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# DEVELOPMENT OF VEGETABLE CROPPING SYSTEMS IN THE NIAYES ZONE OF SENEGAL

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SUMMARY

The importance of vegetable crops has been increasing in West Africa for the past forty years. This paper describes the evolution of intensive mixed vegetable production in the Niayes area near Dakar between 1970 and 1990. The importance of cultivation in low-lying areas with very few inputs have decreased but irrigated cropping systems have become more important due to the better adaptation of vegetative material, application of more fertilizers and better control of pests and diseases. This intensification appears to be irreversible, in spite of the negative effects of the more intensive use of land.

## INTRODUCTION

The first technical recommendations for vegetable crops in Senegal dated from 1911 (Arnaud, 1970). Since then, vegetable cultivation on the outskirts of Dakar has increased steadily from 8500 t in 1939 to about 125 000 t from 8000 ha in the 1990s. Thus, the Niayes zone constitutes 80% of the entire vegetable growing area in Senegal.

Most of the production comes from small traditional family gardens of 2000 to 5000 $m^2$. The name of Niayes is derived from the local word 'niaye' which designates the depressions between dunes which fill up with water during the rainy season. This dune system covers a strip of land between 30 and 40 km wide from the north of Dakar, along the coast towards Saint-Louis. The climate is sub-Canarian, characterized by relatively low temperatures from November to May, due to the influence of maritime trade winds (average monthly temperature 19–24°C), and a short humid season from June to October with an annual rainfall of 300–500 mm and average monthly temperature 25–29°C. Other environmental factors such as the fresh water table at a shallow depth, sandy soils and organic matter rich soils, and the vicinity of urban consumption centres are favourable for vegetable production.

In 1972, the Centre pour le Développement de l'Horticulture was created near Dakar (14°40′N, 17°26′W) with the goal of developing and improving vegetable production in the region. The main results achieved in the first 14 years were published by Beniest (1986). More recently, the Senegalese Institute for Agricul-

tural Research (ISRA) started a research programme on the agronomy of vegetable cultivation including an analysis of the evolution of the cropping systems so as to find out which of the cultural practices had been subject to improvements and which had remained unchanged during the last 30 years. The expression 'cropping system' will be used according to the definition of Sebillotte (1978).

## METHODOLOGY

The on-farm methodology developed for Africa and south and central America in the 1970s was used (Billaz and Dufumier, 1980; Gilbert *et al.*, 1980). The first studies in Senegal were carried out on food crops (Benoit-Cattin, 1986) but have recently combined considerations of agronomic and social sciences to obtain a better understanding of the farmer's problems (Basuki and Koster, 1991), a more complete picture of the production problems in an agro-socioeconomic situation (Altieri, 1984; Byerlee *et al.*, 1980; Doorman, 1989), and to improve the transfer of agrotechnology (Mills-Packo *et al.*, 1991).

Research was based on a review of the informal literature on vegetable development projects (Chastel, 1982; Coly, 1984; Houziaux, 1988); interviewing extension agents; and a close follow-up of five farmers during a complete farm year. As in previous studies, a few farmers were asked, in interviews lasting one hour and repeated every fortnight, to describe all the technical practices. This gave a range of qualitative and quantitative data particularly on the monitoring of crops in farmers' fields. This paper describes the cropping systems used between 1960 and 1970 (Arnaud, 1970) and compares them with current systems.

## THE CROPPING SYSTEMS BETWEEN 1960 AND 1970 IN THE NIAYES

Arnaud (1970) studied the economy of vegetable production in the Cap-Vert Region, considering first the non-irrigated system in the low-lying areas, which is the most important system in the Niayes, and second, the irrigated cropping system on the sandy dunes. The main species grown were garden cabbages, Irish potatoes, tomatoes, onions and green beans; the last was intended for export to the European market. At that time, sweet potatoes were not considered to be a vegetable, and certain traditional vegetables and condiments, such as jaxatu (*Solanum aethiopicum*), marrows and okra, were not always reported in statistics.

### CULTIVATION IN THE LOW-LYING AREAS

Vegetables in the low-lying areas are grown on black soils with up to 35% organic matter content, low pH, rich in calcium and magnesium salts, and with a high water retention capacity (24.5%). Crops were grown either on flat fields or on ridges.

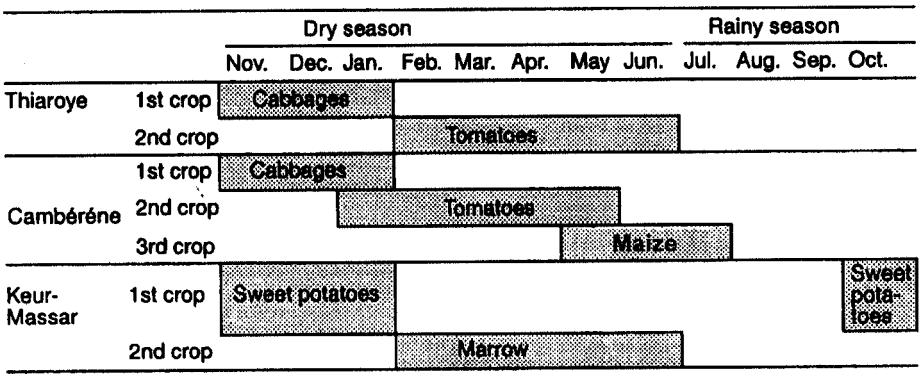


Fig. 1. Examples of the cropping calendar under low-lying condition at three locations near Dakar in the 1960s.

The most important species cultivated on flat fields were garden cabbages, marrows, tomatoes, onions, and occasionally Irish potatoes, maize and turnips; tomatoes and garden cabbages formed the bulk of the production. The growing season extended from December to July, and included the dry season and the beginning of the rainy season (Fig. 1).

Land preparation began in November when the water-table level in the low-lying areas dropped. Aquatic weeds were cut while the land was still flooded and remained on the field as they decomposed. Once all the water had receded, the vegetative residues were burned and the ashes were spread all over the field. Two consecutive ploughings were performed within two weeks, followed by transplanting or sowing. Thus, cropping took place from November to January, and sometimes into March as the water-table level dropped from the outer edges to the middle of a 'niaye'. Nurseries were sited in unflooded areas.

Chemical fertilizers were seldom used but organic compounds, groundnut earth (5–10 t $ha^{-1}$) and fish by-products (1–2 t $ha^{-1}$), were applied frequently. Groundnut earth is a residue obtained after cleaning groundnut shells and it has a mineral content of 1.5%N, 0.65% $P_2O_5$, 2.45% $K_2O$ and 1.77% CaO. Fish by-products consist mainly of residues from Dakar fish processing factories. Plant densities were usually high, up to 15 plants $m^{-2}$ for the cabbage crop. Early or late maturing varieties, particularly of garden cabbage or Irish potatoes, were selected, depending upon the planting date and the possibility of a second crop. The inundation of the soils for a few months prevented the development of several diseases and pests, such as gall nematodes.

Arnaud (1970) reported that yields from the most productive fields were 15–18 t $ha^{-1}$ for onions and 10–12 t $ha^{-1}$ for tomatoes. Sweet potatoes were the most important species cultivated on ridges and were sometimes intercropped with late turnips, marrows or watermelons in low-lying areas. After a first ploughing, ridges 1.0–1.2 m in width and 0.5–0.8 m in depth were formed

between the furrows. Cultivation on ridges allowed sweet potatoes to be grown at the edges of the flooded zone during the rainy season. No mineral fertilizer was added and yields of sweet potatoes varied between 10 and 15 t $ha^{-1}$.

## CULTIVATION UNDER IRRIGATION

Vegetables apart from sweet potatoes, okra and marrow, were grown under irrigated conditions on the sides of the niayes with an organic matter content of 3–5% and on sandy soils with low organic matter content. Crops were also grown in small depressions of sandy mineral soil (1000–2000 $m^2$) near the sea shore. The gardens were surrounded by windbreaks.

Most of the plots consisted of short lifecycle vegetables such as lettuces, green beans and radishes but other important species were Irish potatoes, carrots, tomatoes, garden cabbages and onions. Crops were rarely found during the rainy season but hot peppers were the most frequently grown, followed by aubergines, leeks, local cherry-type tomatoes and cabbages. Nearly all the seeds were imported.

Sunken beds were prepared after very shallow tillage. Sowing or transplanting was carried out at high density and plants were never thinned as in nursery beds, frequently producing a large number of weak plants. Watering took place twice a day but there was no mulching. Fertilizing with groundnut earth was done twice or three times and sometimes with mineral fertilizers applied at low rates, between 100 and 150 kg $ha^{-1}$. Baker (1985) reported wide use of organic fertilizer but there was little knowledge about the use of compost. Weeding and watering were done manually. Treatments against pests and diseases were generally applied late after the disorder had begun as in the low-lying areas, mechanization for pumping of irrigation water and for land preparation was not well understood.

Cabbages, Irish potatoes, onions and carrots were harvested throughout the dry season but tomatoes could be produced until August. Yields varied widely but good growers obtained 35–40 t $ha^{-1}$ from cabbages, 10–15 t $ha^{-1}$ from Irish potatoes and 10–15 t $ha^{-1}$ from jaxatu. The quality of these products was better than that of crops obtained in low-lying areas.

There was occasional intercropping of vegetables but farmers often planted adjacent beds with different vegetables. Moreover, irrigated and non-irrigated cropping systems were often used in the same garden. At one site, the first crop was grown without irrigation while the second and third crops were watered. According to Arnaud (1970), between 30 and 60% of vegetable growing areas were irrigated in the Dakar region.

In the low-lying areas, sole crops were grown annually on the same plot of land, the number of cultivated fields depending on the rainfall and the time it took for the water to recede. Farmers usually grew a crop of tomatoes or okra after sweet potatoes which had been planted at the beginning of the rainy season. Vegetable crops were grown on different plots at different times (Fig. 1).

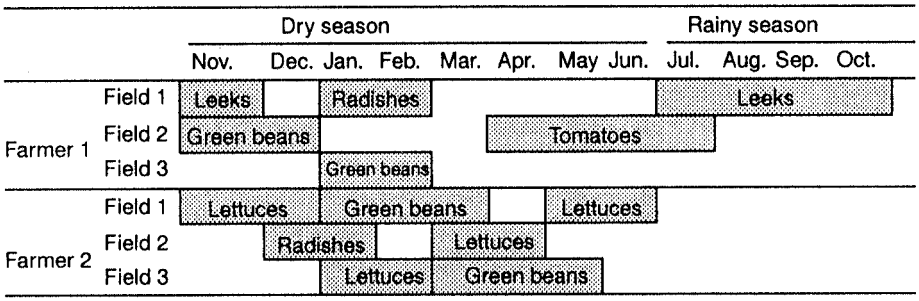


Fig. 2. Successive crops in six fields of two vegetable growers under irrigated conditions at Malika near Dakar in the 1960s.

Under the irrigated cropping system, two to three short-cycle crops could be grown successively on the same plot within the same year following vegetables or groundnuts during the rainy season (Fig. 2). This practice was very frequent and it was common for a vegetable grower to plant his staple food crops, such as pearl millet, on other sandy soil fields. In fact, many growers valued these last crops more than the vegetables. It should be noted that these two cultural systems were developed for crops which were relatively easy to market and that production at the time was on small, individual holdings.

## THE CURRENT CROPPING SYSTEMS

On the Cap-Vert Peninsula the areas under vegetable production are not very extensive because of the strong competition for building purposes. The total area under cultivation in the whole Niayes zone was roughly 8000 ha in 1992. The cultivation in low-lying areas described thoroughly by Arnaud (1970) is no longer of great importance and appears to be decreasing. The cultural practices there have not changed, very little mineral fertilizer is used, and rational pest control management is rarely practised.

At present only about half the producers use irrigation to grow vegetables during the dry season (Masse, 1989). One to four crops can succeed each other annually on the same plot depending on the grower's resources to buy inputs and his knowledge of fertilizer techniques and pest management. The cool season crops are tomatoes, garden cabbages, onions, jaxatu, hot peppers, carrots and lettuces; the hot dry season crops are garden cabbages, Irish potatoes, jaxatu, hot peppers, lettuces; and the hot humid season crops are tomatoes, garden cabbages, jaxatu and hot peppers. Vegetables for export (cherry tomatoes and green beans) can be produced during the cool–dry season and the hot–dry season. Examples of successions are given in Fig. 3.

Cultivation during the cool–dry season, provides high returns as long as the growers are able to hit the market early. The second crop of the dry season occurs during the hot period and is less profitable as the market is supplied abundantly at

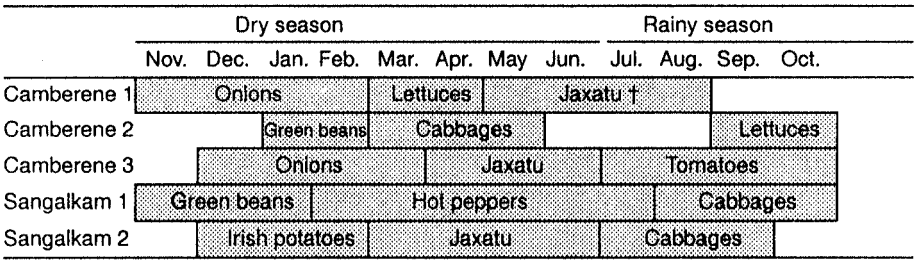


Fig. 3. Five examples of crop rotations under intensive irrigated systems in two localities near Dakar in 1991. †Jaxatu = *Solanum aethiopicum*.

that time. Cultivation during the hot and rainy season occupies only half of the area under production during the cool season. Knowledgeable and resourceful farmers are then able to mobilize sufficient financial resources to buy the inputs, particularly pesticides, required to produce good crops in difficult environmental conditions.

Other crops such as groundnuts and okra can be inserted in the rotations, particularly during the hot and dry season. Cash crops are often mixed with plants which have a longer cycle, for example lettuces at the beginning of the tomato crop, and cabbages at the beginning of the hot pepper and jaxatu crops.

## CULTURAL PRACTICES

Generally seed is still imported, though local seed production is beginning to be practised. Certified seed is used, especially for the hot and humid season crops. This includes cabbage hybrids and the tomato cv. Xina. Mechanization is expanding, particularly for tilling and pumping and the amounts of mineral fertilizers used have also been increased.

Plant protection techniques are variably understood but retailers of plant protection chemicals are doing much to promote the use of more efficient chemicals against the main diseases and pests. However, farmers growing these intensive crops every year cannot avoid yield reductions from gall nematode attacks. They try to minimize damage by growing less sensitive crops such as cabbages, onions, or tolerant or resistant varieties of tomatoes after two sensitive crops such as hot peppers, jaxatu, some tomato varieties, potatoes or lettuces. The inundation of the soil which used to limit the development of nematodes in the low-lying areas is no longer practised. Although chemicals are used widely, reductions in yield are frequent because of the heavy levels of infestation. Growers are trying to develop better control measures by using integrated pest management practices such as the use of fallow, pest-resistant crops and rotations using trap plants. In a few cases, growers have abandoned their gardens to fallow, or indefinitely, because reductions in yield have been considered too drastic.

## CONCLUSION

Vegetable production has been very successful in Senegal over the past 30 years as farms have developed, taking advantage of experience and progress in vegetable gardens. The rate of production has increased by about 5% annually, due to an increase in the total area under cultivation, and an overall 20% improvement in productivity.

This successful development can be attributed in agronomic terms to: better adaptation of vegetative material to adverse conditions; cultivation of local species, such as jaxatu and hot peppers, which perform well during the rainy season; increased application of fertilizers, and better control of pests and diseases by the use of chemical and cultural practices. Development has also been influenced by socio-economic aspects such as the availability of permanent manpower throughout the year, facilities for growers to obtain fertilizers and chemicals and the development of a consumer population in Dakar and the Cap-Vert Peninsula.

Nowadays growers tend to maintain and develop a number of crops on the same piece of land in order to get more from their fields as the urban population encroaches on the land. This intensification appears to be irreversible, in spite of fears about the cumulative negative effects of such intensive land use. Agronomic research must now consider preservation of natural resources and of the environment in the framework of this intensified farming system.

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