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Full Length Research Paper

Constraints on the cultivation of *Colocasia esculenta* in wetland milieux in parts of the South West Region of Cameroon

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Most developing countries are yet to come to terms with the daunting predicament of mastering food security in face of astronomic population growth. This is evident in the South West Region of Cameroon where persistent low yields of *Colocasia esculenta* crop cultivated in the inland wetlands on the north eastern and southern slopes of Mount Cameroon have brought untold suffering to over 60% of the inhabitants by pushing them to greater levels of poverty. The objectives of this study were to determine the cause of the wilting of *Colocasia esculenta* crop cultivated in the inland wetlands in the region, analyse farmers' perception, attitude and response to the problem, evaluate its impact on the inhabitants and propose tenable solutions. Detailed reconnaissance survey and laboratory analysis of physico-chemical properties and microbial quality of *Colocasia esculenta,* water and soil samples revealed that *Pythium myriotylum,* a pseudo fungus is possibly assisting in the decimation of the *Colocasia esculenta* crop cultivated in the region. The paper therefore attempts to suggest some alternative measures that could be adopted which provide food security to the inhabitants, increase household incomes and curb environmental degradation.

Keywords: *Colocasia esculenta,* food security, wetlands, environmental degradation, *Pythium myriotylum,* sustainability.

INTRODUCTION

Humid tropical milieux have commanding agricultural potentials yet food crisis has become a common phenomenon in the region. In Cameroon, one of the tenets of the New Agricultural Policy introduced by the government in the early nineties was the mastery of food security in the country such that the agrarian sector should ensure a guaranteed supply of food both to the 18.5 million Cameroonians and to some countries in the Central African Monetary and Economic Union (CEMAC). Unfortunately, crop failure accompanied by rising prices of foodstuffs in the market has been experienced in Cameroon since 2009, particularly in Fako Division in the South West Region. The situation is so severe that it is not only jeopardizing this vision but also constraining the government's effort to eradicate poverty and hunger by 2015 as stipulated by the Millennium Development Goal 1.

The study area forms part of the Bight of Biafra. It borders the Atlantic Ocean and encompasses the densely settled Fako Division, with a current population of 444,269 inhabitants and a density of 216 persons per square km. Figure 1 indicates that it encompasses six administrative units: Buea, Limbe 1, Limbe 11, Limbe 111, Tiko, Muyuka, and Idenau.

The problem

Sasanka and Gurumoorthi (2011) posit that *Colocasia esculenta*, commonly referred to as taro, is a tropical root crop that produces starch, storage corms and have several genera and species throughout the world. Since

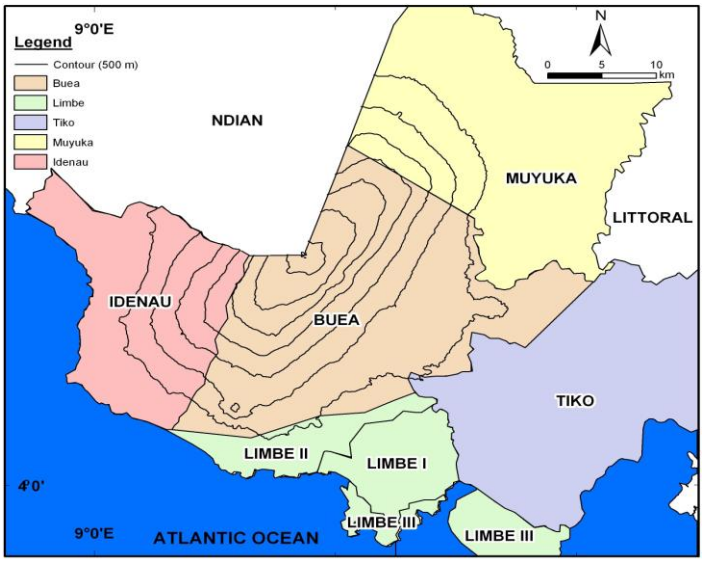

Figure 1. The Study area showing its different administrative units

April 2009, most of the farmers in the region have been suffering from a severe plague that is causing the wilting of *Colocasia esculenta,* the main food crop cultivated in the inland wetlands in the region from Limbe in the south west to Malende in the north east and beyond. The leaves of most of the infested crop depict some yellowish-brown spots. Farmers who cultivate these crops have observed that as soon as they are harvested, they rot within twenty-four hours or thereabout, causing untold suffering to the inhabitants in the region, especially as most of them largely depend on the sale of these for their sustenance. So far, government officials and farmers are yet to make a diagnosis of the problem with the view of identifying the disease, determining its origin/dispersal mechanism and providing a proper solution.

Food crisis is fast becoming a moribund problem on the African continent. On the 13th of June 2012, the on-line newspaper News Mongabay indicates that there is a widespread alarm over an eminent food crisis in the Sahel region of Africa (www.bing.com/news/search?). Similarly, on July 12th 2012, an on-line report from PSB Newshour indicate that eight west African countries are currently suffering from Food crisis (www.psb.org). Aljazeera in another on-line article titled ''Africa facing intensive food crisis'' highlight that up to 39 of the 59 most at risk of food insecurity were African countries (www.aljazeera.com/news/africa/2012/10).

RESEARCH METHODS

To determine the spatial extend of the plaque on farmlands, a detailed reconnaissance survey was carried out using the topographic map of Buea-Douala of the Federal Republic of Cameroon, NB-32-IV-1b of June 1969, with the scale 1:50 000. This was aided by the use of the Global Positioning System-Magellan (Explorist 100) and the Geographic Information System software-ENVI / ArcGIS. Samples of infested *Colocasia esculenta* crops were randomly obtained from two farmlands: a marsh in Mussaka and a flood plain in Ekona for microbial analysis. The samples were collected in the dry season from the 8th to the 9th of March 2010. The two infested crops were taken from these sites because the plague is reported to have originated from there. From where the crops were off rooted, soils within their root system were equally collected for analysis of inherent physico-chemical properties and microbial quality, so that comparison could be made. As soon as the samples were collected, they were instantly stored in ice coolers and transported to the laboratory of the Baptist Health Service-Mutengene for analysis.

Laboratory analysis was carried out using different methods and equipment. Using a high precision/modern computerised equipment ELIT 5- Channel Aqualyser (ELIT 9705 c), that uses electrodes to instantly analyse samples, analysis of physico-chemical properties was done using selective electrodes. The following physico-chemical properties were analysed from the wetland water samples: sodium, potassium, calcium and magnesium as cations while anions were chloride, sulphate, phosphate, bicarbonate and nitrate. For the soil samples, physico-chemical properties analysed were p^{H}, soil texture, percentage of Organic carbon and nitrogen, carbon/nitrogen concentration (C/N), amount of sodium, potassium, calcium and magnesium.

Colocasia esculenta samples for microbial quality were cultured using different media and then sub-cultured to determine the growth of specific

Figure 2a. Infested *Colocasia esculenta,* depicted by the appearance of yellowish-brown spots on their leaves. Photograph taken from a farmland on the flood plains of a stream in Mamu village on the 9/2/2010.

Figure 2b. A cross-section of an infested comet of *Colocasia esculenta* harvested from an inland wetland-Old Koke in Ekona, depicting a reddish brown coloration. Photograph taken on the 8/2/2010.

Table 1. Analytical results of *colocasia esculenta* samples.

Sample Code	Sample site	Nature of Sample	Nature of analysis	Type of organism detected
001	Mussaka stream	Infested *Colocasia esculenta* comet	Culture and sub-culture	*Pythium myriotylum*
002	Old Koke Stream-Ekona	Infested *Colocasia esculenta* comet	Culture and sub-culture	*Pythium myriotylum*

Source: Laboratory analysis of samples.

organisms. A piece of it was cultured in Yeast-Mold Broth at room temperature for seventy two hours (three days). The purpose of culturing at room temperature was to facilitate growth within an environmental temperature. Since Potato Dextrose Agar (PDA) and Sboraud Dextrose Agar (SDA) were not available, the growth obtained was sub-cultured in Nutrient Agar for differential growth and in Brain Heart (BH) and Thioglocolate (TG) Broth media for selective growth. To obtain viable information from the inhabitants in relation to farmers' perception and responds to the problem and its impact on their livelihood, five hundred questionnaires were administered using stratified random method.

Literature review

Most studies carried out in the region this far are based on the analysis of physico-chemical properties and microbial quality of streams, springs and lakes (Orock, 2006), Fogwe *et al;* (2010), Saline intrusion on groundwater (Mafany, 1999), land degradation (Lambi, 2001), spring sources and quality (Endeley et *al;*2001), Coastal pollution (Ekane, 1999) and Ekane *et al*; (2001). Sasanka and Gurumoorthi (2011) on their part examined the ''Effects of Processing on Oxalate Content in Agricultural Produce (Colocasia esculenta, Prunus dulcis, Glycine max)''.

Since the causes of the wilting of the *Colocasia esculenta* crop cultivated by farmers in the region are yet to be known, this study therefore seeks to address the situation. It seeks to determine the cause of the wilting of *Colocasia esculenta* crop cultivated in the inland wetlands in the region, analyse farmers' perception, attitude and responds to the problem, evaluate its impact on the inhabitants and develop a sustainable management paradigm which unites ecology, policy and livelihoods.

RESULTS AND DISCUSSIONS

Field evidence shows infested farmlands from the south west (Idenau Sub-Division) to the north east (Muyuka Sub-Division), depicted by the appearance of wilted *Colocasia esculenta* leaves (Figure 2a). Almost all of the *Colocasia esculenta* cultivated in the region have so far been affected. When a comet of *Colocasia esculenta* harvested from these wetlands is cut, it is observed that their colour changes from white to brown (Figure 2b). This has compelled most of the farmers to abandon their harvested produce at farm gates from 2009 to 2013.

Analytical results of *Colocasia esculenta* samples are shown in Table 1. In both of the results, *Pythium myriotylum* was detected, following culture and sub-culture of the samples at a temperature of 37° C. The

Figure 3. Culture plate (Nutrient Agar medium) showing the growth of *Pythium myriotylum* colonies from *Colocasia* sp. Collected from inland marshes in Mussaka and Ekona.

Table 2. Analytical results of hysic-chemical propertiesof soil samples.

Sample site	Mussaka marsh	Old Koke flood plain-Ekona
Sample code	240	260
p^H	6.29	6.42
% moisture (105^OC)	24.18	13.23
% of Organic carbon	10.21	7.56
% of N	0.39	0.42
C/N	26	18
Av. P(Bray-2) Mg/kg	11.0	38.0
Na^+(AmAc.) – cmol/kg	0.24	0.17
K^+(AmAc.) – cmol/kg	1.92	1.55
Mg^{2+}(AmAc.) - cmol/kg	3.40	5.17
Ca^{2+}(AmAc.) cmol/kg	13.97	8.49
Al+ H (KCl)	0.02	0.05
% Clay	18.44	36.71
% Silt	51.42	33.36
% Sand	30.15	29.93

Source: Field survey (2011).

significant growth of the organism is indicated on the Nutrient Agar medium (Figure 3).

Analytical results of physico-chemical properties of the soil samples are illustrated in Table 2. The results show that the inland wetland soils are slightly acidic, with a mean pH of 6.4 and a range of 6.29-6.42. With a low percentage of organic carbon that ranges from 7.56-10.21, it means that there is a low amount of humus in the soils, since much of it is lost through fluvial erosion.

Concerning soil texture, the dominant component in the Mussaka soil is silt (51.42 %) while that of Old Koke is clay (36.71 %). Both soils do not have excessive concentration of ions as they are often transported in solution (figure 4).

Analytical results of the 500 questionnaires administered on the inhabitants in the region are shown in Table 3. The results show that 92 percent of the inhabitants are aware of the current plague affecting the Cultivation of *Colocasia esculenta* in the region, while the livelihoods of 66.6 % of them are affected by poor *Colocasia esculenta* yields. With regards to the origin of the plague, 52% of the inhabitants are of the opinion that the plague originates from atmospheric precipitation of dust particles on plant leaves while 40% hold the view that it originates from witchcraft.

Pythium myriotylum, a fungus-like species that belongs to the class Oomycetes is identified as a contributing factor that is causing the wilting of this crop cultivated in the region. This pathogen that has both terrestrial and aquatic adaptation strategies has left an immeasurable effect on *Colocasia esculenta* crop cultivated in the region. Due to progressive wilting, there has been a decline in the productivity of this crop in the region. Most often, farmers are forced to dispose of the infested comets either at farm gates or at their residence after transportation. The net effect is that there is a scarcity of this foodstuff in the region.

This Study contrasts with previous studies carried out in the Pacific islands where Deo *et al.,* (2009) observed that the principal plague to the *Colocasia esculenta* crisis

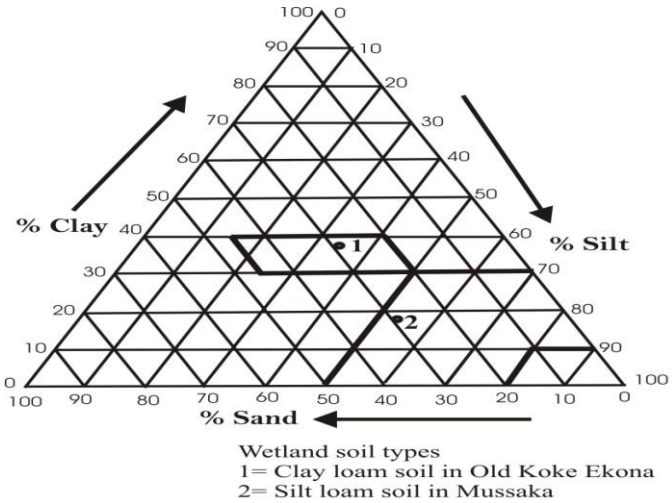

Figure 4. A tenary diagramme of wetland soil types identifiedin the North eastern slopes of Mount Cameroon.

Source: Field survey (2010).

Table 3. Results from the administration of questionnaires.

Item	Number of respondents in favour of.	%	Number of respondents against.	%	No Idea	%
Perception of wetlands as common property resources.	340	68.0	160	32.0	0	0
Awareness of current plaque affecting *colocasia esculenta*	460	92.0	36	7.2	04	0.8
Notion that the plague originates from witchcraft	200	40	235	47	65	13
Notion that the plague originates from atmospheric precipitation of dust particles on plant leaves.	260	52	100	20	140	28
Effect of poor *Colocasia esculenta* yields on livelihood.	333	66.6	167	33.4		

Source: Field survey (2010).

that ravaged more than nine countries in the region resulted from an oomycete water mould called *Phytophthora colocasia.* Humid conditions often favour the proliferation of pathogens. Due to the effects of latitude, altitude and the presence of water bodies, this region receives intense precipitation for most parts of the year. Fráser *et al.,* (1998) note that the mean annual rainfall stands at 8,392 mm in Idenau, 9,086 mm in Debundscha (both of which are located in the south west), 4,384 mm in Mabeta (in the south east), with a progressive decrease north eastward: 2,743 mm in Tole, and 2,085 mm in Mpundu, with high mean annual temperature of 26.5º C.

Their reproductive system shows that most of the oomycetes produce two distinct types of spores: zoospores (asexual, self-motile spores) and oospores (sexual translucent spores) (http://en.wikipedia.org/wiki/water_mould). This pseudo fungus rapidly spreads across farmlands in the region because it possibly has four main dispersal mechanisms which include water, wind, man and animals. Dispersal by water possibly occurred in two ways. Firstly, infested *Colocasia esculenta* could have been transported down slope by running water-springs, streams and runoff. Secondly, infested crops that rotted in water were sometimes transported down stream. In so doing, spores such as sexual spores could be released into the water and carried away. Also, some of the spores, notably

asexual spores could sometimes be dispersed aerially by the wind. This possibly accounts for the large scale diffusion from one farmland to the other. In addition, the inhabitants in the region could serve as vectors in the sense that most of them transport contaminated comets from their farmlands to either the market or their houses. In this course, contaminated ones are ultimately disposed into the environment at waste disposal sites. Finally, animals such as pigs, and insects could equally act as vectors in the dispersion of the spores, either through physical contacts or through metabolism. It is possible that farmlands could have been contaminated in two main ways namely; in-situ contamination through the planting of infested seeds of *Colocasia esculenta* on them and ex-situ contamination through the transfer of *Phythium myriotylum* spores from one farmland to another by dispersal agents. It has a high ability to multiply, since it reproduces both sexually and asexually.

Based on the hydromorphic nature of the soils and their acidity, it is evident that most of the wetland soils are gley soils developed in either depressions or waterlogged conditions that experience restricted out flow. The low concentration of bases is a function of their high dilution and dissolution in water but the high soil moisture content provides a favourable condition for disease causing pathogens to thrive. Originating from North Eastern India and Asia, *Colocasia esculenta* is cultivated in more than sixty-five countries worldwide Deo *et al.,* (2009) and it forms the staple food of most communities. The prevalence of this plague partially jeopardises the desire to enhance food security to the farmers in he region. Food security involves food self sufficiency in a given community. The first decade of the Twenty First Century has been marked by insufficient food production, hunger and starvation in several countries in the developing world, notably in Sub-Saharan Africa. Rising food prices is a call for concern in recent years. In Cameroon for instance, the nation wide strike that occurred in February 2008 resulted from rising prices of fuel and food. The Cameroonian monthly newspaper-The Farmer's Voice N^{o} 176 of March 2010, p. 20 noted that when the FAO Cereal Price Index doubled in April 2008, food security became a global crisis, sparkling riots in 30 countries. In reality, disease knows no borders and population growth is a factor in the recent upsurge of infectious diseases (Donnellan, 2001). The population of this region has witnessed a dramatic increase in recent years as observed in 2010 by the Central Bureau for Census and Population Studies in Cameroon (BUCREP) and such an increase is accompanied by increasing level of pollution, notably on the soil and groundwater resources, thereby resulting into favourable conditions for the occurrence of pathogens.

The link between poor *Colocasia esculenta* yields and livelihood was directly expressed by 66.6 % of the inhabitants, showing the role of this foodstuff in the socio-economic life of the people. Unfortunately, farmers in the region have a dearth of information relating to the cause of the plague as

52% of them relate it to the precipitation of dust particles on plant leaves while 40% of them relate it to witchcraft. As most of the inhabitants perceive wetlands as common property resources, it means that there is unsustainable exploitation of the ecosystems, leading to their degradation.

This study attests that in this part of Africa, the current wave of food crisis relates to rising levels of environmental degradation, the poor mastery of environmental dynamics, increasing population growth that mounts pressure on ecological resources and inadequate attention directed to the agrarian sector by the government. In the Horn of Africa, it is rather related to capricious climatic conditions, the struggle for scarce resources, political upheavals and the impact of the cattle culture. As a whole, the global financial crisis is making untold effect in developing countries that rely on foreign/external support for the undertaking of agrarian reforms in their country. Instead of combating the situation, efforts are currently geared in the importation of food stuffs as a short term remedial attempt.

RECOMMENDATIONS AND CONCLUSIONS

To alleviate the situation, it is recommended that:

- Farmers could be encouraged to practise the technique of green manuring on their farmlands instead of burning organic matter and applying doses of chemical inputs that end up polluting wetlands and the groundwater system.
- Also, to prevent the further spread of *Pythium myriotylum* to other regions in the country, a policy to quarantine the movement of seeds of *Colocasia esculenta* from Fako Division to other regions could be implemented.
- Likewise, there is need for the intensification of cultivation of dry land crop such as *Xanthosoma sagittifolium* (cocoyams), plantains, banana, maize, beans, cassava and sweet potatoes, in order to enhance food self sufficiency and increase farmers' income.
- In the inland marshes, farmers could be encouraged to concentrate in the cultivation of sweet potatoes in the mean time, while waiting for the complete eradications of the spores of *Pythium myriotylum* in the region (oospores and zoospores). This crop takes three months to get mature and it survives in wetland milieux. The relative absence of this micro organism on the leaves of the crop at the moment does not signify a complete eradication in the region, for its spores have the capacity to remain dormant for a good number of years in the soil.
- Perhaps wetland fallowing could be practised by

some of the inland farmers cultivating in the permanent wetlands, notably in marshes, stream banks and flood plains. But this activity may be affected by a number of problems, notably the rapid population growth that is exerting pressure on the wetlands and the lack of alternative farmlands.

- To curb the rate of pollution from the various land use systems in the region, there is need for effective land use planning or zonation of different activities in the entire region by the various municipalities such that well demarcated areas should be allocated for activities that pollute the environment, such as garages and industries. When such services are located away from wetlands/farmlands, they will go a long way to reduce their polluting effect on them.

This study gives analytical results on the possible causes of the wilting of *Colocasia esculenta* cultivated by the farmers on the north eastern and southern slopes of Mount Cameroon as well as provide some panacea to the plight of the inhabitants in the region. It highlights that in Africa, when a plague occurs, due to the dearth of sufficient information, marginal communities in general and farmers in particular are often exposed to greater levels of vulnerability, thus exposing them to greater levels of poverty.

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