Institutional context of soil information in Benin

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List of abbreviations

AIC	:	Inter-professional Cotton Association
ANAF		National Association of Women Farmers
ATDR	:	technical officer of rural development
BMZ	:	German Federal Ministry for Economic Cooperation and Development
CAGIA	:	Cooperative supply and management of agricultural inputs
CAI	:	Central Supply of Inputs
CARDER	:	Regional Action Center for Rural Development
CCIB	:	Chamber of Commerce and Industry of Benin
CCRB	:	Collaborative Council of Benin Rice Farmers
CDR		rural development adviser
CEBEDES	:	Beninese Center for Environment and Economic and Social Development
CeCPA	:	Communal Center for Agricultural Promotion
CEDEAO		Economic Community of States from West Africa
CENATEL	:	National Remote Sensing Center of Ecological Monitoring
CeRPA	:	Regional Center for Agricultural Promotion
CIC	:	Commission Cotton Inputs
CNIDIC	:	National Council of Importers and Distribution of Cotton Inputs
CNOS	:	National Steering and Monitoring Committee
CRA	:	Agricultural Research Center
DAFoP	:	The Directorate TEACH
DAGRI	:	Directorate of Agriculture
DANIDA	:	Danish Technical Cooperation
DET	:	Technical Education Branch
DGDDI	:	General Directorate of Customs and Indirect Taxes
DIP	:	Information and Pre-Archive Department
DPDR	:	Rural Development Policy Statement
DPLR	:	Promotion of Rural and Legislation Directorate
DPP	:	Directorate of Programming and Forecasting
DPSP	:	Directorate of Programming Monitoring and Forecasting
DPV	:	Production Plant Directorate
FAO	:	Food and Agriculture Organization of the United Nations

FA-UP	:	Agricultural Faculty of the University of Parakou
FNAPAB	:	National Federation of Cashew Producers of Benin
FSA/UAC	:	Faculty of Agricultural Sciences/University of Abomey Calavi
FUPRO	:	Federation of Unions of Producers of Benin
GCPV		group of foodstuffs traders
GDT		(gestion durable des terres) sustainable land management
GIFS	:	integrated management of soil fertility
GIZ	:	German Technical Cooperation
Ha	:	hectares
IDI	:	Importer and Distributor of Inputs
IDR	:	Rural Development Engineer
IFDC	:	International Institute for Management and Soil Fertility for Africa
IFS		Initiative for Soil Fertility
IITA	:	International Institute of Tropical Agriculture
IMF	:	Microfinance Institution
INRAB	:	National Institute of Agricultural Research of Benin
INSAE	:	National Institute of Statistics and Economic Analysis
LAMS	:	Medji Sekou Agricultural High School
LDPDR	:	Letter of Rural Development Policy Statement
LSSEE	:	Soil Science Laboratory of Water and Environment
MAEP	:	Ministry of Agriculture, Livestock and Fisheries
NERICA	:	New Rice of Africa
OMD	:	Millennium's Objectives for Development
ONASA	:	National Office of Support for Food Security
OPA	:	Professional Agricultural Organization
PAGER	:	Draft Income Generating Activities
PAPA	:	Agricultural Policy Analysis Program
PAPME	:	Support Program for the Promotion of Micro-Enterprises
PNIA		National Agricultural Investment Plan
PNOPPA	:	National Platform of professional organizations and Agricultural Producers
PSO	:	Strategic Operational Plan
PSRSA		Strategic Plan for Agricultural follow-up Sector
PTF	:	technical and financial partners
PUASA	:	Emergency Support Program for Food Security
RECAB	:	Network of Agricultural Chambers of Benin
REDAD	:	Network for the Development of Sustainable Agriculture
SCRP	:	Strategy for Growth and Poverty Reduction
SDDR	:	Urban Development Plan (Rural development blueprint)
SONAPRA	:	National Company for Agricultural Promotion
SNCA	:	National Strategy for implementation of the Agricultural Council
SRCV	:	Research Station on Foodstuffs Crops

UAC	:	University of Abomey Calavi
UAK	:	Agricultural University of Kétou
UCP	:	Communal Union of Producers
UCPM	:	Communal Union of Maize Producers
UEMOA	:	West African Economic and Monetary Union
XOF	:	*Communauté Financière Africaine* (BCEAO) Franc West African CFA franc

Abstract

The International Center for Tropical Agriculture (CIAT), a member of the Consultative Group on International Agricultural Research (CGIAR), carried out a research study on the institutional context of soil information in Benin.

It aimed to analyse the institutional context for soils research and investment, to describe the institutional arrangements for agricultural soils in Benin and identify the institutional arrangements that support or impede soil management that could be recommended for farmers.

The research study focused on analysing policies and legislation available on soils and its integration into the governance structure in Benin.

The methodology consisted of a review of the literature by examining some key documents in the context of soils in Benin and a field visit with ministries, departments, training institutes and implementers of agricultural programmes to gain a better understand of the context in Benin.

In Benin, tropical ferruginous soils are prevalent, covering more than 9 million ha or 82% of the total area of the country; these are the zones with strong agricultural potential covering North Zou and Borgou-South and Centre and southern Atacora.

INRAB, the principal agricultural research agency of Benin represents nearly 60% of capacity and investment in research and development (R&D) in the agricultural sector of the country.

In all of the different agro-ecological zones, the soil fertility levels are: high, medium and low. The inventory studies and large-scale soil surveys (00, 1/20, 1/50,000) are usually carried out by ORSTOM (French Institute of Scientific Research for Development Cooperation) and CENAP (National Center for Agro-Pedology, currently LNSEE). Generally, producers find these maps difficult to use.

Declining soil fertility and the lack of a specialized agency for credit in agriculture are real difficulties experienced by farmers in Benin. The most used soil restoration practices are essentially fallow, crop rotation, direct rotated park, mulching and inputs of fertilizer minerals or organic fertilizer in the form of manure or compost.

Endogenous practices of assessment of soil fertility or the potential production of plots and exploitation of fields exist are summarized in the first year of cultivation of the land e.g. the productivity of successive cultures throughout the seasons, weeds and the appearance of indicator species of low production capacity and the ability of the soil to hold water, etc.

Agricultural production systems are attached to traditional systems of shifting cultivation, with their own assessments of the level of soil fertility (without the use of soil analysis in laboratories) and face a significant decrease in land reserves due to increased population densities and expansion of cash crops such as cotton.

The study shows a disorganization of inputs apart from the cotton sectors. Cotton has high marketing collateral with known prices; other sectors are not organized as food prices are not the object of support and marketing of food products is atomized. This situation means that producers tend to use some fertilizer for cotton in favour of food crops. The fertilizer market in Benin is mainly characterized by its segmentation between cotton fertilizers and fertilizer outside of cotton. Private sector participation in the import and distribution of fertilizers is about 30%.

According to the stakeholders' forum organized in 2013 in Ghana, the rate of fertilizer use in 2011 in Benin was estimated at about 6.3 kg/ha. The country imported more than 12,000 tonnes (t) of fertilizer in 2011 and more than 1,000 t in 2010. Among the key challenges facing the fertilizer industry in the country is: limited access to credit, small network of distributors of agricultural inputs, poor road and port infrastructure, and an informal intervention fertilizer subsidy. Professional agricultural organizations are weakly involved in the distribution of fertilizers.

Since the campaign in 1999–2000 and after the withdrawal of the government in the supply and distribution of inputs, SONAPRA withdrew from this activity and the private sector took over through cooperation and supply of Management of Agricultural Inputs (CAGIA) with the support of private Importers Distributors Inputs (IDI).

Over the past 6 years, public expenditure in agriculture has increased from XOF 29.5 billion in 2011 to over XOF 60 billion in 2013. Private investment in this sector has constantly increased over the past 6 years; since 2011, the growth rate has accelerated with a record of nearly 55% in 2013. This reflects the private commitment to support the government's efforts to revive the agricultural sector in Benin.

The current agricultural policy of Benin has been implemented since 1991 with the adoption of the *Letter of Rural Development Policy Statement (LDPDR)* in July 2001 with the *Master Plan for Agricultural and Rural Development (SDDAR)* designed and made operational with the development of the Operational Strategic Plan (PSO) as an agricultural strategy documents. In 2002, Benin developed its national strategy *Reduction of Poverty (2003–2005*). In this document, the constraints in agriculture such as soil degradation and loss of soil fertility were highlighted.

Benin registered in 2002 in the process of the New Partnership for Africa's Development (NEPAD) with its detailed programme of agricultural development in Africa (CAADP) launched in 2003 and is a continental vision agricultural development translated into a development programme driven by African agriculture. The Agricultural Investment Plan (AIP) that follows is supported both technically and financially by ECOWAS. This process, taking as an essential basis of the *Agricultural Sector Recovery Strategic Plan (PSRSA)*, ensures the coherence of policies, strategies and programmes at the regional level.

The management of soil fertility is part of the operational strategic plan and is being integrated as the fifth component of the Support Programme for the Agricultural Sector and Rural Organizations (PASAOP).

Diagnosis of soil fertility management technologies identified alley cropping with *Leucaena* and *Cajanus* and cover plants with *Mucuna* initiated by the IITA programme. Alley cropping has not been successfully adapted by farmers and now research advocates growing crops in alternating strips. *Mucuna* was popularized in the south, beginning in 1990.

The use of rock phosphate (crushed limestone of Benin or *fines* of Togo) was used instead of using compost or manure, which resulted in modest results.

Providing stables on successive layers of crop residues or periodically making bush herbs were highlighted. Another technology recommended by cotton research to allow the return of cotton stalks in the north was to graze the cotton fields at the end of the harvest until the end of the dry season. The fields are cleared, livestock are located on further feed units and there is some restitution by the livestock faeces (manure) going back into the soil.

The rotation techniques based on legume uses and forage plants were also tested (*Stylosanthes*, fallow-based ameliorative herbaceous plants), cover plants (tests with oil palm and in other crop systems) and trees shrubs in agroforestry (*Acacia auriculiformis*) or simple association crops (maize, sorghum, groundnuts fighting against striga). The crop-livestock integration through these tests does not mobilize farmers despite interesting initiatives of certain producers (in the northern regions). As against the cultivation techniques and tillage erosion control devices contour, IWRM practices around water points etc. have been recommended.

A National Strategy for Agricultural and Rural Education was developed to allow agriculture training schools to be in line with the changing needs of users in terms of their curriculums. Based on that, ten agricultural technical schools and three higher education universities around the country provide initial training with agricultural curriculums that address the theme of soil.

The contribution of higher education in agricultural R&D in Benin has gradually increased since the 1990s, from 23% in 1990 to 40% in 2008. This is mainly provided by the University of Abomey-Calavi (UAC), which has reported a growth of agricultural R&D.

In its new vision of development of the agricultural sector, the Government of Benin focuses on the agricultural value chains sectors with high added value. However we should include soil fertility issues based on sustainable production and we should integrate the soil conservation programme and land in the national agricultural policy.

Introduction

The International Tropical Agricultural Center, (CIAT in English), is an international research organization with a non-profit goal that conducts research in the social and environmental domains in order to fight against hunger and poverty and to preserve the natural resources in developing countries. As a member of the Consultative Group on International Agricultural Research (CGIAR), CIAT has obtained a subsidy to implement a project financed by the German Federal Ministry for Economic and Development Cooperation (BMZ) on soil

protection and rehabilitation for food security that aims to restore soils in the four African countries of Benin, Burkina Faso, Ethiopia and Kenya.

This project aims to restore degraded soils and support the development of policies addressing rehabilitation, soil information and the extension system.

This study aims to assess the state of research on soils and investments in the four countries previously mentioned. This current study reports on the institutional context of Benin in terms of information about soils.

The soil constitutes the most precious heritage and factor of production in agriculture. However, we witness a more and more accelerated degradation and a decrease of the fertility of the soil, leading to drastic profit decrease.

Because of the rapid demographic growth in the south of Benin (250 to 300 inhabitants per km^2) during the last two decades, the soils need to produce more in order to provide for the rural and urban populations which are becoming larger and larger. The rotational slash-and-burn farming was practiced in the past because there was enough land available (low population density, active low numbers of people involved in farming). This allowed the practice of the natural fallow of long duration (i.e. 10–15 and up to 20 years depending on the situation) for the generation of the land but with recent demographic growth, this practice is now impossible.

Because of this, traditional farming is not sustainable, according to IGUE (1990). The land is exposed to continued exploitation and therefore continued degradation. The ferralitic (red) soils, according the French classification, in the south of Benin have lost their agricultural capacities in certain zones, particularly in the Tableaus of Adja, Sakede and Abomey due to their overexploitation and their state of advanced degradation (BIAOU, 2000).

For a long time, the considered solution in order to raise the productivity of the land was the use of mineral fertilizers. But this method proved to be more and more inefficient on certain soils. On ferralitic soils of sandy-clay type (red soils), the use of mineral fertilizers, far from improving soil fertility, led instead to its acidification because of the lack a sufficient stock of humus, according to IGUE (1990).

To address this problem of a decrease in soil fertility, the national and international research institutes have developed several systems in order to restore the fertility of these soils. These systems include: agroforestry; mineral manure combined with management of waste from crops; the improvement of endogenous practices such as crop rotation or the association of the grain crops with leguminous plants on the same land; and the management of household waste.

Studies by Versteg and Koudokpon (1990) on farmers' practices for the restoration of soil fertility in the department of Couffo are relevant to this discussion.

Glitho (2001) on the evaluation of the level of fertility of the soils with the cowpea plant in diverse agro-ecosystems in the valley of Oueme, found that pH, the addition of exchangeable bases, total nitrogen and the available phosphorus, increased following treatment with a clear improvement in the case of mulching. The restoration of soils is necessary to increase productivity in a sustainable way.

The project "Integrated Management of Soil Fertility" (GIFS), initiated by the International Center for the Management of Soil Fertility (IFDC) in the Tableau of Adja and Sakete uses the symbiotic potential of the leguminous plants (*Mucuna* and *Aeshynomene*) in farming systems in Benin with the aim of restoring the fertility of the soils. However there are certain constraints, such as the lack of opportunity to consume or commercialize the grains of *Mucuna* and the loss of the cycle of farming evoked by the producers of Ahohoue in Klouekanmey community (department of Gouffo) in the south of Benin where farmers have adopted the GIFS technology.

The current study will be structured around the following points:

- Generalities on the soils in Benin
- An assessment of the level of integration of management soil fertility in development policies and strategies
- The consideration of the management of soil fertility in R&D
- Evolution of the systems of agricultural popularization
- The offers and demands for fertilizers and institutional and political obstacles to access fertilizers
- The consideration of soil management in the training curriculums
- Investments by the Government of Benin and private organizations in the agricultural sector
- Innovations undertaken by the Government of Benin.

1. Background

Agriculture is the main source of livelihood and income for two-thirds of Africa's population (IFDC, 2006). Cultivation without sufficient replenishment of extracted nutrients for decades is the major driver of soil fertility degradation. Limitations in organic matter and other key nutrients hugely constrain agricultural production. Population pressure and climate change exacerbate the condition of soils in the region, whereas soils in semi-arid zones are particularly vulnerable. Loss of soil fertility has caused average yields of grain crops in sub-Saharan Africa to stagnate at around 1.5 tonne (t) per hectare since the 1960s, while fertilizer use has remained at around 10 kg/ha of cultivated land over the past 40 years. Maintaining or

rehabilitating soils to increase agricultural productivity is one of the key entry points to tackling hunger worldwide.

The purpose of this project is to provide research and analysis that will support roll-out and implementation of large-scale soil rehabilitation efforts within German bilateral programmes. Bilateral BMZ programmes have been dealing with soil management issues for many years and recently BMZ has initiated a global programme on "Soils for Food Security". This programme will invest in rehabilitation of degraded soils and support policy development on soil rehabilitation and soil information and extension systems in Benin, Burkina Faso, Ethiopia and Kenya.

The scope of work for this consultancy was to analyse the institutional context within which soils research and investment takes place. In most rural zones of sub-Saharan Africa, soil data to analyse key soil properties is still lacking in farmers' fields. Soil sampling and analysis is costly and often not well organized; farmers usually do not have the means to pay for such analyses. Governmental advisory services are weak and either do not offer soil analysis or do not have the capacities to do such analysis at a scale required to make a significant impact. Farmers have a significant and often sophisticated knowledge of soil quality in their fields but lack access to the means to improve their soils. They are constrained from applying new knowledge and techniques by cost, a distrust of the promoted products, or the perception that ultimately these products will not help their soils. Thus, there are significant institutional challenges surrounding access to knowledge and inputs and delivery of quality products.

2. Objectives

The main objectives of this consultancy are to:

- Analyse the institutional context within which soils research and investment takes place

- Describe the institutional arrangements surrounding agricultural soils in Benin and identify which institutional arrangements support or impede effective soil management techniques recommended for farmers

- Analyse policies and legislation available on soils, its integration into governance structures, etc. in Benin.

Expected results and deliverables

- Focused questionnaires and data collection guides

- Field visits
- The institutional context within soils research and investment takes place is described and analysed
- A final report is produced with the main items analysed.

3. Methodology

3.1 Targets

Target 1. Review the literature and examine the different documents, policies and legislation in the different policy documents on soil.

Target 2. Field visits – interviews and examination of the different policies in place on soil in Benin

Target 3. Reports and outlines

3.2 Implementation process and research activities

Step 1. Preparation and review of the available documentation

During this first step, the consultants met and carried out some Skype calls with CIAT staff to gain a better understanding of the expected results of the study. They conducted interviews and reviewed literature, documents (legislation and policies on soils in Benin) and reviewed some previous studies in the subject.

The review of the documentation took place as part of the investigations of policies on soils, including the curriculums of the training institutes, etc.

This first step was focusing on the following activities:

- Organizing some preliminary discussions with resource persons in the different institutions (projects on soil and land-use system) and key persons who implemented soil management in Benin

- Gathering some documentation with projects and development/programmes, government institutions and research institutes to establish the state of art on soil and land use.

Step 2. Elaboration of the interview guide

The consultant and his assistant carried out some interviews. They designed an interview guide for each stakeholder and actor to collect their perceptions as well the institutional context of soil information in Benin.

Several stakeholders were part of the investigations process; they consisted of:

- Government and administrative actors;
- Government institutions and the different ministries on agricultural and soil management at the national, regional and local levels and environment and natural resources management in Benin;
- Farmers/farming actors;
- Students and resource persons/managers in schools, training institutes and universities and researchers around the country, etc.
- Managers of development projects on soil management;
- Civil society actors and non-governmental organizations (NGOs).

The following list of questions (not exhaustive) were integrated into the interviews guide:

- An overview of how soils are integrated into agricultural planning and implementation at the national, regional, district and local levels.
    - Soil fertility and soil degradation including into national policy and strategy documents on agriculture and food security? And if so, what steps and implementation plans are proposed to improve conditions in the country?
    - Sustainable soil management part of the curriculum in the training institutes for agricultural extension officers?
    - Are there any special government initiatives to address soil fertility or degradation issues (integrated soil fertility management schemes [ISFM]; fertilizer subsidies; PES; special loan schemes, etc.)? – probe this more as many countries have fertilizer subsidies; go a step further to ask if there is anything beyond subsidies
    - Do civil society institutions include soil issues in their programmes? If so, what and how?

- Mandatory policies, National legislation, legislation and incentive schemes, soil protection laws, etc.
- How do farmers get access to fertilizers and information about soil management options?
- Are there private service providers for information on soil fertility, fertilizers and information on improved soil management? If so, where?
- What fertilizer mixes are available?

- What are the institutional/political obstacles around improving access to fertilizers and other soil management options? (i.e. resistance to the use of inorganic fertilizer; poor market access/transport networks; black market sales of fertilizers; direction of fertilizer to wealthier clients; dominance of middlemen or brokers, unacceptable trade-offs/failure of soil conserving practices such as conservation agriculture or integrated soil fertility management (ISFM), etc.).

- What is the level of technical knowledge in a) key training institutes and in b) rural extension personnel throughout the country? What is the number of extensions agents throughout the country? What is the average number of farmers they serve?

- Is there knowledge of farmer soil management strategies at the level of national training institutes? Is this knowledge, if it exists, fed into the curriculums of these institutes?

- What new and innovative initiatives are active in the country related to deliver of soil information and recommendations to farmers?

Step 3. Field visits combined by reviewing some documents

Some focus groups discussions were carried out. Field visits were carried out in Abomey, Cotonou, Natitingou, Parakou, Porto Novo and meetings were organized with research institutes, governments and private universities, ministries and key informants at national, departmental and regional levels dealing with soil conservation, agricultural and environment. The interviewees' were selected from government, administration, environmental and agricultural agencies, as well as NGOs and advisory services.

Step 4. Analyse the preliminary results and production of an "*aide-mémoire*"

The first findings of the research were elaborated under an "***aide-mémoire***" by the consultants.

Step 5. Draft report elaboration

A draft of the report was finalized after analysing the data, combined with the literature review.

Step 6. Preparation and restitution of the results

The consultants planned to do a presentation of the research results for the study sponsors and the representatives of the institutional offices, officials and technical partners, government and administrative actors and some key farmers, to share the main findings of the study.

Step 7. Final report elaboration and submission

The global report will be finalized after the comments and suggestions are taken into account. The consultants will send it to the sponsor of the study.

4. The soils of Benin

4.1 Agro-ecological zones

The country is divided in eight agro-ecological zones (ZAE) from the north to the south that we can globally analyse at the level of soil fertility management issues in the following ways:

(i) in the south:

- The Tableaus with a high population density, two rainy seasons and a rainfall gradient from east to west on deep soils but with low fertility and degraded soils as a result of continuous farming. In this area there are oil palm tree plantations and subsistence farming. In the three departments of the south and the south of the department of Zou, the land area covers 780,000 ha.

- The area of the depression of vertisols of Lama, with a high potential, farmed by the community of Holli using manual techniques but being farmed by private companies by mechanized means which have risks of soil degradation, difficult to exploit and maintain but rich with a high potential of subsistence production. The farmable surface area is about 150,000 ha with a rural population of 50,000 inhabitants.

- The area of alluvial soils along the valley of Oueme, of mono and their tributaries. These soils are naturally fertilized by the contribution of the water but with the limits of enhancement due to periodical flooding. This area produces subsistence crops (corn) but also some market gardening (tomatoes, peppers). It is characterized by a high population density, real estate problems related to the ownership and right of exploitation, a speculative real estate market, difficulties of intensive reclamation (hydromorphic and peaty soils) and small exploitation. The farmable surface areas exceeds 200,000 ha.

- The area of sandy land of coastal strip which expands on about 50,000 ha, covered with coconut plantations, with two rainy seasons. The land supports a large human population. The pressure of urban demand for land competes with farming. Market gardening is commonly practiced. The population of these last two zones is estimated at more than 400,000 people.

(ii) In the Centre transition area

The problems with the land area in the centre are the same as those of the land area in the south. The area is marked by the progressive passage of a regime of two rainy seasons to one season. The area is on the border of the department of Zou and the south of the department of Borgou. We can distinguish:

- The area of ferruginous soils with a high settlement coming from the south of Zou, characterized by farming system based on yams grown with cassava and cotton; it is a buffer zone between the agricultural zones, with a possibility of fallow and the large forests whose priority is the long-term management of real estate reserves and natural resources. The population density is a lot lower than in the south. We notice a more or less old type migration.

- An area of gulley land has priority of protection against floods, as well, the management of the fertile solis of all bordering it. The population density is low but the real estate problems about the rough area are of great importance. The estimated surface area in the rough area is close to 100,000 ha.

(iii) In the North:

The problems of development of gullys can be linked to those of the Centre area with a characterization different from land reclamation (rough zones assisted but not arranged). There are:

- The peri-urban zones of Borgou is more densely populated and has limited farmland from 15 to 20 km and uses a lot of mineral fertilizers. The evolution of the ferruginous soils is linked to cotton farming in rotation with subsistence agriculture. We can note a high concentration of prestige breeding in some cases;

- The cotton farming area with animal-drawn farming on ferruginous soils is in a less densely populated area and an area settled by migrants from Atacora; the sustainability and the stabilization of these systems of production are the first constraints to fertility management;

- The area of the extreme north covers the Niger and the Sota valleys, with existing hydro-agricultural zones or in progress. Small irrigation is also practiced in that area. It is an agro-pastoral and transhumance area. The Tableaus are reclaimed with basic systems of grains that are transformed by the introduction of corn. We observe a degradation of rainfall conditions. The fertility conservation poses some problems. The enhancement of the zones leads to real estate problems. The intensification and the double farming requires a follow-up of the fertility of the soils.

- The area of hilly landscape in Atacora is an area that has been settled for a long time and is an immigration zone. In that area, a subsistence-oriented system is practiced. The rainfall high causes intense erosion. The Tanguieta area is a plain area of degraded fallow with a rainfall of 800 to 900 mm and a population density ranging from low to average low. The subsistence systems are dominated by a livestock breeding zone.

Table 1. Agro-ecological zones of Benin.

Zone number	**A. LOCALISATION**		**B. CHARACTERISTICS**				
	Administrative area	**Departments**	**Climate**	**Soils**	**Vegetation**	**Others**	**Culture/System**
1	Karimama, Malanville, Kandi North	Borgou (Far North)	Sudano-Sahelian has a single rainy season from 700–900 mm per year	-Ferruginous on crystalline basement -Fertile Alluvial of Niger River	Shrubby savannah sparse thorn (*Acacia sieberiana*)	-Zone exposed to severe erosion -PVC ∠140 days	base: Millet, sorghum and cowpea (*Niébé*) Secondary cultures: Cotton, corn, onion and gardening along the Niger rivers, Alibory

2	North -Kérou -East/ Kouandé -Banikoara, South Kandi, Ségbana, Gogounou	-Atacora -Borgou (North)	Sudanese with a single rainy season from 800–1,200 mm per year	Tropical - ferruginous on crystalline basement -High proportion of deep soil and few realized	-Shrubby trees with acacia Savannah (thorny) and (Shea) -Highly degraded by man	1<oday<PCV<180 days PCV = vegetative growth period	Apparition of corn and millet reduction Cotton culture often highly developed at start of rotating First yam growing area **ridging** often practiced
3	.Péhunco . Est-Djougou, North-TchaourounParakou, N'Dali, Pèrèrè, Nikki, Sinendé,	-atacora -Borgou (South)	Sudanese with a single rainy season from 900-1,300 mm	-Tropical ferruginous variable characteristics -Average	Savanna woodland shrub dominated by *Butyrospermum* (Shea)	140days<PCV<189days	Base: Sorghum and yam with strong expansion of cotton and corn Yam at start of

	Kalalé, bembèrèkè		per year	Fertility -Very sensitive to leaching			rotation **Sarclo** hilling often practiced
4	Ouakè, West-Djougou, Copargo, Tanguiéta, Matéri, Kobli, Boukoumbé, Natitingou, Toukountouna, Kouandé	Atacora	- Variation of Sudano-Sahelian to Sudano-Guinean Annual rainfall measures = 800–1,300 mm	-Ferruginous often on deep base -Low water reserve -Fertility except shallows level	-Forest clear gallery -Savanna wooded/ shrub with *Butyrospermum* (Shea) and parkia (cheese monger) -Thorny (Acacia in Boukoumbé regions + Tanguiéta)	.Zone homogeneous 1, 2 and 3 with a palette of more comprehensive crops 180 days<PCV<220days	important cowpea (*Niébé*) -Fonio especially at Boukoumbé -Yam, sorghum Groundnuts, manioc -Voandzou, rice -Cultures In tied ridges on the

							hillside -**Culture on bunds** on low terraces
5	-Bassila -Tchaourou-South -Aplahoué -Kétou -Bantè, Glazoué, Ouessè, Savalou, Dassa, Savè, Djidja	-Atacora -Borgou -Mono -Ouémé -Zou	-Soudano Guinea with two rainy seasons in the south and a rainy season in the North Rainfall = 1,000–1,200 mm per year	Tropical - Ferrugineux on crystalline basemen -Very variable characteristics	Savannah wooded/ shrub dominated by *Danifiaohiori*	-PVC<240 days	real dominant - without 2nd season for maize, cowpeas and groundnuts -Peanut + cotton are important places -Cotton at start of rotating -Weeding mounding practice with more **ridging**

6	-Allada, Zé, Tori, Bossito, Kpomassè, Djakotomè, Toviklin, Klouékanmè, Bopa, Dogbo-Tota,Houeyogbé -sakété, Ifangni, Avrankou, Adjarra, Akpro-Missérété, Porto-Novo -Agbangnizoun, Abomey, Bohicon, Za-Kpota, Covè, Zagnanado, Zogbodomey	-Atlantique -Mono -Ouémé -Zou	-Soudano Guinea with two rainy seasons -800–1,200 mm per year in the west -1,000–1,400 mm per year in the east	-Bar on continental land terminal -Deep and easy to work -For most currently degraded	-Mainly anthropogenic: stuffed dense shrub where oil palm and grasses are dominated -Existence of some forest relics in some places	-No mineral and organic refunds -PCV = 240days	-Main cultures = maize (at start of rotation). groundnut and manioc -yam disappearance -Abundant presence of oil palm + palm wine -Cotton presence in some drier localities -Western culture dish and ridging east

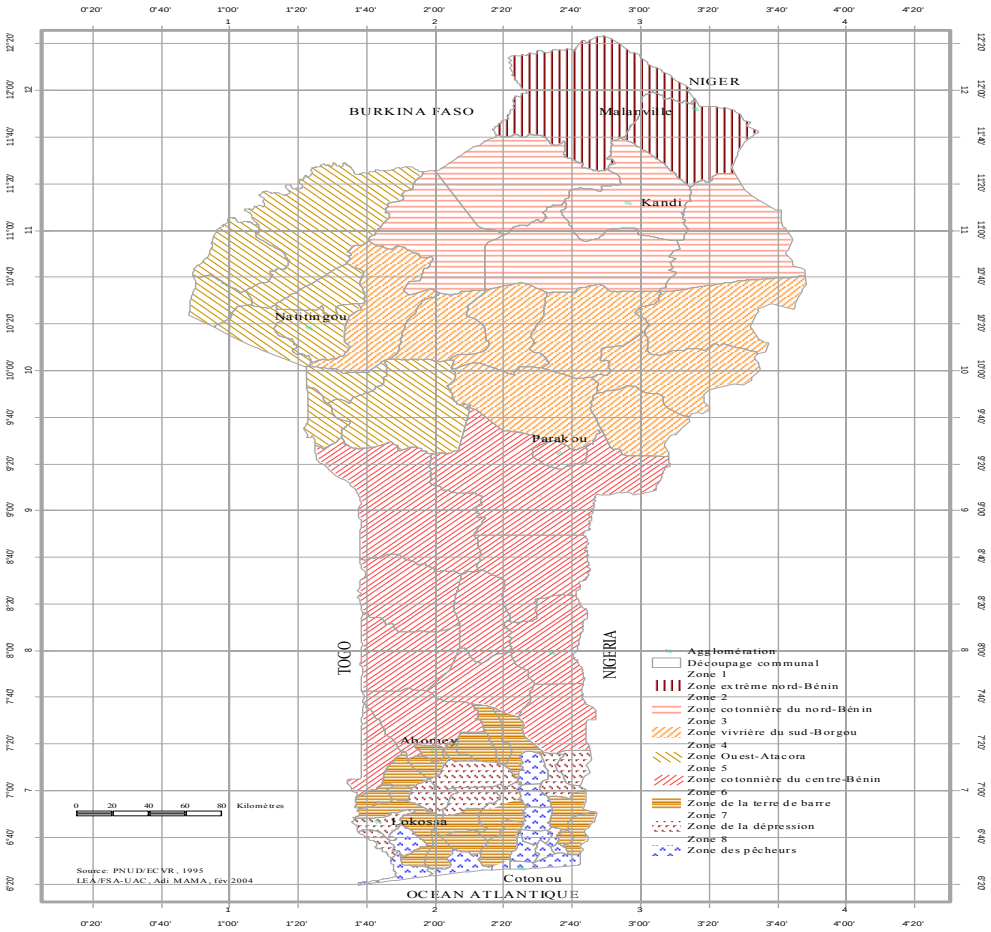
7	-Toffo -Lalo -Adja-Ouèrrè, Pobè	-Atlantic -Mono -Ouémé	-Soudano Guinea with two rainy seasons -800–1,200 mm per year in the west -1000–1,400 mm per year in the east	-Very deep and clayey loamy soils -Fertile but often waterlogged and difficult to work	Dense semi-deciduous forest with large trees	Fairly high depression area -PCV = 210 days to 240 days	-Flat dominant culture with maize on start of rotation -Maize, cowpea, cassava + vegetable crops
8	-Ouidah, Abomey-calavi, Cotonou, Sô-Ava, -Lokossa, Arthiémé, Comé, Grand-Popo, -Sèmè-Kpodji,	-Atlantic -Mono -Ouémé	-Soudano Guinea with two rainy seasons -1,000–1,400 mm	-Fertile alluvial soils -Infertile sandy soils along the coast	-Prairie grassy savannah -Marshy formations raffia -Some	Farming supplemented by fishing Fluvial lacustrine zones	-Essential basis = rotational head corn + cowpea and vegetable crops -Dominant corn and cassava in

	Aguéguée, Dangbo, Adjohoun		per year		mangroves	-PCV = 240 days	non-sandy zones -Crops on ridges or flat

Source: LSSEE, Center of Agricultural Research of 'Agoukoumey, INRAB

Figure 1. Political and administrative map of Benin.

Figure 2. Different agro-ecological zones of Benin.



4.2 Types of soils according to agro-ecological zones

4.2.1 The types of soils in agro-ecological zones 1 and 2

The current model lacks significant relief. They are armoured plating covering the high summits of the interfluxes that form the structure of the landscape. In the cotton area in the north of Benin we can find the following mains soils:

- Tropical ferruginous soils with little leaching and hydromorphic (unit 7),
- Tropical ferruginous soils with little modal leaching non solidified (unit 8) and
- Ferralitic soils with a low desaturation in (B) and depleted (unit 17)

In the area of the far north of Benin, the main soils observed are the following:

- Mineral and brute soils subject to erosion
- Soils with little evolution in contribution (support) (unit 3).
- Tropical and leached soils highly solidified (unit 6)
- Ferruginous soils with little leaching and modal (unit 9)
- Tropical ferruginous,leached soils and concretions(unit 10)
- Tropical hydromorphic, ferruginous and leached soils (11)

4.2.2 The types of soils in agro-ecological zones 3 and 4.

In agro-ecological area 3, eleven units of soils have been identified (Figure 1 and Table 3). They are soils with brute minerals and of non-climatic origin, of lithic on armoured plating (Unit 1), euthrophic and brown soils (unit 5), tropical ferruginous soils with little leaching, modal (unit 6), tropical ferruginous soils with leaching, modal non solidified (unit 8), tropical ferruginous soils leached and solidified (unit 9), tropical ferruginous and hydromorphic soils and leached (unit 11), tropical ferruginous soils little washed (unit 6), tropical ferruginous and modal depleted soils or with little solidification (unit 12), the tropical ferruginous depleted and solidified soils (unit 13), hydromorphic and little humus-bearing soils with leaching and gley (unit 25) and hydromorphic and a little humus bearing with pseudogley (unit 26).

In agro-ecological area 4, thirteen units of soils have been identified. They are: mineral and brute soils of non-climatic origin and lithic erosion on armoured plating (unit 1), mineral and brute soils of non-climatic origin and lithic erosion on outcropped armoured plating (unit 2), soils that have evolved little and of non-climatic origin and with hydromorh erosion and alluvial contribution which is finely sandy (unit 3), tropical ferruginous and little leached, modal, (Unit 6), tropical hydromorph ferruginous soils with a little leaching (Unit 7), tropical ferruginous soils leached solidified (unit 9), tropical ferruginous soils, leached and highly solidified or hardened (Unit 10), ferralitic soils typically desaturated on average (Unit 19), ferralitic rejuvenated soils or penevoluated and desaturated on average (Unit 21), hydromorphic and little humus-bearing with salted gley or non-salted (Unit 24), hydromorph and little humus-bearing with limestone nodules (Unit 27), hydromorphic soils and little humus-bearing with deep gleys (Unit 28).

4.2.3 The types of soils in agro-ecological zone 5

The soils of the area are on average shallow. They present some morphologic, physical and agronomic characteristics extremely variable because of the heterogeneity of the bedrock, of the diversity of the geomorphologic situations and the pedologic differentiation along the steep slopes. However, from one sector to another, a few particular and dominant traits can be identified and will allow to precise cartographically a certain number of pedagologic units whose characteristics are definable by a type of evolution that determines a type of dominant soil. The pedologic differentiations observed in the area are characterized by a type of alteration, the degree of individualization, of the hydroxides and the leaching in the profile. The conditions of pedoclimatic of the whole area leads, in most cases, to an advanced alteration but incomplete in terms of the minerals of the bedrock, an average elimination of the silice with an individualization of the hydroxides offer and of manganese. The constituents such as clay and the hydroxides offer and manganese are never regularly distributed: they are eluviated in the inferior part and often clay-accumlated:

- The brown and euthrophic soils at Logozothè (Ouédèmè-Lahotan)
- The tropical ferruginous soils leached and solidified at Agouagon
- The tropical ferruginous soils which are modal depleted at Paouignan
- The tropical ferruginous soils which are little solidified at Djidja
- The tropical ferruginous and modal leached soils which are non solidified at Bassila
- The tropical ferruginous and depleted soils which are solidified at Bétérou
- The tropical ferruginous soils and a little modal-leached at Tchaourou
- The tropical ferruginous and a little modal-leached soils at Bantè (similar to Tchaourou)
- The hydromorphic and mineral soils with gley at Logozohê
- The tropical ferruginous and depleted soils which are hydromorphic
- The averagely desaturated ferralitic soils in (B) typical
- The highly desaturated ferralitic soils in (B) typical

4.2.4 The types of soils in agro-ecological zone 6

Two types of ferralitic soils that are desaturated on movable sediments of the continental terminal are inventoried in this zone.

They are:

- Ferralitic and lowly desaturated soils on movable sediments, highly degraded.
- Ferralitic and lowly desaturated soils on movable sediments, from average to highly degraded.

4.2.5 The types of soils in agro-ecological area 7

Because of the low position, the soils studied are less subject to scraping caused by water erosion. Nonetheless, a more or less noticeable physical degradation characterized by a caking, affects the horizons of the surface of the soils and the vegetation. This situation is mainly due to the practice of a slash and-burn agriculture that conserves little organic matter. Only one type of soil has been inventoried in that area, namely the vertisols from which two categories have been identified:

- Hydromorphic vertisols with reduced external drainage
- Hydromorphic vertisols with good external drainage

4.2.6 The types of soils in agro-ecological zone 8

The soils in this area are subject to intense formations and erosive factors identifiable by extended surface with stunted vegetation. The soils in the valley of the littoral zone have in common the fact that they are formed on recent material and that they periodically undergo a more or less prolonged saturation by the water; these soils can be subdivided in different types according to their original material and according to the conditions of their engorgement. Two types of soils are inventoried in this zone. They are:

- Hydromorphic and mineral soils with deep gley (CPCS), observed at Comè, Grand Popo and Sèmè.

- Hydromorphic and mineral soils or little humus-bearing with pseudo-gley (classification CPCS), observed at Ouidah.

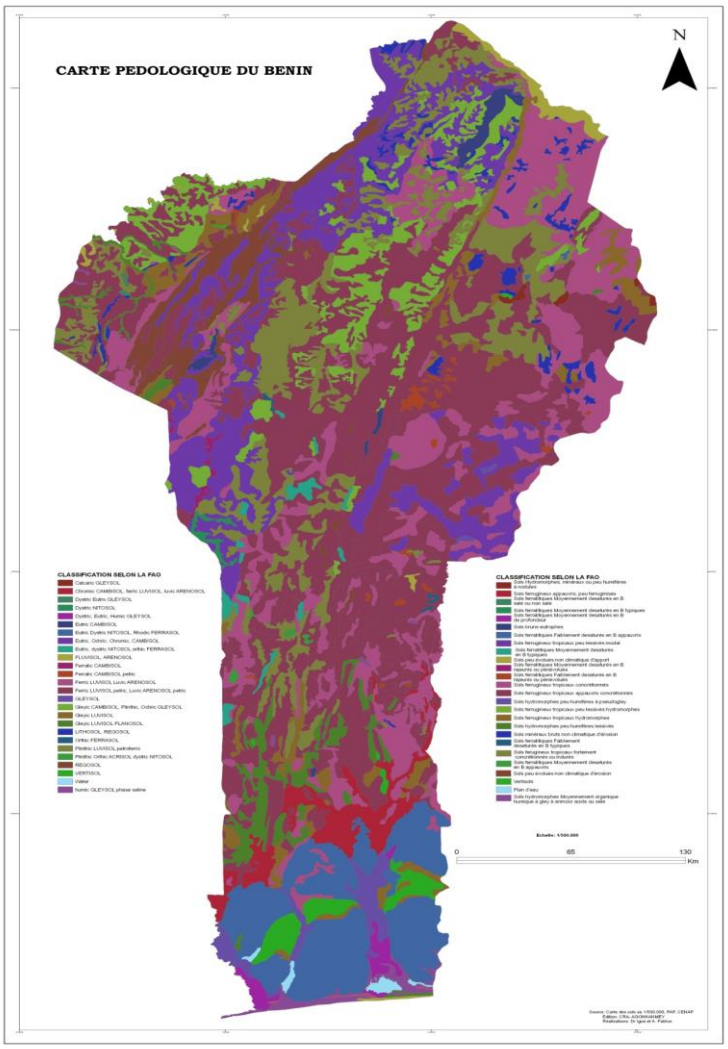


Figure 3: Map of Soils in Benin

4.3 Inventory of soil fertility according to agro-ecological area

4.3.1 Classification of the levels of fertility of the soils

Class I, high level of fertility: soils belong in this class when the characteristics don't present only low limitations,

Class II, average fertility level: soils belong in this class when the characteristics don't present more than three moderate limitations eventually associated with low limitations,

Class III, low level of fertility: soils belong in this class when their characteristics present more than three moderate limitations associated with one severe limitation.

Class IV, low fertility level: soils belong in this class when their characteristics present more than one severe limitation.

Table 2. Evaluation criteria of the classes of chemical fertility of the soils.

Characteristics	**Fertility**			
	High (without limitation)	**Average (average limitations)**	**Low (dangerous limitations)**	**Very low (limitations dangerous)**
Organic materials	> 2	1–2	0.5–1	< 0.5
Nitrogen total (%)	> 0.08	0,045–0.08	0.03–0.045	< 0.03
P ppm (Bray ₁)	> 20	20–10	10–5	< 5
K (meq/100 g of soil)	> 0.4	0.4–0.2	0.2–0.1	< 0.1
Total bases (meq/100 g of soil)	> 10	10–5	5–2	< 2
Saturation on bases (%)	> 60	60–40	40–15	< 15
CEC (meq/100 g of sol)	> 25	25–10	10–5	< 5
pH	5.5–6.5 6.5-8.2	5.5–5.3 8.2-8.3	5.3–5.2 8.3–8.5	< 5.2 >8.5

Sources: Dabin, 1956; Sys, 1993

4.3.2 Inventory of soil fertility in agro-ecological zones 1 and 2

The study on the fertility of the soils of the agro-ecological zones 1 and 2 has allowed noticing that the soils in these zones are much degraded. Low levels of fertility have been observed on the tropical ferruginous and a little modal-leached soils; the tropical ferruginous and leached soils and highly solidified or hardened, the tropical ferruginous, leached and hydromorphic soils; the tropical ferruginous, little leached and hydromorphic soils; the tropical ferruginous, modal-leached and non-solidified soils; and the ferralitic and lowly desaturated soils in (B) and depleted. They cover about 72% of the total surface area of the two zones corresponding to 19% of the total surface area of the country. Low levels of fertility have been observed on with little evolved influence and the tropical ferruginous, leached highly solidified. They represent about 23% of the surface area of the two zones and 6% of the total surface area of the country. This phenomenon is advancing and corroborates with Dagbenonbakinet al (2003)

who predicted that the soils in agro-ecological zones 1 and 2 will be extremely degraded from 1992 to 2025. It is important to take measures immediately in order to reverse the trend.

4.3.3 Inventory of soil fertility in agro-ecological zones 3 and 4

The study of the fertility of agro-ecological 3 and 4 indicates that the chemical fertility of the majority of the two zones is from low to very low. Indeed, about 88% of the surface area is in this class of fertility. Just 11.6% of the surface is averagely fertile. But they concern mineral soils with erosion on rocks, zone non-propitious to farming and the tropical ferruginous and hydromorphic soils in agro-ecological area 4. Less than 0.50% of study area has fertility from average to low. Only 0.07% of the surface areas have a high chemical level. The loss in soil fertility is generalized to all the cultivated land due to the yet low technology level of the farmers.

Under the influence of farm exploitation, the organic stock decreased rapidly in the first years. In intensive farming, the losses exceed 50% of the initial stock (Igué and Youssouf, 1995; Igué, 2009). These losses in organic matter results from the biological imbalance compounded by the exploitations by erosion, leaching and mineralization. They explain for the most part the degradation of several important characteristics of the soil linked to the organic matter such as the structural stability and the capacity of cationic exchange. Experimental studies on the maintenance of the fertility in nitrogen underline the importance of the organic and minerals manure associated. Hence, the need to associate mineral fertilization, organic restitution and the improvement of biological fixation nitrogen by leguminous plants.

4.3.4 Inventory of soil fertility in agro-ecological area 5

In short, area 5 has shallow soils with pretty low levels of fertility and deep soils with high levels of physical fertility but above all, mostly soils with average depth and average physical fertility.

Apart from the tropical ferruginous, leached and non solidified soils in Bassila (5), the depleted tropical ferruginous and solidified soils in Beretou (6) and the tropical ferruginous, little modal-leached in Tchaourou (7) whose fertility level is low, the others have a level of fertility from average to high.

4.3.5 Inventory of soil fertility in agro-ecological zones 6

The soils of the agro-ecological area 6 which are almost all ferralitic soils spread over seven Tableaus of Benin have a fertility level from good to average; nonetheless, their degradation is high. The main causes of this phenomenon are: the overexploitation of the soils with the use of degrading practices such as: the farming based on burning waste on the soil, the flat farming technique, the destruction of trees and the bad orientation of the ridges in the regions where ridging is practiced. These practices have progressively led to the disappearance of organic matter, reduced the mineral reserves and caused the chemical degradation. The level of fertility is therefore low in the Tableaus of Aplahoué and Allada and average in the Tableau of Ketou and the north-west edge of the Tableau of Aplahoué.

4.3.6 Inventory of soil fertility in agro-ecological zones 7 and 8

Area 7 of the depression has almost exclusively vertisols. These are soils with average chemical fertility due to their average permeability and porosity. Nonetheless, they have a high chemical fertility level with good chemical characteristics. The low level of fertility in area 8 is due to their high coarse sand content, their low content of exchangeable bases, of available phosphorus and the low capacity of exchange. This is obviously due to the low level of organic matter (Azonde, 2005) caused by their overexploitation using a slash-and-burn technique. Their exploitation should exclude the use of fire in order to promote the accumulation of organic matter for the improvement of their capacity to retain water.

Table 3. Soil fertility class of agro-ecological zones.

Characteristics	**Soil units**	**Units**	**Fertility class**
Zone of the Far North of Benin	Little evolved soils contributed	3	III
	Ferruginous tropical heavily leached concretions soils	6	III
	Ferruginous tropical slightly leached modal soils	9	IV
	Ferruginous tropical leached soils strongly indurated or concretions	10	IV
	Ferruginous tropical leached hydromorphic soils	11	IV
Cotton belt of northern Benin	Ferruginous tropical slightly leached hydromorphic soils	7	IV
	Ferruginous, tropical leached modal non-concretion soils	8	IV
	Ferruginous, slightly saturated impoverished soils (B)	17	IV
Agro-ecological zone 3	Raw mineral soils erosion (unit 1)	1	III
	Eutrophic brown soils (unit 5	5	II-III
	Ferruginous low-leached modal soils (unit 6)	6	III
	Ferruginous leached modal soils (unit 8)	8	III
	Ferruginous leached concretions soils (unit 9)	9	III-IV
	Ferruginous leached hydromorphic soil (unit 11)	11	III
	Ferruginous impoverished soils (unit 12)	12	III
	Ferruginous impoverished concretions soils (unit 13)	13	III
	Ferruginous rejuvenated soils or unsophisticated slightly saturated (unit 18)	18	III-IV
	Hydromorphic soils low in humus with	25	III

	little gley leached		
	Hydromorphic soils low in humus with little pseudogley	26	III
Agro-ecological zone 4	Raw mineral soil erosion on cuirass	1	III-IV
	Raw mineral soil erosion on rock	2	II
	Slightly evolved alluvial soils intake	3	IV
	Ferruginous low-leached modal soils	6	IV
	Ferruginous low-leached hydromorphic soils	7	II
	Ferruginous leached concretions soils	9D	III
	Ferruginous leached concretions soils	9A	III-IV
	Ferruginous heavily concretions soils or indurated	10	III-IV
	Ferruginous tropical slightly saturated soils	16	IV
	Ferruginous typical moderately saturated soils	19	III
	Ferruginous rejuvenated soils or unsophisticated moderately saturated	21	III-IV
	Hydromorphic low-humus with some gley depth soils	23	III-IV
	Hydromorphic low-humus salted or unsalted gley soils	24	IV
	Hydromorphic low-humus with gley and calcareous nodules soils	27	II
Agro-ecological zone 5	Eutrophic brown soils	1	I
	Ferruginous tropical leached concretions soils	2	III
	Ferruginous tropical modal impoverished soils in Paouignan	3	II
	Ferruginous tropical waterlogged soils with little concretions to Djidja	4	III
	Ferruginous tropical leached modal non-concretion soils to Bassila	5	IV
	Ferruginous tropical low-leached modal soils to Tchaourou	6	IV
	Ferruginous tropical low-leached modal soils to Tchaourou	7	IV
	Hydromorphic minerals soil with gley to Logozohê	8	I
	Hydromorphic minerals soil with gley to Logozohê	9	II
	Ferruginous tropical impoverished hydromorphic soils	10	IV

	Ferruginous typical moderately desaturated soils in (B)	11	IV
	Ferruginous typical heavily saturated soils in (B)	12	IV
Agro-ecological zone 6	Ferruginous slightly saturated soils at Kétou's tray (unit 13)	13	III
	Ferruginous slightly saturated soils at Aplahoué's tray (unit 14)	14	IV
	Ferruginous slightly saturated soils at Aplahoué-Tohoun's tray (unit 15)	15	III
	Ferruginous slightly saturated soils at Allada's tray (unit 16)	16	IV
Agro-ecological zone 7	Vertisols with reduced external drainage (unit 17)	17	I
	Vertisols with good external drainage (unit 18)	18	I
Agro-ecological zone 8	Hydromorphic minerals with some gley depth soil	16	I
	Hydromorphic mineral or low-humus pseudo-gley soils	17	IV

Source: Synthesis done by consultant, Study map of soil fertility, 2015

Generally in Benin, topical ferruginous soils are more widespread with more than 9 million ha, or 82% of the total area of the country. It is currently an area of high agricultural potentiality covering the North of Zou, Bougou-South and the Center, South of Atacora.

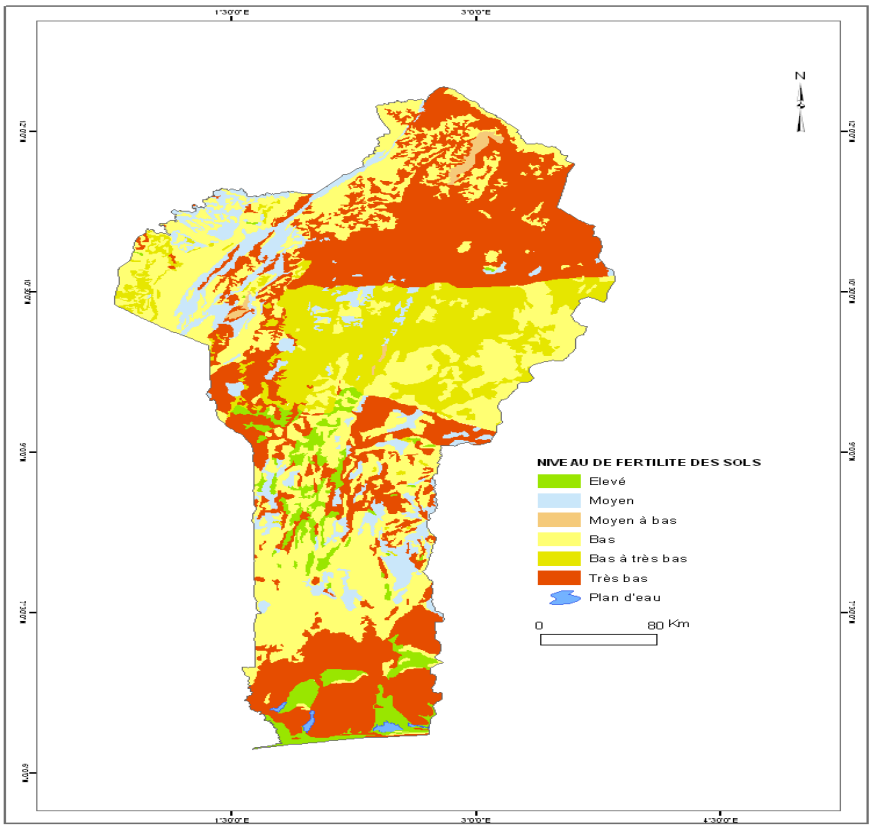


Figure 4: Map of Soil Fertility level of Benin

4.3.7 The deficiency of inventory studies of soils

The inventory and soil improvement studies have been for the most part carried out by ORSTOM (French Institute for Scientific Research for Development in Cooperation) and the CENAP (Agro-Pedology National Center).

About 300 small-, medium- and large-scale studies carried out in this framework by 60 soil scientists cover the entire national territory. These cartographic studies have started in 1947. The genetic classification used in these works is based on the filiation between the bedrock and the product of the degradation resulting from the pedogenesis.

These pedologic studies which cover the whole country cannot be exploited by producers as they contain information obtained from an insufficient number of observations. The firms cannot identify themselves in these studies.

In addition, the genetic classification used in these studies does not consider the level of fertility of the soils while the production of most of these agricultural practices depends on this parameter.

The large-scale pedological studies (1/20,000 to 1/50,000) which should normally serve the producers in the distribution of the crops on their soils is fragmentary.

Furthermore, pedologic maps are often too technical and are difficult to understand, not only for the literate producer but also for the agronomist.

All the pedologic studies carried out so far are not reproducible because none of them has been digitized. They have at the most, an explicative notice allowing the understanding of the phenomenon studied but the maps are difficult to reproduce.

Table 4. Production in overall agro-ecological zones

ZONES/ DESIGNATION	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
I. Characteristics of the zone	-Shrub Savanna -Climate Sudano-Sahelian (one season) -Very fertile et alluvial ferruginous Sols -Zone exposed to severe erosion -PCV<140 day	-Shrubby Savanna tree -Climate Sudanese (one season) -Ferruginous tropical soils -140day<PCV<180day	-Shrubby savannah tree -Sudanese climate (one season) -Ferruginous soils, medium fertility and sensitive to leaching -140day<PCV<189day	-Gallery forest and savanna -Sudano-Sahelian Sudano-Guinean transition -Ferruginous soils, low water reserves -180day<PCV<220day	-Shrub Savanna -Climat Soudano-Guinean at 2 seasons -Ferruginoussoils -PCV = 240day	-Anthropogenic forest and some relics Sudano-Guinean climate with 2 seasons Bar land and deep but degraded -PCV= 240day	Dense forest Sudano-Guinean climate with 2 seasons -Heavy clay soils deep and humus, fertile but often waterlogged -Fairly high depression area -PCV = 210-240day	-Grassland, grasslands and swamps Sudano-Guinean climate with 2 seasons -Fertile alluvial soils and sandy, infertile -Fishing activity -PCV = 240 day
II. Possible activities 2.1. Vegetable production	-Vegetable crops	-Food Crops: maize,	-Food crops: yam,	-Food crops: rice maize,	-Food crops: yam,	-Food crops: maize, cassava,	-Food crops: maize,	-Against culture-season: fresh maize, cowpea, chili, tomato,

	of against season	sorghum, yams, cowpeas -Industrial -Cultures: cotton and peanuts -perennial - cultures: cashew, mango	cassava maize, rice - Industrial crops: cotton and peanuts -Perennial crops: teak, mango and cashew trees - Vegetable crops by location	cassava yam -Industrial crops: peanut -Vegetable crops of against - season; local vegetables, tomato and pepper	maize, cassava, cowpea, pepper, rice lowlands - Industrial crops: cotton, groundnuts -Perennial crops: teak, mango, cashew, firewood - Vegetable crops	cowpea, pepper, pineapple -Industrial crops: peanut -Vegetable crops -Perennial crops cassias, mango, citrus, oil palm	cassava, rice, cowpea, pineapple - Industrial crops: peanut - Perennial culture cassias, teak, acacia, oil palm, citrus - Vegetable crops	vegetables, local and /or exotic
2.2. Animal production	- Fattening: *bovine *ovine/caprine	-Idem + Breeding bulls for animal traction - Beekeeping	- Fattening: *bovine *ovine/caprine -Breeding bulls for animal traction -Semi-traditional poultry	-Breeding bulls for animal traction -Improved traditional poultry farming -Fattening small ruminants -	-Fattening cattle and small ruminants -Bulls for breeding animal traction -Semi-traditional poultry farming	-Fattening bovine and small ruminants -Pig farming (breeder/fattening) -Improved traditional poultry farming and egg	-Pig farming - Fattening small ruminants and swine -Poultry farming -Snail breeding	-Pig farming -Poultry farming -Farming cane rats -Snail breeding

			farming - Beekeepin g	Beekeeping	-Pig farming - Beekeepin g	production -Beekeeping -Breeding cane rats -Snail breeding	-cane-rats	
2-3. Fisheries production	-	-	-	-		-Fish farming in ponds, folds, acadja -Holes fish	-Idem	-Idem
III-Processing of agricultural products	-	-Cossetted Yam -Oil and groundnut cake	-The same + cassava *cossettes, gari*	-Shea butter -Oil and groundnut cake and *gari* -Soap making	-The same as zone 3	-Palm oil and palm kernel -Soap making -*Gari,* oil and groundnut cakes	-Palm oil	-Neem soap
IV. Agricultural marketing	-Setting Market Malanville: sorghum, millet and maize -Buying and selling of cattle and	-Collection And selling food products, cattle and small ruminants and *néré*	-The same aszone 2 + fresh or smoked fish	-The same as zone 2	-The same as zone 3 + almond Shea	-collection and marketing maize, groundnuts, cowpeas, oils -Collecting and selling livestock, gari, fruit -distribution plants	-Collection and sale: gari corn, cowpea, oils	-The same as zone 7 + small business selling firewood, charcoal -Ice sold -pump room

	small ruminants							
V. Delivery of service and crafts	-Labour of animal traction	-Mechanical grubbing -Labour of animal traction - Distribution approved inputs -Veterinary palliative -The coupling transport	-The same as zone 2 + veterinary equipment and possibility of introduction of motor cultivator	-The same as zone 2 + veterinary equipment and possibility of introduction of motor cultivator	-Grubbing, labor, transport of agricultural products and inputs -Delivery and sale of veterinary inputs -Small agricultural mechanization animal traction or rotovator	-Transport Agricultural products -Grubbing and tilling -Small agricultural mechanization animal traction or rototiller -Distribution forest and fruit plants -Input distribution	-Input distribution	-The same as zone 7 Crafts (blacksmithing, weaving basket, weaving)

4.4 Problems of soil fertility

4.4.1 Main degradation factors of the soils

An analysis of the evolution of soil fertility has shown states of progressive and disturbing depletion and degradation. In fact, most of the farming systems used end up degrading the soils in the short term. This is manifested by a reduction of the reserves of organic matter by erosion and over-mineralization. A degradation of the structure of the soil generally follows this loss in organic matter, thus increasing the danger of soil erosion. According to the reports of the national and departmental workshops held on the occasion of the Initiative on the Fertility of the Soils (IFS), the producers point out the decrease in fertility as one of the current difficulties. This analysis reflects a general situation of the sub-region where the traditional systems of agricultural production, derived from the techniques of agriculture based on rotation, encounters an important decrease in the real estate reserves following the increase in the population density and an expansion of commercial farming such as cotton. The exploited surface after some time is replaced by long periods of fallow. Then the phenomenon accentuates and the fallows decrease and even disappear totally from the crop rotation and systematic rotation. At this stage, the transversal carbon flux and other nutritious elements of the natural spaces towards cultivated surfaces become too low to compensate the losses through the burning of waste on farmland, by erosion and exportations by the cultures and a "mining-type" agriculture predominates.

The analysis of the performed activities so far in Benin to improve the fertility of the soils reveals in general the necessity for a more global vision of the problems and their solutions and more research on the integration of the techniques recommended at the level of the management of exploitation. The protection of soil capital (anti-erosive measures, agroforestry, etc.) is not an end in itself, but a vital preliminary to sustainably intensify the production (improvement farming practices, investment in the fertilization and amendments). This also requires an analysis of the problems at the local level (i.e. adapted technology packages, functional organizations), as well as at the regional and national levels (i.e. creation of favourable conditions, access to the fertilizers, legislation, market, credits, etc,).

The main degradation factors of soil resources in Benin related to their mode of exploitation have not been put in hierarchy regarding the importance of the risks, for the short and medium term, on the agricultural activity nor on the human activity. If we can't act everywhere at the same time, we need to proceed with these choices to assure a sustainable management of the fertility of the soils. On the basis of the current information we can cite the following phenomenon by order of importance:

- The farm exploitation on larger and larger portions of land, without enough restitution of the fertilizing elements and without restitution of organic matter on land of old settlement or extensively new occupied land. The diagnosis investigations carried out the national research and development structures have revealed that the decrease in

soil fertility was the main preoccupation of the farmers. The management of fertility factor is the number ılimiting factor of the agricultural production in the zones with high population density in the south area;

- The impact of the farming on the zones of classified forests or wooded fallows, because of the clearing for yam farming as well as cotton farming, in the north and centre-north zones where the most important real estate reserves. The movement of migration from the overpopulated zones of the south and the north (Atacora) towards these zones accelerates the phenomenon. The forest area destroyed as a result of this phenomenon is estimated that 100,000 ha a year. The protection of the classified zones proves to be more and more difficult even in regions where there is a land availability;

- The delimitation of the zones of passageway for indigenous cattle but also transhumant. The pressure on the forage resources leads to a degradation of the soils, conflicts between crop farmers and livestock farmers and the limitation of the reclamation of the land with high potential (the rough zones) which serve as livestock passageway land is in the dry season. The integration of the activities of agriculture and livestock breeding is notoriously insufficient;

- There is no real government legislation that encourages farmers to invest in the improvement of the fertility of the soils. The situation is crucial in the south where all the soils are suitable and often given to households (the Valley of Oueme). The pressure of urban demand for speculative land acquisition is high. In the centre and north, the real estate security must precede certain enhancement practices (planting trees, arrangements of rough zones, etc.) to avoid opposition from the beneficiaries.

- The regular resource-degradation phenomena which are: (i) the practice of frequent soil burning at an advanced stage in the dry season for the preparation of the land for farming, hunting or the use of a livestock passageway; (ii) The production of fuelwood and wood charcoal for domestic needs including those of urban households; this provokes increased demand, which constitutes a better income generating activity than agricultural production (transformation of systems of subsistence to systems of wood production in the south of Zou); and (iii) erosion, a factor caused by practices of resources exploitation rather than conditions related to the nature and climate which mainly affects the zones of relief in the north (Atacora) and centre (Zou).

Benin still has soil resources, either because the land regeneration of the farmed land is more or less easy, or the conservation of the potential in these farmable zones is possible. There exist in that regard, different problematic and different investment choices whose economic and social incidence should be measured. For example, a study conducted in 1993 by CENAP (current LSSEE), in collaboration with Netherland Royal Institute of the Tropical Zones reveals that in the department of Mano, the solution to correct the negative conclusion in nitrogen

and potassium hydroxide between contributions and exploitations necessitates an annual investment of XOF 750 million for the first and XOF 350 million for the second. Can the farmers bear these efforts and what impacts should we expect at their level of their income on the national economy, in the short- and medium-term?

Apart from these degradation factors, there are environmental factors such as: (i) the demographic pressure; (ii) the organization of sectors outside of cotton; and (iii) the low capacity or inadequacy of rural financing.

(i) The demographic pressure: the traditional agricultural systems of production inherited from the techniques of agriculture based on rotation is hindered by the important decrease of real estate reserves due to the increase of the population density and the expansion of commercial agriculture such as cotton.

(ii) The lack of organization in fertilizer sectors apart from the cotton domain

4.4.2 Lack of organization in the fertilizer sector except in cotton domain

The fertilizers in the first order of problem problems expressed by the producers, there is the problem of fertilizer supply. The advice that was given to the farmers is that they should use fertilizers. Until recently, only the fertilizers for the cotton sector were available throughout the country: a) an organization of the demand; b) importations Which is controlled by National Company for Agricultural Promotion (SONAPRA); c) a distribution by accredited private operators; and d) a financing through the canal of private promoters (private operators), in charge of recovering the loans but also the primary cotton collection, which offers a real solidarity guarantee. The supply in fertilizer for the other productions, particularly the subsistence farming, doesn't have the same organization. In 1998, 80,600 t of cotton fertilizers were distributed. For all the other crop production, the volume doesn't reach 2,000 t.

Since the cotton sector receives a guaranteed commercialization with fixed prices, the land price has increased these past years. The other sectors are not organized because the prices of subsistence crops don't receive support and the commercialization of the subsistence products is fragmented. This situation causes the producers to use one part of the cotton fertilizers for subsistence farming. During the last cotton campaigns, average doses of used fertilizers had a tendency to decrease. This phenomenon aggravates a situation already existing for a long time, that of stagnation and even a decrease in cotton productivity.

In fact, the producers aren't satisfied with the new organization of the distribution of the fertilizers because the private enterprises which expressed their interest and got involved in the market are not very motivated by these products but are much more interested in the distribution of phytosanitary products. Mistakes and delays in implementation occur, often at

places that are far from the points of use (parts of departments, even whole departments in some cases). The transportation to the farms poses a problem to the producers. The producers' organizations have the feeling that officials took them out of from the distribution phase, while they are claiming, through their unions, a direct access to the negotiations with the international suppliers and to the importation.

If the research has given recommendations on the doses and the formulas of fertilizers to use, the council doesn't take into account the varied agro-pedologic situations and the incidence of the climatic variables on the mobilization and efficiency of the recommended formulas. Adapting the results of the agricultural research and diffusing them at the level of the producers is the task of the development structures. But in the current phase, the restructuration of the CARDER and in the absence of an assured succession of the private operators, this task is abandoned. The producers raise this deficiency as a key factor of defeat in application and lack of efficiency of mineral manure. The experience of the involvement of certain private operators to support the popularization at the level of the producers is also worth evaluating. The organization of the fertilizer sector requires a definition of what types of formulas should be distributed. The same goes with the phosphate calco-magnesium amendments that have been planned but for which there is no source of national supply exploited. Similarly, the contributions in organic matters can come from the exploitation of the available resources at the level of exploitations, either like some have tried, or of the exploitation of the mud and household garbage of the urban centres. The regime of taxation of these different sources of fertilizers should be reviewed in order to harmonize the customs fiscal regimes. This policy must take into account the current world market conditions of the fertilizers to establish comparisons between prices and the tax regime of fertilizers in Benin and in countries with similar situations in order to put the producers in healthy competitive conditions and/or to make informed decisions about the putting in place a support policy (in particular to the amendments). This analysis should make it possible to make a decision about the benefit of importation sources, of the manufacture, of the modes of formulation and the repercussions on the costs of the distribution in the whole country. There is particularly a factory for fertilizers in Godomey. This unit has been privatized and is now being considered for rehabilitation. New equipment was installed in 1997. It is important to determine in which conditions this unit can participate in an improvement of organization of the fertilizer sector in Benin

4.5 The perception of the producers on the management of soil fertility

4.5.1 The producers' understanding of the perspective of the cultivated soils.

The agricultural producer is attentive to the diverse changes of the soils and his exploitation. His attention is often on the following:

- The state of the soils and the response of the current crops

- The responses of the crops to the contribution of organic and mineral fertilizers

- The short- and long-term effects.

These two observation points and measures allow the crop producer to appreciate the production capacity of the soils being exploited and organize the succession of crops on the same plot of land. It is in the same way that he will appreciate the level of reconstitution of the production capacity of soils in fallow (Figure 1). The changes in soil use, like the cycle of crops and fallows, constitute integrated fertility management of the soils (Igué et al., 2008). The questions raised concerning these forms of management is about the technical, economic and social rationalities (Amidou et al., 2004; Igué et al., 2008)

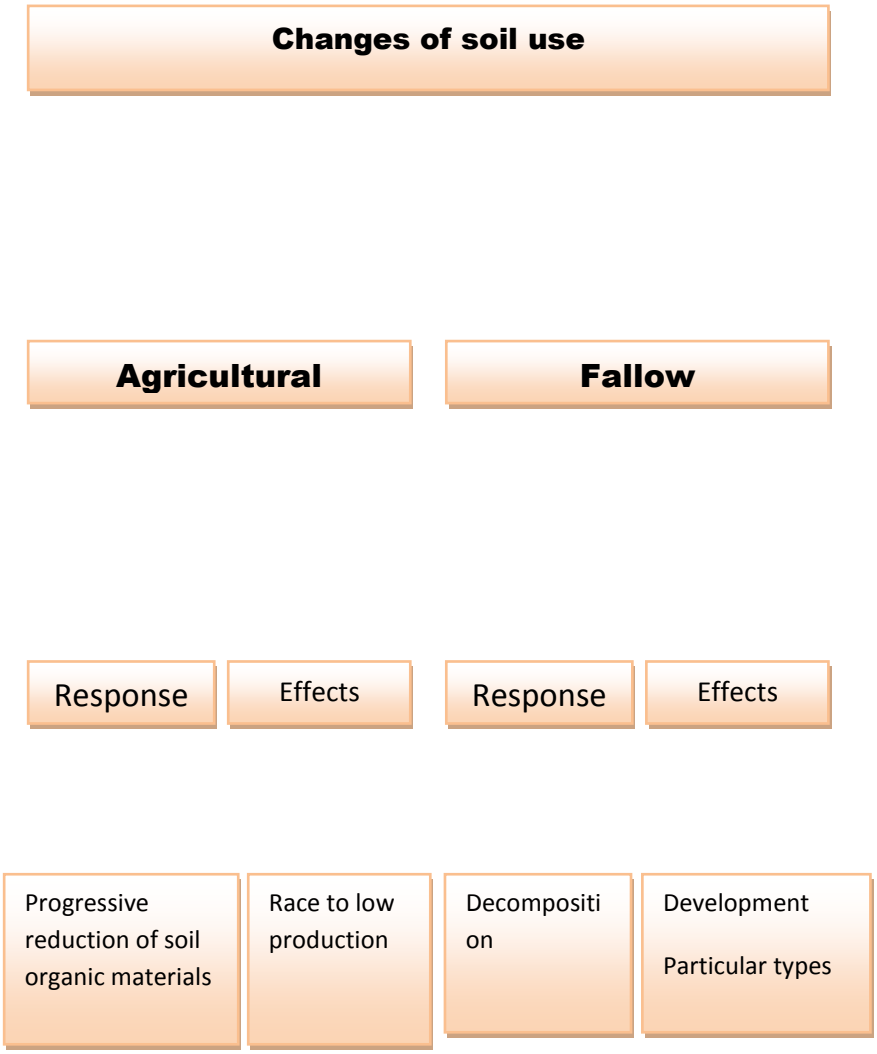


Figure 5. Dynamic evolution of agricultural soils.

4.5.2 Endogenous evaluation practices of the fertility of the soils or of the production potential of the plots of land and exploitation fields

The crop producer first differentiates the plots of land by taking into account the characteristics of the used land in the area such as the structure of the soil, the dominant vegetation of the unit of land, etc. (Igué, 1996; Djenontin et al., 2004) and of the meanings of local names for the units of soils (Djenontin et al., 2004; Igué et al., 2008). The crop producers establish and refer to the history of change of usage of the plots of land and fields with obtained effects as follows:

- The year of the first exploitation of the plot of land
- The productivity of the successive crops after many years
- The grass growing and the appearing of species indicating a low production capacity
- The capacity of the soils to retain water, etc.
- Occurrence of specific dicotyledonous weeds
- Soil texture and hydrological quality
- Soil workability
- Soil fauna, especially earthworms.
-

These indicators are used by farmers to make decisions on what to grow and on the type of soil fertility management required. In the cultivated fields, farmers assess soil nutrient status on the basis of crop behaviour (growth and development) and leaf colour. In the regions they argue that pale and yellowish plants reflect some 'food' (nutrient) deficiencies. For example Farmers in the Save region also use variations in soil colour as an indicator of declining fertility. Such a change in colour always occurs on the soils, which become less dark after continuous cropping. In the Atacora region, the gravel content (> 2 mm) is used as a criterion for soil classification. The research concluded that most of the soil textures assessed by the farmers closely agree with those of the International Soil Science Society (ISSS).

Management practices of the fertility of the soils and the valorization of crop waste.

The model of valorization is a method in which we return to the soil what it has produced. This model takes into account the quality of the crop waste, of their decomposition in the soils in order to increase the organic matter in view of improving the behaviour of plants or crops being produced.

In Benin, farmers have adapted their cropping systems to the local environment by developing traditional and new strategies and activities that could contribute to maintain or enhance crop productivity. These strategies include animal manure, inorganic fertilizer, crop rotation, a 5-year fallow, extensive cropping systems with cassava or *egusi* melon and emigration. Land tenure arrangements between landlords and migrants affect strategies that can be applied to maintain soil fertility.

5 Farmer soil fertility management practices

Agricultural workers in any region in Benin resort to several practices simultaneously in order to manage the fertility of their soils. The most used practices in the diverse combinations are: fallow, crop rotation, the direct and rotary penning, mulching and the contributions of mineral fertilizers or organic manure in the form of manure or of compost. The farmers' practices of soil fertility management can be classified in two groups constituted around the plot of land in exploitation and the plot of land in fallow.

Fallows-A fallow is an old practice whose duration varies from 0 to 10 years and more (Djenontin et al., 2003; Amidou et al., 2005). It is also a flexible practice that crop producers adapt to their environment. In the zones with high real estate pressure such as in Karimama and Banikoara the duration of the fallow is less than 5 years, while at Gogounou and in the east of Kandi, the fallow lasts up to more than 10 years.

6 Management practices involving the valorization of crop waste.

The contributions in organic matter are related to the following practices:

- The storage and the spreading of crop waste
- The manure cowshed and/or the compost of the agricultural producers that have cows for milking or small ruminants.

In the zones where the real estate pressure is relatively low, crop waste is not used for the management of soil fertility. In the zones where real estate pressure is high, mulching of the fields with crop waste, after direct and rotary penning contributes to the maintenance of the soil.

These practices only allows the coverage of 25% at the most of the surface area being exploited in the best conditions despite the plurality of the breeding (cattle and small ruminants) as a source of manure, as well as the availability of crop waste, particularly from cotton and grain crops. The weakness of this system of management of soil fertility and the valorization of crop waste depends on the ability to transport the crop waste of the agricultural exploitation (incomplete equipment drawn by animals) and of production of organic matter from the agricultural exploitations (conversion techniques of matter from the vegetation to organic matter)

The contribution of mineral fertilizers takes into account the productivity obtained with previous crops on the plot at least in the last 2 years. Therefore the dose recommended by the services of popularization for each crop is subdivided in two, three or in four and then applied by bunch (Tables 2 and 3). In certain conditions, the recommended dose is considered insufficient and increased in order to reach a wanted level of productivity (Tables 2 and 3). Doses of fertilizers are then reasoned according to the production objectives of the

exploitation and the potential of production of the plot. Therefore, the number of plots allotted to a given production varies according to the potential of production of the plots and the production objectives of agricultural production.

The average of plots allotted to the growth of cotton is five with extremes of up to 11 at Kokey and at Bensekou and three for corn with extremes of up to eight still in the same localities mentioned previously (Djenontin et al., 2007)

7 Implications for the development

The endogenous practices of fertility management cannot be well perceived without analysis of their context of implementation. Indeed, these practices appear to be reasoned because they display the previous effects of the contribution of fertilizers, the previous advantageous crop effects and the forms of soil preparation. The integrated management of the fertility of the soils is perceived by the crop farmer as the maintenance of the "life" of the soil. The assertion according to which a soil without microfauna is a soil without life and production potential is better understood in all its meaning. In fact, the life of the microfauna and the microflora depend largely on the rate organic matter of the soil. This perception of the life of the soil makes the farmer maintain the rate of the organic matter of the soil with the restitution to the soil *in situ* from the crop waste (Amidou et al., 2005) by the cycles of crops–fallow or the settlement and exploitation of new soils (Djenontin et al., 2003; Aboh et al., 2010). The improvement of the restitution of the soil *in situ* from the crop waste with the direct and rotary penning (Djenontin et al., 2003; Amidou et al., 2005) can be identified in the intensification of the management of organic matter with the help of herds of bovines of the exploitation (Alkoir et al., 2011). The animals intervene here as transporters and biocatalysts of a transformation of the matter from the vegetation. The adoption of the contributions of fertilizers can be perceived as an alternative solution to the lack herds of ruminants for the intensification of the management of organic matter of the soil.

These practices implemented in a rational way allow the farmers to have a relatively high and sustainable productivity (Djenontin et al., 2007) The limitations of this system of management of the organic matter of the soil in order to maintain the potential of production of the plots is then clearly visible as to its speed and quantity of production of the organic matter the intensification of the management of the organic matter of the help of herds of bovine of the exploitation (Alkoir et al., 2011). The animals are transporters and biocatalysts in the transformation of organic matter. The adoption of the contributions of fertilizers can be perceived as an alternative solution to the lack herds of ruminants for the intensification of the management of organic matter of the soil.

Box 1

Integrated soil fertility management is comprised of agricultural producers such as the management of the organic matter content of the soil. The operating life and land use patterns (soil preparation method, estate crops and crop types) affect the organic matter content of the soil. On farms in the North East of Benin, the return to earth of soil residues by the combined mulch or not fold yard managing, production and application of manure, compost and crumb Park are practical which certain efficiency remain. The practice of supplementation of mineral fertilizers is part of the intensification of these farming measures. These practices are effective although limited in scope to the scale of the operation. Indeed, it takes several years to a farmer to restore all these plots without going through the fallow.

8. Assessment of the level of integration of soil fertility management in policy and development strategies

8.1 Review of the assessment of rural development policies

The current agricultural policy of Benin was created in 1991 with the adoption of the Policy Declaration Letter of Rural Development (LDPDR) thanks to democracy renewal. In 1999, the Declaration of the Policy of Rural Development (DPDR) was adopted and has come to reinforce the LDPDR by précising the content and conditions of disengagement of the state from functions of production, transformation and commercialization.

The soil fertility management is part of operational and strategic plan and is currently integrated as the fifth component of the Programme of Support to the Agricultural Sector (PASAOP).

The management of soil fertility is part of the operational strategic plan. The main points of the policy and strategy to implement the sustainable management of soil fertility aims to:

- Assure the institutional support and the reinforcement for a management of the environment and the maintenance of the fertility of soils;
- Develop integrated approaches of fertility management through the action of participative vulgarization and research-action;
- Diffuse by all appropriate means the results of the research on the technology innovations.

Three projects have actively collaborated to the preparatory studies for the Plan of action of fertility management of soils and have wished to support pilot activities of soil fertility management in few targeted villages in their zones of intervention. They are: (i) PAMR Borgou; (ii) PGTRN; and (iii) PSSA.

PAMR Borgou, backed by the World Bank, intervenes through the entire department of Borgou by the financing of micro projects identified and prepared by the communities. The project is ready to assist village or community micro projects related to soil fertility management given the importance and priority to these problems that the producers manifested. Three polyvalent teams of technicians of the project (rural engineering, agricultural popularization and economist) are spread in the targeted area in order to assist the farmers' organizations for the preparation of the project form in collaboration with the agricultural sector that will be submitted to the PAMR for financing.

The PGTRN, backed by the French Agency for Development (AFD) and the German Cooperation (GTZ), intervene at the level of the pilot steep slope ponds representative of different ecological conditions of the country with the support of NGOs in the targeted villages. The local multi-disciplinary coaching team is often composed of (men and women): (i) an agronomy engineer in area leader in charge of the operations of arrangement of the steep sub-ponds; (ii) an arrangement geographer responsible in the area and in charge of the real estate operations; (iii) a legal practitioner, responsible in the area, in charge of gender and development; and (iv) two or three area team leaders often with an expertise in rural engineering. In each targeted area, the adopted approach is the management of the land including mainly the following activities: (i) a participative diagnosis, the plan of functioning of the system and a participative planning in view of the elaboration of an arrangement plan of the land (PAT), of the elaboration of local codes of management of the natural resources and the putting in place of a organizational plan (PGT); (ii) the implementation of the priority activities of the PAT such as the fight against erosion, agroforestry in the framework of soil fertility and reforestation; and (iii) the elaboration of rural real estate plans and their implementation in the long-term.

PSSA, backed by FAO, intervenes in targeted villages spread over the entire Benin. IN the targeted villages, its support to the producers is focused mainly on four domains of activities: (i) water management; (ii) the diversification of the productions; (iii) the removal of the constraints; and (iv) the intensification. It intervenes in targeted villages with the support of national popularization (CARDER) technically reinforced by Vietnamese specialists recruited on the occasion of the programme of cooperation South-South developed by FAO. The sustainable management of the fertility of the soils is part of the priorities of the programme.

The objective of the operational plan of action for the sustainable management of fertility of the soils is to allow the Beninese farmers through their professional organizations and rural communities to manage the fertility of their soils in order to practice a profitable and sustainable agriculture. This objective is part of the general framework of strategies and

national food security programmes, of fight against poverty and preservation of natural resources.

Four specific objectives have been defined:

- Promote technologies appropriate to an integrated management of soil fertility which respects the environment;

- Develop and structure the distribution of fertilizers including fertilizers and amendments for their well-reasoned use;

- Create a legislative and regulatory environment which encourages a global policy of soil fertility management

- Assure the information and training of the producer, the leaders of professional agricultural organizations, of the middle managers of the ministry in charge of agriculture or of the private sector for the mastery of soil fertility management.

In 2002, Benin has also elaborated its strategy of poverty reduction at the national level (2003–2005).

This document displays the constraints of the agricultural sector such the degradation of the soils, the loss in soil fertility without deeply analysing the degradation of the soils that needs to be identified as an important approach in itself.

Starting from 2002, Benin got fully involved at regional level in the process of the New Partnership for Development in Africa (NEPAD), with its detailed programme of agricultural development in Africa (PDDAA) initiated in 2003 and which is a continental vision of agricultural development translated into a programme of development prompted by African agriculture. Its main objective is to accelerate agricultural growth, reduce poverty and assure food and nutritional security by 2015. ECOWAS is in charge of the implementation of PDDAA/NEPAD for West Africa in the framework of regional agricultural policy (ECOWAP) adopted in 2005. In fact, it has opted for a concerted and united approach which put the nations at the centre of their own development, by helping member countries to elaborate and adopt their respective Agricultural Investment Plan (PIA) and the complementary agricultural investment programmes in the average and long term at the regional level (PRIA). In this perspective, the elaboration process is supported at the technical and financial level by ECOWAS. This process, having the PSRSA as its essential base, works for the coherence of the policies, strategies and programmes at the regional level.

8.2 Review of the assessment of political, regulatory and institutional aspects related to the sustainable management of the soils in Benin

The political, regulatory and institutional framework of Benin in terms of sustainable management of soils is now well supported by multiple legislative and regulatory texts since the United Nations Conference on the Environment and Development which was held in Rio de Janeiro in June 1992. The conventions that followed this conference have deeply marked the political, strategic, legislative and regulatory framework concerning the management of natural resources, with repercussions on the sustainable management of the soils (GDT), on the general plan as well as at the level of the sectors. Thanks to the measures of its constitution of 11 December 1990 which states that "All persons have the right to a healthy, satisfactory and sustainable environment and have the right to defend it", the State works to assure the protection of the environment. Benin subscribed to several international conventions and agreements, particularly the three Rio Conventions with promulgations of the laws related to them.

The common point to these three conventions constitutes "sustainable development" which is the objective of the agreement reached between the Republic of Benin and the Netherlands on 21 March 1994. Most particularly in relation to GDT, it should be noted that:

- The outline law on the environment which requires in its article 21 that "the use and the arrangement of the environment for purposes of agriculture, industry, urban development and others as well as the activities of research or of exploitation of the resources of the subsoil capable of affecting the environment in Benin be preceded a prior study on their impacts";

- The law on the organization of the communities which gives them clear competencies in terms of (i) affectation of the soils; (ii) hydraulic infrastructure and hydro-agricultural arrangement; and (iii) maintenance of the plantations and the protection of the natural resources;

- The law on rural real estate regime in Benin which is based on the "Rural Real estate Plan (PFR)" which allows the security of land in rural zones by: a) giving a legal recognition to the real estate rights established or acquired according to the custom. (Rural Certificate); b) building a community plan for rural real estate management; c) assuring a real estate security for the producers in order to stimulate investment in the production and maintenance of the fertility of the soils.

The range of legislative and regulatory texts which Benin endowed itself with these past 15 years should constitute the beacon for the elaboration and implementation programmes and projects able to significantly contribute to the sustainable management of the soils and which orients mostly towards new approaches to a participative management associating the

population. However, these domains still need to be further explored given the constraints. For instance, the stakeholders of the livestock breeding sub-sector wonder how the law on rural real estate regime and the tools such as PFR and the real estate certification will improve the management of the cattle and transhumance pathways, especially since the organic law No. 87-031 of 21 September 1987 on the regulation of the paths to grazing zones, the keeping of domestic animals and transhumance haven't yet received a necessary revision in order to adapt them to the current realities.

- **Place of the GDT in the policies and strategies of the development sectors.**

Be it in the environment sector or the agricultural sector, the place of the GDT is superficially explored in the current strategic plan.

In the domain of environment, the environmental strategies such as Agenda 21, the PAE, the forest policy, the National Plan of Action against Desertification (PAN/LCD) and other ratified conventions haven't put a particular accent on GDT. In the strategic plan of the ministry of Elaborated Environment in September 20010n the basis of the already defined by the PAE and National Agenda 21, only one domain on the 5 carriers of objectives has displayed a few aspects related to the GDT by mentioning "the integration of environment in the entire development process". The current strategy on the sectors rests essentially on two pillars which are:

- The National Environment Management Plan (PGNE 2) whose component "Support to local environment management initiatives" is destined to take care of the problems of soil fertility, desertification, regression of grazing zones, etc.

- The National Programme for the management of Natural Resources (PNGDRN) aims at elaborating a blueprint of soil use, the participative and sustainable arrangement of forests and protected zones, etc.

Box 2

According to the liberal economic option adopted by the Government, the State in Benin focuses on its sovereign functions on its coordinating role, regulation, facilitation, monitoring and control and the provision of public goods and related services. It assumes those functions directly through its central and decentralized service and/or in partnership with other actors, or ensures that they are carried out by other actors. The sovereign functions of the state in the agricultural sector are under the responsibility of the Ministry of Agriculture, Livestock and Fisheries (MAEP) and other sectorial ministries involved in the sector.

The central services of the state are responsible for setting the policy and strategies in the agricultural sector. The decentralized services of the State exist in the regions and municipalities. They work closely with local actors (local authorities, OPA, etc.) to provide technical support nearby. This is the case of the Ministry of Agriculture, Livestock and Fisheries (MAEP) present at regional and local level by the regional centres and rural district for Agricultural Promotion (CeRPA, CeCPA).

The local authorities have legal personality and financial autonomy. They have broad powers relating to local development, spatial planning, social services and basic collective economic infrastructure. They therefore have competence to decide on agricultural development at the local level and in collaboration with the decentralized structures of the state and other actors of which OPAs within the development and implementation of local development activities in the agricultural sector.

The private sector is responsible for all the functions of production of goods and income-generating agricultural services. It contributes to the production of public goods and services in partnership with the State through contracting. The contracts based on project management, or the delegated project management, will continue and strengthen.

9. Consideration of soil fertility in Benin's research

The INRAB, the main body of the agricultural research in Benin, representing close to 60% of capacity and investments of the countrys farm R&D. Set up in 1992, it is a technical and scientific institution endowed with a civil personality and a financial independence. It is under the control of the Ministry of Agriculture, Breeding and Fishing (MAEP). Its main mission consists in producing technologies for the rural area in harmony with preserving the natural resources and contributing to the advancement of science. INRAB is made of a headquarter

based Cotonou and six agricultural research centres (CRA) located nationwide as follows: three regional centres (the Southern CRA Sud in Niaouli, the Centre CRA in Savè and the Northern CRA in Ina), two secto-specific research centres (the coton-.bres CRA in Parakou and the perennial plants CRA in Pobè) and national research centre (the Agonkanmey) (Gaillard 2008). In 2008, the INRAB employed 65 ETP researchers and the support staff was 252, which represents a lower level than the one recorded in1990.

The R-D aims to be the link between the research and development so as to promote innovations to meet the farmers' needs and possibilities. In this respect, it cooperates with the national and international thematic research, the CeRPA, the NGOs and the farmers themselves. The Research-Development tries to comprehend the issues in an orderly manner.

Thus, the diagnosis is carried out in every agro-ecological area by a multi-disciplinary team. This diagnosis requires the participation of different actors involved in the agricultural committee and partners in development working in the area namely: the researchers, the popularisers, the NGO, etc. (Assan, 2005). This stage allows us to identify the major assets and constraints that are thoroughly analysed with the actors of the area. The constraints are sent to the research team for the development of technological innovations that are adapted to them.

The second step of the process is the experimentation, which aims at testing the designed innovations carried out by the thematic research so as to ensure that they meet the producers' needs. Indeed, to develop suitable technologies for a manageable production by the farmers, all the technologies should be tested by the R-D to value their adaptation to the production conditions of the producers before the popularization. And this is where the producers' and researchers' implication is needed in carrying out the test.

This approach is also seen as an iterative approach in which the tests are carried out on a showcase plot involves the producers who take part in on the same basis as the researchers but to different degrees such as: management by the researcher, management by the producer, or joint management by the researcher and the producer. The results of these tests were presented in the village by the experimental producers at the end of the campaign.

Finally, the innovations with known conclusive results must get to a larger spread at the level of the potential users. The implementation of the bodies of popularization of the technologies constitutes the third step of the process.

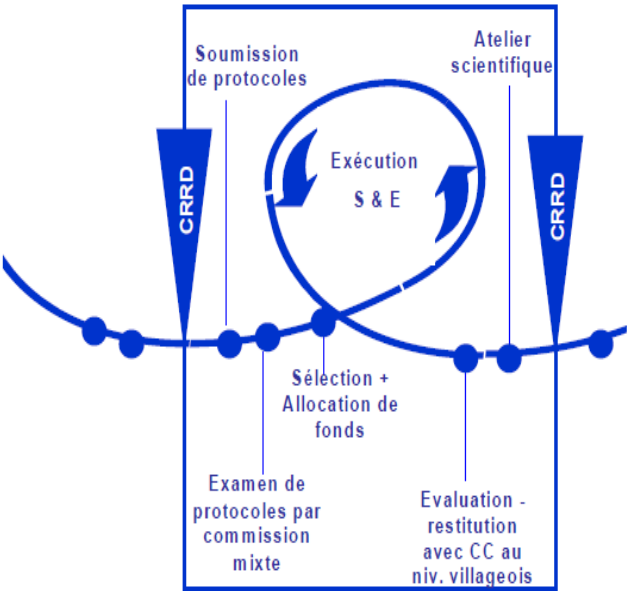


Figure 1. Cycle of agricultural research management.

Since 1986, the Government of Benin has opposed the recruitment of permanent civil servants and consequently, the INRAB can only give short-term contracts.

Currently, about two-thirds of the researchers and technicians are contractors. It has been widely accepted that this situation makes INRAB more fragile, since the contractor status does not provide as many as training opportunities, nor the same advancement possibilities, like the permanent civil servant status and consequently, the contractors are more likely to quit the institution. However, an INRAB's project of capacities building is currently in the process of elaboration that will lead to the future conversion of the contractors into the government's permanent agents and boost the recruitments of personnel. Unlike the levels of the personnel, the level of INRAB's expenditure has progressively increased since the beginning of the millennium, up to ZOF 2.7 million corresponding to 12.4 million of dollars (in 2005 currency). This increase is largely due to a greater will of the national government to fund the agricultural research, especially since 2007. In Benin two non-profit bodies practice agricultural research, namely the Benin centre for the environment and economic and social development (CEBEDES) and the Development Network for Sustainable Agriculture (REDAD). In 2008 their numbers in ÉTP got respectively to three researchers and one researcher.

The researches being carried out by these two non-profit bodies are rather socio-economic organizations but they are linked to agriculture. Most of the higher training schools in the agricultural R&D in Benin have progressively increased since the 90s, going from 23% in 1990 up to 40% in 2008. It is especially the Abomey-Calavi University (UAC), the country's main

body of higher training in agriculture, which has recorded a growth in its farming R&D. In 2008, the UAC employed 44 ÉTP researchers in comparison to 20 in 1990. Seven units have been identified at the UAC which carry out agriculture R&D. Composed of 25 ÉTP researchers in 2008, the Unit of agronomic science (FSA-UAC), included its five departments is the most important among them. The Department of Agronomy of the University of Parakou (FA-UP) is the only school of higher education that is carrying out agricultural R&D in Benin, which is not under the control of the UAC. In 2008, the FA-UP only employed two ÉTP agricultural researchers. It is important to notice that in average the salaries paid within the universities exceed from 25 to 30% the salaries within the INRAB; this partly explains why the universities have succeeded in strengthening their capacities to the detriment of the INRAB

9.1 Inventory of places of technologies of management of soil fertility

9.1.1 Diagnostic of technologies of management of soil fertility

Research works on soil fertility are old in Benin and were intensified through research on crops and cotton as of 1960s. These works first tried to determine mineral deficiencies of main types of soil encountered. Yet, issues of organic materials deterioration and its evolution in tropical climates, even though they were known, haven't been under technology development to be transferred in farming zones because land resources were important and the long pace of set-asides seemed to be sufficient for enabling the natural reconstruction of humus stock. The demographic expansion and the introduction of cash crops led to the land clearing of increasingly fragile zones and accelerated the erosion phenomena on sensitive soils by nature. For several years, advice on fertilization developed by research was broadcast based on the popularization classical approach (information, demonstration, application), with the support of a store network for the distribution of fertilizers and loan credit system for funding. This broadcasting method had the merit to advertise fertilizers and their effects. However, it put aside the issue of the maintenance of soil organic matter. Moreover, it does not take into consideration the economic conditions of the implementation of recommendations in production systems. Changes in prices rations between products and production factors have shown farmers' financial limits to follow such recommendations.

As of 1980s, in light of the poor use of mineral fertilizers in farming zones and mainly the deterioration of continuous cultivation zones on account of the demographic expansion, the research focused its works in two directions:

- The use of local resources such as rock phosphates
- The regeneration of soil organic status.

From this period starts the onset of international cooperation programmes for Benin research with various institutes (IFDC, IITA) or universities (Louvain, Hohenheim). IITA initiated a

programme for **lane crops** with*Leucaena* and *Cajanus* and cover crops with *Mucuna*. Lane crops have been unsuccessful in farming zones and today research suggests strip cropping instead. The mucuna was popularized in the South, as of the year 1990. Farmers adopted its introduction not only for the fertility management purpose but has rather proved to be an effective mean against the quack grass. *Mucuna* is used as a fodder but farmers claim that its grains are not edible. The study on *Mucuna* use is deepened by both RAMR and IITA within the INRAB. Yet, other cover plants (Glyricidia, Cajanus, Leucaena, Pueraria and Vigna) are also introduced in observation networks in farming zones.

The trials to use **rock phosphate** (crushed limestone of Benin or 'fine' limestone of Togo) have shown that phosphates intakes should be combined to a regeneration of the M.O ration in the south. In the north, trials have been significant. The suggested technology cannot broadcast itself because there is no organized source of supplies in rock phosphate and the ratio cost/profit of the technology is not satisfactory with phosphate from Togo. Trials on pulses (cowpea, soybean and groundnut) are underway with TSP and the analysis of other needs in nitrogen and potassium fertilization.

Attempts to extend **manure or compost manufacturing** made by research led to modest results. The classical manufacturing processes with stables under shelter and manure pit have not been adopted because they assume to have significant transportation of materials from fields to the farm, an almost daily basis work of pit load and a watering. It also assumes food provided to in-house animals. A minimum of 3 to 4 heads of cattle is needed for manufacturing a significant quantity of manure. This explains why the technique is unsuccessful, even in farming zones equipped with ploughing oxen. The loose housing of animals on successive layers of crops residues or even bush weeds regularly provided, have been developing more quickly.

Another solution being recommended by the cotton research in order to enable the restitution of cotton stalks in the north, for grazing cotton farms from harvest time till the end of the dry season. Fields are cleared, the cattle can find supplement feed grains units and there is a kind of restitution by the faeces. The use of the organic material obtained in a form or another, remains problematic on account of the weakness of the equipment as to means of transportation and producers' plough.

Leguminous-based rotation and fodder plants techniques were tested (*Stylosanthe*s, improving herbaceous-based fallows),cover plants (trials with palm oil but also in other systems of cultivation), trees and shrubs in agroforestry (*Acacia auriculiformis*) or simply a combination of crops (maize, sorghum, groundnut to fight against striga). Mixed farming through various trials did not appeal to farmers despite interesting initiatives of some producers particularly in the northern regions. The researchers' conclusions are that the issue of organic material is essential mainly on the most degraded lands in the south; the harvest residues restitutions need to be found and the supplementary mineral manure intake are still necessary.

Cultivation techniques recommending a minimum work on the soil have not been subject of research programmes. The practice of zero tillage and semi-direct under coverage is less well known by researchers and developers. Yet, cultivation techniques and erosion control mechanisms were recommended. Land structures in the south (small land zones and availability, speculation) and the traditional land management in the north (uncontrolled land clearing, 'right holders' refusal of proprietary marks by tree planting) slowed down all initiatives and the adoption of solutions.

10 Technology dissemination

Solutions dissemination follows two main channels:

- **The development research** is conducted by the national agricultural research with the support of institutes and foreign universities. The development research intervenes in some selected villages as representatives of various situations of the country. It used the tools of the participatory research accelerated (PRA) method for villages' approaches. Among issues pointed out by producers, soil fertility management is the first concern.

  The RD introduces itself in the "soil" dimension of fertility management instead of plot. The topics relative to the coverage plants to the cropping – rotary system and to the production of organic materials have been presented to producers and some fodder crops have been presented (*Stylosantheshamata, panicum*). The management of conflict between the livestock breeders and agricultural producers is also the subject of the implementation of the mediation procedures, of the sharing of space between the route zones, the corridor and the agricultural zones. At its side the IITA did tests in the region, either through thematic approach (at random) and formation of contour line of production, or through some tests more integrated into divers agro-pedagogic or socio-economics situations. In all these participative approaches we were looking for the producer's reactions and their evaluation to the proposed solutions. These approaches have not extended to the nearer environment of the choosen villages but they serve to support the visits of technicians and responsible of development bodies (Administration, study offices N G O, OP). They permits to a direct discussion between researchers and producers;

- **The development**'s administration is managed through CARDER and whose producers are managed through Farmers' organization (FO). Nowadays the transfer of the development function is carried out for FOs.

- Although DICAF (The Agricultural Training and Operational Management Council)/of MAEP initiated a participative approach which gives to producers the decision on their development programme and on their supporting actions. Soil fertility management is introduced in these programmes. Some NGOs that combine producers liability

approach and support to innovation transfer are also involved Sasakawa Global 2000 since 1992 to 1997 would have been diffused through CARDER 40 to 50 t of *Mucuna* seeds produced by piloting farmers. NGO Songhai settled in the south diffuse the technical bases of a sustainable agriculture through the canal of youth and some peasant leaders training at specialized center. Some National study offices are in charge of the implementation of the Natural Resources Management Project (PGRN) in the five intervention zones retained. The participative approach chosen also brings the users to have global vision of soil management and some techniques of natural resources protection that is the soil. It is in this programme that the let allocation safety which would have to lead to a National Allocation Plan.

11 Adoption of technologies

From the results obtained, we notice that all technologies (fertility management of soils) analysed have a positive net updated value (VAN) and they are then economically yieldable. But it is the rotation maize-*niébé*, which has the highest VAN. The ratio-benefit /costs of rotation systems maize-*niébé*, of *Aeschynomene* fallow and of *Cajanuscajan* fallow have a ratio higher than 1. These systems are economically efficient. Indeed the system of natural fallow, of management of harvest residues and of mineral steam, Mucuna fallow, Acacia fallow, have a ratio less than 1 and are economically efficient. The system of rotation maize-*niébé* has the highest ratio-benefit/costs and a recuperation deadline of minimum (1 year). The rotation maize-*niébé* represents the best alternative to soil fertility management technologies.

The farmers have almost the same perception about the importance of technologies in terms of efficiency in the improvement of soil fertility. Apart from the old practice used (tree fallow, palm fallow etc.) and which are well known by the farmers, the new practice of soil fertility management of soils is also known. In the choice of techniques of improvement of soil fertility, the farmers considered the quantity of biomass, the weak need in work, the additional benefits, the product incomes, the speed and the fertility scale and finally, the control of weeds.

11.1 Inventory of places on the GDT (land management) technologies and their adoption scale

Many GDT technologies are experimented in Benin to ensure the regeneration of soil fertility. Among these we can mention:

- Traditional technologies,

- Steam technologies based on chemical fertilizers

- Fertility supporting technologies based on vegetables (*Mucuna, Ashynomenae, Stylosanthes* etc.)

- Agroforestry technologies based on lined vegetables (*Acacia, Moringa,*

- *Glyricidia, Anterololium* etc. . . .)

- Techniques of water conservation on the soil (against erosion, labour at curved level, GIRE practice round the water level etc.)

- Technologies based on compost and the use of manure

Analysis of adoption and application of these different technologies rate was the aim of some investigation works on RAMR project. On the overall the technologies proposed for fertility management, we notice that those giving more interests to producers are:

(i) Application mineral steam; (ii the preparation and the use of manure; (iii) the making and the use of compost; (iv) management of harvest residues; (v) cropping and rotation system of crops; and (vi) the regeneration by Mucuna.

Agroforestry technologies are in majority preferred in the south for the production of wood than for fertilization, while *Moringa* and *Glyricidia* integrate in cultural practices of central and northern regions in their role in the feeding of livestock (*Moringa*) and their role in fyam's agriculture (*Glyricidia*). Their adoption rates are largely below the excepted scale.

Technique of **rotation based on vegetables** and fodder plants have been tested.

Agro-breeding integration through these different tests doesn't mobilize producers combining with interesting initiatives of some producers in the regions particularly in North.

Cultural techniques recommending a **minimum work of soil** integrate some agricultural systems in the centre and the north while the practice of SCV of minimum tillage and of direct seeds was known before. Some cultural techniques and components against vulgarized anti-erosion did not have a high adoption level. Many initiatives and actions have been developed in Benin for regeneration of soil fertility. At the time of the analysis, it was demonstrable that the overall importance of these innovations to producers was emphasized.

Box 3

Analysis of adoption and application of these different technologies rate was the aim of some investigation works on RAMR project. On the overall the technologies proposed for fertility management, we notice that those giving more interests to producers are:

(i) application mineral steam; (ii) the preparation and the use of manure; (iii) the making and the use of compost; (iv) management of harvest residues; (v) cropping and rotation system of crops; and (vi) the regeneration by mucuna

12. Evolution of the system of agricultural vulgarization in Benin

12.1 Colonial period: 1894–1959

On behalf of the V/A, indigenous populations received during the colonial era strict guidelines on issues related to agricultural production, natural resource conservation and other specific requisitions. More specifically, the extension was at that time the following objectives:

- Empowerment of communities and local institutions
- Promotion of industrial crops for export to the metropolis
- Constitution, demarcation and protection of the forest area of the colony
- Conservation of water and soil
- Protection and enhancement of wildlife
- Promotion of technical use of early fires as part of the fight against bush fires.

At that time, rural extension technical themes revolved broadly around:

- The nature protection by the constitution and protection of the forest area of the colony.
- The protection and restoration of soils.
- Stimulation of the cooperative movement.
- The promotion of export products including:
- Oleaginous plant (oil palm, coconut, shea butter, castor);
- Textiles (cotton, *kapok, kenaf*);
- Stimulants (tobacco and coffee).

Organizationally, there was at local level, a senior agricultural section headed by Commander of the circle. The main actors of the system were:

- The Department of Agriculture in charge of defining, at the central level, the overall agricultural policy and strategies and means of implementation.
- The Forest Water Department and hunting Dahomey created by Decree No. 2428 of 23 July 1938 as part of the reorganization of local government departments.
- Farmers' organizations composed of various cooperatives whose creation was prompted in 1947–1948 and which came together in 1950 in the Cooperative Union of Dahomey (UCODA).
- The Trading Houses represented by buyers of products that roamed the bush to collect markets various products (cotton, palm, peanut, etc.).

The legal basis for interventions consisted primarily of the main laws and regulations as follows:

- Decree of 4 July 1935 on the Forest Regime in French West Africa;
- Local Order No. 414 of 18 March 1937 regulating logging and forest system of Dahomey.
- Local Order No. 1107/SCF of 11 September 1943 laying down conditions of application of the Decree of 4 July 1935 on the forestry regime in French West Africa and regulating the exploitation and circulation of products of Dahomey forests.
- Decree No. 55-582 of 20 May 1955 on the protection of forests in the African territories under the Ministry of France Overseas.

The Rural Life in the colonial era was distinguished by its interventionist approach made guidelines, instructions and formal notices of application. Tools were constituted inter alia by:

- Circulars and memoranda transmitting the guidelines;
- The dissemination of these guidelines tools within the population and regrouped: singing griots (griots are storytellers who maintain a tradition of oral history in parts of West Africa), village assemblies, traditional music, etc.

12.2 Post-colonial period: 1960–1971

This era was characterized mainly by the grid of the country by intervention companies operating in different departments, so much so that there was neither unified service V/A nor formal consultation framework to harmonize strategies intervention at the farmers. The technical directions of MDR4 framed some of the farmers, each in its field, with resources (human, material and financial) to the needs of rural populations and the low level of performance.

The objectives of the V/A programmes are as follows:

- Improvement of living conditions of rural populations;
- Increased agricultural production of:
- cash crops (oil palm, coconut, cashew, shea butter, coffee, cotton, tobacco);
- food crops (maize, yam, cassava, groundnuts, cowpeas, sorghum, rice);
- improved farming techniques;
- the development and restoration of soil fertility;
- Development of community forestry by introducing trees into cropping systems, through the project "Development of Benin's forest resources" prepared in 1970;
- Supporting the establishment and capacity building of pre-cooperatives and cooperative organizations, including functional literacy.

The legislative framework of the colonial era was reinforced by other provisions on agricultural cooperation, rural development, inland fisheries and rural loan. These include the following:

- Act No. 61-26 of 10 August 1961 on the definition and development of procedures for rural development schemes.
- Act No. 61-27 of 10 August 1961 on the Statute for Agricultural Cooperation.
- Decree No. 143/PC/MDRC/Agro of 15 April 1965 establishing a mutual agricultural loan fund.
- Ordinance No. 20/PR/MDRC/EF of 25 April 1966 for the general regulation of fishing in the inland waters of Dahomey and Decree No. 183/PR/MDRC of 25 April 1966 for its implementation.
- Ordinance No. 59/PR/MDRC of 20 December 1966 on professional producer associations.

Given the orientation given to agricultural production during this period, the V/A Rural were characterized by an approach by product/speculation. The agro-ecological conditions in each region imposed on this approach, a geographical connotation in relation to different departments. Traditionally used tools were reinforced by film screenings, rural radio broadcasting and by extension sheets that summarize the arguments that create motivation.

12.3 The Period 1972–1989

At the structural and organizational level, this period was particularly marked by the creation in December 1975, at each of the six departments of the country, a Regional Action Centre for Rural Development (CARDER). The approach when creating CARDER was to encourage development partners to concentrate, according to their own option, on the department of their choice, through programmes and/or specific projects. Under the supervision of the MDR, CARDER was among others in charge of technical support to farmers and their organizations.

Their advent has brought an end to the dispersion of efforts in technical training for rural people. To do this, CARDER possessed six technical divisions that include: the extension direction and support to farmers' organizations (DVAOP); management of forests and the protection of natural resources (DFPRN).

The six main objectives in terms of V/A programmes were:

- The strengthening power of communities and local institutions;
- increasing and diversifying agricultural production (agriculture, forestry, livestock and fisheries);
- Capacity building of pre-cooperatives and cooperative organizations;
- fight against desertification;
- diversification of income sources for rural populations, by carrying micro-projects 7;
- rehabilitation of ecosystems (terrestrial and aquatic) degraded by:
- anti-erosion development;
- promotion of integrated production systems (agro-forestry and agro-forestry-pastoral in particular);
- Bank protection of rivers and lakes.

In forestry and natural resource management, this period was marked by a growing awareness of environmental problems reflected particularly by:

- The publication in April 1985 of the *Action Plan against Drought and Desertification*;
- The institution of a National Tree Day and a national reforestation campaign.
- The emergence and implementation of several forestry projects.

The forest legal arsenal has also seen following this awareness of environmental realities, a remarkable evolution. It has undergone significant changes, including attributable to: (i) the *de facto* obsolescence of certain texts following the accession of Benin (formerly Dahomey) to independence on 1 August 1960; (ii) the inadequacy of other texts then in force, with ecological, economic and socio-cultural country. It is in this context that the following texts were adopted:

- Act No. 87-012 of 21 September 1987 on the Forestry Code of the People's Republic of Benin;
- Act No. 87-013 of 21 September 1987, regulating the common grazing, custody of pets and seasonal migration;
- Act No. 87-014 of 21 September 1987 on the regulations on the protection of nature and exercise of hunting in the People's Republic of Benin, with its implementing decree;
- Act No. 87-016 of 21 September 1987 on the Water Code in the People's Republic of Benin;

- Decree No. 89-385 of 24 October 1989 laying down detailed rules for the application of Law No. 87-012 of 21 September 1987 on the Forestry Code of the People's Republic of Benin.

During this period, the contents of the V/A was in the form of "technical data" detailing the weekly tasks, which were based on the training and retraining of staff. In their interventions at the field level, all divisions/units, including forestry, worked under this system and in conjunction with the agricultural extension agent (AVA). The themes of the V/A was based on a fairly comprehensive manner: (i) reforestation; (ii) the conduct of nurseries; (iii) agricultural production (food crops, cash crops); (iv) the fight against weeds; (v) the improvement of soil fertility; and (vi) rotations and cropping patterns, etc.

The permanent concern of improvement of V/A systems justifies the adoption of business-training approach (M&V system) that was repeatedly modelled to fit the great diversity of agro-ecological conditions departments. The goal of the approach is to provide appropriate support for rural development by helping farmers to increase production and increase and diversify their incomes. One of its main characteristics is the need of recourse to regular and ongoing training. Among the various methods used, we can cite in particular, that of the cascade formations, where each level of the hierarchy form the next lower level. The various tools used in V/A tend to make farmers more aware.

12.4 The Period 1990–2000

Restructuring of agricultural services

One of the highlights to face during this period is the implementation of the Agricultural Services Restructuring Project (PRSA). This resulted, among others, the creation within the MDR of DIFOV9. Among the responsibilities of the latter, the animation/coordination at various levels of cooperation between CARDER, farmers' organizations and research institutions on all aspects of extension, research and development and advice to farmers. The objectives of the programmes of V/A rural are:

- Training and redeployment of senior staff
- Improving the productivity of small farms
- Improving sustainable food and nutrition situation of the most vulnerable sections of the population
- Support, in the broader context of improving production systems at the village land, the villagers reforestation activities
- Intensification and implementation, according to the approach/participatory approach, pilot actions capable of supporting the sustainable use of agro-forestry-pastoral resources

- Diversification sources of income of local populations through the implementation of micro-projects
- Improving technical opening firewall and the fight against bush fires.

Reform of legislative texts

The requirements arising from new policy directions and development strategies based on the participatory approach led to the reform of certain laws and regulations, including:

- Decree No. 90-82 of 9 May 1990 on the organization of the CLCAM-MCRA rehabilitation project and creation of the Cashier rehabilitation funds;
- Inter-Ministerial Order No. 10/MISAT/MDR/D-CAB of 20 January 1992 on the establishment, organization, powers and operation of transhumance committees;
- Act No. 93-009 of 2 July 1993 governing forests in the Republic of Benin and its implementing decree;
- Order No. 025/MDR/DC/CC/CP of 11 January 1995, on the establishment, powers and operation of the measures responsible for managing the funds allocated to agricultural promoters of funds from the national budget;
- Act No. 98-030 of 12 February 1999 on the Framework Law on the Environment in the Republic of Benin.

Among other important provisions resulting from the new policy and strategic direction, there must be observed that relating to micro-project funding mechanisms through the implementation of some integrated rural development projects. It is, among others, the villagers equipment fund (FEV), the village development fund (FDV) of the basic initiatives funding agency (AGEFTB), etc.

In general, contrary to the laws and regulations of the colonial and post-colonial era, defined by measures limiting, restrictive and coercive legislation the past 10 years takes more account of the concerns of local people and communities. Thus, the Act 1993 on forestry prevailing 11 requires participatory management of forestry resources of the state, on the basis of management plans and management. In general, contrary to the laws and regulations of the colonial and post-colonial era, defined by measures limiting, restrictive and coercive legislation the past 10 years takes more account of the concerns of local people and communities. Thus, the 1993 Act to lay down forestry 11 requires participatory management of forestry resources of the state, on the basis of management plans and management. In the same vein, other laws and regulations are being updated. These include the Law No. 87-014 of 21 September 1987 regulating the protection of nature and exercise of hunting, including the current update is done under the new conservation strategy and management of protected areas in 1995.

The framework law on the environment, which the preparation process has been long, is under restoration at all social and professional groups of the country, under the aegis of the Benin Environment Agency (ABE). As for its application texts, they are being prepared for adoption and translation in the dominant national language.

Steps/methods/Rural V/A approaches

Regarding methods/approaches, the momentum of the "Earth Summit" in Rio in 1992 and the execution of projects intended to "environment and sustainable development" have changed "project approach" to "participatory approach". It is an iterative methodological approach in which the various steps are described in Appendix 2.A series of participatory approaches as valid as each other have been developed, among which, we can mention the following:

- Participatory approach for sustainable management of natural resources, implemented by some forestry projects and land management.
- Approach "process" implemented by SNV, an international NGO.
- Approach "Support for rural self-promotion" broadcasted by FIDESPRA, continuing education and research institution of the Faculty of Agricultural Sciences of the National University of Benin, which helps to meet the major development challenges.
- Participatory approach at the village level (APNV) developed by INRAB, pre-tested on extension by the DIFOV then adopted to strengthen national agricultural extension system.

A unified national agricultural extension system (SNVA) was introduced and applied throughout the country from 1992. It is in fact a unified business training system at national level and reinforced since 1996 by APNV. Its objective is to improve the performance of extension and strengthening its links with research on one side and farmers on the other.

The main actor of this measure is the versatile extension agent (VPA) which occurs through contact groups (GC). It is supported at the Sector (sub-prefecture) by a multidisciplinary team of specialized technicians (TS), coordinated by the Rural Development Officer (RDR). The support at the departmental level is provided by the CARDER through its Directorate of Extension and support to farmers' organizations (DVAOP). At national level, he is assisted by the Directorate of Operational Training and extension of MDR. Depending on the specific themes, other structures are also involved in supporting the national level. As for forests and other natural resources, including are:

- At MDR: the Forestry and Natural Resources (DFRN) and the National Institute of Agricultural Research of Benin (INRAB);

- At the Ministry of Environment, Housing and Urban Development (MEHU): Environmental Directorate (DE), the Planning Branch Planning (DAT) and the Beninese Agency for the environment (ABE).

Everything is complemented on the ground by NGOs, private partners, farmers' organizations (FOs) and local management structures (SLG) formed by participatory management of certain classified forests. The tools used by the system of V/A rural were chosen in the range of those of the accelerated participatory research method (MARP) and the objectives of the projects by planning (PPO).

Rural development approach

A new rural development policy was implemented in 1991. Its main objective is to raise the living standards of the rural population, not by the mere pursuit of an objective of regional or national self-sufficiency, but by improving the competitiveness of Beninese farmers to ensure the conquest of agricultural markets. The cooperative movement has, in this context, grown significantly with a consequent strengthening of mobilization capacities, organization and negotiation skills of farmers. Thus, since 1995, farmers have a "chain of producers" from the village to the national level, through the sub-prefecture and departments. These are:

- Village Groups (GV).
- Unions' Sub-Prefectural Producers (USPP).
- Departmental Unions of Producers (UDP).
- Federation of Unions of Producers (FUPRO).

There are currently approximately 3,500 GV of which 1,200 GF, 77 USPP and 6 UDP. The chain is well structured and operational, especially in areas of cotton production. It is involved in various areas including: i) marketing of seed cotton (100%); ii) input management; iii) setting up and loan recovery; iv) inventory management and calculation of discounts; vi) production and sale of plants; vii) processing and marketing of agricultural products; viii) production and marketing of cashew nuts, pineapple, palm oil, etc.

In the particular case of the forestry sector, local management structures (SLG) were created as part of the participatory management of natural forests. These are the village development organizations (OVD), development Village Committees (CVD), natural resource management committees (CGRN), the Councils of supervising management actions (SCAN), management committees of management unit (CGUA), etc.

In general, farmers' organizations (FOs) have become valid interlocutors of governments and donors, as well as genuine development partners.

Communication and information

The momentum and the spirit of initiative and creativity thus created in the rural world, reflect the positive impact of actions in the field of information and communication through rural radio stations and other media. Indeed, since the release of the audio-visual space in the context of democratization and decentralization, rural radio has grown remarkably in the past 10 years. Rural radio stations broadcast in all categories in 18 national languages. Benin is currently covered by:

- The national radio network based in Cotonou since 1953, with rural radio section.
- Rural radio stations located in Tanguiéta (Atacora) Ouaké (Donga department) Banikoara (department of Alibori), Lalo (Couffo department) and Ouèssè (Hills department)
- The private radio stations located in Allada (Atlantic department), Lema (Hills department), Adja-Ouèrè (Tableau department) and AtakeWèkè-Djrègbé (Oueme department).

Even if other information and communication are less developed, they are still useful and complementary to those already described. These include newspapers and other published brochures in national languages, cinema and theatre.

Box 4.

Agricultural vulgarization in Benin progressed during the history combining with development policy aims. The uni-sector and managerial approach gradually swopped places with a participative approach or the participative approach at village level. Viewing the results recorded, advantages and disadvantages, it was necessary to reinforce the V/A rural system of Benin through implementation and diffusion of technologies that were ecologically rational, viable and less costly. It is wished to have also the support and financial techniques from DIFOV in operation transfer of activities of V/A to OP and NGO.

In this context it is recommended that we:

- *Reinforce the training personal capacities and the OP in matter of the use of TCI.*
- *Study the modality to establish a coordinating and monitoring systems of rural V/A activities in different agro-ecological zones in the country.*
- *Proceed to systematically censor and promote the practice of US and favourable costumes to conservation of* in situ *and* ex situ, *the sustainable valorization and the use of biological resources by landowners and villagers*

13. Offers and requests for fertilizers and the institutional barriers to and policy around fertilizer access

13.1 Regulatory and institutional framework of the cash distribution of fertilizers in Benin

13.1.1 National policy and institutional framework

In general, Law No. 90-005 of 15 May 1990 establishes the conditions for the exercise of commercial activities in the Republic of Benin. Several laws have been progressively put in place to regulate the trade of agricultural inputs in Benin. These include first Decree No. 99-537 of 17 November 1999 dealing with the transfer to the private sector the responsibility of organizing consultations for the supply of agricultural inputs in general and fertilizers in particular. But this law took effect in 1992–93 with the grant of 20% of the fertilizer market to SDI. The share reserved for private operators in the importation and distribution of fertilizers

was then gradually increased from 40% in 1993–94 (SDI SAMAC, SOTICO, SOGICOM) to 100% in 2000–2001.

However, in the cotton sector, the State withdrawal decision was made early in 1988 with the transfer of industrial and commercial activities of CeRPA (ex CARDER) to SONAPRA as part of the Commission permanently established by Decree No. 88-30 of 20 January 1988.

Table 5. Companies involved in input business providing system in Benin.

Distributors name	**Starting year**	**Provider**	**Commercialized product**	**Fertilizerinputin the private market of input out cotton**	
				In the past	***Currently***
SDI	1992–93	HYDROAGRI international, AGROSCIENCE, AVENTIS, BAYER, CALLIOPE, ALM, DOW.	Fertilizer, pesticides, treatment machine	yes	yes
SOTICO	1995–96	SENCHIM Sénégal, MICRON.	Fertilizer, pesticides, treatment machine	yes	no
CAI	2009	-	Fertilizer, pesticides, treatment machine	-	yes
SOGICOM	1995–96	CALLIOPE	Fertilizer, pesticides, treatment machine, vegetable seeds.	yes	no

DEFIS-SARL	1998–99	AVENTIS	Fertilizer, [esticides, treatment machine	no	no
DFA-PACOGE	2002–03	-	Fertilizer, pesticides, treatment machine	no	no
AGRITEC-SA	-	-	Fertilizer, [esticides, treatment machine	-	yes
ECA	1996–97	-	Fertilizer, pesticides, treatment machine vegetable seeds	yes	no
FRUITEX	1995–96	MELCHIMIE	Fertilizer, pesticides, treatment machine	yes	no

Source: Consultant's literature review synthesis.

Since 1997, Decision No. 30/SGG/REL August 6, 1992 ordering the continued withdrawal of the state, Decree No 99-537 of 1999 and the No. 2000-294 2000 opened the door to development and to the establishment of new structures such as the CIC (e.g. CAGIA Benin), AIC and CSPR-GIE. These structures define the current institutional framework for the marketing and distribution of agricultural inputs in Benin. In recent years, the institutional framework for the marketing and distribution of agricultural inputs in Benin has experienced difficulties. These include: non-compliance with operating rules adopted by the AIC; rising sale price of agricultural inputs to farmers, the late delivery of agricultural inputs to farmers, the low level

of supervision of farmers, the malfunctioning of the joint guarantee mechanism in several OPA coupled to the marketing of bursting seed cotton in parallel networks at CSPR-GIE mechanism (AGROP, FENAPRA, FENAGROP). To avoid these risks, two ministerial orders were taken during the 2003/04 campaign. These are: Decree No 16/MICPE/APRM/MFE/DG/SG/DCCI of 14 March 2003 fixing the import conditions and distribution of cotton inputs in Benin Republic and Order No. 022/MICPE/APRM/MFE/DG/SG/DCCI of 7 May 2003 marketing of seed cotton that gives the CSPR-GIE, exclusive of seed cotton purchases.

13.1.2 Regulation and legislative framework

There is to date in the strict sense of the term, no legal mechanism regulating the manufacture and distribution of fertilizers in Benin outside of the specifications of the tender for cotton. However, a number of texts can be applied to regulate its production and marketing. These include Act No. 90-005 of 15 May 1990 on the exercise of commercial activities laying down the conditions for conducting trade activities in the Republic of Benin in general, four decrees, order, decision and their application notes. The first decree (No 88-30 of 20 January 1988) is the creation of the Standing Committee of Supply Production Factors of Marketing of Agricultural Products and General Trade. The second decree (No 93-313 of 29 December 1993) sets the importer profession. The Decision (No 36/SGG/REL 15 September 1994) concerning exemption of agricultural inputs taxable duties and taxes relates to the exemption of duties and taxes paid to cotton inputs.

The factory layout is managed by the general texts on industrial companies whose application is the responsibility of the Industrial Development Department of the Ministry of Trade and Industry.

Any company registered in the commercial register, who imports and distributes agricultural inputs must receive professional accreditation of agricultural inputs distributor at the Service of Plant Protection and Plant-care Control (SPVCP) of the Department of Agriculture (DAGRI) before being issued the merchant card or importer card by the Chamber of Commerce and Industry of Benin (CCIB).This card allows wholesale margins and retail and mandates the reporting of inventories to the Directorate of Foreign Trade. It also stipulates that the exercise of trade activities is subject to permanent control of directorates of domestic and foreign trade and sets the penalties for any violations. These conditions and the penalties incurred for violations were taken or re-specified by the decree 1993 defining the profession importer. However, the most recent (2003) legislation stipulates that we can import and distribute cotton inputs from a list drawn up annually by the Minister of Agriculture. It also limits the importers and distributors of cotton inputs to those who hold a license issued by the Ministry of Trade. The requirements to qualify for this authorization include selection at communal level by the OPA at the end of work of the Commission Cotton Inputs (CIC) and the commitment to comply strictly with the terms in place and in particular commissioning, practice of unique price on entry requirements throughout the territory. Finally, this law mandates the control of agricultural inputs before their use.

Decree No. 2006–2900 concerning import conditions and distribution of cotton inputs and marketing conditions for seed cotton under the 2006–2007 campaign defines the regulatory framework for the supply of inputs for cotton production. Only pesticides are highly regulated by the above-mentioned laws. However, all types of fertilizers are approved before being imported into Benin. Such legislation harmonization efforts have been undertaken in part by the countries of the coast as part of an "inter-approval project", the other by the Sahelian countries of CILSS member. UEMOA and ECOWAS have commissioned a study to harmonize the procedures for the registration of plant protection products throughout the West African space (IFDC, 2005). To this end, within the MIR project implemented by IFDC, it was helped in the definition of Regulation No. 04/2009/CM/ UEMOA on the harmonization of the rules governing the certification, marketing and control of pesticides in UEMOA. Following this, it was approved in Regulation No. 03/2009/CM/UEMOA on the harmonization of rules governing quality control, certification and marketing of vegetable seeds and plants in the UEMOA space.

At the sub-regional reference elements of the input supply strategy are provided in particular by the strategic orientations of ECOWAS and the Abuja Declaration on Fertilizer for an African Green Revolution (June 2006). ECOWAS proposes to set up a fertilizer marketing strategy, whose general objective is to solve the major constraints of this input market in West Africa to increase agricultural productivity through better management of soil fertility and increased use of inorganic fertilizers in respect of the environment.

Nationally, the current strategy of agricultural inputs refers to the following documents:

- *The Declaration of Rural Development Policy (DPDR);*
- *The Master Plan for Agricultural and Rural Development (SDDAR);*
- *The Operational Strategic Plan (PSO);*
- *The Revival of the Agricultural Sector Strategic Plan in Benin (PSRSA).*

These documents underline the strengthening of the private sector and producer organizations, decentralization and refocusing of the State in its sovereign functions.

13.1.3 Tax system

For seeds and crop protection products, the taxation of fertilizers in Benin is governed by the rules of UEMOA. Indeed, among the main objectives of the treaty establishing UEMOA was the establishment of a common market between Member States.

In 1994, the government, through a decision of the Council of Ministers No. 36/SGG/REL 15 September 1994 exempts agricultural inputs from customs duties and taxes payable. Only the statistical fee (1% of CAF value) imposed by the Common External Tariff (TEC) adopted by

UEMOA countries is required for importers. The exemption being inputs of registered distributors within the cotton sector, following the call for tenders launched by FUPRO.

14 The supply and demand of fertilizers in Benin

According to the results of the market research of agricultural inputs in Benin (IFDC/MIR Project, 2005), Agro Hub, 2013 the fertilizer market in Benin is characterized by its segmentation and its small size (75,000 tons to 100,000 t, depending on the year), a predominance of fertilizers for cotton (96%) and low product diversity. A supply system of fertilizers for cotton is almost nonexistent as it is only in recent years (2008–2011) that the PUASA has ensured the provision of food inputs through CeCPA. But globally, private sector participation in the import and distribution of fertilizers is active. The capital supply is held by various players in the sector inputs in the following proportions:

- Importers/distributors of inputs: 35%

- Status: 30%

- Banks: 20%

- SONAPRA: 10%

- Producers: 5%

Consequently, direct sales of fertilizers to farmers are made either in cash or on credit. Cash sales are made by mutual agreement with OPA and with individual producers. Credit sales are made exclusively with the OPA cotton based on firm orders. For cotton fertilizers , prices are largely set by the law of supply and demand. While the purchase price of fertilizers (through tenders) is based on the lowest CAF price obtained by product category, the transfer price is derived from the principle of equalization of prices over the whole of the territory and between products (urea and NPKSB).

Table 6. Types of fertilizers used in Benin.

Types of fertilizers	**Formulation**	**Application**	**Price CR average kg of last 3 years**	**Report to producers**	**Tax subsidy /**	**Observations**
NPKSB (cotton fertilizers)	$N_{14}P_{23}K_{14}S_5B_1$	Poor: 100 kg/ha Average: 150 kg High: 200 kg/ha	350 F	207 F	41%	
NPK (food crops)	$N_{15}P_{15}K_{15}$	-				Quality doubted according to users
Urée	45%	poor: 50 kg/ha average: 75 kg/ha high: 100 kg/ha				
Kcal	60%	100 kg/ha				Used in gardens
TSP(Tri-superphosphate)	-	100 kg/ha				Amendment

The following table gives a view on the volume of fertilizers offered by IDI for the last 15 years.

Table 7. Quantity of fertilizers in markets during the agricultural campaign 2001–2015.

Agricultural campaign	**Fertilizers**			**Fertilizers total**
	NPKS (kg)	UREE (kg)	Kcal (kg)	
2001–2002	54,662,350	22,533,030	23,580,550	**100,775,930**
2002–2003	58,500,850	2,799,210	1,269,600	**62,569,660**
2003–2004	52,313,400	24,230,950	729,850	**77,274,200**
2004–2005	61,733,405	29,699,950	16,000	**91,449,355**
2005–2006	34,229,400	19,561,500	235,750	**54,026,650**
2006–2007	45,646 550	23,522 480	-	**69,169,030**
2007–2008	42,794,000	21,755,800	-	**65,361,555**
2008–2009	42,795,200	21,765,800	-	**64,561,000**
2009–2010	30,386,100	14,000,150	215 650	**44,601,900**
2010–2011	30,205,650	14,589,250	-	**44,794,900**
2011–2012	47,014,000	28,874,640	-	**75,828,000**

2012–2013	96,147,960	60,521,580	-	**156,665,390**
2013–2014	92,590,750	63,248,160	-	**155,833,910**
2014–2015	78,469,000	28,973,000	2,200,000	**109 642,000**
Average (kg)	**45,326,691**	**23,662,725**	**4,341 233**	**75,568,143**
Average (tonne)	**45,327**	**23,663**	**4,341**	**75,568**

Source: AIC-Bénin, 2011, SONAPRA 2015

Table 8. Analysis of offer and request of cotton fertilizers satisfied.

Varieties		**2006–2007**	**2007–2008**	**2008–2009**	**2009–2010**	**2010–2011**	**Average**
Offer	**NPK (t)**	45,647	42,794	42,795	**30,206**	30,386	**38,366**
	Urea (t)	23,522	21,756	21,766	**14,589**	14,000	**19,127**
	Total fertilizers	**69,169**	**64,550**	**64,561**	**44,795**	**44,386**	**57,492**
Total area of cotton cultivated		230,788	230,788	234,490	209,803	194,574	**201,323**
Quantity of NPK necessary		34,618	34,618	35,174	31,470	29,186	**30,198**
Quantity of urea necessary		11,539	11,539	11,725	10,490	9,729	**10,066**

Total fertilizers utilised		46,158	**46,158**	**46,898**	**41,961**	**38,915**	**40,265**
Useful demand	**NPK (t)**	34,618	35,174	31,470	20,544	29,186	**30,198**
	Urea (t)	11,539	11,725	10,490	6,848	9,729	**10,066**
	Total fertilizers	**46,158**	**46,898**	**41,961**	**27,392**	**38,915**	**40,265**

Source: AIC for offer, MAEP for the zones cultivated and our calculations for the rest.

Analysis of this table shows that the current level of cotton fertilizers is between 15,000 to 20,000 tonnes more than the quantities required to cover the land under cotton. These gaps confirm the assertions that cotton inputs are regularly used for other purposes including crops other than cotton (food crops). The tonnage at the disposal is more than those corresponding to fertilizers quantities used to cover the forecast's cotton zones.

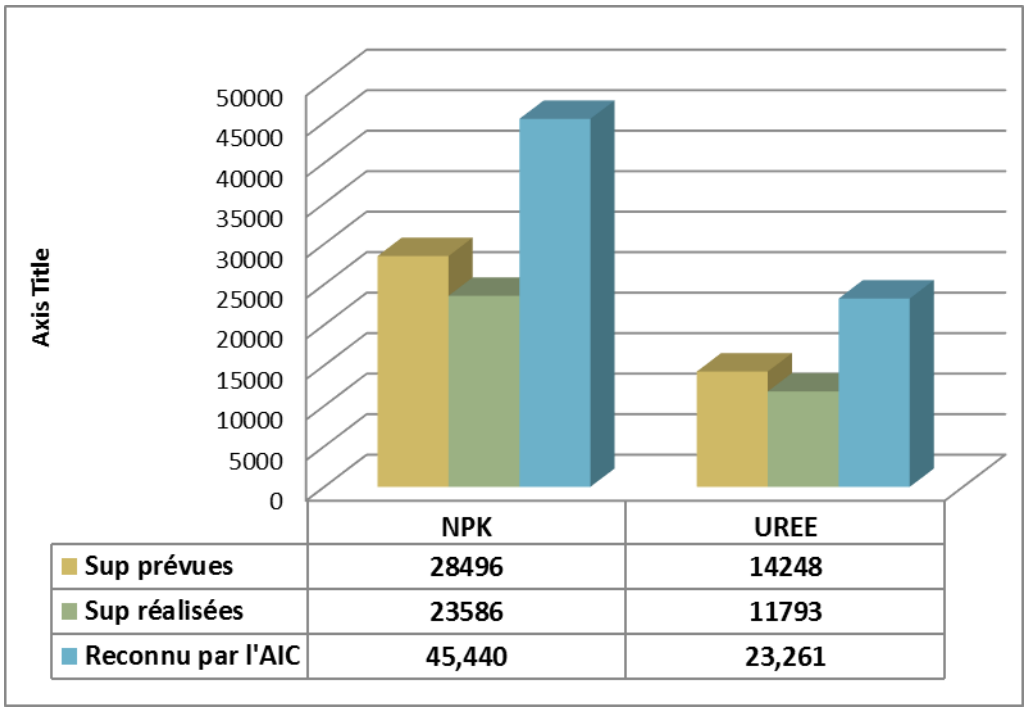


Table 1. Tonnage of NPK and Urea fertilizer on the base of cotton surfaces provided realized and those delivered and known by AIC

The predominant use of cotton fertilizer on the cotton crop in Benin is the reason why the government supports this network organization because of its economic importance.

The network integrates the supply of agricultural inputs and the commercialization of cotton grain combined with a financing system for these two functions and a training service. Since 2003, fertilizers reserved for cotton agriculture benefit from a rights and taxes exemption upon entering Beninese territory. In addition, the structure and functioning of supply management are modulated by the professionalisation of the network organization.

15 Access to finance

Benin's financial system is dominated by a few commercial banks that serve the structured formal sector but which do not meet the needs of small and medium enterprises (SMEs) and farmers (Integrated Framework DTIS, 2005). The banking system contributes little to the financing of agriculture and development of rural credit seems essential to compensate for lack of self-financing farmers. The federation of savings banks and mutual agricultural credit (FECECAM) has many local and regional agricultural credit banks, but according to the Beninese authorities, practiced rates are high (17–18%) and the repayment period rarely exceed 24 months and only a very small share of credit (less than 1% by the BCEAO) is granted to agricultural productive activities (OMC, 2004a).

According to Vincent Joseph MAMA 1998:

> Producers, in particular their professional organizations estimate that the government lacks of political will to fund agriculture. Recurring issues are often related either to the lack of a specialized institution of credit to agriculture like other countries in the West African sub-region (National Bank of Agricultural Development in Mali, for example), or poor coordination by the state of supply of inputs producers (fertilizers, pesticides) other than cotton. The experience of the credit for the promotion of food crops conducted by the State on the national budget between 1996 and 200 and then resumed under the name Credit 'support to small producers' since 2003 has been poorly managed. In fact, these loans set up: by CARDER from 1996 to 1998, the OPA from 1998 to 2001 and NGOs from 2003, experienced some difficulties, especially in terms of reimbursement from the OPA and accountability of NGOs. The experience must be pursued but the management will have to be entrusted to some professional microfinance institutions (MFIs).

16 Institutional and policy barriers around access to fertilizers

Indeed at regulatory level, the results revealed some bottlenecks including:

- Most of the texts governing the supply and distribution of inputs in Benin are already obsolete as there are new organizations and guidelines on the matter.
- There are no regulations on fertilizers in Benin and even less in cash purchases.
- Inputs imported outside the cotton sector; currently subject to the cash system are subject to duties and taxes.
- There are delays in the application of fertilizers.
- There is a problem of fertilizer accessibility due to the transport from the municipal council to the villages.
- There is inadequate formulation of food fertilizer.
- There is non-compliance with requirements.

At the organizational and institutional level, the following major findings were revealed:

- The OP (GV, UCP, UDP, FUPRO) have not yet fully engaged in distribution and cash purchases. This creates a weak link in the structure of the market.
- Private companies for distribution of inputs have no experience in this area and are not interested in this activity. Financial flows generated by this market are perhaps not attractive for those companies.
- The State's involvement in the management of the input sector out cotton via SONAPRA is a little rough – the sector is experiencing significant disruption in the area of marketing.
- Information on the market situation of inputs and management coordination between the different actors are failing to ensure that the individual inputs in fertilizers are sold off in some zones while in others there is a shortage.
- Some frauds happen sometimes in terms of fertilizer quality in informal companies and in the management of input OP stores responsible for marketing. This causes a boycott of products by consumers.
- Most of the OP in the zones of food crops is badly equipped for the operations of coordination and/or distribution that they wish to use especially due to lack of financial means.
- Training and informing producers are inadequate and sometimes inappropriate for the system.
- The input distribution systems subsidized for some food crop with cross-bred acquisition modes (cash and credit) is often restricted to a list of producers.
- There are currently a few specific programmes designed to help agricultural producers to finance the purchase of inputs. The distribution of cotton inputs is fully supported by the inter-professional AIC cotton.

The opinions and perceptions of producers gathered on the subject are certainly divergent but they all reveal the depth of frustration and the current phase which speak about "public action of input supply" and "peasant rationality". The following comments are illustrative of such findings.

"Before the reform PARFC we receive the inputs at the right date and in the right quantities; today after the reform PARFC inputs do not come on due dates and are no longer sufficient for our forecasted needs. Pesticides do not come when it is necessary to perform the necessary treatment."

Box 5

Furthermore, feasibility analyses for the cash purchase of fertilizer for food by producers indicate that it is feasible to identify sufficient income when harvesting (product sales) and to save part of it for purchase of inputs for the next season. This will also involve the organization of different groups of stakeholders (producers, input suppliers, traders) around relationships contracting guaranteeing to each his interest even the viability and sustainability of its business. The major role of the State (regulation) is also essential for the survival of such measures.

17 Consideration of soil fertility management in the training curriculum

17.1 Post-secondary training in agricultural technical schools

Ten agricultural technical schools give an initial agricultural technical training:

- Agricultural technical school of Natitingou,
- Agro-pastoral technical school of Djougou,
- Agricultural technical school of Ina,
- Agro-pastoral technical school of Banikoara,
- Agricultural technical school of Kika,
- Agricultural technical school of Medji de Sékou
- Agricultural technical school of AdjaOuere,
- Agro-pastoral technical school ofSavalou,
- Agricultural technical school of Akodéha,
- Agricultural technical school of Adjahonmé

Table 9. Post-secondary training scheme.

Scheme	Cycles	Hours					Specific competences
		Total	Contact	TD	TP	TI	
General agriculture	1st cycle	12	6	2	3	1	Describe the physical components of the soil
		12	6	2	3	1	Describe the chemical components of the soil
		6	4	0	2	0	Describe the biological components of the soil
		9	2	2	4	1	Know the types of soil
		8	4	1	2	1	Know the different reserves of water in soil
		8	2	2	2	2	Make the outcome of water in soil
General agriculture	2nd cycle	12	6	2	3	1	Structure and soil texture
		12	6	2	3	1	Agro-ecological zones of Benin
		6	4	0	2	0	Improve the pH of soil (amendments)
		9	2	2	4	1	Methods to fight against different types of erosion

		8	4	1	2	1	different types of fertilizers, calculation of dosage of fertilizers
		8	2	2	2	2	Methods of application of fertilizer

Table 10. Example of specification of knowledge, aptitudes and attitudes of 1st cycle.

Competence	**Sub-competences**	**Knowledge of:**	**Knowledge of:**	**Life skills:**
Identify the physical chemistry and biological properties of the soil	Describe the physical properties of soil	-Identify the components of soil -Define the concepts of texture and soil structure -Determine the porosity and permeability of the soil -Determine the density of the soil	-Measure the size of the ground -Determine the water infiltration rate -Determine the density	-Know how to use measuring instruments -Be meticulous and organized

	Describe the chemical properties of soil	-Describe the clay-humus complex and its absorbency -To determine the pH, CEC, exchangeable cations, organic matter,	-Apply the procedure of chemical analysis in the laboratory	-Know how to handle measuring devices in the laboratory -Be meticulous and organized
	Describe the biological properties of the soil	-Identify macro and micro-organisms in the soil (soil fauna) -To characterize the mineralization process and humidification of organic matter -Explain the role of soil organic matter	-Identify soil fauna in soil horizons -Describe the role of soil fauna in the decomposition of organic matter	-Hardworking, laborious -Be careful

Characterize soil types	Recognize the types of soil and agro-ecological zones of Benin	-Describe the types of soil through the items below -Texture and soil structure -Porosity and permeability of the soil -Density of the soil -PH, CEC, exchangeable cations, organic matter - -Climate of Benin	-Make a soil cutter -Recognize soil horizons -Collect samples of soil -Mastering climate map of Benin -Recognize landforms	-Know how to use the data and the laboratory results
Determine soil water	Making the water assessment in the soil	-Rainfall data according to agro-ecological zones, -Evapo-transpiration -Run-off useful reserve, infiltration	-Take stock of the calculation from the data	-Know how to handle measuring devices

	Recognize the different water reserves in the ground	-Soil moisture (weight and volume) -Useful soil water (field capacity, permanent wilting point, easily usable reserves) -Types of sheet	-Apply the procedure steps	-Know how to use the data

18 Higher education

Three establishments are in charge of agricultural initial training.

- Faculty of Agro-Sciences of University of Abomey-Calavi, established in 1997 and train 3 years for professional license (BAC + 3 years) in agriculture and agronomy engineering (BAC+ 5 years). There are 50 agronomy engineers and 15 students of license pro in agriculture each year.

- Faculty of Agronomy of Abomey-Calavi and Agronomy School of University of Parakou which trains in agronomy engineering (BAC+ 5 years)

- Agricultural University of Kétou which offers training to pro license in agriculture (BAC+ 3 years)

Table 11. University training schemes.

Establishments	**Year**	**Cycles**	**Schemes**	**Hours** **(CT+TD+TP)**
	1st year	Engineers	➢ Geology ➢ Structures	28H+ 8H de sortie 30H
	2nd year		➢ Physics of soils and pedology	46H+16H de Sortie
	3rd year		➢ Chemistry and fertility of soils	40H
	4th year		➢ Conservation of natural resources	30H
Facultyof	5th year PV		➢ Cartography and evaluation of soils; Fertilizer analysis and fertility of soils Conservation and microbiology of soils	26H 30H 20h+16H de sortie

	1st year	Licence Pro	➢ S1: Geology: mineralogy ➢ S2: NA	15H+7H+3H 0H
	2nd year		➢ S3: Microbiology of soils ➢ S4: Genesis and classification of soils, basis and principles of fertilization; methods of indigenous fertilization of soils; modern methods of preparation of soils; Instruments	10H+5H+10H 6OH+30H60H
	3rd year		➢ S5: Cartography and evaluation of soils; fertilizer analysis and fertility of soils; conservation of soils against erosion ➢ S6: NA	30H+15H30H OH
	4th year	Master STPV	➢ S1: Management and agricultural soils organization; management of soil fertility; microbiology of soils (mycology and mycorrhize); basis and principle of fertilization ➢ S2: Degradation of soils and techniques against erosion; techniques of regeneration of soils	56H+40H+25H 24H+16H+10H
	5th year		• S3: NA • S4: NA	0H 0H

	1st year		• Chemistry and fertility of soils • Conservation of soils • Evaluation of soils	-
	2nd year		• Pedology and classification of soils • Water in the soil • Structures of soil • Classification of soils	-
	3rd year		• Chemistry and fertility of soils	-
	4th year	Engineers	• Management of fertility of soils • Role of nutrients in the feeding of plants • Methods of application, calculation of dosage of fertilizers • Evaluation fertility from physiologic +retained and practical analysis of soils and observation of vegetation • Law and principles of fertility (law of restitution of higher and minimum)	-

Faculty of Agro-Sciences /University of d'Abomey Calavi	5th year PV		• Integrated Management of fertility of soils, fertility and pollution of soils • Microbiology and the use of inoculas • Biology of soil • Evaluation of soils • Use of model (foresight the yield of crops on the base of soil results for fertilizer recommendation	-
	1stYear	License Pro	• Pedology	-
	2nd year		• Tele-detection and cartography of soils • Pedogenesis and classification of soils • Base and principles of fertilisation • Methods of soil work	-

	3rd year		• Special fertilization of soils • Types of fertilizers and application • Fertigation (fertilisation and irrigation • Fabrication of organic fertilizers and use of inoculas • Legislation on inputs	-
	4th year	Master STPV	• S1: Climate changes, soils and climate changes (adaptation measures of CO_2, Biodiversity and climate changes • S2: Evaluation of soils, cartography of soils and SIG, Conservation of soils	-
	5th year		• S1: Nutrition and reason fertilization of crops use of fertilization models of soils, Bases agro-ecological and fertility of soils • S2: Organic materials and fertility of soils, pollution and protection of soils, Technique analysis and management of science of soils laboratory development of sustainable technology of soil fertility management	-
	1st year		• Pedology	-

University of Agriculture of Kétou	2nd year	Licence Pro	• Tele-detection and cartography of soils • Pedogenesis and classification of soils • Base and principles of fertilisation • Methods of soil work	-
	3rd year		• Special fertilization of soils • Types of fertilizers and application • Fertigation (fertilisation and irrigation) • Fabrication of organic fertilizers and use of innoculums • Legislation on inputs	-

Table 12. Example of knowledge, aptitudes and attitudes for professional bachelor diploma or 1st degree license pro

Competence	**Sub-competences**	**Knowledge:** **Knowledge of:**	**Skills:** **Ability to:**	**Life skills:** **Attitudes to show:**
Master the soil fertility management concepts		Knowing the different soil fertility indicators	Linking the vegetation and the level of soil fertility	Have a sense of observation and diagnosis

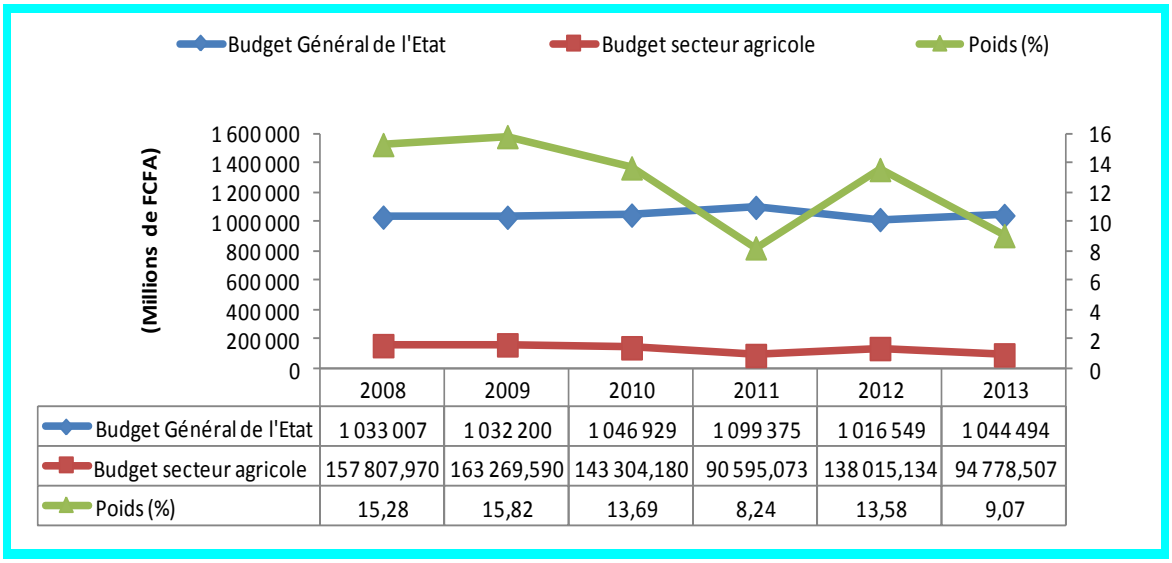
and conservation	Evaluate the level of soil fertility	Know the main nutriments and forms in soil assimilated	Determine the nutrient content of soils Identify the available forms of nutrients	Being methodical and have a mind of synthesis
	Master the techniques of fertilization and soil conservation	Define nutritional requirements of the plant	Apply technical fertilization and soil conservation	Being methodical and have a mind of synthesis
		Knowing the techniques of fertilization and soil conservation		
		Knowing the environmental impacts of soil fertilization		

19. Investments of the Beninese Government and private sector in the agricultural sector

19.1 Public forecast budget for the agricultural sector

The government budget provided for the sector for 2013 showed a substantial reduction of 31.3% from 2012, an increase of 2.75% that the government knew about. Then the general part of government budget was allocated to the agricultural sector was reduced by 10% against 13.6% in 2012. The scale is little under that of 10% recommended by the Head of African States in Abuja and Maputo.

The following Table shows the tendency of budgetary forecasts for the last 6 years.

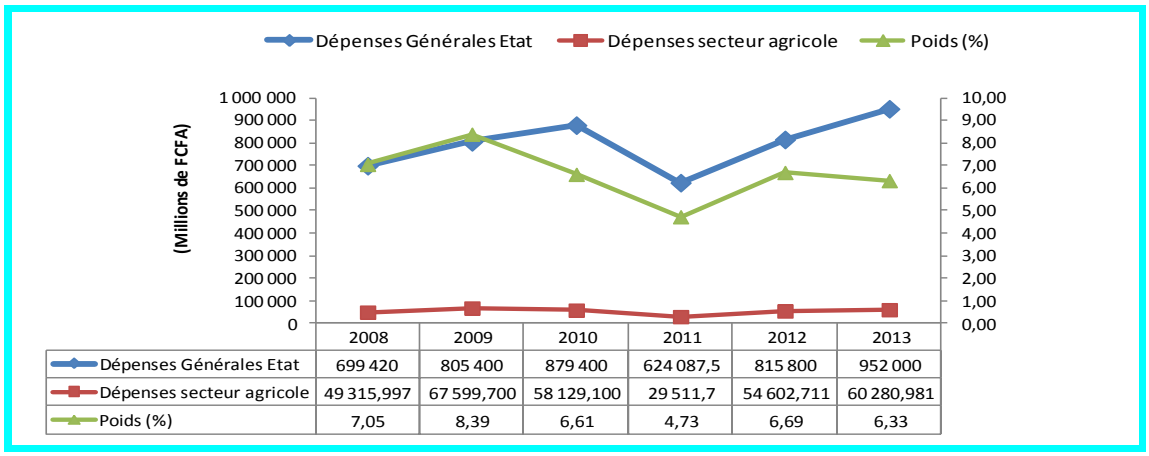


	2008	2009	2010	2011	2012	2013
Budget Général de l'Etat	1 033 007	1 032 200	1 046 929	1 099 375	1 016 549	1 044 494
Budget secteur agricole	157 807,970	163 269,590	143 304,180	90 595,073	138 015,134	94 778,507
Poids (%)	15,28	15,82	13,69	8,24	13,58	9,07

Table 2. Evolution of public forecast budgetary for the agricultural sector.

19.2 Public expenses for the agricultural sector

During the last 6 years, the public expenditures realized in the sector have been evaluated in an erratic manner, combined with their lowest level recorded in 2011. But with the measures taken by the government to progressively resolve the economic recession since 2010, the scale of government expenses in the agricultural sector continue to increase, to over XOF 29.5 billion in 2011 and more than XOF 60 billion. Upon this improvement, the weight of the sector in the public expenses is estimated as 6.6% on average in the period of 2008–2013, a level which still poor compared to the target of Maputo which is 10%.



	2008	2009	2010	2011	2012	2013
Dépenses Générales Etat	699 420	805 400	879 400	624 087,5	815 800	952 000
Dépenses secteur agricole	49 315,997	67 599,700	58 129,100	29 511,7	54 602,711	60 280,981
Poids (%)	7,05	8,39	6,61	4,73	6,69	6,33

Table 3. Evolution of public expenses realized in the agricultural sector.

20. Agricultural sector concentration zone of PTF involved in Benin

The agricultural sector constitutes one of the zones of intervention of technical and financial partners (PTF). Indeed, of the total of 23 PTF who intervene in the key sectors of Beninese economy, 13 are in the agricultural sector, 7 are through multilateral cooperatives and 6 are through bilateral cooperatives (see Figure 4)

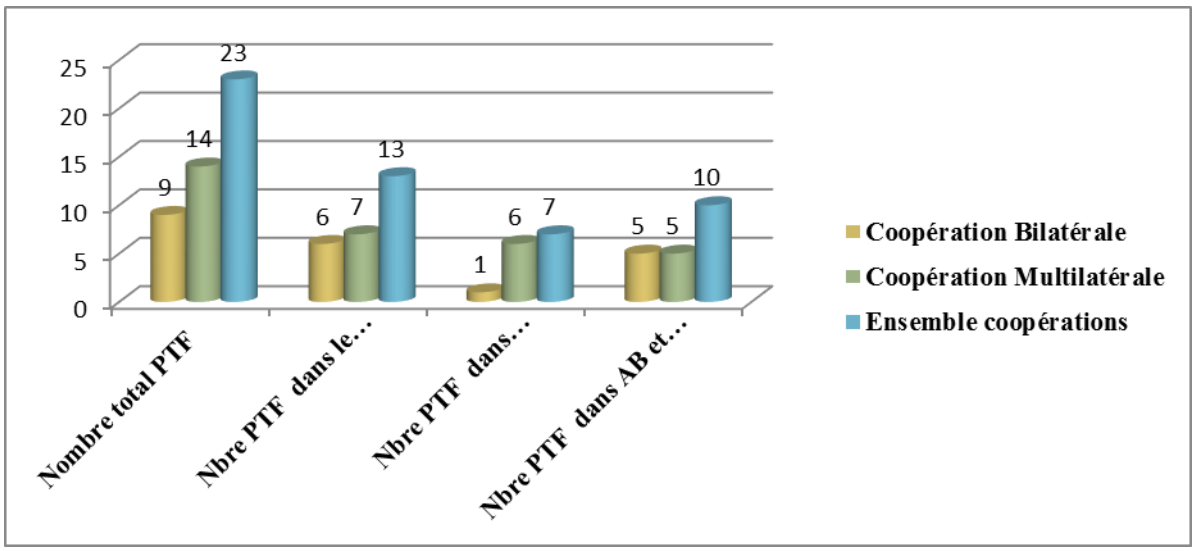


Figure 4. Sharing of PTF in key sectors of the Beninese economy.

21. Private Investment in Agriculture

Table 12: Evolution of private investors in the Sector of Agriculture

Indicators	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Global private investment (billions of Franc CFA)	357.90	338.10	376.90	394.80	428.80	722.1
Private investment in the agricultural sector (billions of Franc CFA)	49.1	51.7	52.4	54,9	64.9	100.4
Rate of increase of private investments in the agricultural sector (%)	7.5	6.7	6.6	7.2	11.7	54.8

Source: INSAE (2013). Estimations DPP/MAEP

The private investments realized in the agricultural sector increased during the last 6 years but since 2011, the growth accelerated to a high of 55% in 2013; this testifies to the involvement of private to support government efforts to strengthen the agricultural sector in local enterprise innovations by the Beninese Government.

21.5 Key issues and challenges of soil degradation

The analysis of the current situation of land management shows the following main issues of the policy framework for investment (CSI) of Benin will meet in the coming years:

- Establish a legal, institutional and right policy to the promotion and investments for GDT;
- Develop forest ecosystem management methods and water resources Water compatible with GDT; Control and effective adoption of the GDT (Sustainable management of soils/lands) techniques and technologies provide added value.

It shows in a particular way the need to:

- Develop close partnerships between the various categories of actors whose roles and actions influence the level of land degradation, particularly in the sharing and management of knowledge on the factors of success or failure of sustainable management actions, possible innovative measures and planning concerted actions;

- Establish a strategic intelligence on controlling degradation factors and construction of innovative responses to sustainable land management needs in order to adapt the support strategies of the actors;
- Be on the look-out for technological advances and successful experiences in GDT and encourage key players to use in combination with their indigenous knowledge to improve their practices and their incomes;
- Identify investment financing sources required for the implementation of GDT and implement effective mechanisms for mobilizing resources and their proper use;
- Adapt to new responsibilities for managing the effects of climate change and loss of biodiversity, enhancement factors of land degradation.

To be able to deploy capacity to effectively meet the above challenges, the major challenges are:

- To ensure effective coordination of activities of various structures and institutions involved directly or indirectly in GDT, with an institutional anchor well known and accepted by all and clear mechanisms driving the SLM approach;
- To pass the harmonious integration of sustainable land management as a priority cross-cutting theme in macroeconomic policies in the major process of cooperation and development plans and its effective integration in budget allocations;
- To ensure the existence and observance of appropriate texts to have a legislative and regulatory framework and securing incentive for GDT;
- To ensure the quality and availability of knowledge and human resources required for the efficient implementation of GDT strategies in response to new needs for innovation in all spheres of activities related to the sustainable use of land resources;
- To engage key actors in the restoration of degraded lands and sound management of available land resources.

In order to increase the performance of the sector, it has been engaged in a process of collaborative thinking among all stakeholders in the agricultural and rural world. This process has led to the development of the *Strategic Plan for Agricultural Sector Recovery in Benin* (PSRSA) whose vision is to "make Benin a dynamic agricultural power in 2015, competitive, attractive and respectful of the environment, create wealth to meet the needs of economic and social development of the population".

21.6 Operational strategies of PSRSA

Successful strategic options based on: (i) the professionalisation of family-type farms; and (ii) promoting agricultural entrepreneurship, including large farms.

To achieve this, eight axes are defined as follows:

- Reinforcement of availability and accessibility of quality seeds
- Reinforcement of inputs accessibility
- Mechanization of adapted farming and accessible
- Establishment of adequate and accessible financing
- Improving access to professional knowledge and technological innovation
- Development and operationalization of agricultural development
- Securing and managing access to land
- Facilitating access to markets.

A National Agricultural Investment Plan (NAIP) was initiated in 2010. The NAIP (2010–2015) describes the total investment needed for the efficient implementation of PSRSA in the spirit of the provisions of a pact signed by the main stakeholders during a roundtable organized in 2009.

It will be implemented actions for: (i) the development of appropriate technologies that increase agricultural productivity (integrated management technologies of soil fertility); (ii) improving the efficiency of delivery mechanisms/technology transfer; (iii) capacity of building support services to producers; and (iv) strengthening capacities of producers and their organizations in the technical, organizational, managerial and marketing.

22 Creation of the central purchasing agricultural inputs

Since 2006, considerable efforts have been made to improve the supply system for producers of cotton inputs. These efforts are still limited towards other priority sectors targeted in the *Strategic Plan of Recovery for the Agricultural Sector* that still faces enormous difficulties in the supply specific inputs.

For a good organization, providing appropriate inputs is a key factor in the promotion and development of agricultural sectors. The private sector and farmers' organizations have played an important role in the supply and distribution of agricultural inputs. However, the supply system of agricultural inputs has not yet reached the level of organization and necessary development to adequately meet the needs of the sector.

Thus, since the 1999–2000 campaign and with the withdrawal by the State of supply and distribution of inputs, SONAPRA withdrew from this activity and the private sector took over through cooperation of supplying and management of agricultural inputs (CAGIA) with the support of private Importers Distributors Inputs (IDI). The contradictions between these private players were quick to damage the system. In order to always make available the inputs to producers, the State of Benin has encouraged the creation of the central purchasing inputs (CAI), together with private operators. This could not achieve the expected results because of competition among potential shareholders in defiance of producers. Drawing lesson from

these bad results and in favour of the last crisis of the Inter-professional Cotton Association (AIC), the State decided to create a new structure called the "Central Purchasing Agricultural Inputs (CAIA) of Benin.

The creation of the CAIA, as a mixed company, will eventually provide the Beninese agricultural sector with a permanent structure to ensure the availability, throughout the national territory, agricultural inputs for plant production, animal and fish production as well as food annuities.

The CAIA thus created became operational during the 2014–2015 campaign. Currently, the State provides porting actions assigned to the other shareholders (producers, banks and the private sector) for the first 5 years of operation.

The CAIA is a company that ensures the availability, throughout the national territory, of agricultural inputs for crop, animal and fish production as well as food annuities.

It:

- Ensures the evaluation needs of producers, supplying and distribution of agricultural inputs and the recovery of input credit;
- Ensures the organization and dissemination of information on agricultural inputs;
- Research the competitive prices of agricultural inputs on the basis of global and related to the quantitative objectives of the campaign;
- Provides and manages agricultural inputs security stocks in order to maintain a constant level of balance-supply to avoid disruptions;
- Establishes an annual assessment of use and availability of agricultural inputs;
- Ensures the profitability of the business by setting up an effective collection plan;
- Encourage, alongside the state short-term facility, private or semi-public plant fertilizer manufacturing to guide the controls of the CAIA exclusively to local manufacturers.

The CAIA-SA, became operational during the 2014–2015 campaign, is under the supervision of the Ministry of Agriculture, Livestock and Fisheries (MAEP). Its headquarters are in Cotonou and two regional offices (Bohicon and Parakou).

The CAIA covers throughout the national territory and operates through the Regional Agricultural Centre for Rural Development (CARDER).

23. National Strategy for implementation of the Agricultural Council (SNCA)

The diagnosis of extension plan reveals some characteristics including: (i) the existence of a National System for Agricultural Council (SNCA) whose mission definition and implementation of national agricultural extension policy. It is open, *inter alia*, the Professional Agricultural Organizations (OPA) and relevant NGOs in this area and helped unify the group of extension approaches previously developed by the various stakeholders such as the government and NGOs since the policy option of classifying agricultural extension in non-exclusive mission of the State; (ii) strengthening the linkage between research and development, extension and farmers, marked by the existence of a mechanism of interaction between research and development, farmers and their organizations through the regional committees' research and development (MRCC) allowed to involve and increase the accountability of producers and their organizations in identifying search constraints in order to provide the most appropriate responses to the peasant demand;(iii) the implementation of a village-level participatory approach (APNV) to identify individual and collective concerns of the community.

The "agriculture council approach" of building the capacity of farmers in technical and economic fields, has been established to complement the existing system. It calls for efforts to fill the void created by technical staff from the period of the structural adjustment programmes (SAPs). The recruitment of a large number of extension agents operated in 2007 has probably helped to improve this situation.

Table 13. Distribution of rural development agents per CARDER.

CORPS	**CARDER Borgou Alibori**	**CARDER Atlantique Littoral**	**CARDER Atacora Donga**	**CARDER Mono Couffo**	**CARDER Ouémé Tableau**	**CARDER Zou Collines**
ATDR	149	65	126	82	79	129
CDR	246	209	93	121	163	214
IDR	31	28	23	24	29	24
Engineers of works	10	10	13	8	14	10

Inspectors of rural development l	2	2	1		2	2
Total	**438**	**314**	**256**	**235**	**287**	**379**

Source: Service of personal of MAEP, January 2015

Table 14. Distribution of agents of rural development by CARDER.

Bodies	**Agri-culture Office**	**DGANA**	**Breeding Office**	**Rural civil Engineering Office**	**DICAF**	**Fishing Office**	**DPLR**	**DPP**	**DPQC**
ATDR	4		5	2					6
CDR	12	3	11	7	1	15	1	1	5
IDR	9	2	6	7	10	8	4	19	3
Engineers of works			4	1		5		1	
Inspectors of Rural Development l			2	1		1			3
Total general	**25**	**5**	**28**	**18**	**11**	**29**	**5**	**21**	**17**

Source: MAEP (2015).

Staff coaching ratio: The extension agent is based in an extension centre covering two to three villages. He is responsible for advising 500 farmers. One hundred and twenty operators advise about 320 farmers in a group and 60 individual farmers.

Frame 6. The following provisions are taken into account to ensure the implementation of the Agricultural Council by the various stakeholders and its sustainability. Among these there is an emphasis on:

- The involvement of all public and private stakeholders in the actions in this framework
- The formalization of consultation frameworks at the common level, State and national
- Strengthening of the level of maturity and bid management capacity to ensure project management
- Alignment of objectives with those of farmers through: the Agricultural Research Council and the Regional Committees for Research and Development.

Conclusion

Agricultural development in Benin is seriously threatened by the degradation of natural resources (water, soil and vegetation).

Because of population growth, there is pressure on farmland; clearings significantly reduce fallow periods, resulting in overexploitation of land with all its consequences.

In addition to population pressure, the lack of control of water, the practice of slash and burn shifting cultivation, transhumance and lack of secure land tenure dangerously compromise the Beninese agricultural production. This results in a loss of production potential due to a decline in soil fertility and severe erosion and increasing pressure on the zones classified as well as a loss of vegetation.

The balance between supply and demand for food is threatened by a decline in soil fertility leading to food insecurity. Indeed, Benin in general is generally self-sufficient in food, but pockets of food insecurity exist in places, even in zones of high food production due to poor management.

After this study, it appears that:

A. Soil fertility levels

Soil fertility levels in Benin are:

- Very low fertility level
- Low fertility level
- Average fertility level
- High fertility level.

These levels are divided as follows in different compartments studied:

- First compartment grouping agro-ecological zones 1 and 2:
  - Very low fertility levels covering 21,851.37 km² or 72% of the compartment and 19% of the total land area.
  - Low fertility levels covering 7,001.32 km² or 23% of the compartment and 6% of the total land area.
- Second compartment grouping agro-ecological zones 3 and 4:
  - High fertility level: occupies 0.07% of the total area of Compartment 2.
  - Average fertility down levels: occupies 0.5% of the total area of Compartment 2.
  - Average fertility level: occupies 11.6% of the total area of Compartment 2.
  - Fertility low levels to very low, occupies 88% of the total area of Compartment 2.
- Third compartment grouping agro-ecological zones 5, 6, 7 and 8:
  - A high fertility level, they cover an area of 5,366.13 km² or 12.26% of the total area of the third part of the study and 4.71% of the total area of the country;
  - A medium level of fertility, they cover an area of 4,048.37 km² or 9.25% of the total area of the third part of the study and 3.55% of the total area of the country;
  - low levels of fertility, they cover an area of 16,956.36 km² or 38.74% of the total area of the third part of the study and 14.87% of the total area of the country;

The degradation of the zones studied is growing; these soils can become seriously degraded (except for vertisols and eutrophes brown soils with a high fertility level), and they deserve to be maintained.

Restoration technologies of soil fertility

Restoration technologies of soil fertility introduced revolve around the cover crops (*Mucuna, Aeschynomene*, *Stylosanthe*s), integrating agriculture/livestock with promoting the production and use of manure and compost, a better management of crop systems with the enhancement of crop residues to be used for cattle and sheep to improve the quality of manure, and finally agroforestry with multipurpose species such as *Acacia auriculiformis*, Sennasiamea, *Albizzialebbeck*, *Acacia tortilis*, *Sesbania grandifolia*, etc. But all these technologies do not have economic interests for producers. Endogenous technologies developed by producers revolve around the rotation, the combination of legumes edible seeds (cowpeas, soybeans, Cajanus, voandzou and groundnut) with cereals, short fallows which does not allow restoring fertility,

burying legume residues, ploughing, fold yard rotating and animal waste and rubbish for house fields. From these technologies, some deserve to be valued to enable producers to improve their performance. The relevant technologies that catch the attention of the producers are: soybeans, Cajanus, pulses edible seeds, and *Gliricidia*. The adoption of cover crops requires that we solve the problems of seed supply, management of bush fires, the straying of animals and outlets for seeds.

The management of soil fertility through organic fertilizer methods is a good opportunity for agriculture. These methods are mainly based on the principles that are:

- Improving crop associations in order to reduce competition and increase the complementarity between the species involved
- Based on the recovery, maturation and the contribution of organic materials from plant and/or animal to soil (manure, compost)
- *In situ* producing the organic material and its incorporation into the soil;
- Limiting run-off losses (cover crop, agroforestry, erosion control).

Several erosion control practices were identified. These technologies include mechanical measures for reducing run-off speed (e.g. bunds, stone bunds, benches, fagot wood and tied ridging and perpendicular to the slopes) and biological measures with lines of vetiver grass or leguminous shrubs planted next the contour lines. For better control erosion the extension services recommend a combination of the two methods of growing vegetation along the contours.

The fertilizer mode

Inputs are the subject of transactions involving several economic actors i.e. importers, private operators, retail projects and NGOs. In zones of production, cash payment mechanisms include financing structures, development institutions and/or peasant organizations. We distinguish four types: the spot supply channel in suburban zones; the cash supply system in zones supervised by projects and NGOs; the cash supply system in weakly governed or reduced agricultural potential zones; and the method of credit cash payment system grafted cotton. The organization of the cash supply of fertilizers suffer from problems of mismanagement of inputs to shops and insufficient support/advice to producers. However, analysis of opinions and perceptions of producers as well as of the feasibility of buying fertilizer for cash, show that the system is feasible but only under certain conditions: review of the national policy on supply and distribution of inputs (regulations, legislation, taxation, quality control; strengthen the organization of professional associations and technical capacity and financial support).

The calculation of the profitability of input use shows that for rice and cotton, whatever the system, performance levels are high enough to allow the introduction of a cash payment of inputs; this is not the case for maize, for which we must either:

- Organize the industry to promote a delayed sale and bundling
- Increase the yield to about 2,500 kg/ha i.e. intensify maize production
- Subsidize during the short- or medium-term, at least 25% fertilizer imported and locally sold.

In the current context, the proposed comprehensive mechanism will be to the establishment of «inputs Boutiques» or «Stores inputs». The two best plans offered in this context are the full liberalization of the system or input savings.

At institutional level

The Government of Benin focuses on those aspects of the agricultural sector with high added value in its overall agricultural policy. However we have to consider soil fertility issues as the basis of any sustainable production. We must integrate soil conservation and land programmes into the national agricultural policy; we must ensure the continued training of technicians in agro science and in agro soil science, and the participation of farmers and their local organizations in including consideration of soils by local authorities.

In all documents produced by local authorities, communal development plans take into account the problem of declining soil fertility each in terms of its development priorities. The diagnostics are the inventory of various common soil, types of soils encountered and the state of natural resources. However, this problem and efforts to restore soil fertility has not been highlighted.

Propositions and perspectives

A conservation plan and fight against degradation requires knowledge of soil and water resources. This knowledge enables development, on a rational basis, of effective programmes that consider the characteristics of the environment and the maintenance of soil fertility.

We share the ideas of Vincent Joseph Mama in 1998 as follows:

Soil mapping must move towards digitization in order to produce databases to reproduce or improve the maps. Work already carried out at the National Agro-Soil Science Center (CENAP) and the National Remote Sensing Center and Monitoring Forest Cover

(CENATEL) promises great results. Indeed, to overcome the obsolete cartographic situation as a basis for environmental management, CENATEL developed in 1993, with support from the Natural Resource Management Project (PGRN), a vegetation map of the entire country to scale 1/100,000.

The political authorities must develop plan to progressively achieve digital mapping of all soils at a medium scale (1/50,000).

Soil mapping must be carried out using the American or FAO classification (fertility level).

The soil map in Benin is at the scale of 1/200,000 and was conducted between 1968 and 1969. It is therefore imperative to redo the soils map to better define the degraded soils in different agro-ecological zones. The State should consider introducing inventory studies and land evaluation (as for cotton) to ensure agricultural sustainability.

Farmers who wish to conduct large-scale soil surveys on their land must be given financial assistance to do so. Zones already studied widely should be periodically verified in order to redefine the many fertility levels especially as dynamic organic and inorganic elements levels drop if there is no compensation for withdrawals.

A. *Concerning access to agricultural loan*

Measures should be taken to facilitate access to loan for farmers, by raising both lenders and borrowers and deploying loan lines and limited guarantee funds set up by donators. It should also consider the creation of a guarantee fund for export loans and other export financing mechanisms.

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Annex I. Terms of reference for a consultant on institutional context of soil information in Benin

- **Period**: 1 March–1 April 2015
- **Honorarium**: Daily rate plus expenses for research costs with submission of receipts.

Background

Agriculture is the main source of livelihood and income for two-thirds of Africa's population (IFDC, 2006). Cultivation without sufficient replenishment of extracted nutrients for decades is the major driver of soil fertility degradation. Limitations in organic matter and other key nutrients hugely constrain agricultural production. Population pressure and climate change exacerbate the condition of soils in the region, whereas soils in semi-arid zones are particularly vulnerable. Loss of soil fertility has caused average yields of grain crops in sub-Saharan Africa to stagnate at around 1.5 tonnes (t) per hectare since the 1960s, while fertilizer use has remained at around 10 kg/ha of cultivated land over the past 40 years. Maintaining or rehabilitating soils to increase agricultural productivity is one of the key entry points to tackling hunger worldwide.

The purpose of this project is to provide research and analysis that will support roll-out and implementation of large-scale soil rehabilitation efforts within German bilateral programmes. Bilateral BMZ programmes have been dealing with soil management issues for many years and recently BMZ has initiated a global programme on "Soils for Food Security". This programme will invest in rehabilitation of degraded soils and support policy development with regard to rehabilitation, soil information and extension systems in Benin, Burkina Faso, Ethiopia, Kenya and India.

Scope of consultancy

The scope of work for this consultancy is to analyse the institutional context within which soils research and investment takes place. In most rural zones of sub-Saharan Africa, soil data is still lacking on farmers' fields to analyse key soil properties. Soil sampling and analysis is often not well organized and costly and farmers do not usually have the means to afford such analyses. Governmental advisory services are weak and either do not offer soil analyses, or do not have the capacities to do such analyses at a scale required to make significant impact. On the other hand, farmers have significant and often sophisticated knowledge regarding soil quality in their own fields but lack access to the means to improve their soils. They are constrained from applying new knowledge and techniques by cost, a distrust of the promoted products, or the perception that ultimately these products will not help their soils. Thus, there are significant institutional challenges surrounding access to knowledge and inputs, but also delivery of quality products.

Expected activities

This consultancy shall **examine the institutional context of soil information in Benin**. The following tasks will be carried out:

1) An overview of how soils are integrated into agricultural planning and implementation at the national, regional, district and local levels. Questions to guide the research include:
   a. Does soil fertility and soil degradation appear in national policy and strategy documents on agriculture and food security? And if so, what steps and implementation plans are proposed to improve conditions in the country?
   b. Is sustainable soil management a part of the curriculum in the training institutes for agricultural extension officers?
   c. Are there any special government initiatives to address soil fertility or degradation issues (integrated soil fertility management schemes [ISFM]; fertilizer subsidies; PES; special loan schemes, etc.)?; – probe this one a bit more, since many countries have fertilizer subsidies, go a step further to ask if there is anything beyond subsidies
   d. Do civil society institutions include soil issues in their programmes? If so, what and how?;

e. How do farmers get access to fertilizers and information about soil management options?;
f. Are there private service providers for information on soil fertility, fertilizers and information on improved soil management? If so, where?
g. What fertilizer mixes are available through those in (f)?

2) What are the institutional/political obstacles around improving access to fertilizers and other soil management options? (i.e. resistance to the use of inorganic fertilizer; poor market access/transport networks; black market sales of fertilizers; direction of fertilizer to wealthier clients; dominance of middlemen or brokers, unacceptable trade-offs/failure of soil conserving practices such as conservation agriculture or ISFM, etc.).

3) What is the level of technical knowledge in a) key training institutes and in b) rural extension personnel throughout the country? What is the number of extensions agents throughout the country? What is the average number of farmers they serve?

4) Is there knowledge of farmer soil management strategies at the level of national training institutes? Is this knowledge, if it exists, fed into the curriculums of these institutes?

5) What new and innovative initiatives are active in the country related to deliver of soil information and recommendations to farmers? One Acre Fund, Soil Doc, etc.

Expected deliverables

Final report summarizing, addressing and analysing points 1-4 above.

Guidance will be provided on specific questions to ask experts and officers at various institutional levels through co-design (with consultant) of a questionnaire and data collection guide. CIAT will also provide guidance on structure and content of final report.

Contact: Please send letter of interest and CV to Dr. Katherine Snyder and Dr. Rolf Sommer at CIAT, Nairobi office – k.snyder@cgiar.org and r.sommer@cgiar.org

Annex II. List of persons met

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Annex III. Thematic Research of Abomey-Calavi University

- Integrated management of crops and soils
- Formulation of fertilizers
- Recommendations of fertilizers
- Management of organic elements of soils
- Activity of mycorhiziennes in plant nutrition
- Cultural association, rotation

Annex IV. Database of fertility of soils of the faculty of agronomic of Parakou
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ANNEX V: Characteristics of agro-ecological zones of Benin

CHARACTERISTICS	ZONE SOUTH	ZONE CENTRE	ZONE BORGOUSOUTH	ZONE BORGOU NORTH	ZONE ATACORA
CLIMATE	Sudano-Guinean with two rainy seasons: 800 to 1,400 mm/annum	Sudano-Guinean with two rainy seasons in south and 1 in north: 1,000–1,200 mm/annum	Sudano-Guinean with one rainy season: 900–1,300 mm/annum	Sudano-Sahalian with one rainy season: 700–1,200 mm/annum	Sudano-Sahalian to Sudano-Guinean: 800– 1,300 mm/annum
SOILS	Soils ferralitics soils sandy soils hydromorphes Vertisoils soils ferrugineous tropical soil	soils ferralitics sols ferrugineous tropical on crystalline basement soils hydromorphe	soils hydromorphes of valleys soils ferralitics soils ferrugineous tropical	soils ferralitics soils ferrugineous tropical soils hydromorphes Soils alluvial of river Niger	Soils minerals little progress low reserved in water
VEGETATION	savannah weed Prairy mangrove, Shrub forest semi-deciduous relic forestry	Shrub savannah and savannah with trees dominated by *Daniella olivieri*	Shrub savannah and savana with trees dominated by *karité*	Shrub savannah and savana with trees dominated by Thorny and shea at high degradation from men	Little forest savannah Shrub savannah and savana with trees dominated by thrny cheese in some places
POPULATION	3,040,670	397,652	552,224	355,950	569,059
% POPULATION RURAL	56.4	77.6	59.3	74.6	66.9
SOIL CULTIVATED/PERSONNE	0.19 ha	0.38 ha	0.25 ha	0.25 ha	0.36 ha
PROBLEMS OF NATURAL RESOURCES MANAGEMENT	Degradation of soil fertility through over used, sandy	Deforestation thorugh unlawful occupation of forest	Destruction of forest bushfires Techniques cultural inadapted	Poaching bushfires. Mode breeding and techniques cultural inadapted	Poaching, erosion, bushfires Techniques cultural inadapted

Sources: Synthesis from MDR, 1994: opportunity of creation of agricultural activities in Benin, INRAB, 1995: Master planning of agricultural research in Benin, volume 1.

ANNEX VI. Action of *Mucuna*

Mucuna attacks nitrogen of air as niebe and beans used to do. This Nitrogen is generally stocked on leaf and grain. Stems of mucuna produce many leaves and grains were left in farm to fertilize it. While covering totally the soil, the mucuna permits to fight against many weeds like and striga.

Maize in association with Mucuna.

Photo Credit: Georges Serpantié

The technique evolution of *Mucuna*

Mucuna is cultivated between maize lines during long rainy season. Vulgarization agents advise farmers to adopt a space of 80 cm between the lines and 40 cm between the plants. These measures were not observed by the producers.

In order to prevent *Mucuna* disturbing the maize, it is sown after 60 days and after removing weeds in the field. About 60 kg of Mucuna is sown per hectare to ensure maximum soil coverage.