RESEARCH PROGRAM ON Roots, Tubers and Bananas

CGIAR

Status of Cocoyam (*Colocasia esculenta* and *Xanthosoma spp*) in West and Central Africa: Production, Household Importance and the Threat from Leaf Blight

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RTB-Commissioned Scoping Study on Status of Cocoyam *(Colocasia esculenta* and *Xanthosoma* spp) in West and Central Africa

PREAMBLE

Cocoyam is an important staple food across many developing countries in Africa, Asia and the Pacific. It is particularly important in Sub-Saharan Africa where the two most commonly cultivated species (*Colocasia esculenta* and *Xanthosoma sagittifolium*) are grown extensively. The cultivation of cocoyam in most African countries is essentially by small-scale resource-poor farmers with minimal input. These crops play very important roles in the livelihood of rural farmers, who often resort to cocoyam as an alternative source of their daily calories during periods of food scarcity and economic stress. In recent times *Colocasia esculenta,* popularly known as taro, is being threatened by the spread of Taro leaf blight (TLB) caused by *Phytophthora colocasiae* Raciborski in Africa. TLB, which has had considerable impact in the Pacific region, is believed to have spread to West and Central Africa in the last few years. *Xanthosoma* spp also face strong disease pressures, particularly with respect to complex root rots. When compared to other root and tuber crops such as potatoes, cassava and yam, relatively little research attention has been devoted to cocoyam. This is partly because the cocoyam production system is often regarded as an informal activity, and both researchers and policymakers have ignored it as a legitimate crop for research and development (R&D). Consequently, cocoyam remains an under-exploited and poorly understood crop despite its nutritional value and its potential as a food and cash crop. Although the crop is contributing substantially to the food and income security of many households in West and Central Africa, there is a lack of well documented and consolidated information on its cultivation, consumption and importance to livelihoods in this region. There is also need for better understanding of the current threats posed by diseases, particularly TLB, to cocoyam production in this region.

The CGIAR Research Program on Roots, Tubers and Bananas (RTB) has the mandate to develop the under-utilized potential of bananas and plantain, cassava, potato, yam, sweet potato and other minor root and tuber crops. The RTB Research Program includes scientists from four CGIAR centers (CIP, IITA, CIAT and Bioversity International) and the French Agricultural Research Centre for International Development) CIRAD in collaboration with a wide spectrum of research-for-development stakeholders and partners. The program structure is based on seven themes, namely:

1) Conserving and accessing genetic resources.
2) Accelerating the development and selection of better varieties.
3) Understanding and managing priority pests and diseases of the RTB crops.
4) Making available low-cost, high-quality planting material for farmers.
5) Developing tools for more productive, ecologically robust cropping systems.
6) Promoting postharvest technologies, value chains, and market opportunities.
7) Enhancing impact through partnerships

This report was therefore commissioned by RTB in pursuance of its mandate, to review and compile existing information that will serve as a guide towards a meeting of subject matter experts to develop an agreed action plan aimed at addressing key research needs of cocoyam in West and Central Africa. The report is based on bibliographic analysis as well as meetings and interviews with NARS scientists, cocoyam farmers, marketers and other stakeholders in the three focus countries of Cameroon, Ghana and Nigeria.

Terms of Reference: This scoping study was commissioned as a largely desk based study, but to also involve one-on-one interactions with major stakeholders in Nigeria, Ghana and Cameroon. The five critical deliverables of the study are:

1) An assessment and compilation of evidence of the extent of cultivation of *Colocasia* and *Xanthosoma* in West and Central Africa particularly Nigeria, Ghana and Cameroon.
2) A consolidated evidence of the role of these two edible aroids in livelihoods of smallholder farmers in these three countries
3) An analysis of consumer demand for these crops and the current status of the market for these crops in West and central Africa
4) An assessment of the current impact and threat posed by diseases particularly TLB, with a focus on Nigeria, Ghana and Cameroon
5) Identification of the highest priority research interventions that are required to improve knowledge and control of TLB and CRRD in West and Central Africa

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Dr Grace Bolfrey-Arku – Crops Research Institute, Kumasi, Ghana

Mr Emmanuel Omenyo – Crops Research Institute, Kumasi, Ghana

Dr Regina Sagoe – Crops Research Institute, Kumasi, Ghana

Dr Francis M Tetteh – Soils Research Institute, Kumasi, Ghana

Dr Okoye Benjamin – National Root Crops Research Institute, Umudike, Nigeria

Dr Godwin Chukwu – National Root Crops Research Institute, Umudike, Nigeria

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RTB Commissioned Scoping Study on Status of Cocoyam *(Colocasia esculenta* and *Xanthosoma* spp) in West and Central Africa

EXECUTIVE SUMMARY

Cocoyams (*Colocasia esculenta* and *Xanthosoma* spp) are well adapted food crops across many agro-ecological zones of sub-Saharan Africa. They rank third in importance, after cassava and yam, among the root and tuber crops cultivated and consumed in many West and Central Africa countries. Cocoyams are nutritionally superior to both cassava and yam in the possession of higher protein, mineral and vitamin contents as well as easily digestible starch. Africa in the last three decades has consistently accounted for an increasing percentage of global cocoyam production, which currently stands at about 10 million tonnes per annum (FAO, 2012). In the last 5 years (2008 – 2012), the continent accounted for 74% of global cocoyam production, with the bulk of this production (approximately 50% of global output) occurring in the West and Central African sub-region. Cocoyam is therefore undoubtedly an important food crop in sub-Saharan Africa (SSA), particularly in Nigeria, Ghana and Cameroon. However, the increasing production in the region has depended largely on farming more land rather than increasing crop yields. This is contrary to the projections of FAO that the 70% growth in global agricultural production needed to feed an additional 2.3 billion people by 2050 must be achieved by increasing yields and cropping intensity on existing farmlands, rather than by increasing the amount of land brought under agricultural production (FAO, 2009).

Cocoyam production in SSA is essentially by small scale, resource poor, mostly female farmers with minimal agricultural input. Hence, the crop is often referred to as a “poor man’s crop” or “woman’s crop” because it is consumed mostly by the low income earners and the economically vulnerable groups in the society. Regrettably, in spite of the wide adaptability of cocoyam, its nutritional benefits and its role in the economy and livelihood of the rural poor in SSA, the crop has received very little attention from agricultural researchers and government policymakers. Maximizing profits from cocoyam for the millions of rural households depending on the crop has therefore remained a mirage. Many constraints, including two important diseases – Cocoyam root rot disease (CRRD) and Taro leaf blight (TLB) – affect production of cocoyam in this region. The impacts of these diseases are exacerbated by the fact that cocoyam’s vegetative mode of propagation supports transmission of diseases from one generation to the next. The recycling of infected planting materials from farmers’ fields leads to reduced yield and build-up of diseases, particularly for CRRD, a fungal pathogen-induced root rot which often results in total crop failure in *Xanthosoma* spp. Similarly, the recent outbreak of TLB in many countries of West and Central Africa has drastically reduced the productivity of *C. esculenta* in the region. TLB is caused by *Phytophthora colocasiae*, and it takes less than 14 days to completely attack an entire cocoyam field, leading to massive defoliation and plant die-back. Both CRRD and TLB are of great concern to cocoyam farmers in the region because of their potential to cause total crop failure, thereby posing a great threat to food security. In addition to constituting a threat to income and food security, both diseases have the potential of depleting the diversity in the already narrow genetic base of these crops because of the high susceptibility of most farmers’ cultivars which results in their inability to survive in the field.

Since cocoyam was removed from the focus crops of the CGIAR centers some decades ago, there has been limited progress from the various African national agricultural research service (NARS) institutes who took over the responsibility of conducting research on the crop.

This is chiefly due to a dearth of cocoyam research personnel coupled with limited research facilities and funding available to these few researchers. Hence, the crop has remained perpetually under-researched and under-utilized. During the First International Workshop on Cocoyam in Cameroon, the International Institute of Tropical Agriculture (IITA) noted that the situation of marginalized or under-researched crops such as cocoyam, which nevertheless are undoubtedly important to food and income security for millions of resource-limited farm households, will continue to worsen due to neglect and limited competitiveness unless we take steps to raise their profile (IITA, 2008). The role of cocoyam in the economies of countries in SSA and its importance to the livelihoods of millions of people has been under-estimated, under-reported, and therefore poorly appreciated. Those who depend heavily on the crop for survival – the most vulnerable groups – have neither the resources nor the voice to influence its future. It is the responsibility of scientists and policymakers to change this situation through strategic interventions. This report highlighted the trend and challenges of cocoyam production, and the highest priority strategic research interventions required to improve the knowledge of key cocoyam constraints in West and Central Africa, and reposition the crop for maximum profit and empowerment of the millions of rural households depending on it.

CHAPTER ONE: INTRODUCTION

In the region of West and Central Africa (WCA), the term cocoyam refers to two members of the Araceae family, namely *Colocasia esculentum* (L.) Schott and *Xanthosoma sagittifolium* (L.) Schott, in the sub family Colocasioideae (Dahlgren *et al.*, 1985). They are staple foods for many people in developing countries of Africa, Asia and the Pacific (Aguegui *et al.*, 1992). In other parts of the world, species of *Colocasia* are often referred to as taro, while cocoyam or tannia is use for species of *Xanthosoma* (Manner and Taylor, 2010; Lebot, 2009). In the Pacific Island Countries (PICs) where taro is widely grown and consumed, two botanical varieties of *Colocasia* have been recognized as *C*. *esculenta* var. *esculenta,* often called dasheen, and *C*. *esculenta* var. *antiquorum,* often called eddoe. The dasheen varieties have large central corms, with suckers and/or stolons, whereas eddoes have a relatively small central corm and a large number of smaller cormels (Purseglove, 1972). *Colocasia* is believed to have originated in the Indo-Malaysian region, from where it spread into the pacific islands, the Eastern Mediterranean and finally to Africa (Kay, 1987; Wagner *et al.*, 1999). *Xanthosoma* spp is native to tropical Central and South America and the Caribbean where it has been cultivated and consumed since the pre-Columbian epoch and from where it spread to other parts of the globe (Kay, 1987; Valerio, 1988; Ki-zerbo, 1990; Onwueme, 1994).

Physiologically, cocoyam is a herbaceous monocotyledonous plant of 1 m or more in height. The aboveground stem consists of large heart shaped sagittate leaves supported by solid and long erect petioles. The underground stem or corm is a compact structure filled with nutrients. The corm branches to form starchy tubers or cormels. The root system arises from basal nodes of erect shoots or from any node on the corms (Wilsom, 1984). Flowering occurs sparsely, and where it occurs the inflorescence is a spadix surrounded by leaf-like spathe. Pollination within a spadix rarely occurs naturally as pistillate flowers become receptive about 4 days before pollen shedding. However, cross pollination between two different stands may occur through insects, giving rise to the fruit which are clusters of berries containing a variable number of seeds (Wilson, 1984).

The Food and Agriculture Organization (FAO) database on production of major crops uses the label taro to represent the total production of all *Colocasia* and *Xanthosoma* spp. The database indicates that West Africa is by far the largest taro producing region. In the last 5 years (2008 – 2012), Africa accounted for 86% of global area harvested and 74% of total taro production. The West African sub-region alone accounted for 61% of global area harvested and 50% of global production. These figures however indicate a decline in the contribution of the region to global taro production in the preceding 5 years (2003 – 2007, Table 1).

Cocoyam is undoubtedly an important food crop across many countries in SSA, particularly in Nigeria, Ghana and Cameroon. It is the third important staple root/tuber crop after yam and cassava in Nigeria and provides a cheaper yam substitute, especially during periods of food scarcity (Ene *et al.*, 1997). Nutritionally, cocoyam is rich in carbohydrates with nutritional value comparable to potato (Wang, 1983), and superior to cassava and yam in the possession of higher protein, mineral and vitamin contents as well as easily digestible starch (Parkinson, 1984; Splittstoesser *et al.,* 1973). Cocoyam also contains higher appreciable amounts of essential minerals (Ca, Mg and P) than cassava and yam. It is highly recommended for diabetic patients, the aged, children with allergies and for other persons with intestinal disorders (Plucknett, 1970). The corms and cormels of cocoyam are processed by boiling, baking or frying in oil. They are also processed into different products in many parts of WCA. All major parts of cocoyam (corm, cormel and leaves) are edible. The young leaves are a nutritious spinach-like vegetable, which provides a lot of minerals, vitamins and thiamine. It is particularly a major vegetable and source of income to farming household is Ghana.

Cocoyam can tolerate shade and is often intercropped with perennial cash crops such as cocoa, bananas, oil palms, etc., especially at the early stage of these plantations. The cultivation of cocoyam is essentially by small scale, resource poor farmers with minimal agricultural input, and most of these are women. For example, a recent gender efficiency analysis of smallholder cocoyam farmers in Eastern state of Nigeria revealed a ratio of 3:1 for female against male farmers (Dimelu *et al.*, 2008). However, the ratio of men to women appears to be increasing as the crop attracts more economic value.

Table 1: Percentage contribution of Africa to global area harvested and production of taro (*Colocasia* and *Xanthosoma* spp)

Year	Area Harvested (Ha)		Production (tonnes)	
	Africa	W/Africa	Africa	W/Africa
2003	87.46	64.55	77.39	59.31
2004	87.51	64.15	78.24	60.18
2005	87.72	64.28	79.29	60.28
2006	88.23	65.35	80.30	61.61
2007	88.03	65.06	78.60	58.94
Mean	*87.79*	*64.68*	*78.76*	*60.06*
2008	87.14	67.49	79.25	59.72
2009	85.68	60.44	73.09	48.94
2010	85.85	60.35	72.72	47.38
2011	85.72	58.56	74.52	48.97
2012	85.86	59.37	73.84	48.91
Mean	*86.05*	*61.24*	*74.68*	*50.78*

Source: FAO production database (FAO, 2013)

Unfortunately, most growers and consumers of other root crops are not aware of the nutritional advantages of cocoyam. But they often resort to it as a major staple during critical periods for survival, such as during social and natural disasters, when socio-economic status is low and when food insecurity escalates. Generally, cocoyam commands a higher price per tonne than most root and tuber crops, with the exception of yam. Data from FAO (1990) showed that the price of one tonne of cocoyam was 32.5% lower than one tonne of yam, but it was higher than one tonne of cassava by 75.7%, and one tonne of sweet potato by 38.2%. The relatively low price of cocoyam when compared to yam makes cocoyam a ready alternative for yam during its off-season. The status of cocoyam as a reliable alternative in times of difficulty is playing out in the hitherto banana growing region of the Eastern Democratic Republic of Congo. In this region cocoyam is widely grown as a subsistence crop, and often intercropped with banana. However, due to loss of banana to the devastating *Xanthomonas* wilt disease (BXW), cocoyam has become a major source of food, thereby ameliorating the emerging food insecurity due to the outbreak of BXW (Mwangi *et al.*, 2007). In addition, the broad canopy and roots of cocoyam help to reduce water erosion in areas where BXW infected banana mats have been uprooted.

Despite the nutritional advantages of cocoyam and its potential for poverty alleviation, relatively little research attention has been devoted to it. Consequently, the potentials of cocoyam as an important staple food crop and its associated nutritional and health advantages remain under-exploited. It has been noted that the situation of marginalized or under-researched crops such as cocoyam, which nevertheless are undoubtedly important to food and income security for millions of resource-limited farm households, will continue to worsen due to neglect and limited competitiveness unless steps are taken to raise their profile (IITA, 2008). The role of cocoyam in the economies of countries in SSA, and its importance to the livelihoods of millions of people, has been under-estimated, under-reported, and therefore poorly appreciated. Those who depend heavily on the crop for survival – the most vulnerable groups – have neither the resources nor the voice to influence its future. There is no doubt that investment into research and development on cocoyam could help unlock the potential of the crop, improve livelihoods of the millions who depend on the crop, create jobs and enhance food security in Africa.

CHAPTER TWO: TRENDS AND CURRENT STATUS OF COCOYAM PRODUCTION IN WEST AND CENTRAL AFRICA

Africa in the last three decades had consistently accounted for an increasing percentage of global cocoyam production, which currently stands at about 10 million tonnes per annum (FAO, 2012). The mean global production in the last decade (2003 – 2012) is therefore more than double the mean production three decades ago (1983 – 1992) due principally to increased production in Africa. The bulk of this increase occurred in Nigeria, Ghana and Cameroon (Table 2). These three countries accounted for 41% of mean global output between 1983 and 1992, approximately 62% of the average output between 1993 and 2002, and about 68% of mean output between 2003 and 2012.

Table 2: Contributions of top producers to global cocoyam output in the last three decades

	1983-1992		1993-2002		2003-2012	
	Mean[a]	%[b]	Mean	%	Mean	%
World	4.88		8.04		10.72	
Africa	2.74	56.26	5.88	73.13	8.25	76.96
China	1.20	24.62	1.40	17.47	1.61	15.04
Cameroon (C)	0.49	10.14	0.88	10.98	1.40	13.02
Ghana (G)	1.01	20.64	1.53	19.04	1.57	14.62
Nigeria (N)	0.52	10.61	2.60	32.36	4.28	39.91
C+G+N	2.02	41.39	5.01	62.37	7.24	67.54

[a] = Mean production in million tons over 10 years, [b] = Percentage of contribution to global mean

A closer look at the production trend in the last three decades in these three countries shows that Ghana was the leading producer until 1996 when production in Nigeria rose significantly. The production in Nigeria and Ghana appeared to have attained a peak between 2007 and 2008, followed by a sharp decrease in production from 2009 (Figure 1). This period of sharp decrease coincided with the outbreak of taro leaf blight in the region.

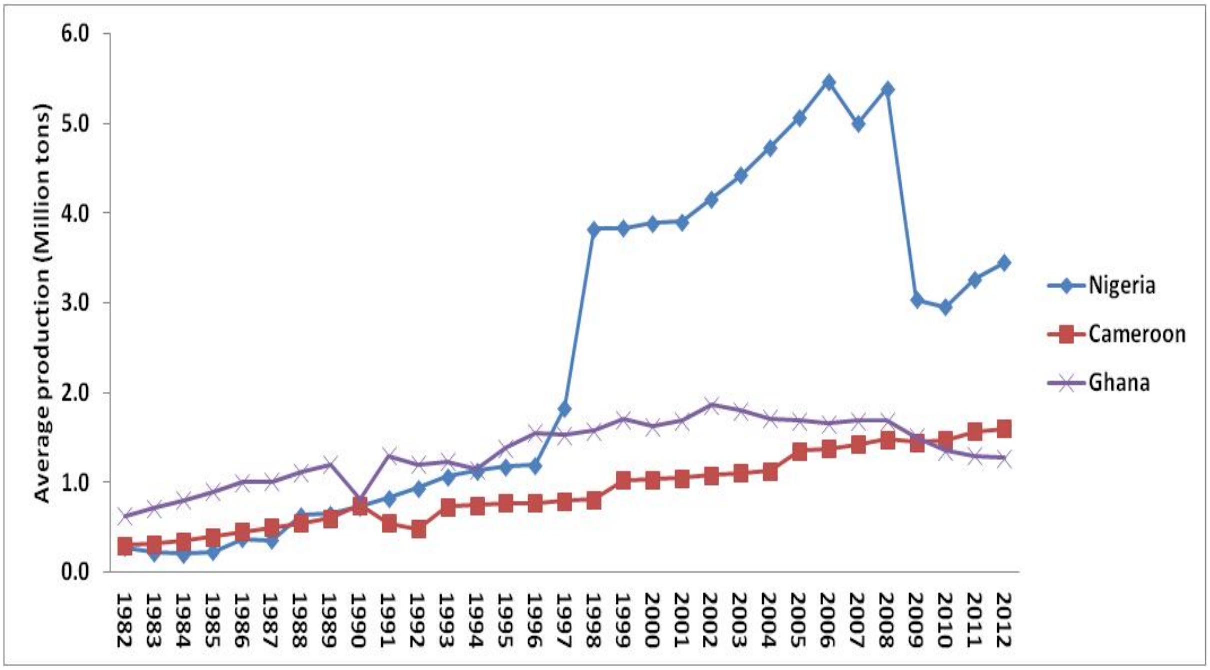

Figure 1: Cocoyam production trend in Cameroon, Ghana and Nigeria from 1982 to 2012.

Productivity and yield potential

There have been significant increases in the total output of cocoyam in West and Central Africa in recent times. These, however, are due to increased harvested area rather than increase in yield per land area. The average yield per land area has remained relatively low, ranging between 5 and 7.5 t/ha in Nigeria and Ghana, and between 4 and 8.5 t/ha in Cameroon. This is far below the obtainable yield of 17.5 to 19 t/ha in China and 23.5 to 35 t/ha in Egypt (Figure 2). This discrepancy is a clear indication that current yield of cocoyam in WCA is currently far below its potential yield. And this could be attributed to the fact that cocoyam production in West and Central Africa is basically with minimal input and often on marginal soils. The practice of increasing output by increased area under cultivation is not sustainable, as this implies increasing demand for available land.

It is worth nothing that the FAO figures indicating relatively stable yield in Cameroon, Ghana and Nigeria in the last 5 years, are not consistent with the information obtained directly from the farmers which showed significant reduction in yields, particularly for *Colocasia esculenta* within this period.

Figure 2: Average yield of cocoyam in countries of West Africa compared to Egypt and China

Distribution within country

Cocoyam grows well in shade, which facilitates its intercrop with permanent plantations of banana, coconut, citrus, oil palm and cocoa. It is also intercropped with annual and perennial crops, thus making it a choice crop in the farming systems of the forest and forest/savanna transition zones in most countries. The bulk of Nigerian cocoyam is produced in the humid forest and derived savannah agro-ecological zones. This is currently the area where cocoyam is an integral part of the farming system and where about 10-30% of the cropland is under cocoyam. The official figures from the National Bureau of Statistics (NBS) identify 21 out of the 36 states of Nigeria with appreciable hectares planted with cocoyam (Figure 3). However, in the field survey of TLB in 2012, a substantial amount of cocoyam production was also observed in some other states in Savanna ecological zones which are not captured in the 2006 NBS data.

In Cameroon, cocoyam is highly adapted to three agro-ecological zones, namely Zone III – High plateau of the west, Zone IV – Humid forest with mono modal rainfall, and Zone V – Humid forest with bimodal rainfall. The crop is widely grown in these three zones where annual precipitation ranges between 1600 mm and 3000 mm. Cocoyam can however be found growing in all five agro-ecological zones of Cameroon.

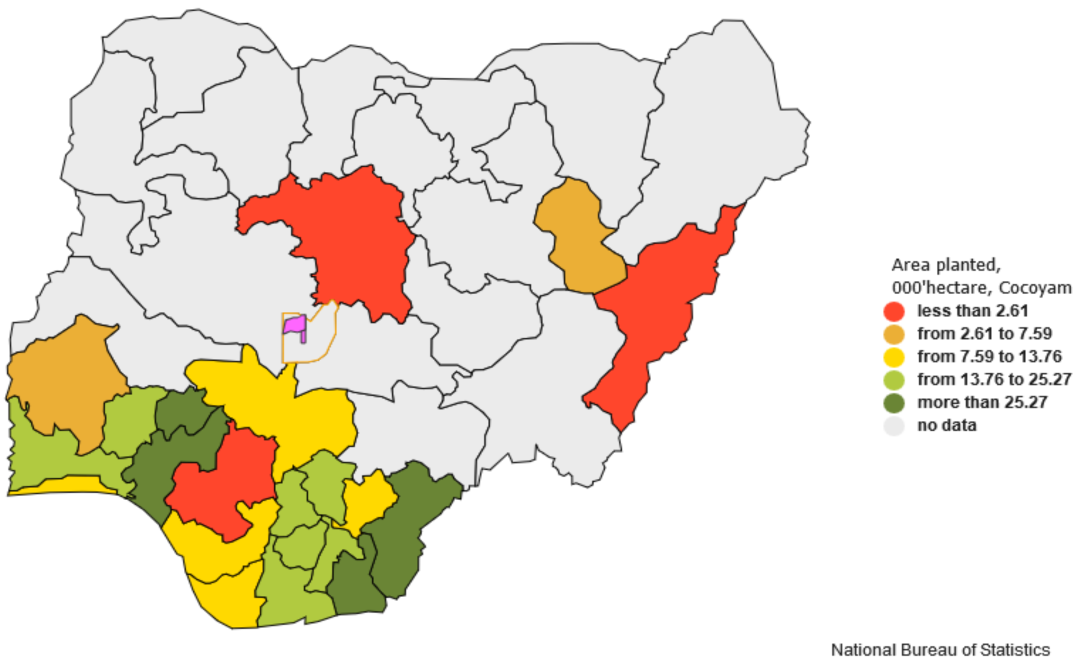

Figure 3: Area ('000 hectares) planted to cocoyam in various states of Nigeria in 2006

In Ghana, cocoyam is predominantly grown in the wetter forest zones because of its high moisture requirements for growth. Average yield in this region ranges between 4 and 7.5 t/ha, and the crop is produced for both cash and food because of the high stable price that it commands. Total production has been increasing in the past years, basically due to increase in acreage but not production per unit area. The crop produces the best yields in well-drained fertile loamy soils with abundance of organic matter, typical of newly cleared forest land. Most often, after the clearing and burning of secondary forests, there is usually a profuse sprouting of cocoyam as a volunteer crop. Farmers take advantage of these volunteer plants by tending and incorporating them into the cropping system. Since cocoyam tolerates shade, the crop is frequently grown in intercropping systems together with permanent crops such as banana, coffee, coconut, rubber, oil palm and cocoa. During interaction with scientists from Crops Research Institute (CRI) Kumasi, Ghana, it was noted that persistent decline in soil fertility, decreasing rainfall, and the loss of forest lands have all been identified as causes of reduction in cocoyam production as well as a decline in the genetic diversity of the crop in Ghana.

CHAPTER THREE: ROLE OF COCOYAM IN LIVELIHOODS OF SMALLHOLDER FARMERS IN NIGERIA, CAMEROON AND GHANA

Cocoyam is the third important staple food among root and tuber crops after yam and cassava, and provides a cheaper yam substitute, especially during period of food scarcity, in many parts of Nigeria and Ghana (Ene *et al.*, 1997; CRI-personal communication). Nutritionally, cocoyam has advantages over other root and tuber crops (Lyonga and Nzietchueng, 1986). It has more crude protein than other roots and tubers and its starch is highly digestible because of the small size of the granules. Its contents of calcium, phosphorus and vitamins A and B are reasonably higher (Ojinnaka *et al.,* 2009). These nutritional attributes make it a good base for food preparation for infants, and it has been shown that cocoyam starch can be incorporated in the development of weaning food which is highly digestible and accessible to low-income earners (Oti and Akobundu, 2008). Although the nutritional advantages highlighted above are not fully known to rural farmers, cocoyam production is an integral part of many smallholder farms in the ecological zones where it is produced in various countries of WCA. For example, most of the output that places Nigeria as the global leader in cocoyam production is carried out by rural farmers who employ primitive technology and traditional practices. Similarly in Ghana, cocoyam is generally grown by small-scale farmers and cocoyam farms under intensive management are very limited. Cocoyam leaf is produced on a subsistence basis, and pickers who are not farmers dominate its harvesting and marketing.

Various studies on the analysis of socio-economic characteristics of cocoyam producing households in many countries revealed that cocoyam farmers in WCA are mostly women who depend on the crop to support their families (Scott *et al.*, 2000; Azeez and Madukwe, 2010; Quaye *et al.*, 2010; Adisa and Okunade, 2011; Ugbajah, 2013). In most studies, the majority of the cocoyam farmers play critical role in provision of food for other members of the family. The studies also revealed that in places where cocoyam is grown more for income generation, the proportion of men involved in cocoyam production tends to increase. The results from the various studies above are in agreement with the observations from interaction with stakeholders during preparation of this report. It was observed that in Cameroon, cocoyam is mostly grown by women, although men may be involved in the land preparation for cocoyam in conjunction with land preparation for other cash crops. The men claim ownership of the plantation crops such as banana, coffee, rubber, cocoa and yam farms, while the women handle most processes of cocoyam production (planting, weeding, harvesting and processing). After harvesting cocoyam, the women are also in charge of the decision on whether to use it for household food or to take it to the market and use the income to meet other household needs. Similarly in Ghana, it was observed that the women are the owners of cocoyam farms although the men often help with the land preparation. After land clearing, the women tend the volunteer cocoyam plants and do the harvesting when needed. The women noted that they cherish cocoyam because it matures early and therefore helps in addressing one of their main concerns, which is how to feed their families when other crops are not ready for harvest. Because cocoyam is naturally tasty, it can also be eaten with satisfaction even when there is no money to prepare stew or buy other ingredients. The men depend on cash crops from which to provide money for family needs. During the off season of the cash crops, the women are compelled by circumstances to assume responsibility for certain family needs, and the income generated from their cocoyam often comes in handy.

In general, cocoyam represents a prime mover of socioeconomic development and activities in most rural households where it is produced for food and/or market. In the south-east and south-south regions of Nigeria, cocoyam production, marketing and consumption are interwoven enterprises that sustain many rural dwellers. The livelihood of rural dwellers in these regions revolves greatly around women investing their resources in cocoyam production and sale in local markets. Incomes generated from these activities are channeled into meeting various family needs. As a result of this, cocoyam farming, production and sale contribute substantially to the economy of rural households across the country. Although women have dominated cocoyam production in many WCA countries, it has been observed that in places where cocoyam is acquiring high commercial status more men tend to go into its production. Cocoyam production therefore constitutes an important component of household food production and income generating activities. This is in line with the observation of Talwana *et al.* (2009) in a survey of the status of cocoyam production in the three East African countries of Kenya, Tanzania and Uganda. The study showed that in urban areas where markets exist, more men are involved in cocoyam production and the crop contributed substantially to food and income security. In the rural areas, women are more involved in cocoyam production, and the importance of cocoyam is shifted more towards food security.

The role of cocoyam in the livelihood of rural women was made clear during interaction with the Nokware Women Group in Kwaso located in the Ashanti region of Ghana. When asked if they could do without cocoyam if provided with support in growing alternative crops such as plantain, cassava or yam, the women overwhelmingly exclaimed that doing without cocoyam production is a recipe for hunger which is practically impossible for them to accept. Their argument is hinged on the following points:

- Cocoyam is not just a food to them but part of their culture and society, and therefore cannot be replaced.
- Cocoyam is their means of survival as it is the only crop you can count on during the period of food scarcity. Also, it is the first crop to harvest while they are still waiting for cassava, yam and plantain.
- Cocoyam is more filling than yam, cassava and plantain, and it gives them more money than these other crops.
- Cocoyam is more preferred by the aged in the communities, and often used by mothers as weaning food in the absence of commercial baby foods.
- Cocoyam stores longer even after harvest, and can be left in the ground until needed, thereby providing food all year round.
- Because of the all season availability of cocoyam, it comes in handy in periods of financial stress, particularly when other crops are out of season. They can easily harvest cocoyam and sell it to meet needs like school fees, and other needs peculiar to women.
- Cocoyam helps to bring stability to the home because the women do not have to depend on the man for every bit of financial need in the home.
- Cocoyam provides a leafy vegetable which cannot be replaced by any other vegetable source.
- A woman who does not have a cocoyam farm can as well be qualified as a non-farmer.

The implication of potential yield loss and the benefit of any intervention that could mitigate this could be better appreciated by considering the proportion of rural farming households that could be impacted by interventions aimed at improving sustainability of cocoyam in West Africa. Apart from being the third important staple root and tuber crop, cocoyam is being grown by 25-35 % of rural households in the growing ecologies of Nigeria and Ghana. According to the 2005/2006 Ghana Living Standard Survey of nationally and regionally representative household (Quiñones and Diao, 2011), cocoyam is one of the eight important crops grown by more than (or close to) 25 percent of rural households. The survey which was facilitated by the International Food Policy Research Institute covered a total of 8687 households from different regions of the country. A total of 5209 households indicated involvement in crop production and 31.7% of the national crop holders (1651 households) were involved in cocoyam production (Table 3). The result indicated that over 82% of all cocoyam growers are from the rural households. The observation that over 30% of crop holders nationally are involved in cocoyam production underscores the importance of the crop in Ghana. Moreover, the proportion of farm families involved in cocoyam production could be as high as 60% of the crop holders when the survey is focused on the Forest agro ecological zone of the country which is more suitable for cocoyam production.

Similar trend of cocoyam importance to rural households could be seen from the 2010/2011 National Agricultural Sample Survey conducted by the National Bureau of Statistics in collaboration with the Federal Ministry of Agriculture and Rural Development in Nigeria (NBS, 2012). The survey showed that a total of 22 out of the 36 states of Nigeria reported cocoyam in the period under consideration (Table 4). Conservatively, it is estimated that between 5-35% of farm families in these states cultivate cocoyam depending on the agro ecology of the states. Based on this estimate, over 2 million farm families are currently engaged in cocoyam cultivation in Nigeria (Table 4).

These figures are only indication of the enormous number of rural households threatened by the various biotic challenges to cocoyam production in West Africa. The livelihood of these farmers as well as those involved in the various stages of cocoyam trade will be enhanced by research intervention to mitigate these challenges.

Figure 4: Participants at the stakeholders meeting explaining why cocoyam is crucial to the rural women

Figure 5: A group photo with the Nokware Women Group after the stakeholders meeting on importance of cocoyam to the rural livelihood

Table 3: Number of farm households producing various major crops in Ghana (N=8,687)

	Rural household		**Urban household**		**National Total**	**% all crop holders**
	Number	**%**	**Number**	**%**		
Maize	3,291	63.0	565	15.7	3,856	74.0
Cassava	2,837	61.3	549	16.6	3,386	65.0
Pepper	2,285	42.5	292	8.3	2,577	49.5
Plantain	1,813	40.2	400	12.5	2,213	42.5
Okra	1,773	28.1	203	5.3	1,976	37.9
Yam	1,770	33.2	256	7.4	2,026	38.9
Tomato	1,466	27.7	173	4.8	1,639	31.5
Cocoyam	***1,358***	***29.8***	***293***	***9.3***	***1,651***	***31.7***
Groundnut	1,254	17.6	106	2.3	1,360	26.1
Leaf Vegetables	1,060	18.2	127	3.7	1,187	22.8
Oil Palm	1,023	22.4	175	5.2	1,198	23.0
Beans & Pulses	1,006	13.7	65	1.5	1,071	20.6
Millet	986	12.1	69	1.1	1,055	20.3
Sorghum	980	12.4	45	0.7	1,025	19.7
Cocoa	848	19.3	128	4	976	18.7
Rice	736	8.7	39	0.8	775	14.9
Banana	605	12.4	94	2.7	699	13.4
Pawpaw	598	11.9	88	2.5	686	13.2
Eggplant	594	12.7	115	3.5	709	13.6
Orange	479	10.3	81	2.4	560	10.8
Pineapple	447	9.5	67	1.9	514	9.9
Avocado	337	6.8	66	2	403	7.7
Mango	268	5	44	1.2	312	6.0
Other Vegetables	268	5.2	46	1.2	314	6.0
Other Staple Crops	231	3.4	31	0.9	262	5.0
Sheanut	180	1.8	1	0	181	3. 5
Onion	178	3.4	27	0.6	205	3.9
Potato	158	2.1	12	0.3	170	3.3
Coconut	141	3	14	0.4	155	3.0
Other Fruits	131	2.6	26	0.9	157	3.0
Cashew	71	1.2	20	0.6	91	1.7
Cotton	67	0.9	1	0	68	1.3
Colanut	62	1.1	4	0.1	66	1.3
Sugarcane	39	0.8	13	0.3	52	1.0
Lime/Lemon	29	0.7	1	0	30	0.6
Tobacco	29	0.6	0	0	29	0.6
Ginger	20	0.4	0	0	20	0.4
None	**719**	**17.2**	**2,759**	**75.8**	**3,478**	
Total	**5,069**	**100**	**3,618**	**100**	**8,687**	

Table 4: Distribution of crop holders (farm families) by State of Nigeria and proportion of farm families in cocoyam production (2010)

State	Total No. of farm families	2010 cocoyam production in ('000 tons)	Proportion (%) of farm families in cocoyam production	Estimated no of cocoyam farm families
Abia	309,199	142.38	35	108220
Adamawa	494,144	.	.	.
Akwa-Ibom	572,002	192.43	35	200201
Anambra	447,454	137.80	35	156609
Bauchi	671,790	8.13	5	33590
Bayelsa	178,537	48.38	25	44634
Benue	657,767	.	.	.
Borno	676,474	.	.	.
Cross River	532,005	141.87	35	186202
Delta	588,842	102.25	25	147211
Eboyin	384,855	247.80	35	134699
Edo	434,051	146.19	30	130215
Ekiti	208,161	161.69	25	52040
Enugu	443,973	228.98	35	155391
Gombe	*315,479*	*7.38*	*5*	15774
Imo	475,460	142.61	35	166411
Jigawa	605,963	.	.	.
Kaduna	896,761	10.75	5	44838
Kano	1,031,290	0.94	.	.
Katsina	853,187	.	.	.
Kebbi	474,062	2.33	.	.
Kogi	277,482	6.36	5	13874
Kwara	396,239	.	.	.
Lagos	160,848	.	.	.
Nasarawa	247,230	.	.	.
Niger	627,524	.	.	.
Ogun	489,392	124.70	25	122348
Ondo	432,835	605.71	30	129851
Osun	507,479	189.34	25	126870
Oyo	767,146	107.11	25	191787
Plateau	522,864	102.87	25	130716
Rivers	632,648	99.09	25	158162
Sokoto	516,285	.	.	.
Taraba	301,705	.	.	.
Yobe	438,291	.	.	.
Zamfara	451,502	.	.	.
Fct Abuja	155,155	.	.	.
Total	**18,176,082**	**2,957**		**2,449,640**

CHAPTER FOUR: STATUS AND OPPORTUNITY FOR COCOYAM MARKETS IN WEST AND CENTRAL AFRICA

There seems to be a dearth of information on the international trade of cocoyam from Africa. McGregor *et al.* (2011), based on an estimate from available FAO data, conclude that less than 1% of the total output of cocoyam grown and consumed worldwide enters the international trade. The estimate showed that China is the number one exporter of cocoyam, followed by Fiji (Table 5). None of the cocoyam producing countries from sub-Saharan Africa, which accounts for over 70% of global cocoyam production, was listed among the top five cocoyam exporting countries. This is however not surprising considering the difficulty in finding reliable data on cocoyam import and export for most African countries. Although over 60% of the global cocoyam production is accounted for by Cameroon, Ghana and Nigeria, there seems to be not much information on the contribution of cocoyam from these countries to the international cocoyam market. This could be partly due to poor documentation of trade in cocoyam, but more importantly, it could also be an indication that cocoyam production in WCA is basically targeted at meeting local needs for food security.

Table 5: Top five cocoyam exporting countries/territories

Rank	Area	Quantity (tones)	Unit value (US$/ton)	Value (US$1,000)
1	China	70,235	569	39,937
2	Fiji	12,661	1,255	15,885
3	USA	6,307	1,086	6,850
4	Dominica	500	1,388	694
5	Tonga	852	475	405

Adapted from McGregor *et al.* (2011)

Notwithstanding the paucity of information on the contribution of cocoyam from SSA to the global trade, the crop is gradually receiving attention as a non-traditional export commodity in the region. For example, data emanating from the Export Promotion Council of Ghana shows that export of cocoyam has been on the increase since 2000. In 2000, the country earned approximately US$54,400 from cocoyam exports, and this increased to a total of US$211,690 in 2008, which is about a fourfold increase (Table 6). While the total volume (tons) of cocoyam export appears insignificant in comparison to the volume of yam or pineapple exported within the same period, the economic value (US$/ton) of cocoyam is comparable to these two commodities.

Table 6: Comparison of yam and cocoyam exports with pineapple in Ghana

	Yam			Cocoyam			Pineapple		
	Volume (t)	**Value ($1,000)**	**Value ($/t)**	**Volume (t)**	**Value ($1,000)**	**Value ($/t)**	**Volume (t)**	**Value ($1,000)**	**Value ($/t)**
2000	12,463	7,171	575	117	54	465	28,512	11,900	413
2001	9,629	5,203	540	172	59	343	33,174	13,300	401
2002	13,025	8,248	633	224	78	347	46,391	15,500	334
2003	7,974	4,442	557	228	83	364	45,145	14,400	319
2004	16,169	8,399	520	64	36	563	71,804	22,069	308
2005	18,376	10,951	596	189	96	508	46,694	12,784	274
2006	20,296	14,157	598	244	155	634	60,751	38,760	638
2007	19,715	14,551	738	234	114	485	44,723	38,760	887
2008	20,841	14,889	714	273	212	776	35,134	11,842	337

Source: Ghana Export Promotion Council

There is no doubt that economically, cocoyam commands a higher price per ton than most root and tuber crops with the exception of yam. According to available data from the Nigerian Bureau of Statistics on the farm gate prices of major agricultural commodities, the price of cocoyam varied from one state to another with a national average of 31.6 naira/Kg (approx $197/ton) in the year 2009, and 33.8 naira/Kg (approx $211/ton) in the year 2010. In both years the farm gate price of cocoyam was higher than that of cassava but lower than that of yam (Table 7). The difficulty in assembling reliable market data is compounded by the fact that the cocoyam market is not organized in most communities and often the marketers do not use a standardized measurement for their sales. This was evident in the visit to Buea market in Cameroon, where the traders just pile up the cocoyam in variable sizes with non-uniform price tags (Figure 6).

Figure 6: Cocoyam on display at Buea market in Cameroon (price ranged from 500 – 7000 CFA).

Table 7: Farm gate Prices (naira/kilogram) of 3 major root crops across states of Nigeria

	Cassava		Cocoyam		Yam	
States	**2009**	**2010**	**2009**	**2010**	**2009**	**2010**
Abia	24.48	23.19	22.85	23.28	34.57	37.17
Akwa-Ibom	22.74	25.37	28.13	39.75	36.75	41.76
Anambra	28.05	28.46	26.37	24.89	33.98	37.06
Bayelsa	23.67	21.22	26.73	32.56	40.95	38.10
Cross River	25.57	13.56	28.40	34.10	46.31	47.52
Delta	21.88	18.01	37.25	36.26	57.97	67.44
Eboyin	28.38	25.78	28.09	29.59	37.93	42.48
Edo	26.96	19.57	28.65	25.76	38.30	37.95
Ekiti	26.13	21.15	46.01	43.24	40.19	53.14
Enugu	23.94	29.31	32.36	35.54	31.86	35.34
Imo	22.53	21.31	36.04	43.30	37.95	40.08
Ogun	29.63	33.44	26.37	34.56	34.12	41.94
Ondo	28.47	18.81	29.10	37.40	36.69	39.76
Osun	25.48	18.94	29.01	33.48	26.32	37.89
Oyo	29.09	21.55	30.79	31.13	45.16	44.32
Rivers	25.76	31.35	30.76	27.30	36.75	39.93
Taraba	13.41	20.39	50.54	42.92	43.46	44.15
National	***23.44***	***21.41***	***31.62***	***33.83***	***39.22***	***43.11***

Data Source: National Bureau of Statistics (NBS) – Nigeria

Presently, the two major importers of cocoyam are the United States and Japan. It is likely that import to the U.S. is majorly made up of cocoyam from Caribbean and Latin American countries and to a lesser extent from the Pacific Islands. Import to Japan and Australia would likely be mainly from the Pacific Islands. The main use for cocoyam in importing countries appeared to be mainly consumption. Consequently the preference for importation of Colocasia or Xanthosoma varies from different countries according to the population of the consumers. For example in New Zealand , the main cocoyam consumers are Pacific Islanders, hence most of the importation of New Zealand is made up of Colocasia from the Cook Islands, Fiji, Niue, Tonga, Samoa, Australia, Korea, Philippines (McGregor et al., 2011). The USA importation is made up of both Xanthosoma and Colocasia that serve large and diverse consumer groups. The market is however dominated by Xanthosoma known as malanga, the preferred taro of the Latin American community, whereas the preference for Colocasia is limited to the Pacific Island and Asian communities.

Although, there is a great potential for cocoyam export from WCA, particularly with the increasing migration of Africans to various part of the globe, it is not likely that the export from Africa will easily replace export from the already established exporting nation due to many factors including strict required standards and proximity to the major importing countries. However, there are opportunities for trade in cocoyam between countries in Africa which could be harnessed for economic empowerment and food security. As of 2008, the value of cocoyam production from four West African countries (Cote d'Ivoire, Ghana, Nigeria and Togo) was estimated at above US$2 billion annually (Table 8). This great opportunity is however threatened by diverse production constraints, notably the increasing biotic constraints among others. This is evident from the sharp decline in the gross production values for Ghana and Nigeria since 2009 (Figure 7). Even with the present focus on domestic markets, cocoyam production in various WCA countries is still highly profitable. In an assessment of profitability of cocoyam production in Nigeria, Azeez and Madukwe (2010) conducted a survey of returns from cocoyam production in some localities of south-east Nigeria and concluded that cocoyam is highly profitable with a net return of over 100% of the total production cost. There is a need to better organize cocoyam production and marketing structures in Africa so as to maximize the opportunity of the crop for economic empowerment.

Table 8: Economic value of cocoyam production in four West African countries (FAO, 2009).

Country	Area harvested (ha)	Production (tonne)	Price (US$/tonne)	Value (US$1,000)
Côte d'Ivoire	68,000	93,639	193.9	18,157
Ghana	251,850	1,688,330	338	570,656
Nigeria	728,000	5,387,000	333.3	1,795,487
Togo	13,221	15,500	616.3	9,553

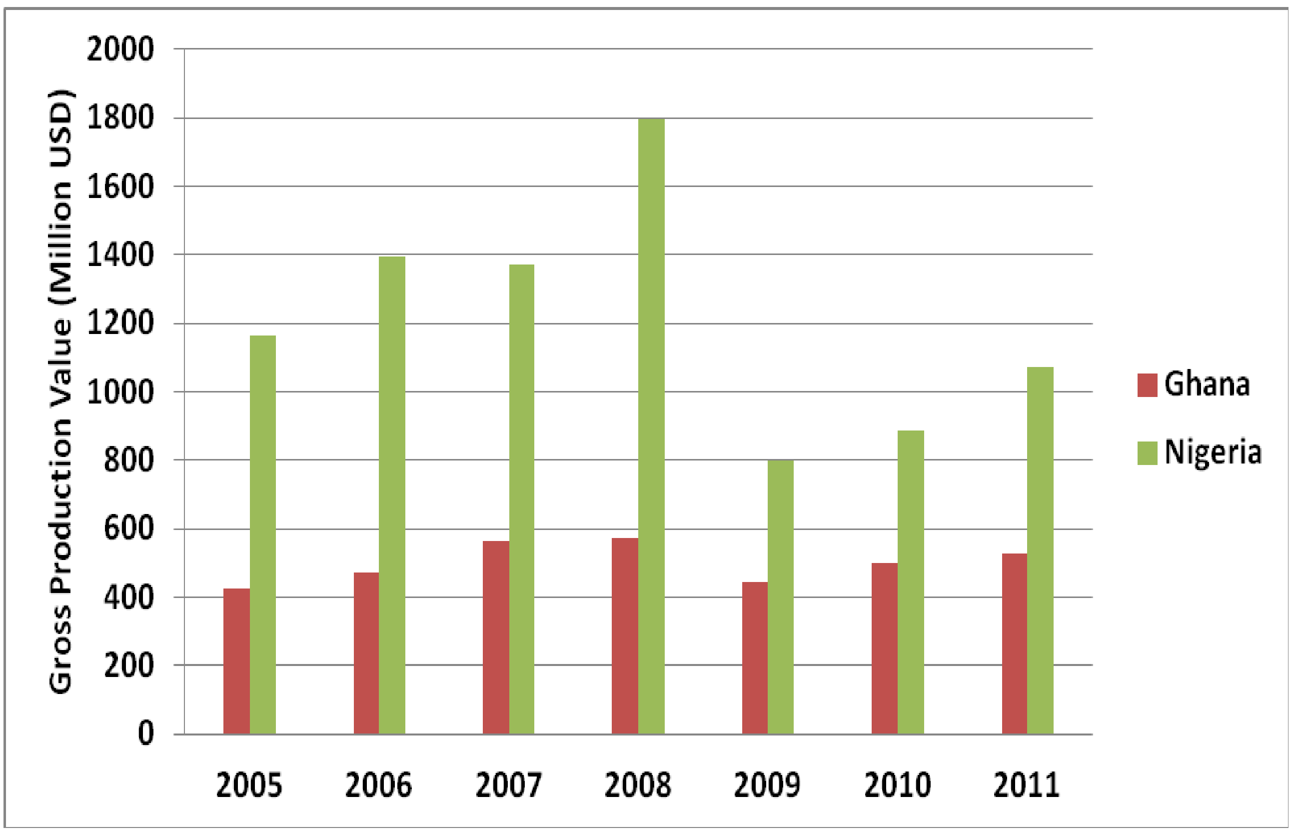

Figure 7: Trend in gross production value of cocoyam production in Nigeria and Ghana

CHAPTER FIVE: CHALLENGE OF TARO LEAF BLIGHT (TLB) AND COCOYAM ROOT ROT DISEASE (CRRD) IN WEST AND CENTRAL AFRICA

Until recently, the most important disease of cocoyam in WCA was the cocoyam root rot disease (CRRD) of *Xanthosoma* spp. Field symptoms of the disease are stunting, yellowing of leaves and severe reduction of the root system. Early studies on the etiology of CRRD in Nigeria (Okeke, 1982; Arene and Ene, 1987) attributed the disease to a complex of fungal pathogens, hence the term cocoyam root rot blight complex (CRRBC). However, later research efforts in Cameroon based on epidemiological studies and molecular characterization identified *Pythium myriotylum* as the causal agent of CRRD in Cameroon, and this is probably the same for all other countries in WCA. Unlike the *Xanthosoma* spp, *C. esculenta* had been grown without significant disease threats. This has however changed with the recent outbreak of Taro leaf blight (TLB) across several countries in WCA. TLB, which is caused by *Phytophthora colocasiae* Raciborski, is the most destructive disease of *C. esculenta* globally. Symptoms appear as small, water-soaked spots that increase in circumference and also spread to healthy plants. The entire leaf area of an affected plant is destroyed within 3-5 days after the initial symptoms depending on the weather conditions. Under cloudy weather conditions with intermittent rains and temperature around 28°C, the disease spreads at tremendous speed. The entire field could give a blighted appearance within two weeks of infection.

Spread and impact of CRRD in *Xanthosoma*: CRRD caused by *P. myriotylum* can attack the plant at various stages of its growth cycle. Early infection at the root emerging stage induces stunting and plant die-back, while late infection (at 5-6 months after planting) reduces the number of feeder roots, causing chlorosis and poor yields (Figure 8). The disease can result in yield loss of up to 100% under favorable environmental conditions (Agueguia, 1987; Nzietchueng, 1984).

In Nigeria, early reports indicate that the disease is of particular importance in the humid forest ecological zone (Nnoke *et al.*, 1987). This zone is characterized by high rainfall, high relative humidity and high soil water which favor the development of root rot pathogens. However, reports from farmers' fields in recent times suggest that CRRD could be spreading to the nontraditional zones of derived savanna and dry savanna ecological zones of Nigeria. The most recent CRRD report of root rot in nontraditional zones in Nigeria was observed by the local farmers in Bokkos Local Government Area near Jos in Plateau state (Onyeka *et al*., 2008). It is not yet clear if this is as a result of increase in the spread and/or virulence of the pathogen, or as a result of poor cultural practices of the farmers which created enabling conditions for development of previously existing pathogens. In Cameroon, the impact of CRRD has been long identified and both farmers and scientist believe that the disease is contributing to diminishing cocoyam production and marketing enterprise in the country. During a visit to the cocoyam market in Buea, Ekona in 2008, one could see many trucks being loaded with corms and cormels of cocoyam for onward movement to neighboring countries, particularly Gabon. However, a visit to the same market during the course of the preparation of this report in January 2014 gave a pitiable scenario with prevailing scarcity of cocoyam in the market. Efforts to find out the cause of this change from both farmers and the scientists at the Institute of Agricultural Research for Development (IRAD) station in Ekona indicated that CRRD had made it virtually impossible to produce cocoyam profitably. There is however no doubt that some other factors may have contributed to diminishing cocoyam market. Similarly, during a visit to Ghana in the course of this assignment, CRRD was identified by stakeholders as a major constraint to production of *Xanthosoma* spp. The farmers literarily described the situation as "helpless," since they could do nothing but just wait and see their crops devastated. The situation makes some farmers leave their crop un-harvested until the next year with the expectation that some harvestable cormels would have developed after two years

Figure 8: Effect of cocoyam root rot disease showing plant stunting and yellowing of leaves

Spread and impact of TLB: Leaf blight is the most important disease of *C. esculenta* globally. This disease was not known in West Africa until 2009 when there was simultaneous outbreak in Nigeria, Cameroon, Ghana and other neighboring countries. A conservative estimate indicates that the economic loss due to TLB in West Africa may be above US$1.4 billion annually, in addition to potential genetic erosion in the crop's genepool in WCA. Because TLB is new to the sub-region, its understanding and control methods were virtually non-existent at the time of the outbreak. Immediate response therefore was on the need to carry out proper diagnosis of the observed symptoms by matching symptom development with pathogen identity. The causal organism of TLB in WCA has been confirmed through bioassay as well as DNA analysis in recent studies conducted in Nigeria and Ghana (Bandyopadhyay *et al.*, 2011; Omane *et al.*, 2012). There is still a need to properly document the prevalence and severity of the outbreak in various countries, and develop both short and long term management strategies for the disease.

Reports from farmers' fields across diverse agro-ecological zones of various countries, as well as preliminary field surveys (Onyeka *et al.*, 2013; Mbon *et al.*, 2013), indicate that the disease is widely spread across all cocoyam growing ecosystems of various countries in the region. In the Nigerian survey, which was more systematic, a total of 70 farmers' fields across 8 states representative of taro growing agro-ecologies of Nigeria were evaluated. The incidence of

TLB ranged from 65% to 90%, and the severity of the disease within fields was generally high. In all the states, the farmers noted that the disease was unknown to them until the 2009/2010 cropping season. The impact of TLB on the livelihood of the cocoyam farmers is made worst by the fact that some farmers literally abandon TLB infected fields due to the misconception that the disease could be transferred to humans. The abandoned TLB infected fields quickly get overgrown with weeds (Figure 9) leading to total crop failure for the year.

Figure 9: Abandoned TLB infected cocoyam field overgrown with weeds in Kaduna state of Nigeria

Further interaction with the farmers also indicated that they do not have any known TLB resistant cultivars, as all of their cultivars have shown susceptibility to the disease. Field evaluation of the nine known Nigerian *C. esculenta* landraces maintained at the National Root Crops Research Institute (NRCRI) showed that they were all highly susceptible to TLB, although in varying degree. In a recent review of the impact of TLB in Cameroon (Mbong *et al.*, 2013), it was shown that *C. esculenta* production is facing a significant decline due to the increased incidence of TLB. The disease outbreak has resulted in widespread reports of low yield, poor quality corms and reduced commercialization of *C. esculenta* across the country. In Ghana, farmers' experience is that of inability to grow *C. esculenta* at all because of TLB.

The farmers observed that their present varieties could not survive in the field as a result of die-back due to TLB. Similar to the situation in Nigerian, all the Ghanaian landraces are highly susceptible to TLB. The situation was more dramatic in Cameroon as it was difficult to see corms and comels of *C. esculenta* in the Buea market. The farmers and traders interviewed explained the situation in their own way by saying that "a new disease came and the taro plant just left". This may sound un-technical, but it is the only way they could explain that you will scarcely see a plant growing in the field. To the farmers, it is like a natural disaster in which they were just helpless.

It is clear that both CRRD in *Xanthosoma* spp and TLB in *C. esculenta* are negatively impacting the productivity of these important food crops in WCA. The scarcity and high cost of cocoyam is not only affecting the ability of rural poor, who often depend on cocoyam to feed adequately, but it is also affecting how they live by imposing on them the need to change their feeding culture. These diseases are also of significant importance in many other countries of Africa outside Nigeria, Cameroon and Ghana. For example Talwana *et al.* (2009) observed that 45% of cocoyam farmers interviewed in the East African countries of Tanzania, Uganda and Kenya identified diseases as one of their main constraints. The authors noted that the lack of research on cocoyam diseases seems to directly affect the farmers in these countries as the incidence of these diseases was high in fields where they occurred.

CHAPTER SIX: RESEARCH PRIORITIES FOR BETTER UNDERSTANDING AND CONTROLLING OF TLB AND CRRD IN WEST AND CENTRAL AFRICA

From the interactions with various stakeholders in Cameroon, Ghana and Nigeria, there is a general consensus that the current cocoyam yields are low and still declining due to diverse production constraints which seem similar across the three countries. The cocoyam farmers are therefore wishing for intervention from research institutions and government agencies to help manage the challenges they are encountering. Among the various important needs for potential research intervention, stemming the spreading effects of TLB on *C. esculenta* and CRRD in *Xanthosoma* spp remains a high priority in the assessment of farmers as well as cocoyam researchers.

The deployment of any control measure for disease management will however depend on proper understanding of the pathosystem, and this is presently lacking for both TLB and CRRD in most countries of WCA. Knowledge of the spatial distribution and severity of the diseases in diverse agro-ecological zones in the region is also lacking, as well as the possible existence of potential sources of resistance in the gene pool available in various countries. The most economical method of controlling root CRRD is by the use of tolerant varieties where such varieties are available and use of disease free planting materials. Similarly, previous research in the Pacific has demonstrated that management measures such as chemical and cultural control for TLB are largely ineffective and that breeding for disease resistance is the most sustainable approach to manage the disease (Singh et al., 2012). Developing resistant genotypes will require a robust cocoyam breeding programme which is presently lacking in all the NARS institutes in the region. The genetic diversity of cocoyam in all countries of WCA is still poorly characterised, although studies based on morphological and agronomic characterization (Mbouobda et al., 2007) tend to suggest narrow genetic base. Considering the ability of TLB and CRRD to completely destroy susceptible cultivars, they could lead to depletion in the diversity of both *C. esculenta* and *Xanthosoma* spp in the region.

Therefore, to mitigate the effect of TLB and CRRD on rural households whose livelihoods depend on cocoyam, there is a need for short-term measures for immediate relief as well as long-term measures for sustaining and institutionalizing the gains from the short-term interventions. For the immediate short-term measures, the following research interventions are suggested to improve knowledge and management of both diseases in WCA.

1. **Evaluation of the current status of TLB and CRRD and their associated pathogens in various agro-ecological zones of WCA**
    a. A good understanding of the distribution and severity of the TLB and CRRD in farmers' fields in diverse agro-ecological zones of major cocoyam producing countries of WCA is crucial to the management of the diseases.
    b. The pathogen of TLB has been confirmed in Nigeria and Ghana through efforts of the national partners with IITA Ibadan (Bandyopadhyay *et al.*, 2011; Omane *et al.*, 2012). Research effort in other parts of the world has shown some genetic variability in TLB pathogen isolates, although the relationship of this to pathogenicity is as yet unknown. Also, two mating types of the pathogen (A1 and A2) have been identified elsewhere in the world. The distribution of the mating types in a system can have a bearing on pathogenicity as mating between A1 and A2 isolates is likely to create more aggressive strains, a phenomenon seen in Europe with the introduction of a

second mating type of *Phytophthora infestans*, the potato blight pathogen. It would therefore be useful to know the extent of genetic diversity and the mating type(s) of the TLB pathogen in WCA.

2. **Conservation and characterization of the genetic diversity of *C. esculenta* and *Xanthosoma* spp in WCA**
    a. There is an urgent need to collect and conserve the various landraces of *C. esculenta* and *Xanthosoma* spp from farmers' fields in different countries to prevent loss due to their high susceptibility to diseases.
    b. Collected material will be transferred into tissue culture and maintained at the IITA Genebank, Ibadan, with a duplicate in a suitable NARS partner.
    c. The accessions will be characterized in the field and screen houses at both centers for key traits and morphological descriptors, and passport data will be made available online.
    d. The accessions will also be subjected to DNA fingerprinting to dissect the extent of genetic diversity and establish a core collection. This will improve the availability and easy access to these genetic resources.
3. **Improving genetic base of *C. esculenta* and *Xanthosoma* spp in WCA through germplasm exchange**
    a. It is envisaged that the genetic diversity of cocoyam in different WCA countries could differ from each other. Promoting exchange of germplasm between these countries could serve as a way to rapidly enhance the genetic diversity within each of the countries.
    b. Also facilitating exchange of germplasm between WCA and other parts of the world where cocoyam is important such as in the Pacific (represented by the Secretariat of the Pacific Community, SPC) and South America. This will not only serve as a safe duplication of these gene pools, but will enable and enhance research and breeding efforts in the various regions of the world.
4. **Initiation of first stages of breeding for disease resistance in *C. esculenta* and *Xanthosoma* spp**
    a. Breeding in cocoyam has been a very difficult task without much success in the NARS institutions that have managed to sustain some degree of cocoyam research in the last three decades. There is a need to review and optimize breeding techniques for cocoyam.
    b. The core collection of pan-African germplasm and introduced germplasm from other regions will be evaluated for identification of disease resistance.
    c. Crosses shall be conducted between adapted local varieties and identified sources of resistance for variety development and evaluation.
5. **Establishment of a regional network of cocoyam researchers in WCA**
    a. The recent outbreak of TLB in many countries of WCA is a reminder that diseases do not respect transnational boundaries. Moreover, there is no single country in WCA that has sufficient resources to tackle the problems of TLB and CRRD alone. Establishing a regional network will foster better collaboration and development of a more strategic approach to disease management and cocoyam improvement generally. Such a network will facilitate germplasm sharing and enhancement, and

keep countries informed of activities in the region and beyond. A similar regional network mechanism has been used to successfully manage TLB in the Pacific (Singh *et al.*, 2012**)**.

b. The regional network could also be linked with existing networks in other parts of the world such as the International Network for Edible Aroids (INEA) currently being coordinated by CIRAD from the Pacific island.

The modalities for optimal implementation of the above interventions could be finalized by convening a meeting of major cocoyam stakeholders in WCA. The convening will also help to identify critical players that will facilitate the realization of the goals and objectives. In addition, the convening will also consider the medium-term and long-term measures which are needed to consolidate the gains of the short-term interventions. Consequently, it could include a few subject matter experts working on cocoyam from outside the WCA sub-region. The following could be considered as medium and/or long term strategic interventions.

1. Better understanding of cocoyam farming systems and indigenous knowledge of CRRD and TLB
2. Identification of resistant factors for CRRD and TLB
3. Implementation of genomic tools in the improvement of cocoyam and better understanding of the major biotic challenges. This could include full genome sequencing of the crops and the pathogens:
    - *a. Xanthosoma* spp
    - *b. Pythium myriotalium*
    - *c. Colocasia esculenta*
    - *d. Phythophthora colocasiae*
4. Enhanced capacity of partners for cocoyam breeding, disease diagnosis and surveillance and novel strategies for disease management.

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APPENDIX

Timeline for the study: The study was aimed at being completed in two months with the following schedule. The study was eventually completed in 9 weeks.

Date	Location	Action
Week 1	IITA Ibadan	Review of literature and published reports
Week 2	IITA/Transit	Working on literature online
Week 3	Field - Nigeria	Interaction with stakeholders in Nigeria
Week 4	IITA Ibadan	Compiling and reviewing information
Week 5	Field - Cameroon	Interaction with stakeholders in Cameroon
Week 6	Field - Ghana	Interaction with stakeholders in Ghana
Week 7	IITA, Ibadan	Compiling information and drafting report
Week 8	NRCRI	Revision of draft report
Week 9	IITA Ibadan	Final Report ready

Highlights from interaction with stakeholders

Meeting with stakeholders in Nigeria – 18-22 December 2013. Contacts: B.C. Okoye, NRCRI Scientists.

At the National Root Crops Research Institute (NRCRI) Umudike, there has been recent progress towards reawakening the country to the importance of cocoyam. Also, the institute had benefited greatly from their involvement in the international Edible Aroid project in collaboration with SPC, Fiji. However, the challenge of TLB is still a major concern, and from national emergency stakeholders meeting on TLB the institute proposed the following immediate measures that could help in addressing the challenge of TLB:

1. Establish an organizational structure for management of the spread of cocoyam leaf blight in Nigeria with the aim of minimizing the impact.
2. Determine the current status (actual spread and severity) of cocoyam leaf blight and conduct a disease risk assessment in Nigeria.
3. Create awareness among farmers of the basic cultural practices to prevent or minimize the spread of the disease from infected to uninfected locations.
4. Evaluate range of readily available fungicides for efficacy in the short term management of the disease.
5. Evaluate various cultural and agronomic strategies to minimize/prevent the spread of the disease.
6. Evaluate imported genotypes from the SPC, Pacific under the Edible Aroid project – this activity is ongoing.

Meeting with stakeholders in Cameroon – 3-6 January 2014. Contacts: Amayana Abiodo and Levai Lewis Dopgima.

The visit to Cameroon involved a visit and interaction with cocoyam farmers at Buea market, and interaction with the cocoyam research team in the Institute of Agricultural Research for Development (IRAD) station Ekona. The visit showed that cocoyam is mostly grown by women, although men may be involved in the land preparation for cocoyam in conjunction with land preparation for other cash crops. The men claim ownership of the plantation crops such as banana, coffee, rubber, cocoa and yam farms, while the women handle most processes of cocoyam production (planting, weeding, harvesting and processing). The women are in charge of taking decisions after harvesting on whether to use it for household food or to take it to the market and use the income to meet other household needs.

The visit to Buea market showed a complete disappearance of the once booming wholesale cocoyam market. The few cocoyam traders/farmers available in the market lament the prevailing low yield of cocoyam and gradual disappearance of cocoyam farms due to diseases which make the crop unproductive. They attributed the lack of wholesale traders in the market to the inability of the cocoyam farmers in the area to produce enough for sustenance of the trade.

Meeting with stakeholders in Ghana – 21-23 January 2014. Contacts: Grace Bolfray-Arku, Emmanuel Omenyo and Regina Sagoe.

The Ghana visit provided an opportunity for meeting with two important sets of stakeholders in the cocoyam value chain, the research scientists and the farmers/marketers. The meeting with the cocoyam farmers involved a women's cooperative group operating under the name Nokware Women Group. A total of 23 women farmers were present and participated actively in the discussion. The highlights of key findings from the discussions are as follow:

- Depreciating yield of *Xanthosoma* spp probably due to soil fertility depreciation and increasing root rot disease severity which varies with locations.
- Increasing cost of planting materials as result of poor yield which creates scarcity of planting materials.
- Poor quality of planting materials purchased from the market which often consists of mixture of different varieties.
- The women believe that they cannot do without cocoyam as the crop is part of their culture as well being uniquely suitable for managing some of their food and financial needs.
- The unique suitability of cocoyam for managing some peculiar needs of the women informed the involvement of more women than men in its production.

The meeting with the scientists involved two separate sessions with two institutes under the Council for Scientific and Industrial Research (CSIR). The first meeting was with 3 scientists from Soil Research Institute (CSIR - SRI) and the second was with 8 scientists from Crop Research Institute (CSIR - CRI). These interactions corroborated the key findings from the visit to farmers. In addition, the scientist identified the following as research priorities in cocoyam:

- Development of new varieties
- Management of diseases: TLB in *Colocasia* and root rot in *Xanthosoma*
- Soil fertility improvement and management
- Germplasm enhancement and preservation
- Attitudinal change from scientists and policymakers towards cocoyam development
- Production of clean planting materials
- Proper documentation and innovative approaches to understanding cocoyam
- Better understanding of cocoyam farming systems and indigenous knowledge

A broad alliance of research-for-development stakeholders & partners