited for my land	8	2	0	0	68
Lack of plants	16	6	0	0	0
Enough land	3	0	0	0	0
Borrowed terrain	5	2	6	0	0
Just learned	5	0	0	0	0
Other	3	0	3	8	0
n	39	55	34	39	15
No-response %	5	7	9	8	8
North-west					
Too much work	34	27	0	47	0
Not enough land	3	7	88	0	0
Too expensive	16	33	0	0	0
No advantage	13	20	0	11	0
Not suited for my land	6	0	6	37	50
Lack of plants	9	0	0	0	0
Other	19	13	6	5	50
n	33	21	19	20	4
No-response %	3	29	11	5	0
North-east					
Too much work	36	42	0	57	0
Too expensive	28	47	0	0	0
No advantage	0	0	71	29	0
Not suited for my land	0	0	18	14	100
Just learned	24	0	0	0	0
Destruction by straying cattle	0	5	0	0	0
Other	12	5	12	0	0

n	27	23	18	7	7
No-response %	7	17	6	0	0

Source: Survey VU-UNB (1995)

Annex 6b: Reasons for not using/abandoning manuring techniques (column %)

	Green manuring	Compost	Chemical fertiliser	Animal manure	Parking animals
South					
Too much work	79	82	3	69	15
Too expensive	11	3	95	2	22
Lack of cattle	0	3	0	26	60
No advantage	11	6	0	2	2
Not suited for my land	0	3	1	2	0
Just learned	0	3	0	0	0
Not available in the market	0	0	1	0	0
Theft (of animals)	0	0	0	0	2
N	22	43	94	69	67
Non response %	14	21	21	16	10
Centre					
Too much work	42	71	0	67	18
Too expensive	17	2	98	3	15
Lack of cattle	0	0	0	27	58
No advantage	25	2	0	1	4
Not suited for my land	8	6	0	1	1
Just learned	0	12	0	1	1
Difficult	8	4	0	0	0
Theft (of animals)	0	0	0	0	1
Other	0	2	2	0	2
N	14	51	107	81	100
Non response %	14	4	7	7	4
North-west					
Too much work	48	49	1	24	10
Too expensive	0	4	97	0	6
Lack of cattle	0	11	0	59	80
No advantage	14	5	0	7	0
Not suited for my land	10	0	1	3	0
Just learned	7	7	0	0	0
Difficult	7	11	0	2	0
Lack of transport	0	2	0	2	0
Theft (of animals)	0	0	0	0	1
Other	14	11	1	3	4
N	40	65	97	65	94
Non response %	28	15	5	11	11
North-east					
Too much work	75	70	0	50	21
Too expensive	13	4	72	3	5
Lack of cattle	0	9	0	20	59
No advantage	0	4	17	3	0
Not suited for my land	0	9	6	0	0
Just learned	13	0	0	0	0
Lack of transport	0	4	0	23	10
Other	0	0	6	3	5
N	9	27	18	44	42

Non response %	11	15	0	9	7

Source: Survey VU-UNB (1995)