



ENDA TM

LINKING CLIMATE ADAPTATION PROJECT

Adaptation to Climate Changes

The Sebikotane farming system case study (Senegal)

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I- General information

1-1 Geographical location



Map 1 :Senegal's geographic location

Lying at the westernmost point of mainland Africa, Senegal covers 200,000 km² between 12° and 17 ° northern latitude and 11° and 18° western longitude. It is bordered to the north by Mauritania, to the south-east by Mali, to the south by Guinea and Guinea Bissau and to the west by the Atlantic Ocean. The Gambia is fitted in Senegal's geographic area. (see map 1).

Senegal is a flat country with the only elevated relief being the volcanic Cape Verde peninsula, the Thiès “cliff” and the foothills of the Fouta Djallon mountain range on the border with Guinea, where the four major rivers (the Senegal, the Gambia, the Saloum and the Casamance) that meander through the country have their sources.

Senegal's coast along the Atlantic runs for 700 kilometers of beaches broken by some rocky parts along the Cape Verde peninsula and the region of Thiès. A stretch of fertile low land lying between sand dunes runs along the northern coast from St Louis to Dakar. This area is known as **Niayes** and it is potentially favorable for produce growing, thanks to maritime trade winds. The coast to the south of the Cape Verde peninsula is split by the Toubab Dialaw cliffs and then by the Saloum mangrove, where stretches of water run through the land like a maze, giving rise to dozens of small islands. Still further to the south, the sub-tropical zone of lower Casamance has very dense vegetation and enormous trees, rice fields, fruit trees, palm trees, etc. Meanwhile, the country's inland area features a dry plain suitable for herding.

The main climate types in Senegal are, from north to south:

- The dry Sahelian climate, where annual rainfall does not exceed 350 mm;
- The dry, continental Sahelian-Sudanese climate, where annual rainfall ranges from 350mm to 700mm;
- The Sahelian-Sudanese climate milder and more humid, where annual rainfall is between 700mm and 900mm;
- The Sudanese climate, with average rainfall of between 900 and 1,000 mm;
- The Sudanese-Guinean climate, which is characterized by heavy rainfall of about 1,000mm to 1,200 mm.

This climate is marked by two distinct seasons:

- A rainy season from June to October, which features a hot and humid monsoon wind from the St Helena anticyclone;
- A dry season from November to May, where northerly winds prevail (maritime trade winds from the Azores anticyclone and the Harmattan from the Libyan anticyclone).

1-2 Socio-economic situations

According to the 2002 census, Senegal's population was 9,956,202. This rose to 10,127,809 in 2003. The country's gross domestic product is US\$600 per capita. Debt servicing accounted for 70% of this GDP in 2000, as compared to 86.2% in 1994. 53.9% of Senegalese households lived below the poverty line in 2001, as opposed to 57.9% in 1994. Accordingly, Senegal was classified as a Least Developed Country (LDC) in 2001 and drafted its Poverty Reduction Strategy Paper (PRSP) in April 2002.

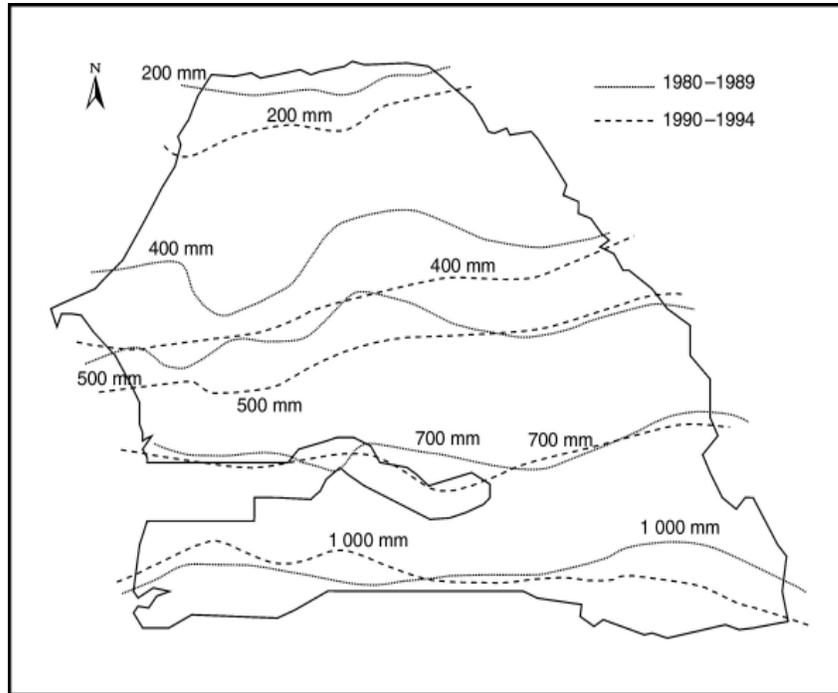
The following table displays some socio-economic data on Senegal.

Economic indicator:	GNP (2004) : US\$ 4.7 billion; US\$602 per capita GDP per capita (2003) : US\$ 635.70 per capita National external debt in 2001 : 2477,3 billion FCFA or 73,07% of the GDP
Agriculture:	Arable land (2001) : 3,800,000 ha; 19% Irrigated land (2001) : 76,000 ha
Population:	Annual growth (2003) : 2.5% Rural population : 51,1% Urban population (2003) : 48,9% Distribution: (2001) Agriculture : 70% Industry : 15% Services : 15% Population in 2003 : 10,127,809 Population in 2025 : 16,900,000 2002 life expectancy : 52.9 years

II- Overview of Senegal's vulnerability to climate change

The climate change (CC) vulnerability studies conducted in Senegal focused on agricultural productivity, coastal zones, water resources, tourism and fishing. The studies found that climate change has had a significant impact on the country's agricultural output. As with the other countries in the Sahel, Senegal has endured 17 years of drought over the last 30 years. This situation of chronic drought spawned a process of desertification that is quasi irreversible. This is because of the extent of the degradation of ecosystems that followed the drop in agricultural yields and the consequent rise in deforestation and rural poverty and exodus.

Water resources have also been hard hit by climate change. Rainfall has dwindled by 30 to 40% over the last three decades and in the space of just four years, isohyets have drifted southwards (see map 2).



Map 2: Average isohyets 1980-1989 and 1990-1994 ¹

Coastal zones are also affected. The Cap Verde peninsula has proven very vulnerable to climate change and currently risks losing half of its beaches². The Saloum estuary has become very prone to floods and, according to one disaster forecast study, risks having half of its eco-systems, especially around the delta, submerged by 2050³.

All of these factors combine to make Senegal highly vulnerable to climate change, whose effects are reckoned to cost several hundred billion CFA francs⁴. For example, climate change is expected to cause the sea level around Niayes and the Cap Verde peninsula to rise by 7 to 34 cm by 2050 and by 19 to 94 cm by 2100.⁵ Similarly, national agricultural losses arising from drought severely curtailed GDP growth between 2000 and 2002 as shown below.

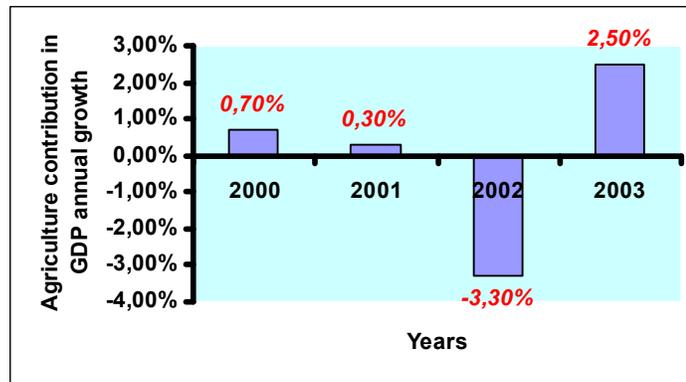
¹ http://reseau.crdi.ca/fr/ev-27906-201-1-DO_TOPIC.html

² Scénario hypothèse moyenne - Méthodologie IS92a du GIEC - Horizon 2050 - Direction de l'Environnement et des Etablissements Classés - 1999 - Niveaux d'inondation calculés selon la formule de Hoozemas et al. (1993).

³ Scénario hypothèse moyenne - Méthodologie IS92a du GIEC - Horizon 2050 - Direction de l'Environnement et des Etablissements Classés - 1999 - Niveaux d'inondation calculés selon la formule de Hoozemas et al. (1993).

⁴ Programme d'assistance des Pays Bas sur les Changements Climatiques et Programme CC-Train - Direction de l'Environnement et des Etablissements Classés - 1999.

⁵ Scénario hypothèse basse - Méthodologie IS92a du GIEC - Horizon 2050 et 2100 - Direction de l'Environnement et des Etablissements Classés - 1999 - Niveaux d'inondation calculés selon la formule de Hoozemas et al. (1993).



Data Source: Ministry for the Economy and Finance - <http://www.finances.gouv.sn/sitescoi.html>

III- National environmental policy and planning tools

The Environmental Code (Law no. 2001 – 01 of 15 January 2001) forms the basic systems of references for environmental protection and management in Senegal. The country’s environmental plans and strategies, listed below, constitute a fundamental part of its environmental policy:

3-1 The Climate Change National Adaptation Program of Action (NAPA)

The purpose of this plan is to identify sectors most at risk to the effects of climate change, devise implementation projects along participative lines, and raise funds for carrying out these projects. Launched in April 2004, Senegal’s **NAPA** identifies and focuses on four main sectors, namely agricultural production, coastal zones, water resources and tourism and fishing.

In accordance with the recommendations made at regional capacity-building workshops, the involvement of local communities is fundamental to the legitimacy and success of the process. The **NAPA** is currently in its participative phase, whereby once all relevant information has been gathered; participative risk assessment will determine the priority target groups, sectors and regions. Adaptation exercises will then focus on these. Senegal’s **NAPA** is expected to be ratified in 2005.

3-2 Senegal’s Initial Communication

In accordance with Article 12 of the United Nations Convention on Climate Change, which requires parties to supply “a national inventory of entropic emissions by source and absorption by sinks of all greenhouse gases”, Senegal produced its first national greenhouse gas inventory in May 1994 on the basis of data from 1991.⁶ The Initial Communication updates this inventory to reflect 1994 data. It also highlights the vulnerability of water resources, agriculture and coastal zones and puts forward strategies for coping with the effects of Climate Change. This Initial Communication was submitted to UNFCCC in 1997. The second is under preparation.

⁶ Inventory carried out by Direction of Environment and classified establishments.

3-3 The National Implementation Strategy of the United Nations Convention on Climate Change (NIS)

Drafted in 1999, the National Implementation Strategy of the United Nations Convention on Climate Change (NIS) may not be mandatory given Senegal's commitments arising from the UNFCCC (such as the national communication), but is intended to demonstrate to the International Community how the country intends incorporating climate change concerns into its overall social and economic development policy.

The NIS highlights the vulnerability of the agricultural sector and sets out the major ways of adapting to cope with climate change. These entail:

- Making irrigation more efficient;
- Improving practices of working with soil;
- Allowing soil to lie fallow;
- Promoting new seed varieties;
- Developing research into improved genetic materials.

3-4 Senegal's Forestry Action Plan

In 1981, Senegal launched the Forestry Development Guideline Plan (PDFF), a genuine forestry management scheme. The plan outlined mid- and long-term action strategies designed not only to propel a dynamic for conserving forests and natural areas but also to stimulate substantial growth in public investment in this sub-sector. Since the national and international context was subject to constant change, this plan was updated via a Senegalese Forestry Action Plan (FAP - 1993). This FAP is being reviewed in 2005 because the forestry board has become aware that it needs to adopt more participative approaches and attitudes since the causes of deforestation and natural resource degradation are to do more with the overall complexity of management systems and practices than merely with the headline act of cutting wood. The goal is now to ensure that rural forestry, which covers forestry, agriculture and pastoral farming, helps boost natural resources productivity while preserving ecological balance.

3-5 The National Program to Combat Desertification

This is the main instrument for implementing the United Nations Convention to Combat Desertification (CCD) at national level. A study ⁷carried out in 1984 as part of national land management planning found that 47% of soils are of poor quality or are totally unsuitable for agriculture, while a further 36% are subject to desertification-related factors that restrict their productivity. As part of efforts to achieve sustained agricultural growth and thereby boost food security and better manage natural resources, the government undertook actions to reflect the provisions of the CCD. These included: fighting erosion, regenerating soils, combating salinisation of soils, restoration of depleted land (reforestation, soil restoration and rest, deferred grazing), imposing regulation on resources use (legislation on exploitation of woodland, fauna and sea resources) and rationalization of wildlife and fish resources.

⁷ MEPN - Programme d'Action National de Lutte Contre la Désertification - Octobre 1998

3-6 The National Environmental Action Plan (NEAP)

The National Environmental Action Plan (NEAP) was drawn up in 1997 and was one of the initiatives taken by the Senegalese government in the wake of the Earth Summit in Rio in June 1992. The NEAP is an overall strategic framework that aims to ensure harmony between all the policies across different sectors that relate to natural resources management and planning. One of its key objectives is to ensure that environmental considerations are taken into account in all social and economic planning. This plan was approved by a national forum and adopted by a ministerial council. The NEAP provides the umbrella for the National Strategy, the National Action Plan for Preserving Biodiversity, and the National Action Plan to Combat Desertification.

3-7 The Biodiversity Conservation Strategy and Action Plan

The Biodiversity Conservation Strategy and Action Plan (1999) forms a part of the Senegalese government's efforts to pursue both effective macro-economic management and effective natural resource management by redressing and maintaining the balances that are crucial to the sustainable development of the country.

The Biodiversity Conservation Strategy and Action Plan's aim for agriculture include ensuring that efforts to conserve biodiversity are more fully integrated into production programs and activities.

3-8 Poverty Reduction Strategy Paper (PRSP)

Senegal presented its Poverty Reduction Strategy Paper to the International Community in April 2002. It identifies public authorities' spheres of intervention and the results that guide these interventions. It is based on analysis of all forms of poverty and it aims to encourage the involvement of all players.

With regard to the agricultural sector, which is where 60% of the population is active, the PRSP strives to lay the foundations for increased growth. In spite of its importance in terms of employment, the primary sector contributes very modestly (18, 5% in 2000) to the GDP because agricultural outputs still weak and tributary of climatic risks.⁸

The strategies to be applied are designed to boost gross domestic agricultural product by removing the barriers currently impeding small farmers and providing economic security for the most vulnerable of these small farmers.

IV-Case study: the agricultural production system of the Sébikotane district in the Niayes area

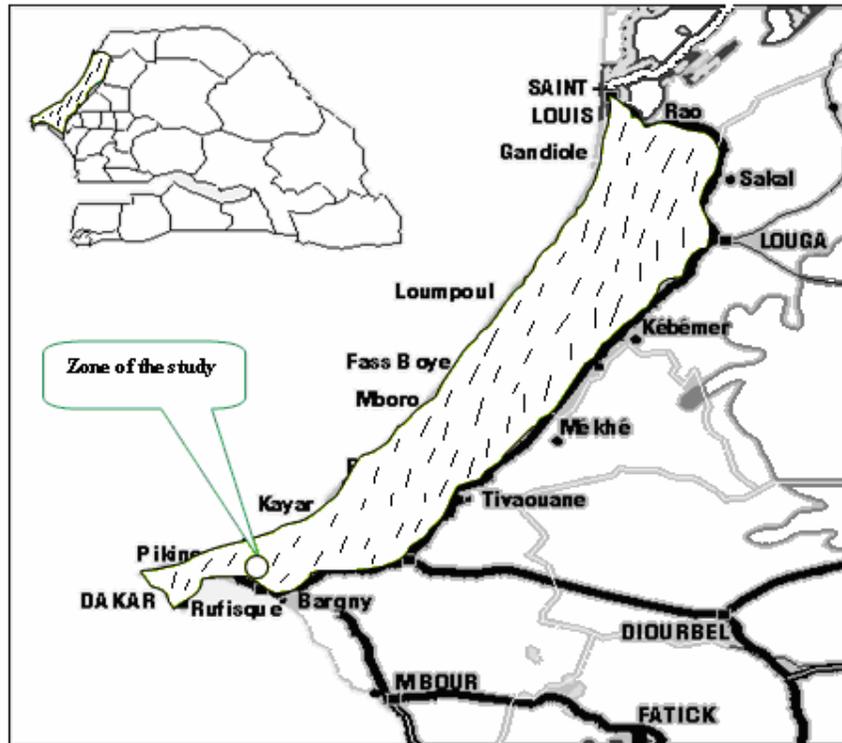
4-1 The study's framework

The Niayes area lies between 14°37' and 16°02' of northern latitude and is subject to the influence of the cold current from the Canaries. Trade winds temper the aridity of the overall climate of the country's interior, through which the Harmattan sweeps. The Niayes region stretches along Senegal's northern seaboard and boasts a physical setting (climate, soil and hydro-geology) that makes it suitable for agriculture (horticulture, poultry and dairy farming) and herding. It is 180 kilometers long and 20 kilometers wide and is responsible for 80% of Senegal's market gardening output

⁸ Republic of Senegal: Poverty Reduction Strategy Paper (PRSP) - April 2002.

and fruit and vegetable exports. Furthermore, Niayes is home to most of the country's dairy production and almost all of its poultry production. The Sébikotane district which is the subject of our study represents a sizeable (one third) portion of the Niayes agricultural hub (Map 3), where export horticulture is mainly developed.

Massive migration from inland areas towards the coasts was to a large extent fuelled by the droughts of the 1970s and 80s. The Niayes area absorbed around half of these migrants, who were attracted by the fact that the region's climate makes it more conducive to high-yield agriculture in smaller spaces. This was crucial taking into account the new intensified population density. Its closeness to the sea was also a significant pull factor, since there are ample ground water tables in the inter-dunal areas. Niayes is also close to major urban centers such as Dakar, Rufisque, Thiès, M'bour, Saint Louis and Louga. The study is shaped by the area's population levels, environmental characteristics, economic potential and its exposure and vulnerability to climate change. These are central to explaining the solutions that have been selected to enable part of the ecosystem and population to adapt to climate change and prosper.



Map 3: Geographical location of Niayes ⁹

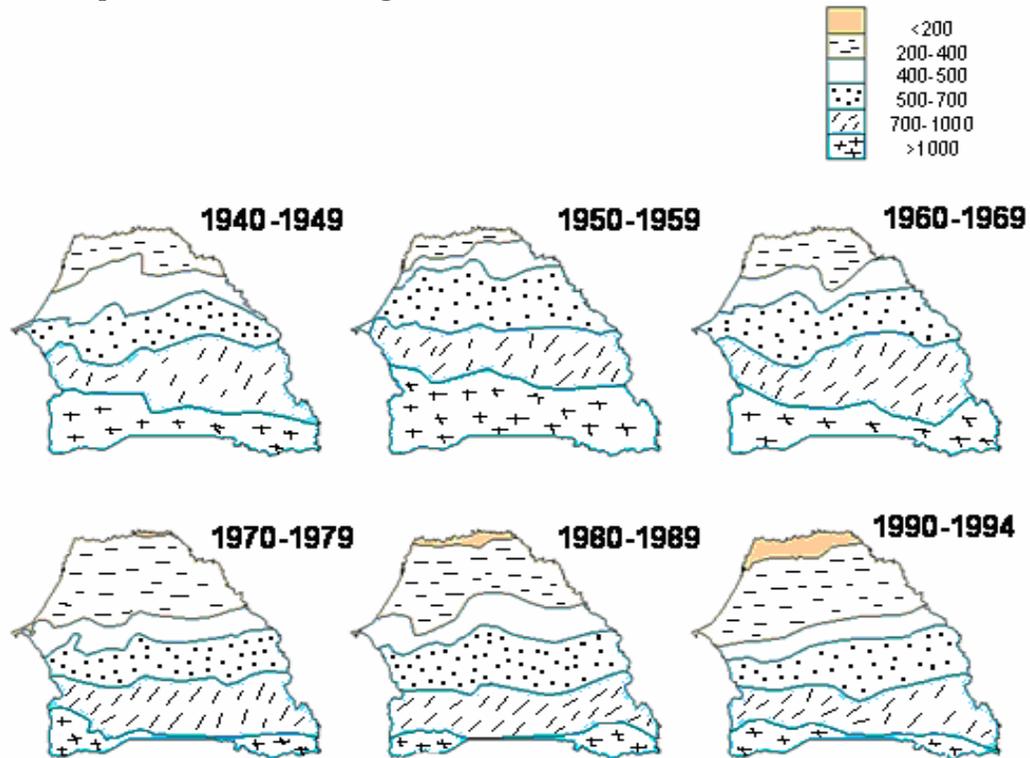
4-2 The issue

4-2-1 The vulnerability of Senegalese agriculture to climate change

Eight of the ten driest years in Senegal's recorded history came in the period between 1970 and 1986. The country's authorities reacted by looking into alternatives to cultivating rain fed crops, since the rainy season only lasted from June to late September. This entailed promoting irrigation and, especially, developing

⁹ http://reseau.crdi.ca/fr/ev-27906-201-1-DO_TOPIC.html

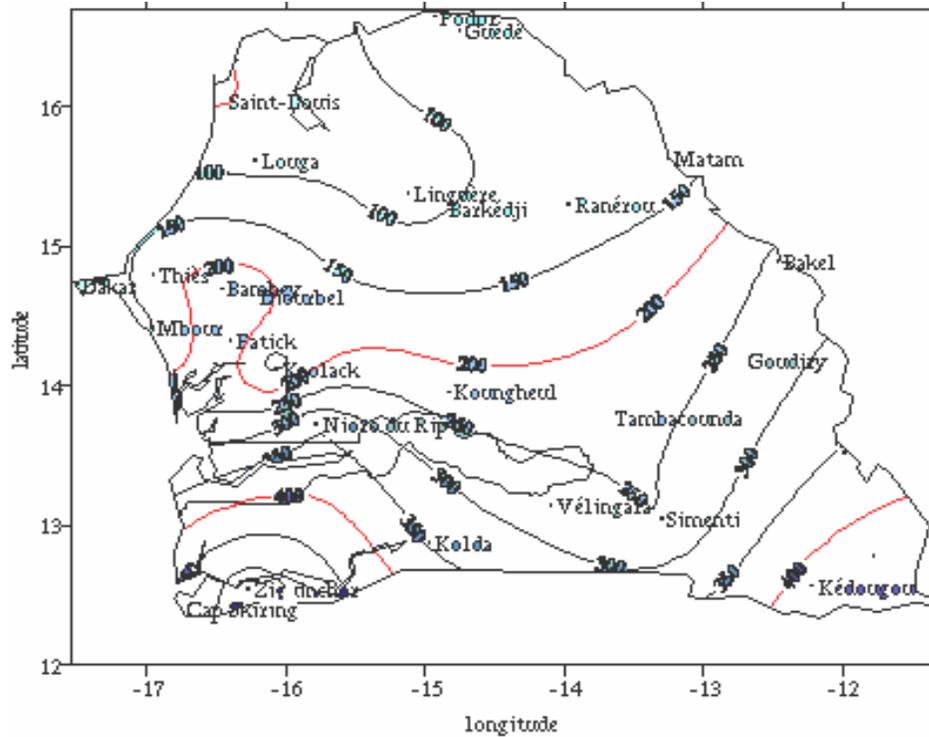
horticulture during the other nine months of the year. Further misfortune for Senegal lays in the fact that the droughts coincided with the first major oil recession of the post-independence era. The first big drought occurred in 1972, and a few years the country was gripped in a devastating drought cycle that covered 1976, 1979, 1982, 1983, 1984 (the record low rainfall), 1985 and 1986. This cycle razed almost all the vegetation covering and led to aggravated wind erosion, a drastic drop in ground water table levels and a stark shift of isohyets towards the south. These facts are depicted in the following table.



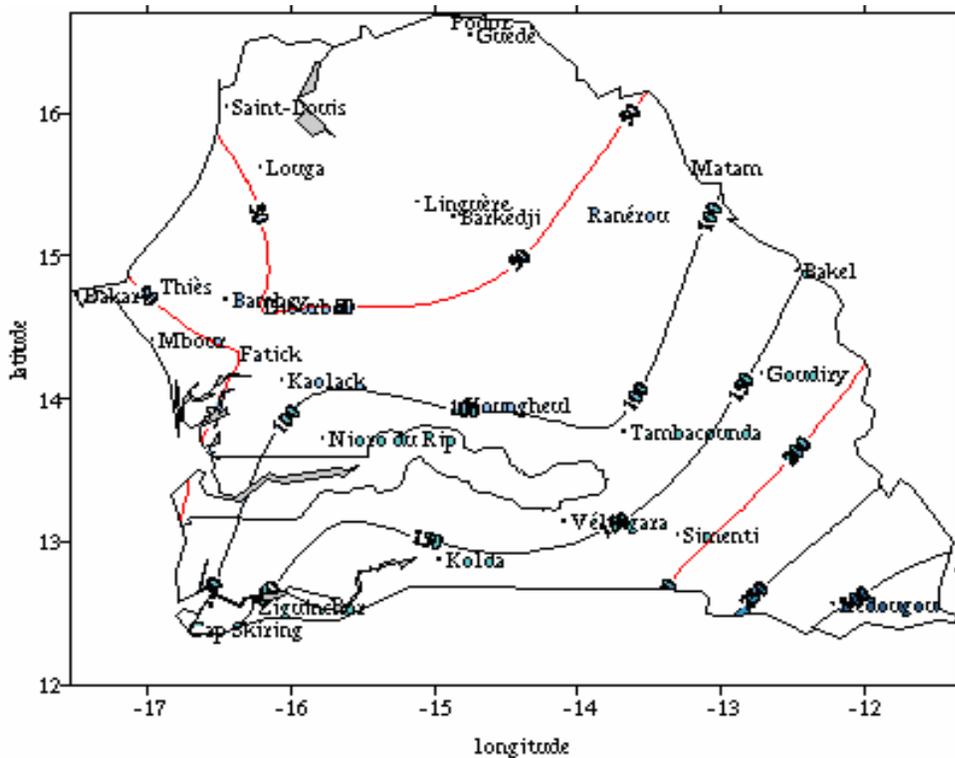
Source:¹⁰

Rainfall had already begun to dwindle in previous decades but the droughts that persisted until 2000 caused it to dry up even more and left Senegalese agriculture further exposed to climatic swings. The table below compares rainfall totals for 2001 and 2002 to those recorded from 1961 to 1990.

¹⁰ Papa Mawade Wade: Continuous monitoring and evaluation of the dryness and the turning into a desert in Senegal: Systems of early alarm to mitigate their effects - Presentation submitted to the occasion of the first session of the JACK - Rome, November 2002: <http://www.unccd.int/cop/cric1/presentations/357,4,Diapositive 4>.



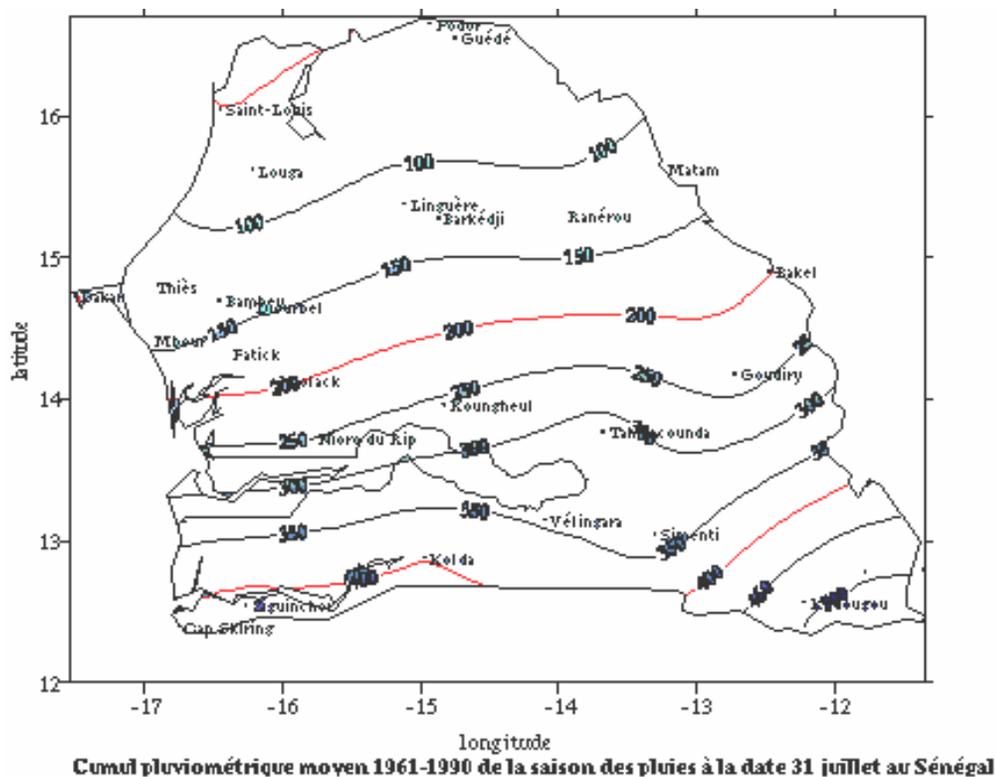
Cumul pluviométrique de la saison des pluies à la date du 31 juillet 2001 au Sénégal



Cumul pluviométrique de la saison des pluies à la date du 31 juillet 2002 au Sénégal

Sources: ¹¹, ¹²

¹¹ <http://medias.obs-mip.fr/emercase/Emercasse/precipsen100702.html>



Sources: ^{13, 14}

The extent and impact of these calamities hit Senegal hard, both in terms of environmental degradation and the resultant dip in plant and animal production. This convinced the Government authorities and populations that they needed to pursue alternatives to the rain fed crops that hitherto made up 95% of rural production systems.

4-2-2 Identifying an appropriate and productive agricultural system

1971-72 saw the creation of the country's first large horticultural farm, BUD Senegal. This was the fruit of co-operation between the Senegalese Government and the Dutch food company BUD Holland. The farm covered 1,000 hectares in the Niayes area (see map) and in the space of just a few years made Senegal the biggest ACP (Africa, Caribbean and Pacific) exporter of fruits and vegetables. Thousands of people – including youth, women and both rural and urban dwellers – were introduced to this new agricultural system and employed in it. ¹⁵

Five years later, BUD Senegal an agribusiness led by **European expatriates** met its first crisis: an administrative restructuring created on the same land anew structure named Sen-Prim. Sen-Prim with its **Senegalese managers** operated the farm for ten years before failing and being replaced by another structure Seproma, run this time by former BUD Senegal **technicians**. Seproma only lasted one season. In 1990, a

¹² <http://medias.obs-mip.fr/emercase/Emercace/precipsen100702.html>

¹³ [http://medias.obs-mip.fr/emercase/2001/264,38,Perspectives et recommandations](http://medias.obs-mip.fr/emercase/2001/264,38,Perspectives%20et%20recommandations)

¹⁴ <http://medias.obs-mip.fr/emercase/Emercace/precipsen310702.html>

¹⁵ http://ecopol.cirad.fr/cameroun/article.php3?id_article=4

group of former Bud Senegal **workers** took up the reins, with the support of a private local agricultural company.

Basically, a series of players (European expatriates then national executives, then technicians and then workers) attempted, on the same land, to show that horticulture could become the engine of Senegalese agriculture. Several explanations have been put forward for the failures of these players.¹⁶ Somewhat inevitably, most fingers have pointed to management shortcomings – but the truth lies elsewhere! The fact is that the lack of rain during the drought years caused massive loss of vegetation and, therefore, left soil bare (see below for more explanation). Once good rainy seasons returned, soil was swept away, reducing much of Senegal to desertic conditions. There were the circumstances in which the farms were set up – with fragile and sensitive market gardening crops having to be cultivated in an environment lacking in ground cover and exposed to wind and cold nocturnal temperatures. It is hardly surprising that yields plummeted.

Niayes is exposed to brutal sea winds, which had hitherto only swept through a small section of the mainland but, with the vegetation gone, could now reach right across the Cap Verde peninsula and the southern coast (see map and ¹⁷). This intensified the effects of winds.

After assessing the impact of previous agricultural policies, farmers who first expressed this knowledge, quickly understood that practices had raised neither output nor income, nor their living conditions. In fact, due to the aggravating effects of droughts, these practices had severely depleted their prize assets: the natural resources. It was essential that a new form of agriculture be explored.



Environmental degradation in Niayes.



BUD Senegal's land 30 years on, green beans

In 1990, a group of agricultural workers who had formerly worked for BUD Senegal, plus partners, took up the flame, suspecting that poor performance to that point was less down to management failures and more to do with complex and vicious environmental issues. The partnership between workers and a local company did not last long – the workers left the land, leaving it in the hands of the company that still holds it today and, along with hundreds of small producers, is now prospering on it. What allowed this company and hundreds of small producers to thrive on several thousands hectares, until these days and in the same soil, is the subject of account which follows.

¹⁶ http://web.idrc.ca/es/ev-33702-201-1-DO_TOPIC.html

¹⁷ http://www.numericworld.ch/~lmboro/mboro_geo1.htm & <http://unfccc.int/cop3/senncl.pdf>

4-3 Report

4-3-1 An environmental problem

As already mentioned, expatriate and local experts, technicians and workers all fell victim to environmental pitfalls in the Niayes area, since the zone became unfavourable to agriculture in general, and market gardening in particular.

The second debilitating factor: winds

In addition to successive droughts that severely depleted natural resources, the Niayes region is an area where through which many winds (Harmattan and trade winds) sweep through.

Trade winds, north-southerly maritime winds that blow for 7 or 8 months (from October to May). Crossing seas impacts on their humidity and diurnal thermal amplitude. The effect of these winds on the region primarily relates to heat insofar as they diminish average local temperatures by a few degrees in mainland parts of the country that lie just a few dozen kilometres from the coast. When blowing in squalls, they substantially increase potential evapotranspiration and, due to the lack of vegetation in dry seasons, shift large quantities of fine sandy particles. (PRONAT, 1999).

The Harmattan is a hot and dry easterly originating in the Sahara. It blows in the dry season. It had hitherto been unknown in the area, but its presence is becoming increasingly significant from April and May. It is responsible for a large increase in evaporation requirements and is thus a significant constraint on market gardening in the dry season. Moreover, hot squalls cause vegetation to burn (PRONAT, 1999).

The average monthly speed of these winds in Dakar ranged from 2.9m/s in September to 5.3m/s in March from 1980-1997 (UNEP – UNESCO, 2003). Given Niayes coastal location, these speeds are most likely even higher, making open country agriculture particularly difficult. It became critical, therefore, to find an alternative, some solution that would protect soils and restore lost productivity.

4-3-2 Adaptation alternative

The production systems that Enda Third World's Systems and Prospects Department (SYSPRO) recommended to Sébikotane farmers attached much importance to the role of wind-breaks, primarily to provide mechanical protection from winds to plants and limit potential evapotranspiration while simultaneously supporting organic matter in a way that enhances soil fertility.

4-3-3 The great beginning: how did it all start?

In Senegal, the story has taken on the proportions of a legend. It all began with the design of a new production system based on four pillars: technical and environmental aspects; economic and social factors. It is known as a third-generation production system, representing a step forward from first-generation

(traditional) systems and second-generation (state-sponsored) agricultural systems. Developed by an agricultural engineer¹⁸ who is also a current member of SYSPRO, these third-generation agricultural systems rank, unlike its predecessors, environmental considerations as fundamentally important. In addition, they apply a new concept of the environment, whereby the environment is something that can be “produced” rather than merely protected and preserved. It was in this context that SYSPRO designed agricultural systems that “produce favorable environments.”

This whole dynamic, which paved the way for the creation of sustainable agricultural systems, responded to the urgent need to meet one mighty challenge: to stimulate and develop agriculture capable of fuelling social and economic development in Senegal. The following chapter offers a concise analysis of the basic concepts that were used in exploring and devising this form of appropriate and productive agriculture. These are rooted in four key considerations: environmental, technical, economic and social.

□ **Technique: the space-time ratio**

With an output rate of one ton per year, it would take Sahelian farmers in general, and Senegalese ones in particular, 100 years to produce 100 tons from a single hectare – unless they could extend their holdings to 100 hectares by cutting down yet more trees! This is, quite obviously, a tremendously low productivity rate and is totally out of kilter with the urgent need to feed, clothe, educate and invest in themselves and their children. Accordingly, how to produce more is the first question farmers ask themselves. It takes Sahelian farmers 5, 10, 20 or 100 years to produce as much as farmers elsewhere can produce in just 12 months. Some Western farmers can grow 800 tons of tomatoes per hectare per year. But how could Sahelian farmers reduce production time and increase arable space without cutting down more trees?

Agricultural intensification does not necessarily mean using more chemicals or machinery. It can be more straight-forward than that: it is possible to achieve satisfactory annual production per hectare simply by increasing crop cycles and diversifying to use crops such as vegetables that naturally give high yields¹⁹. For example, two successive sowings of potatoes and cabbages can yield cumulative output of 60 tons, and that is just one possible combination.

Moreover, Sahelian farmers must learn to use and apply irrigation, fertilization and crop protection on a daily basis. To meet its pressing food needs, Africa has to compensate for its technological lag. Pluvial production systems are dominant in Africa, accounting for some 94% of agricultural systems, while just 6% of the continent's arable land is irrigated.²⁰ Yet in terms of agricultural GDP, eight of the top 12 most productive countries in Africa are in dry or arid zones. Egypt, where it hardly ever rains, is the most productive country in the continent simply because its production relies exclusively on its 3 million irrigated hectares. Contrast this with Nigeria, the continent's second biggest producer: it pursues pluvial hectares over 30 million hectares – 10 times as many as Egypt. In third place comes Morocco, which has just 1.3 million hectares, but irrigates them.²¹

¹⁸ Moussa Seck devised these third-generation agricultural systems in 1981. They were implemented for the first time in 1985 in Daga Dialaw and were then extended to Sébikotane in Niayes in 1990.

¹⁹ CSE, 2003 et <http://are.berkeley.edu/~zilber/water.ppt>

²⁰ SECK M. : Assets of one African agriculture - SYSPRO 2005 - 23 p.

²¹ SECK M. : Assets of one African agriculture - SYSPRO 2005 - 23 p.

It has frequently been demonstrated that irrigation is precursor to technological development. In other words, that irrigated farms are more favorable and more receptive to technological innovation (seeds, fertilizers, machines, etc.)

Sébikotane's agro-forestry system has been successful precisely because it is rooted in effective production techniques. In addition to the quickset hedges that lend the farm a distinct shape, the practice of contour cropping creates a micro-climate that stimulates production. All the farms are irrigated, with particular emphasis being placed on drop irrigation, which is very economic with water and labor and had the added merit of fertilizing while it irrigates (fertigation). Other irrigation methods used are sprinklers and ploughed furrows.

□ **Environmental factors**

As far as producers are concerned, these are the factors that create the conditions for optimal production. ***The environment is here understood in its broadest sense: until now, it can have been protected, preserved, conserved, threatened, degraded and everything else you can mention – except produced!***

Given that it is possible to identify and define the environment, and to preserve, degrade or conserve it, then it should also be perfectly conceivable to produce it, so long as we know of what it consists. When we say there has been environmental degradation, what exactly has been degraded? If we are talking about natural resources, then we may mean that plant cover has been and the entire ecosystem of which it is part. Therefore, if we can intelligently and realistically simulate plant cover, then we can erect wind-breaks, offset hydric and wind erosion and positively alter the micro-climate, rendering the environment a productive factor for agriculture.

Wind-breaks planted in well thought-out and linear fashion make it possible not just to trace the physical perimeter of a farm, including distribution roads, but also to delineate and protect crop plots. This whole system constitutes the productive environment and confers on the new ecosystem the capacity to boost production. That is why we may say that designing and implementing such a system is tantamount to 'producing' an environment and, at the same time, turning the environment into a producer. This release a raft of components and complex relations between the various actors and factors within the freshly-created ecosystem, leading to a food chain, habitat and substrate of biotic and abiotic elements including animals, plants, micro-flora, temperature, humidity, sun shine, etc.

On this basis, the farmer can then devise the rules for selecting and developing the biotic and abiotic factors that yield the most benefit and minimize those that harm production – and all the while maintaining appropriate balances to embed a sustainable system (see photos below).



Linear forest (windbreak)



Productive environment



Windbreak, passage ways, crop plot



Productive environment 'ecosystem'

Through perennial wind-breaks, the environment thus became an essential component of the so-called third generation production systems that SYSPRO introduced to Senegalese farmers. This concept and usage of wind-breaks reflects an appropriate response to the climate changes wrought successive Sahelian droughts.

❑ **Economic factors**

Produce consists mainly of fruits and vegetables and most of it is geared towards national and international markets. Depending on target clientele, the produce is either packed (in boxes or trays) for external markets or sold in bulk on the local or sub-regional market. Farmers achieve average yields of about 20 tons per hectare, and sometimes as much as 50 tons for speculative crops such as tomatoes. This means that farmers' income is 20 times higher than when they used pluvial agriculture system. Average gross income per hectare can reach 3 million CFA francs (US\$6,000). What's more, when produce is packed and exported, extra added value and jobs are created (in packaging – by sea, road and air – processing and marketing). Indeed, these agro forestry systems permanently employ three to four employees for each hectare of ground cultivated, without including seasonal workers who intervene only during harvest, conditioning or transport.



Plots of green beans with internal wind-breaks of corn and external windbreaks of leucaena



Manual harvesting of green beans cultivated via drop irrigation



Green beans being packed into 2.7kg boxes



Cherry tomato sorting tables in a packing dock

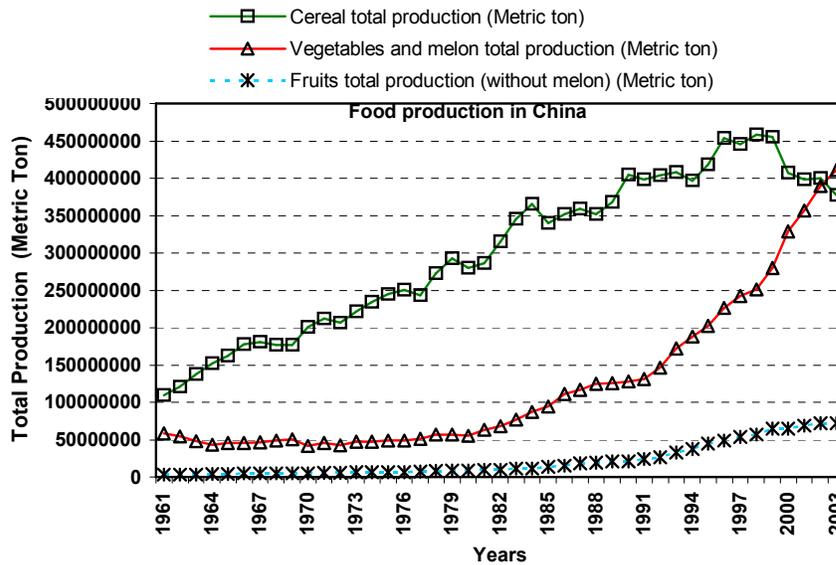


Pallet of topped green beans in 6-tray boxes ready to be dispatched

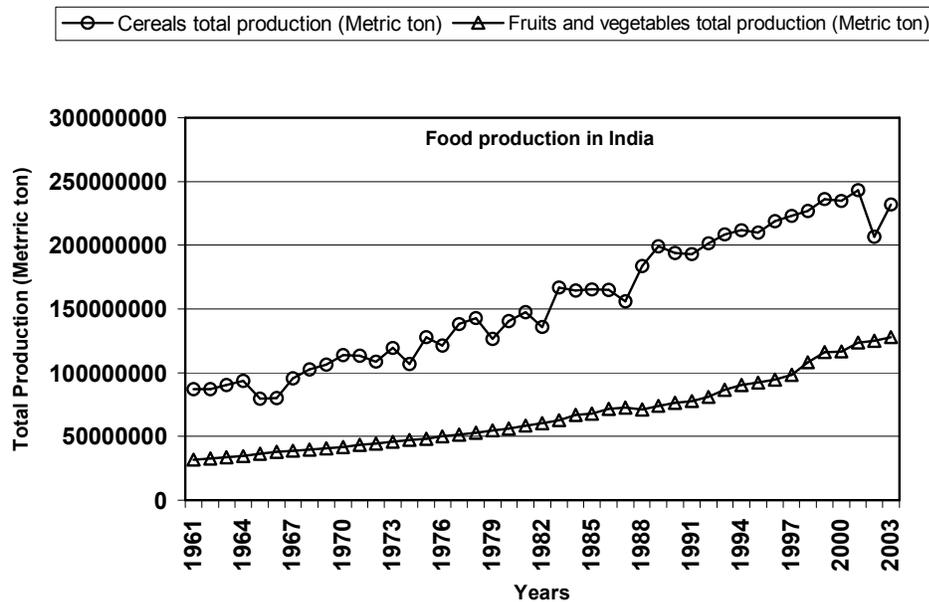


Cherry tomatoes in trays and boxes

Vegetables have the additional merit of helping overcome Senegal’s chronic food deficit. Due to their diversity and high yields, they are ideal for compensating for poor cereal yields. In China, for example, vegetable production has caught up with and overtaken cereal production – and yet China is the world’s highest producer of cereals.²² India, which has one of the biggest populations in the world, is making similar efforts to increase vegetable production.



Source: Profile of SME in Agriculture and the Agro-alimentary in Africa - SYSPRO 2004.



Source: Profile of SME in Agriculture and the Agro-alimentary in Africa - SYSPRO 2004.

Vegetable production promises rural-dwellers genuine opportunities to boost income thanks to the good market prices (twice as high as for cereals) and the capacity to

²² www.fao.org/es/debut.htm

increase production cycles in a single year – this is crucial when we consider that 60% of Senegal’s active population work in the agricultural sector, including pastoral farming, forestry and fishing, but that this sector only contributes 20% of GDP. There is now ample evidence to prove that farmers who use irrigated systems and market gardening fare better than those practicing pluvial agriculture.²³ Metaphorically speaking, the former live in solid brick-built houses while the latter still shelter in huts.

□ **Social factors**

80% of Senegal’s population is younger than 35. It is then, like most of Africa, incredibly young. The droughts of the 1970s and 80s impacted heavily on rural incomes, and one of the major consequences of this has been the flight of young men towards cities, where they seldom find jobs, and leaving disproportionately large numbers of women in the countryside. Agriculture in Senegal is confronted by two challenges: to boost productivity by increasing investment in farms, and to attract back young people as they are more likely to absorb the information needed to use new technologies.

This new generation of Senegalese farmer sprouted in Sébikotane. They have thrust themselves into horticulture and the most demanding export markets possible. Men were the first, but women have quickly followed suit and not only have they become farm-owners but they also continue to carry out the tasks traditionally assigned to women, such as sowing, weeding, harvesting, packing and processing.

This movement constitutes a shift towards the formation of a genuine socio-professional community and citizenry. Their production systems represent a considerable stride ahead of traditional methods and are closer to high-yield modern methods, with the crucial addition of being environmentally sound. These new players are forging a place for themselves in Senegal’s economy, since they are an indispensable link in the production chain, covering everything from the provision of inputs to packaging and transportation. They are generally organized into economic interest groups (EIG) or small or medium-sized businesses and are recognized as such by the state.

V – Successes and key results

Many reports, media features, memoirs and thesis have been written on the production system described above (example:²⁴, ²⁵ and²⁶). It is of interest to a wide range of spheres, from agriculture and pastoral farming to natural resource management, climate change (quantification, adaptation and mitigation), rural economics, market access, water and irrigation to decentralized co-operation and so on. Visitors have come from all over the world to study it. It employs thousands of young people and it is planned to introduce the system to thousands more hectares

²³ Chapitre 6. Intégration de l’horticulture et de l’élevage : études de cas - Abdou Salam Fall, Ibrahima Cissé, Maty B. Diao et Safiétou T. Fall - http://reseau.crdi.ca/fr/ev-27937-201-1-DO_TOPIC.html

²⁴ MOUSSA NA ABOU M. : Justification et critères de durabilité des projets de séquestration du carbone dans la lutte contre les changements Climatiques : cas des systèmes agro forestiers de Sébikotane – Mémoire de DEA – SYSPRO - UCAD Dakar – Janvier 2004 – 102p.

²⁵ Oumar BAKAYOKO: Valorisation énergétique de la biomasse dans les systèmes Agroforestiers en zone aride et semi-aride : cas des exploitations agro forestières de la zone SAAF – Juillet 1999.

²⁶ DE La Torre S. : Etude typologique d’exploitations agricoles de la zone périurbaine de Dakar dans le cadre du programme de Niayes Export. – Study report - ENDA-Tiers Monde. SYSPRO. – August 2002.

and hundreds of thousands more players. The Senegalese government has indicated its approval for propagating through its “Sénégal Agricole” program. After several years of implementation, the third generation production system has recorded significant results and transformed Senegalese agricultural practices in technical, environmental, socio-economic and political terms. It has been then spread outside the area of Sébikotane in order to be implemented in the entire Senegal.

5-1 Technical results

Techniques have been considerably overhauled from traditional methods. From rudimentary beginnings in 1985, the system now harnesses some of the most sophisticated techniques in existence. The level of technical achievement does vary between farms but in general it is accurate to say a new breed of modern farms has emerged in the country. For example, the use of drop irrigation systems is now widespread. Similarly, packaging systems are getting more and more advanced, as is necessary in order to comply with the raft of standards and norms imposed by the international market. With such enhanced techniques, improved productivity quickly followed; cherry tomato yields reached 120 tons per hectare in open country and carrots, cabbages and potatoes all exceeded 30 tons per hectares. Finally, farmers have become increasingly aware of the importance of planning effective spatial layout of their farms so that they are harmoniously integrated into the natural landscape, though it is true that there are still a large number of traditional farms to be converted to this way of thinking.



Fields of sweet corn



Plots of cabbage under glass



Sorting green beans

5-2 Environmental factors

5-2-1 In terms of wood production

Sébikotane's third generation production system uses windbreaks requiring the production of some 19 tons of wood per hectare. This is mostly procured from planned cutting of the windbreaks every two years, a practice designed to prevent them from competing with crops. This means that in addition to producing food, this system generates a surplus of wood that can then be used as cooking fuel. This is in contrast to traditional production systems, which use natural wood for cooking the food they produce. Just 50 years ago, an ample supply of wood lay just 50 km from Dakar: now you would have to travel 600 km.

It is slowly becoming impossible to fetch fuel-wood and charcoal as reserves are reaching exhaustion point. Annual food production in Senegal is around 2.5 million tons, while annual wood consumption stands at 3 million tons, meaning it takes 1.2 ton of wood to cook 1 ton of food produced. Moreover, we also need to factor in the consumption of imported food produce and other forms of cooking fuel such as gas. It is therefore of paramount importance that production systems 'produce' the environment rather than degrade it by cutting down yet more wood.



Land clearing, deforestation



Charcoal production

5-2-2 In terms of carbon sequestration

The first assessment of carbon stocks in agro-food systems carried out by SYSPRO was in 1998 (**Bakayoko, 1998**). Owing to technical and methodological difficulties, the measurement taken then concentrated solely on aerial biomass. The stocks of carbon sequestered in the aerial parts of the windbreaks was gauged at 13.46 t/ha in a five year old plot and 1.19 t/ha in a one year old plot. The average amount of carbon stocked in crops was 4.17 t/ha for green beans and 1.935 t/ha for tomatoes.

In June 2003, SYSPRO carried out further measurements (**Na Abou, 2004**) using mathematical models. These take account of both epigeal (*leucaena leucocephala*) and root part of the windbreaks.

This study shows that Sébikotane's agro forestry systems sequester on average 15 tons of carbon per hectare (root and aerial biomass) in five year old plots. This study, taking account of root carbon, was the first of its kind in Senegal. The amount of detected carbon stocks is the same as that occurring in natural prairie and tropical savannah ecosystems according to a study conducted by **Cairns and Meganck** in 1994.

A further study (**Gueye, 2002**) assessed the quantity of carbon in the juice of the fruit of the cashew tree. This can be obtained by fermentation and measurement of the amount of ethanol mixed in with cellulose to produce gel fuel for cooking – this could replace charcoal, fuel wood and non-renewable natural gas. This saves thousands of hectares of woodland from clearing, since all that is required is the juice rather than the tree itself.

5-2-3 In conceptual terms with regard to combating carbon emissions

The debate on reducing carbon emission almost swung against the South as international recommendations demanded that all countries decrease emissions and took no account of efforts made to sequester carbon. The purpose of insisting on such rules was to prevent the big polluting countries from replacing reductions with the quantities sequestered by their forests. But this blanket measure stripped many Southern countries of the option of harnessing their sequestration potential, even those that emit less than 30% fossil fuels. This led SYSPRO to devise an operational model in which the choice of whether to reduce or sequester is guided by the type of carbon (fossil or non-fossil)²⁷.

Fossil carbon refers to carbon stored in fossil fuels (hydrocarbons and coal) and in sedimentary rocks formed deep underground after millions or billions of years. The amount of fossil carbon is estimated to be about ten million giga-tons (Gt), or ten times more than the amount of carbon in all living organisms. These stocks include carbon fossilized in sedimentary rocks, which amount to some 5.10^7 Gt, while that in fossil fuels is put at 5.10^3 Gt;²⁸ the remainder is stored in kerogen (an intermediary form common to all fossil fuels).

Non-fossil carbon is the carbon in living plant and animal organisms. Stocks of non-fossil carbon are estimated at 2300 ± 350 Gt, including carbon in vegetation (550 ± 100 Gt) and soil carbon (1750 ± 250 Gt);²⁹ thus, plant and soils have about three times as much carbon as the atmosphere, which only contains 760 Gt. Carbon stored in living organisms accounts for less than 1% of carbon on Earth.³⁰

In Senegal, the agricultural systems we are dealing with here sequesters an average 15 tons of non-fossil carbon in the windbreaks (see photos), and this does not include the significant amount (6%) of carbon in the organic matter in the soil.

Of all the types of carbon in nature, only non-fossil carbon (in plants and soil) and fossil carbon (in fossil fuels) is accessible by humans (see table below).

Fossil/non-fossil carbon balance in global climate change ³¹

Atmospheric carbon	760 Gt
Non- fossil carbon (plant +soils)	2300 ± 350 Gt
Fossil carbon (fossil fuels)	5000 Gt
Total	≈ 8 000 Gt

²⁷ SECK M. : Agro forestry Systems, well of carbon in the Sahel - SYSPRO 2000 - 7 p.

²⁸ <http://www.ggl.ulaval.ca/>

²⁹ Royal Society: The Role of Land carbon Sinks in Mitigating Global Climate Change — July 2001.

³⁰ <http://www.ggl.ulaval.ca/>

³¹ <http://www.ggl.ulaval.ca/> & Royal Society: The Role of Land carbon Sinks in Mitigating Global Climate Change — July 2001.

From this table it is clear that what is at stake when we talk of carbon is the variation of 8,000 Gt of carbon out of the 50 million Gt trapped in the lithosphere. A slight variation in stocks of fossil or non-fossil carbon can impact strongly on the amount of carbon held in the atmosphere, which currently stand at a mere 760 Gt. Extracting just 15% of fossil carbon stocks (hydrocarbons and coal) would double carbon content in the atmosphere. The degradation of 33% of non-fossil carbon would be equally far-reaching. It can be seen, therefore, that the all issue of anthropogenic-induced climate change relates to the balance between **fossil carbon** and **non-fossil carbon**.

This leads us to conclude that what needs to be **reduced** is emission from fossil sources, while emission of non-fossil carbon must be **sequestered**. What's more, the fight against climate change must be sustainable, but also equitable. Certain countries in the North with large forest cover hope to get credits from these non-fossil stocks and reach their commitments in relation to the Kyoto Protocol that way, while neglecting demands to reduce carbon emissions – this would hamper any effort to combat climate change on a sustainable basis. 70% of emission by countries in the South are non-fossil (from fuel wood, agriculture, materials, etc.), meaning these countries need to concentrate more on **sequestration**. But the industrialized countries, which mainly emit fossil carbon (produced through industrial activities and burning fossil fuels), must **reduce** their emissions. With countries pursuing these paths according to the diagram below, the principle of equity between the North and the South will be respected.

5-2-4 In terms of adaptation to climate change and impact on national agricultural policy

“Sénégal Agricole” is a huge program designed by SYSPRO and implemented by the government of Senegal. It aims to achieve food sovereignty for the country and boost economic growth by marketing produce. It will be implemented across some 300,000 hectares in 33 sites in each of Senegal's 33 departments. Embedding production systems that ‘produce’ environment will lead to the sequestration of some 4.5 million tons of carbon over a five year period, or 16.5 million equivalent tons of CO₂. This figure represents five times the net emission of Senegal in 1995. If carbon is worth, say, 10 dollars per ton, these production systems could earn Senegalese farmers 45 million dollars, on top of the income from selling their produce.

Furthermore, these production systems also serve to help adapt to the droughts wrought by climate change. They make it possible not just to sequester carbon but also to preserve forests; this in turns means less emissions.

5-3 Socio-economic factors

The most critical factor in determining the success and the consolidation of production system is without question the installation of windbreaks to neutralize the harmful effects of the long years of drought. This is what enabled agricultural entrepreneurs to finally taste enduring success and what attracted hundreds of producers into the area. The arrival of so many enthusiastic workers led to the creation of producers' organizations, who then expressed their needs to development partners. Accordingly, in 1995, the European Union funded the construction of a road paving the way to 8,000 hectares of land, thereby connecting production and consumption zones. In light of the massive contribution (80%) this zone makes to the country's figures for fruit and vegetable exports, the Prime Minister gave the go-ahead in 1997 to recovery six bore-holes to Niayes farmers.

In addition, the German co-operation authority supported producers, through KFW and AGETIP and with the help of SYSPRO, and enabled them to build a packing plant to promote exports by small producers. Similarly, the President of the World Bank visited Sébikotane farms in 1994 and afterwards promised to help fund exports to the tune of 8 million dollars. Producers in this zone now earn some 15 billion CFA francs from exports. This had had a huge knock-on effect, with horticultural endeavors now sprouting all over the country, particularly in the River Valley, where water is relatively plentiful. Local and regional banks, such as the African Development Bank (ADB) and the West African Development Bank (WADB), plus credit and savings institutions, are now working in tandem with the government and other partners to raise more funds to support production and producers to fill the quality standards of Western markets. This is through individual financing of private businesses.



Fruit and vegetable packing plant



Roads opening the region

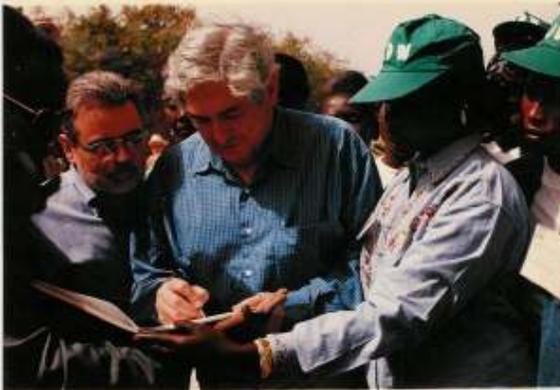
5-4 Political factors

The success of these production systems has attracted thousands of visitors over the last 15 years, the most well-known being:

- ❑ The Organization of First Wives and Spouses – led by Queen Fabiola. A guided tour by Mrs Viviane Wade, the wife of Senegal’s head of state, included Mrs Bongo of Gabon, Mrs Dos Santos of Angola, Mrs Obasanjo of Nigeria, Mrs Touré of Mali, and princesses from Morocco, Jordan, etc.;
- ❑ President James Wolfensohn of the World Bank, his wife and the two Vice-Presidents for Africa, Calisto Madavo and Jean Louis Sarbib. This visit was guided by the Prime Minister of Senegal, Habib Thiam;
- ❑ The General Manager of the FAO, Jacques Diouf ;
- ❑ The President of the Sustainable Development Commission, Nitin Desai,
- ❑ The Office of the Executive Council of the UNDP;
- ❑ The President of Senegal and his wife, the President of the National Assembly, the Prime Minister and several other members of the government.

It was during one of these visits that the “Le Sénégal Agricole: for modern and competitive agriculture” program was launched. One year later, this launch day was publicly commemorated by the country’s president, who decreed it National Rural Day, which will now be celebrated on the second Sunday of February every year. This feast day was celebrated for the first time in the rural community of Yenne in 1999, where 50,000 people from all over rural Senegal gathered to mark the occasion. The most important political decision taken in relation to rural life was the one that was affirmed both of the presidents that Senegal has had since independence to create “Sénégal Agricole”. In September 2004, Senegal renewed its development convention with

Minnesota University to continue extending the program. Furthermore, France and the Kingdom of Morocco have agreed to work on this program too, and plans are afoot to extend it throughout Africa.



Visit by the President of the World Bank, James Wolfensohn, who signed the launch of “Sénégal Agricole”



Visit by the Director General of the FAO, Jacques Diouf
The “Sénégal Agricole” logo



Visit by the Vice-Secretary of the United Nations, and the President of the Sustainable Development Commission, Nitin Desai.



Visit by the Office of the Executive Council of the UNDP, with Cheikh Hamidou Kane, CEO of Enda TM



Visit by the Organization of the First Wives and Spouses of Heads of State



National Rural Day

VI- The main lessons learnt

6-1 Agriculture and natural resource management

- ❑ In Senegal and in the rest of the Sahel, adapting the agricultural sector to climate change necessarily means adopting 'complementary substitution' of pluvial agriculture by irrigated agriculture. The latter is not only less susceptible to climatic whims, but also has the advantage of being practicable all year round;
- ❑ It is not just possible to protect, preserve and restore the environment, it is also possible to **'produce'** and treat it like a factor of production just like seeds, inputs and production techniques. This is the main lesson that can be drawn from the case study.
- ❑ Desertification is, therefore, not irreversible!

6-2 The target groups (populations of Sébikotane)

- ❑ The reluctance of local populations to adopt agricultural innovations was due to the failure of previous adaptation strategies. However, the successful testing (in Sébikotane) of the third generation production systems, encouraged populations to appropriate these new techniques.
- ❑ Applying this success story on a wider scale should be accompanied the building peoples' capacities – otherwise spreading the system elsewhere will simply trigger problems. One key factor in the success of Sébikotane was the fact that the workers involved were young and had a relatively high level of education.
- ❑ To tackle rural depopulation, it is essential that all the various links in the production chain (input sale, packing, processing, transport, etc.) are performed in rural areas rather than in cities.
- ❑ It often takes a long time to learn how to use this system properly: this result was only achieved after 15 years. And the national "Sénégal Agricole" program has not yet got underway, even if all of its various components have already been applied on an experimental basis.

6-3 The availability of funding

- ❑ Donors are more and more willing to back a venture that is a tried and tested success. Visits by the heads of the World Bank, FAO and the UNDP enabled these donors to see for themselves the success of Sébikotane and therefore encouraged them to promote this type of sustainable agriculture.
- ❑ The fact that the state is involved, guarantees a certain level of funding from development partners. NGOs can devise programs and then the government can help them up-scale.
- ❑ In spite of the clear ecological and economic benefits to this system, it would still be of great value to allocate a specific budget to encouraging farmers to adopt it – given that so many of them are so poor. Indeed, for a certain period, USAID offered incentives of 40 francs for each tree planted in Niayes. Sébikotane farmers planted many for their windbreaks and quickly exhausted USAID's budget.
- ❑ To safeguard on-going funding, private businesses should seek private funds (from credit unions, etc.) while collective utilities must be back by the state.

6-4 The role played by political decision-makers at local and national level

- ❑ The appropriation of this experiment by Senegalese decision-makers (notably through “Sénégal Agricole”) will make Senegal an ‘environmental producer’ rather than an ‘environmental consumer’.
- ❑ Political decision-makers will have to take part in regional, even continental, forums to spread the word of this experience of adapting to climate change and furthering sustainable development. The international “Dakar Agricole” meeting that was held in Dakar on 4-5 February 2005 gave SYSPRO the platform to launch a debate on a new way to thinking about agriculture on local and continental level. The concept of **African agriculture**³² was thus born and Senegalese experience could be of wide application in Africa.

6-5 Lesson that other adaptation activities in Senegal could build on

- ❑ The climate change aspect needs to be taken on board in all economic sectors. This will prevent encountering the same pitfalls that all previous attempts at introducing productive agriculture had encountered.
- ❑ Adapting agriculture to climate change must be tied in with other adaptation initiatives. While it has been possible in Niayes to adapt agriculture to cope with drought conditions, no solution has yet been found to the problem of salt ridge intrusion due to dwindling ground water tables. Similarly, in order to protect the coastline, the government, with backing from development partners, planted a 200-metre wide cluster of filaos trees along 150 km in Niayes. Since it lies by the coast, Niayes is exposed to a host of risks related to climate change (such as drought, dwindling groundwater tables, salinisation, coastal instability, etc.)

6-6 Lessons that other adaptation activities around the world could build on

- ❑ It is important to turn agriculture into a carbon sink rather than a source of carbon. In other words, agriculture must ‘produce’ rather than ‘consume’ the environment. Production systems that sequester just as much carbon as it produces food should be promoted, particularly as most production systems entail issuing emissions in order to consume the food produced.
- ❑ Sequestering as much or more carbon than the amount food produced can help countries in the South (or at least the Sahel) to achieve enhanced synergy between fighting poverty and adapting to climate change.
- ❑ The industrialized nations of the North, who are major polluters, must reduce their emissions of fossil carbon while countries in the South, whose emissions are primarily non-fossil, should sequester carbon through agricultural or forestry programs that can help alleviate poverty.

³² SECK M.: Assets of one African agriculture - SYSPRO 2005 - 23 p.

VII – Conclusion

The recurring droughts of the 1970s and 80s in the Sahel embedded the idea that the climate had really changed. This realization altered a lot of the preconceptions on which populations had hitherto based their management of natural resources, especially in rural areas. Sahelian countries, who already had little rain fall yet of whom 95% of the agricultural systems were dependent on rain, had to come up with alternatives. But drought led to a whole slew of disasters (deforestation, erosion, desertification, etc.), so adapting to climate change meant embarking on a complex adventure.

In Senegal, people in the Niayes region decided to invest in irrigation. A variety of horticultural endeavors were tried in a 20 year period, in turn by expatriates experts, local technicians and workers, yet none met with lasting success. This changed, however, with the invention of a production system based on a new interpretation and application of the ‘environment.’

Perennial windbreaks planted in linear fashion delineate crop plots and became the passage ways and contours of farms. These trees created a micro-climate that enhanced production and offset wind and hydric erosion. In addition, the windbreaks served to produce wood while helping farmers produce vegetables and fruits. It was so successful that the news spread (by the radio and television) and hundreds of farmers were attracted to join the venture. The use of the system spread so quickly that dignitaries and decision-makers came from far and wide to see the success story for themselves; these included the Director General of the FAO, the President of the World Bank, the President of the Sustainable Development Commission, the President of Senegal, and the Organization of the First Wives and Spouses of Heads of State.

Moreover, as debates continued on the relative merits of carbon sequestration and reduction, measurements of the amount of CO₂ trapped in these farms showed that they were in fact genuine carbon sinks that could hold up to 15 tons of carbon per hectare. The need to spread use of these carbon sinks and simultaneously boost farmers’ income lead to the calculation of an operational model for fossil and non-fossil carbons whose conclusion was the following: that the industrialized countries of the North, who are massive polluters, must reduce their emissions of fossil carbon, while the countries of South, whose emissions are primarily non-fossil, should sequester carbon by implementing agricultural and forestry programs that at the same time alleviate poverty.

These production systems were incorporated into a program entitled “Le Sénégal Agricole: for modern and competitive agriculture.” This will be applied across 300,000 hectares on 33 sites through the country and in co-operation with development partners. This example of adaptation, combining natural resource management, agricultural development, carbon sequestration, anti-desertification and anti-poverty measures, is undoubtedly a sound model for sustainable development and can undoubtedly be applied in similar situations elsewhere.

ACRONYMS / GLOSSARY:

CETUD : Centre d'Etudes sur le Transport Urbain à Dakar

ENDA SYSPRO : Department Systeme et Prospective de Enda TM

DEEC: Direction **de l'Environnement** et des Etablissements Classés

ENDA PRONAT : Département de ENDA TM orienté vers la Recherche Action, la Formation et l'Information.

ENERBAT : Projet Efficacité Energétique dans les Bâtiments

MEPN: Ministère de l'Environnement et de la Protection de la Nature

RISO: National laboratory under the Danish Ministry of Research and Information Technology.

UNITAR: United Nations Institute for Training and Research

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ANNEXE : PRESS CLIPPINGS ON THE SUBJECT

