

Mapping the Natural Distribution of Genus *Vetiveria* in Senegal, Traditional Uses and the Potential for Business Opportunities

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Abstract: As part of project to better understand the traditional uses of vetiver in Senegal (West Africa) in 2001 and to stimulate rural enterprises, we set out to establish a distribution map of *Vetiveria* and its uses by the populations. The mapped areas represented seven ecological zones which was fully detailed using their ecology, soil type, socio-economy, geo-referencing and size of the plant population.

Results show that in Senegal, only *Vetiveria nigriflora* is found in the wild in regions that had been known inundated from floods emanating from the Senegal, the Gambia and the Casamance River. It was found in areas where rainfall is between 200 mm and 1,100 mm, in sandy, clay and/or silted soil and where salt crystals can be seen on the soil surface. It is resistant to fires and is an indicator of a reliable water table. In the country's northern river region, vetiver presence has diminished significantly since the 1970's drought coinciding with the construction of a large hydroelectric dam river. The plant there is referred as "the plant that never dies".

Vetiver roots are traditionally used to improve the taste of drinking water and to eliminate pathogens bacteria. Water found near vetiver is considered safe for drinking. In areas where land-use is intensive, vetiver is planted to demarcate between vegetable plots to avoid land disputes among farmers. Such application seems to go back several generations. When leaves are mixed in clay to make "adobe" type dried bricks, it "prevents walls" from cracking. Functional handicraft and thatching were also found using vetiver leaves. In the South of Senegal, some rice-farmers leave vetiver in the soil to "help fertilize the fields". Despite its multiple applications, the local variety was not found to be used for erosion control.

No attempt to multiply the plant (nurseries) for commercial purposes was not found, although occasional farmers used to sell the "harvest" of a hectare of vetiver for about \$80. This commercial approach of selling the vetiver in-ground crop has disappeared.

We found there were unexploited business opportunities for vetiver in Senegal, but an innovative program was needed to expand the use of vetiver to resolve the country's and region's serious soil erosion problems.

Key words: *Vetiveria nigriflora*, Senegal, West Africa, GIS map, drinking water, commercial uses, business opportunities.

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1 INTRODUCTION

Prior to initiating a national vetiver program in Senegal and to develop markets for the product and its technology in order to stimulate rural enterprises, we were contracted to conduct research on the availability and distribution of the country's local vetiver variety. We were surprised to find very little information on usage and availability of the local variety, *V. nigriflora* which was supposed to grow in West Africa. According to our bibliographical researches, we found very little had been written about vetiver except for one researcher from ISRA, the National Ag Research Institute, shortly after *Vetiveria zizanioides* were introduced 10 yrs ago when a World Bank Representative had tried to establish a vetiver program by initiating research into its application. Our efforts were to document the areas where one could find *V. nigriflora*, to identify it and testing if there were any other species in the region that would behave like *zizanioides*.

The real aim of the study was to find native agricultural practices that could help stimulate rural enterprise; we had a suspicion that since the plant had been around for generations, practical applications had been developed. To achieve objective, we set out to establish the presence or the absence in the wild of the genus *Vetiveria* in Senegal. The research was conducted in 7 areas, which were visited in the North western part of Senegal (coastal, lake and Senegal River region), and for each, we fully detailed the specific ecology, soil type, socio-economy, and geo-referenced the sampled vetiver. Where it was present, we developed a distribution map and we conducted a survey in which we recorded what the local population said about their use and knowledge of the plant. We conclude with the potential business opportunities of the Vetiver System in Senegal and the region.

2 MATERIALS

Vetiveria nigriflora is a robust densely tufted shortly rhizomatous simple erect perennial grass about 2,4 m. high; it has large open and spreading purple panicles composed of long slender racemes, each with a fine stalk and arranged in 8-10 whorls around a central axis, bearing numerous slender spikelets with inconspicuous fine short hair-like awns, straight or slightly bent.

Leaves blades are erect or ascending at an acute angle to the culm, long linear, to 1m x 1cm, tapering very gradually from the base to the long fine tip; folded at first then expanded or partially folded later, glabrous, pale green, with the midrib recessed on the upper surface and protruding in a fine sharp line on the lower, the margins with a sharply toothed cutting edge; the base passing straight into the sheath. The ligule has a vestigial membranous rim, with short hairy behind it. Its sheath is glabrous and strongly compressed, especially the sharply keeled ones at the base of the culm; pale yellow, shining, and closely interleaved at the base. Culms are coarse and pale yellow-green, tereted above and compressed below, with short thick rhizomes. Roots are very coarse, strong yellowish, sometimes from a short rhizome (INNES & CLAYTON, 1997).

The systematic position was established on the basis of the "Flora of Senegal" BEHRAUT (1967) and the "Manual of Ghana Grasses" (INNES & CLAYTON, 1977): - Tribe: *Andropogoneae* - Family: *Gramineae* or *Poaceae* - Genus: *Vetiveria* - Species: *nigriflora*.

3. METHODS

3.1 Study site

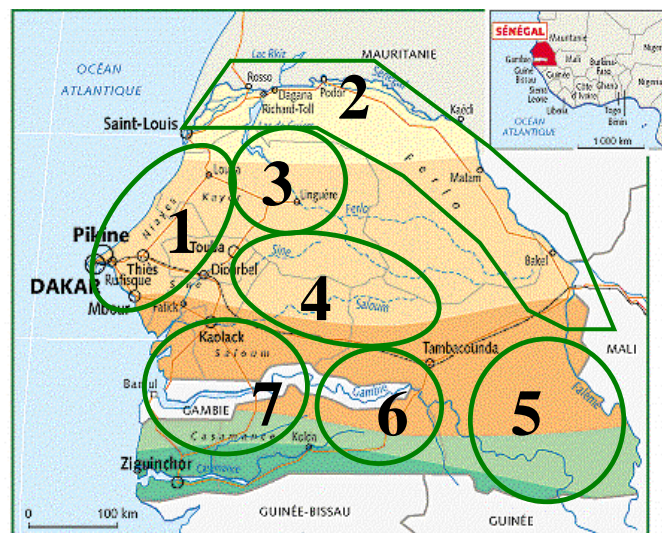
Senegal is the westernmost country of the African continent bordering the North Atlantic Ocean. The terrain is generally low, rolling plains rising to foothills in the Southeast. The climate is characterised by two seasons: the rainy season from July to September and the dry season from October to June. In rainy season, the maximum of rain generally occurs during the months of August and September. Mean annual rainfall progressively increases from the Northern to the Southern Senegal. The dry season is the hottest time of the year and the mean monthly temperatures can reach 50°C on April and May. The coolest time occurs also in dry season with a mean monthly of 10 – 15°C on January.

Figure 1. Clump of *Vetiveria nigritana* growing in the wild in Senegal (West Africa).



Research was conducted in 2001 in all seven ecological zones of Senegal. In connection with the mean annual rainfall (STANCIOFF *et al.*, 1986), the bibliographic search and the consultation of the largest national herbaria: IFAN (Institut Fondamental de l’Afrique Noire), 7 zones covering the territory were overall chosen: Area of Niayes (coastal), valley and delta of the Senegal River; Ferlo and the site of the Lake Guiers, the Centre of Senegal (Bassin Arachidier), South-Eastern Senegal, Middle Casamance and The Gambia. Each time the vetiver was perceived, their geographical coordinates were noted using GPS and were later recorded in a digitalized map of Senegal using MapInfo software.

Figure 2. The map of Senegal showing the 7 zones prospected: area of Niayes (1), valley and delta of the Senegal river (2), Ferlo and the site of the Lake Guiers (3), the Centre of Senegal named “Bassin Arachidier” (4), South-Eastern Senegal (5), Middle Casamance (6) and The Gambia (7).



3.2 Soil characteristics

In each the plot where we found vetiver, we made a floristic inventory of the plants nearby. The vegetation associated with the vetiver gave us capital information on the ecology of the later. The soil texture was described (fraction argillaceous, sandy and muddy) and the pH measured with a portable pHmeter (Schott-Garäte). Salinity was also measured using electrical conductivity. In

each explored site, samples of vetiver were delicately taken and transferred in the laboratory for systematic determination.

3.3 Population survey: socio-economic aspects

In each site of vetiver, the surrounding populations were subjected to a questionnaire. The questions related primarily to: the knowledge of the species and its mode of reproduction, all local uses and exploitations with financial profitability on the vetiver.

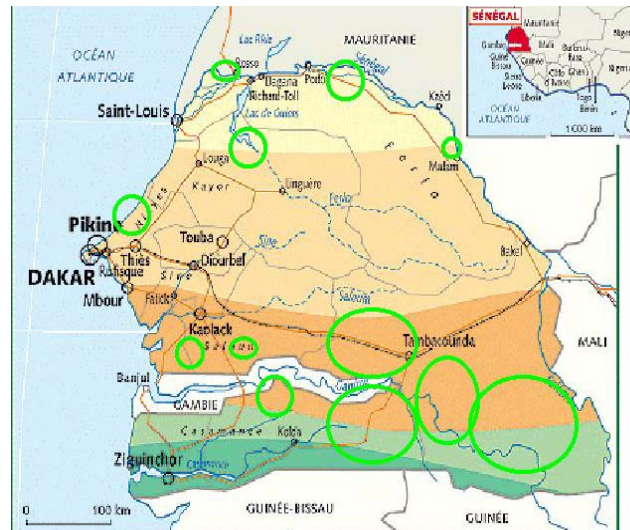
4 RESULTS

4.1 Species of vetiver found in the wild in Senegal, distribution map and Ecology

The morphological criteria on which we based ourselves indicate only the presence in the wild in Senegal of the species *Vetiveria nigriflora*. Its distribution map is shown in the Figure 3.

In the agricultural region North of Dakar (area of Niayes) soils are sandy ferolic and acid (pH 5.45) with a shallow water table (around 2 m). The mean annual rainfall varies between 200 and 300 mm and this area is greatly influenced by the spray due to the vicinity of the Atlantic Ocean. Vetiver are noted in agricultural fields, planted by the peasants but, according to them, vetiver populations were known to grow in the past naturally in the area.

Figure 3. Natural distribution of *Vetiveria nigriflora* in Senegal showed by the green circles. The size of the circle indicate the importance of the vetiver population.



The delta of Senegal River area is characterized by clay and silt soils acid (pH3.2) temporarily flooded. Sometimes, salt crystals can be seen on the soil surface. The mean annual rainfall ranges from 100 and 200 mm. In the valley of Senegal River, soils are clayish with silt and neutral pH (7.59). Spotty traces of vetiver were found, but little utilized. Vetiver presence has seriously diminished since the 1970's Sahelian drought, although the plant in that region is referred to as “the plant that never dies”.

In the Lake Guiers area, soils are sandy and the pH is 6.3. The vetiver population noted is threatened by large scale irrigation projects and by recent migrants who don't know the virtues of the plant. These new settlers uproot vetiver to make way for irrigated agriculture.

In the Centre of Senegal named “Bassin Arachidier,” soils are clay, silt and sandy. The pH ranged from 5.32 to 6.02, the electric conductivity from 63 mV to 180 mV and the mean annual rainfall from 350 to 600 mm. Spotty traces of vetiver were found in some places that have been temporary inundated during the wet season. In spite of the tendency to the degradation of the area, the vetiver population seems to function in the direction of the soil and water conservation at certain points of the same valley. The vetiver population, with foliage overall green, is divided into

easily recognizable sporadic spots by its characteristic aspect. Certain clumps appeared trimmed to the ground leaving us to assume the leaf is used in the zone. This use could be the fact of the wild fauna which is very represented in this zone. Globally, the population of vetiver has diminished due to the overexploitation according the population.

In South-Eastern Senegal area, the pH ranges from 4.51 to 8.07 and the electric conductivity from 20 mV to 158 mV. The mean annual rainfall varies between 550 and 1,100 mm. The ground is stony in the upper layer, the whole resting on a dismantled armour with concretion of fine gravels. In other places vetiver grows on hard and compact volcanic rocks which it penetrates deeply by its roots. In this area, even the population of vetiver is very important, the population has seriously diminished during these last years. We noted also that vetiver resist fire.

In the Middle Casamance area, the pH of the soil ranges from 5,82 to 7,28 and the electric conductivity from 10 mV to 67 mV. The mean annual rainfall varies between 700 and 900 mm. Soils are clay, silt and a little sandy with a wet climate. Several valleys are noted all around the area. The main is constituted by the Casamance River flows West to East.

In the Gambia area, we visited sites that were rice fields with clay and silt soil which are temporarily flooded. The mean annual rainfall varies between 600 and 750 mm.

4.2 Traditional uses of vetiver by the populations

The vernacular names used by the different Senegal ethnic's groups to name vetiver are listed below:

- Diola: *Foutoura*;
- Mandingue: *Kamare*;
- Peulh: *Sodhorde*;
- Sarakholé: *Khamare*;
- Serere: *Sintche*;
- Toucouleurs: *Sembane*;
- Wolof: *Cepp* or *Tchepp*.

In the agricultural region North of Dakar (area of Niayes), a few farmers used vetiver as: a wind break, to line vegetable plots, to separate fields to avoid land disputes and for mulch. Leaves are also used to make mats. Apparently the use goes back several generations and we noted an insufficiency of vetiver biomass.

In Delta River region of Senegal, vetiver is used for thatch, and mixed in clay for making building bricks. According to villagers, using vetiver in the adobe-type, sun-dried bricks prevents walls from cracking. Vetiver stems are sold in the local market. According to testimony, the presence of vetiver is used as an indicator of a reliable water table. Water found near vetiver is sure to be safe drinking. It is also used as animal fodder. Roots are braided into perfumed necklaces. In the Senegal River region vetiver were little utilized. In the protected forested area (Diarra), vetiver is used for bricks making and handicraft and domestic animals were noted eating new leaves.

In the Lake Guiers area, the indigenous populations prefer leaving vetiver in the soil since according to them it helps fertilize the fields. In fields that are invaded by *Typha australis* (horizontal root spreading plant that rapidly colonize wet growing areas), fields are burned to get rid of the *Typha*, leaving vetiver, since the people know that vetiver resists fire, and springs back soon after the field has been scorched. People use to sell the "harvest" of an acre of vetiver for about \$80 per hectare as the leaves were used for bricks and thatching. On the local market, a clump would fetch \$.50. One needs about 20 to 25 clumps of vetiver (about \$11) to build a house. This commercial approach of selling the in-ground crop has disappeared. One old timer told us when he was a kid, their corn was continually attacked by birds. For protection, they would wrap the vetiver leaf around new corn cobs, and this he said prevented the birds from pecking at the ripening corn. It was labor intensive, but it worked. Another spoke of women grinding vetiver roots into powder and using it to heal wounds, reduce swelling, and in a sense use it as an antiseptic.

In the Centre of Senegal named "Bassin Arachidier", vetiver roots help purify the water and improve its taste. In association with *Combretum micrantum*, it treats high blood pressure. The populations use also vetiver to make bricks, in handicraft to make hats, as insect repellent and as thatch. The later is preferred to the thatches of other plants due to its longer life span and its best resistance against the attacks by the termites. It would also play the same role as camphor by

protecting the clothes in the bags against mildew. As perfume, the women tie braided roots of vetiver round the waist. They released all day a pleasant odour thus attracting the covetousness of the loved person.

In the South-western zone of Senegal, the roots of vetiver are used to purify and to improve the taste of water. Vetiver roots are bought on the local market and not harvested on the vetiver growing in the area. An infusion of vetiver roots, sometimes mixed with mushy millet, is widely used in this area for gynaecological diseases before and during the pregnancy and after the delivery. On a watershed, we saw vetiver used as a lived hedge by a peasant to protect his field against erosion. Some termites attacks are noted on the plants around the field but not on the vetiver. This prove that vetiver resist termites attacks. Its leaves are used to make hats, baskets, utilitarian and decorative lids and thatch. The thatch of vetiver have a longer life span (around 2 years) in comparison with the thatch of other species.

In the Middle Casamance area, the roots of vetiver are used to purify the water and to improve its taste. Vetiver seems to have magic or mystical powers. Clay water containers are covered with vetiver plus cotton to protect from the harmful actions of the malefic spirits. The system of refrigeration is non-existent in these zones and this poses the problem of the conserving the deceased prior to burial. Vetiver then is braided and deposited on the corps and then covered with sand. According to the populations, vetiver helps conserving the deceased until the funeral. It is also the custom among the Peul tribe of the region to possess a broad lid made of braided vetiver leaves. When the lid is placed on top of the milk bowl, it constitutes a mystical guard able to keep away the bad spirits from the house in which the lid is placed. When the device is brought by the herder to the pasture, it is said to protect the herd against attacks by hyenas. It keeps at bay the evils that affect the stomach and drinking water. It is also used to treat pain in the stomach, impotent men, sterility, miscarriage and syphilis. It is used to make thatch, hats, lids and bee hives. The construction of bee hives and other articles with vetiver is rare however, and this is due to the insufficient amount of biomass available. It then poses the problem of the conservatory management of vetiver which seems to disappear in favour of rice growing.

In the Gambia area, we found vetiver used by the populations to protect the dykes of the rice fields against erosion and also the salinity. The dykes were 50 cm high and the plants of vetiver 10 cm spaced showing that the technology was conformed to the specifications of the Vetiver System. The vetiver used seemed to be *Vetiveria zizanioides* and the hedges were still green despite the fact that the we were at the sixth month of the dry season. Vetiver hedges are very strong and resist animal pressure. The populations told us that vetiver had been introduced several years ago by a NGO but they did not remember the name. However, the peasant manage themselves right now the maintenance of the vetiver lived hedge. Roots of vetiver were also used as water purifier and to improve its taste.

5 DISCUSSION

In condition of culture it is not easy to distinguish *Vetiveria nigriflora* and *Vetiveria zizanioides*. The totality of the authors who studied the vegetation of Senegal (HUTCHINSON & DALZIEL, 1972; INNES & CLAYTON, 1997; MICHEL *et al.*, 1969) underline only the presence of *Vetiveria nigriflora*. BERHAUT (1967) indicated also the presence in Senegal of the species *Vetiveria fulvibarbis*. However the morphological criteria on which we based ourselves indicate only the presence in the wild in Senegal of *Vetiveria nigriflora*. This later is met in all the eco-geographical zones of Senegal. It is found in a wide ranges of pH (between 3.2 and 8.7) and in a wide range of soil electric conductivity (between 20 mV and 180 mV). It is localised however regularly on the level of the marshy zones generally on heavy grounds with argillaceous texture associated in variable proportions silt and/or fine sand. The presence of the vetiver generally implies that of levelling ground water. It should be noted that even after draining of these places with temporary clogging, vetiver continues to grow normally. The vetiver introduced into adjustments for soil and water conservation with a very deep ground water develops also perfectly well. This aptitude to colonize defective areas out of water enables us to conclude that vetiver is a rustic species. This confers the plant a considerable advantage compared to the other trees used in the forestation. Ultimately, vetiver must be recommended in reforestation actions.

These observations are not in accordance with the assumptions of the surveyed population who advance in an almost unanimous way that the disappearance of vetiver is the result of the recurrence of dry periods that occurred in Senegal these past 30 years. However a brief reply based on our observations can be brought to partly explain the disappearance of vetiver: It is the strong anthropic pressure (large dam on the Senegal river, overexploitation for the use of the roots and sale in the markets or quite simply ignorance of the plant) associated with an incapacity of vetiver to naturally regenerate by seeds, these being sterile. The reproduction is done indeed only through separation clumps.

The most common use of *Vetiveria nigriflora* in Senegal and The Gambia is as a "water purifier," a disinfectant and an antiseptic. It apparently helps eliminate pathogens bacteria and also improves the taste of water. It is said that water found near vetiver is safe for drinking. These uses are widespread in Senegal and Gambia. Even If we don't know exactly when these uses started, we can hypothesize in accordance with what we observed and heard that vetiver usage could go back several generations.

It seems thought that contrary to what one have been hearing and reading, which was that vetiver is not used in Senegal except to purify water and improve its taste, needs to be expanded. At least in one of the country's regions, its use is not wide-spread, but it is used in a variety of applications, although none yet for soil erosion control. There appear to be good prospects to develop the demand if we can promote commercial multiplication nurseries. There has been no sign yet that the variety is fertile. In accordance with our observations and our information near the surveyed populations, this species does not multiply by sowing. However there exists in the literature of the cases or of the plants of the *nigriflora* variety would have multiplied by this way. It is not an invasive plant, by what naturally is not propagated easily.

Interestingly and despite the wide use of vetiver root to purify the water by the populations, there were no nurseries in any region visited, or any attempt to multiply the plant for commercial purposes. If the vetiver use continues and in addition we promote it for soil and water conservation, we could assist on the disappearance of vetiver population. Thus, people have been trained in the proper application and multiplication of vetiver, and in the management of the nurseries.

6 CONCLUSION

In order to stimulate the rural enterprise in Senegal, a cartography of vetiver and its socio-economical aspects were carried out in 2001. *Vetiveria nigriflora* is the only species which grows in the wild in Senegal. It was found in all the eco-geographical zones mainly in temporarily flooded places. The ecological interest of this species is that it occupies indifferently the very acid ranges of pH in very alkaline and grows also in soil of high amount of salt. It was also found in a wide rang of soil structure: clay, silt and sand and resist fire. This wide ecological amplitude of *Vetiveria nigriflora* is interesting in the case of growing it successfully at the scale of the territory.

In a poor country like Senegal the Vetiver System offers an interesting opportunity for the populations to increase their income by multiplying, selling and using vetiver for soil and water conservation. We found that people in these areas don't have enough informations about vetiver uses, particularly on a large scale such as for soil and water conservation. Thus, it is important to establish demonstration sites which should promote it application in bioengineering, soil and water conservation, waste water treatment, forestry, agriculture, bioremediation in particular for the soils invaded by the salt. Some people have been trained in the proper application and multiplication of vetiver, and in the management of the nurseries.

It is important initially to expand the vegetable material of vetiver when introducing in the technology in Senegal, and to propagate particularly the variety *Vetiveria zizanioides*, whose technology is more easily controlled. The latter presents the advantage of being non-invasive (interest in agriculture) since the plant is sterile and that the roots are vertical, deep and can reach 2 meters length in 1 year of plantation.

At least, for the success of the vetiver program in Senegal, we encourage the development of private contractors and suppliers of plants as a way to innovate, as they should be the vectors of the systems' dissemination.

7 ACKNOWLEDGMENTS

This research was funded by Dynaentreprises Senegal (USAID project N°: 685-C-00-00-00002-00). We are very grateful to Criss JULIARD for his constructive comments and his contribution to the revision of the initial manuscript.

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Introduction of Venceslas Goudiaby

Dr Venceslas GOUDIABY is a specialist in plant biology (Ecology Option). He did his studies at the University Cheikh Anta DIOP of Dakar, Senegal where he obtained a Doctorate degree in 2003. He is a member of a Research team that focused on the impact of water stress on ecosystem functioning in semi-arid area.

He initiated a proposal for the creation of the Senegal Vetiver Network (SNVN), and was selected as its President. He recently established his own business which has focused on vetiver and undertook a program to protect of a water basin against erosion. Since 2001, he was implicated in several actions of vetiver propagation. He has conducted some training sessions in the Vetiver System, and was an animator of workshops during two TechnoFaires which took place in Tamba and Ziguinchor, two regions of Senegal. With the assistance of a private sector project, he developed an information-based CD-rom in French on vetiver, about 10 technical papers, 6 posters and some radio emissions on the subject.