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Adaptation of market gardening in a context of climate variability: the case of marketing gardening at administrative area of Korhogo (Northen Cote-d'Ivoire)

Abstract

This study focused on the management of water resource by vegetable growers to cope with the phenomenon of climate variability. This work aims to improve production capacity of market gardening even if water resource can decrease. The database is constituted by hydro-climatic data (precipitation, temperature, water table) and inquiries from 128 agricultural producers spread over 5 geographical sites of administrative area of Korhogo, located in the north of Côte d'Ivoire. Sampling was carried out at two levels: 1) the choice of survey sites with the plants grown there, 2) the quality and number of producers. The different types of data and inquiries findings have been examined through descriptive and comparative statistical analysis. The evolution of market gardening production is following rainfall one. Therefore, it is suitable to mobilize surplus of water occurred in extreme rainy season or maintain soil moisture which can keep natural vegetables crops requirements. The majority of market gardeners applied drainage during rainy season to remove surplus water from the plots, and they collected groundwater from no deeper wells or surface water through dams during dry season.

Keywords: market gardening, water resource, climate variability, Korhogo

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Introduction

Market gardening is one of the main sources of income for most communities in northern Côte d'Ivoire. It is practiced at any time of the year, in the rainy season as in the dry season, generally around streams, reservoirs and wells. Market gardening is dependent on the availability of water. However, numerous studies on climate variability in Côte d'Ivoire[1,2] have shown a downward trend in rainfall since 1970. This drop in rainfall is a serious threat to the smooth running of market gardening. The persistence of this situation is likely to lead to food insecurity and the migration of people to areas more suitable for agriculture. Indeed, the 2020 vision of the CILSS (Permanent Inter-State Committee for Drought Control in the Sahel) on the consequences of climate change in West Africa, considers that global warming may accelerate the phenomenon drought and flooding, weakening of water resources and a drop in agricultural yields, increased prevalence of crop diseases, etc.[3] This study is based on the idea that vegetable crops resist very little to the prolonged absence of water in the soil. The objective is to improve market gardening production capacity in a context of climatic variability.

The study area is part of the Poro Region, specifically in the Korhogo department of northern Côte d'Ivoire (Figure 1). It is located in the Sudano-Guinean part according to the distribution of the climatic zones of Ivory Coast. The physical environment contains a number of natural factors such as the climate characterized by a long dry season where the temperature can reach 40°C, and a short rainy season during which the rainfall can be around 400mm over ten days. The topography of the area is characterized by slightly undulating plateaux 300 to 400 meters above sea level, with generally low slopes; hills with smooth, steep walls; This makes it difficult for some places to work, especially the development of rural roads where the difficulty of evacuation of agricultural products. However, the presence of numerous talwegs favors lowland rice cultivation and off-season crops. The soils are of tropical ferruginous type, the vegetation is savanna wooded with a grassy tendency further north. The dynamics of these elements condition the development of the socio-economic activities of the population. During the 2013-2014 marketing year, around 50000tonnes of market gardening products were recorded on markets. However, rural development workers reported that potential productive from market gardening considerably deteriorated over the years.

Material and methods

Database of this study falls into two categories: hydro-climatic data such as temperature, precipitation, water table of wells and findings of survey about market gardening production systems, crop yields, varieties of cultivated crop requirements, availability of water, nature of the water resource. The temperature and water depth respectively were measured with thermometer and rain gauge. A sump, watering cans and a duck were used to estimate water quantity used to water crops grown by market gardeners. A metric tape was used as a measuring instrument to know the level of the water in the wells and surface water tanks. The diameter of the wells and their depth respectively spread around 1 or 1.5m and 4 to 5m because market gardening is practiced near shallows or rivers. The number of people and public and private services surveyed are reported in Table 1 below.

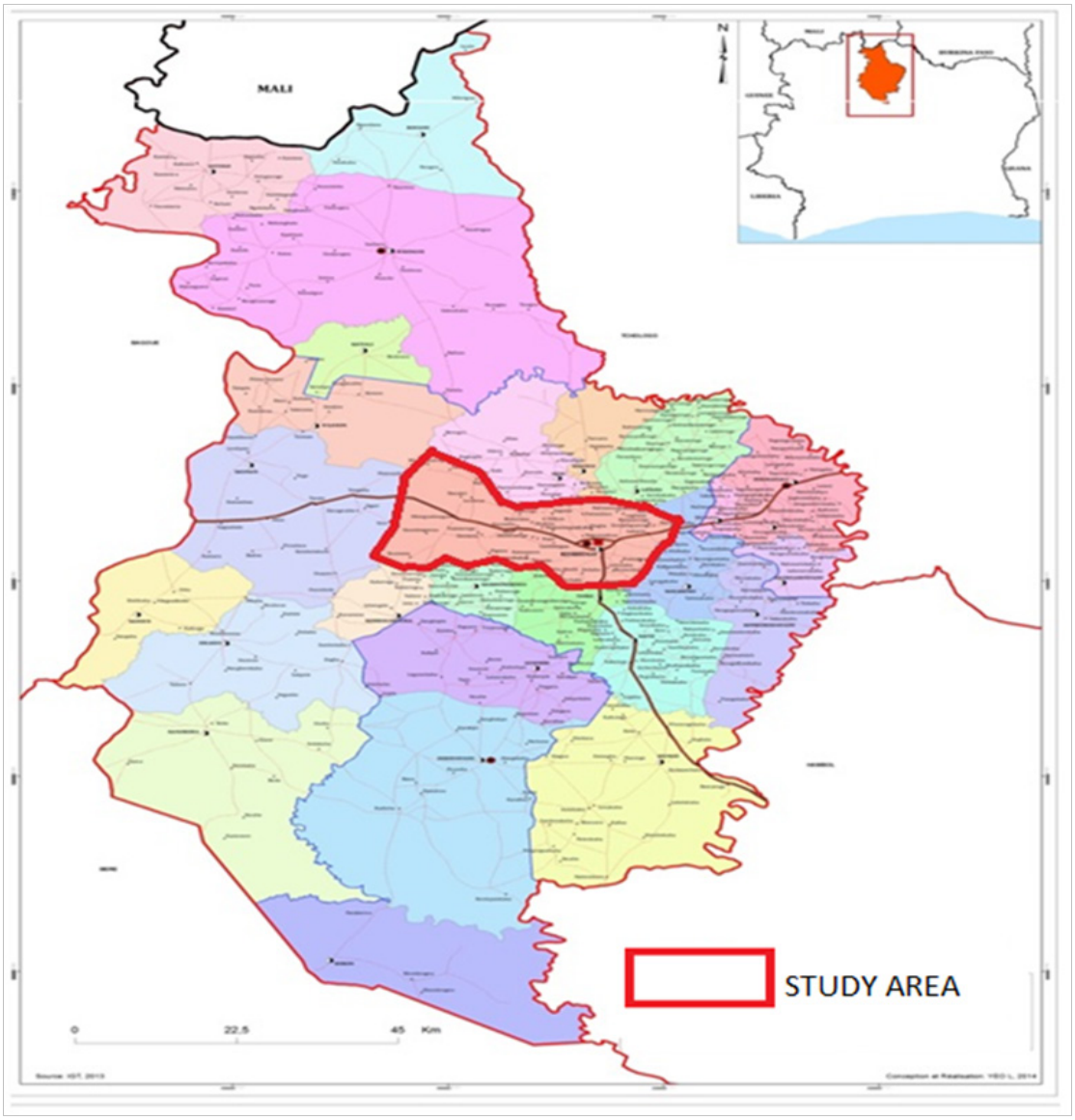

Figure 1 Location of administrative area of Korhogo.

Table 1 Number of people and public and private services visited

Names of sampling sites	Market gardening producers		Specialized structures for research and agricultural development
	women	men	
Sozoribougou	20	5	3
Cocody	32	7	
Koko	26	3	
Petit-paris	17	1	
Lataha	10	4	

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Data collected from the land and producer survey were carried out following relationship through qualitative and quantitative views. Quantitative data were subjected to a descriptive statistical analysis, while the qualitative data were simply subjected to a comparative analysis of their magnitude with respect to the expected return of producers.

Results and discussion

Variability of hydro-climatic parameters

From 2010 to 2015year, the average of annual rainfall reached 1210mm. Two (2) pluviometric periods were identified (Figure 2):

a. one deficit rainfall period where precipitations were lower than interannual rainfall average; this period extends from the beginning of the dry season 2010 to the beginning of the rainy season 2011;

b. one rainfall surplus period where precipitations were higher than interannual rainfall average; this period extended from ending dry season 2011 to rainy season 2014.

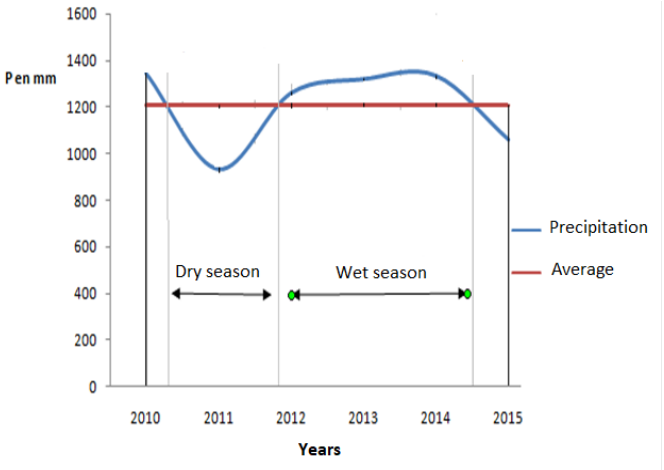

Figure 2 Climate season based on rainfall from 2010 to 2015 at Korhogo administrative area.

From 2009 to 2015, annual temperature reached 26.5°C and it can identified three thermal periods occured (Figure 3): one cold thermal period where temperatures were below average interannual heat and extending from the beginning rainy season 2009 to the end of rainy season 2011, one short and warm period where the temperature is largely above the thermal average from the end of rainy season 2011 end of the dry season 2012; and one longest cold thermal period with a lower temperature than the thermal average. It extends from the end of dry season 2012 to the end of rainy season 2015.

Fluctuation of groundwater table in the wells varied between 1 and 3.25m in rainy season compared to 0.5 and 2m at dry season. Table 2 below presents the water table levels for studied wells used by market gardening producers for watering vegetable crops.

Water and temperature needs of vegetables cultivated by producers

Whole list of vegetables species studied in this work are: chilli (*Capsicum sp*), tomato (*Lycopersicym esculentus*), lettuce (*Lattica sativa*), eggplant (*Solanum melongena*), onion (Allimum cepa), cabbage (Brassica oleracea) and carrot (Daccus corota). According agriculture works, these vegetables crops have specific water and heat needs, market gardeners had to provide to ensure good production. Table 3 below highlights an overview of these crops needs.

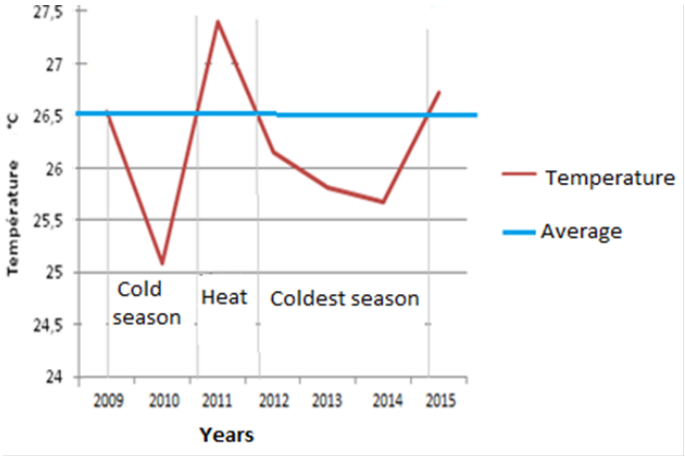

Figure 3 Evolution of the temperature in Korhogo from 2009 to 2015.

The comparative analysis of Tables 2&3 reveals that only exception for green beans, water available in wells is not enough to satisfy water needs of market garden crops at all sampling sites studied,. The comparison between rainfall and the yield of vegetable production is shown in Figure 4. This figure shows that the evolution of market gardening production is following rainfall one. Therefore, it is suitable to mobilize surplus of water occurred in extreme wet season or maintain soil moisture can match natural vegetables crops requirements.[4]

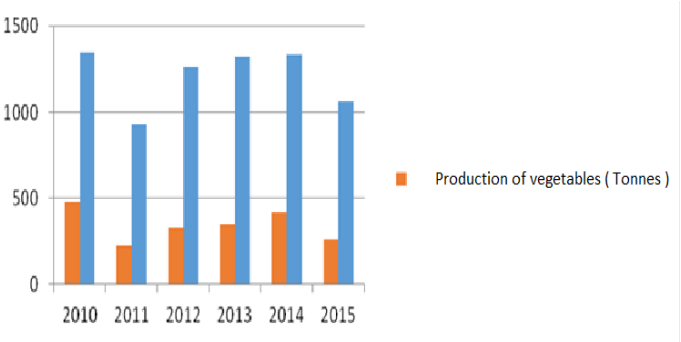

Figure 4 Comparative evolution of rainfall and vegetables.

Table 2 Water table in the wells for watering vegetable crops

Names of sampling localities	Water table in rain season (m)	Water table in dry season (m)
Sozoribougou	2,5-3	1-1,5
Cocody	2 - 2,5	0,5 - 1,5
Koko	2,5 – 3	1,5-2
Petit-paris	01-Feb	0,5-1
Lataha	2-3,25	1-2

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Table 3 Water and temperature needs for some of market garden crops

Market gardening	Water requirement	Favorable temperature	
		20 - 30 °C	30 - 40°C
Green bean	250 - 300mm	++	-
- Tomato	700 - 750mm	++	+
Onion	450 - 500 mm	++	+
Cabbage	650 mm	++	+
Carott	400 - 500 mm	++	-

Legend : ++: very favorable; +: favorable; -: unfavorable (source: Dupriez H,[4])

This reality justifies the mobilization of water resources by market gardeners in Korhogo through various methods. Their skills for adapting variation of available water quantity for market gardening in Korhogo have been developed since the rainy season until the dry season. In the rainy season, 79% of producers set up an open drainage system to evacuate the plots characterized by lot of water; while 21% of them preferred to create some contour bunds to mitigate erosion-related shocks. In the dry season, 90% of market gardeners build open wells whose maximum depth did not exceed 5meters in order to collect water for watering; while 10% collected water from installed hydro-electric dams or they used organic manure to guarantee the humidity of their arable plots.

Discussion

Lack of enough water quantity for satisfying of vegetables crops needs can be tribute to lack of anticipated strategies and technical practices to collect and secure water when extreme humid season occurs. Indeed, it is possible to realize sustainable market gardening by securing vegetables water needs. This idea is corroborated by work of Autissier[5] who estimated that it takes about 158 to 211gallons per day for watering garden of 100m^2 when dry season.

This local adaptation for unstopping production of market gardening, even if climate variability forced the change of cultural calendar, is in line with the results of the work of Celestin[6] who identified that the adaptation to climate variability brought a new orientation and behaviors of market gardening producers. In his study, producer's changed on their choice of vegetables seeds and their resort to agrochemical regulators inputs.

Conclusion

The difficulty to manage water for doing market gardening in a context of climate variability is a reality at Korhogo. Vegetable production is highly dependent on the availability of soil water during the climatic seasons. The majority of market gardeners applied drainage during rainy season to remove surplus water from the plots, and they collected groundwater from wells or surface water from dams during the dry season. By the way, it is also possible to use organic manure to keep the water humidity of crop plots. These adaptating techniques and strategies can be improved on market gardening field through the fitting of water availability on the time and the choice of appropriate vegetables to cultivate, with increasing of reforest coverage for a trend towards reversible climatic variability.

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Conflicts of interest

Authors declare no conflict of interest exists.

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