NIGERIA

Cassava Master Plan

A STRATEGIC ACTION PLAN FOR THE DEVELOPMENT OF THE NIGERIAN CASSAVA INDUSTRY

PREPARED WITHIN THE FRAMEWORK OF THE NIGERIA COUNTRY SERVICE FRAMEWORK AND IN COOPERATION WITH THE PRESIDENTIAL INITIATIVE ON CASSAVA

March, 2006

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Glossary and Acronyms

EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FGN	Federal Government of Nigeria
HA	Hectares
HQCF	High Quality Cassava Flour
IITA	International Institute of Tropical Agriculture
M & E	Machinery and Equipment
MT	Metric Tonnes
N	Naira
R & D	Research and Development
SMEs	Small and Medium Enterprises
SMEIs	Small and Medium Scale Enterprises Investment Scheme
T	Tonnes
T/Ha	Tonnes per Hectare
UNIDO	United Nations Industrial Development Organization
US$	US Dollar

Executive Summary

Nigeria is the highest cassava producer in the world, producing a third more than Brazil and almost double the production capacity of Thailand and Indonesia. She currently produces about 38 million metric tones (MT) per annum; a figure expected to double by 2020. Although the world leader in cassava production, Nigeria is not an active participant in cassava trade in the international markets because most of her cassava is targeted at the domestic food market. Her production methods are primarily subsistence in nature and therefore unable to support industrial level demands.

The Presidential Initiative on Cassava, which was launched in 2003 brought cassava and its potentials to the national limelight. The Initiative has as goal, the promotion of cassava as a viable foreign exchange earner for Nigeria, and also development of the cassava production system in order to sustain the national demand. The challenge however, is how Nigeria can earn US$5 billion from value added cassava exports by the year 2007. The vision for cassava is that it will spur rural industrial development, helping raise incomes for producers, processors and traders while contributing to the food security status of its producers and consumers, by a shift from cassava as principally a sustenance food to an industrial crop used in the processing of ethanol, starch, pellets, and high quality cassava flour for the export trade. To achieve this goal, Nigeria must adopt a demand-driven approach in promoting, developing and diversifying its cassava-based industries.

To aid its achieving the set goals, the Ministry of Industry with the framework of the CSF in cooperation with the Ministry of Trade and Commerce commissioned UNIDO to assist in the development of a Cassava Blue Print. In developing the Master Plan, the opportunities and constraints cassava may face at each stage of the commodity development cycle (Value Chain Analysis) have been systemically identified and analyzed and important tools such as Business Development and Management, International Economic Cooperation and Scientific Support have been proposed. Furthermore, benchmarking the Nigerian cassava sector against competing cassava nations; Thailand and Brazil has provided an insight of outstanding practices adopted by these nations that Nigeria could adopt and adapt. In addition, SWOT Analysis has identified the internal and external factors that affect the cassava sector and these have been used in developing the strategies proposed for the short, medium and long terms.

Following primary and secondary data, interviews, visits, brainstorming and interactive sessions used in the development of this document, an analysis of all available data shows that the primary challenge the cassava sector faces is low productivity due to Nigeria's subsistence cassava farming culture. A rudimentary industry although large, it is underdeveloped, inefficient and uncompetitive in the global arena, a consequence of high ex-factory prices. Nonetheless, a critical analysis of the data supports the view that Nigeria has the potential to achieve its US$5 billion earnings target from cassava products, once it addresses the current major bottlenecks along the Value Chain.

Her high cassava production levels mean that the implementation of equitable governmental policies, such as import substitution, 10% mandatory use of Ethanol as fuel, and 10% cassava flour substitution in bakery and confectionery, could see her earnings from reduced imports and industry savings surpass the projected government target.

This Master Plan envisages a dual phased, market led and private sector driven developmental approach. In the First Phase is the development of a vibrant cassava industry, aimed at the domestic market and geared towards import substitution. Once a healthy local cassava industry has been established, in the Second Phase, Regional and Global export opportunities can then be aggressively pursued. A vibrant market will create the demand for raw material (cassava), spurring increased and improved production of tubers at the farm level. Ethanol, flour and pellets are identified as potential earners in the domestic market, while starch will be developed primarily for the export market. Encouraging joint venture partnerships in the cassava starch industry in order to facilitate international market access may fast track Nigeria into the global context for competition in the commodity.

This Master Plan proposes the necessary government policies like interventions to improve productivity and competitiveness at the farm and processing levels, effective marketing in the domestic, regional and international arenas, financial investments, institutional support, sector wide linkages, and capacity building. It additionally provides the framework for the implementation of the Cassava Sector Development Action Plan in the immediate, medium (2-5 years) and long term (5-10 years).

In the short term, investments will be needed in at least 100 small to medium scale plants while the long term domestic demand will require further private sector investments in nearly 500 plants, with associated investment costs estimated at over N10 billion.

Finally, the Annex Section shows indicative Enterprise Analysis for investment in the processing of each cassava - based product in Nigeria.

Outline of the Master Plan

This document consists of 5 parts and 6 chapters.

Part one	***Cassava – The World Context***
Chapter 1.	This provides and examines the global trends in the global cassava sector.

Part two	***The Present Situation of the Nigerian Cassava Sector***
Chapter 2.	Examines the current status of the Nigerian cassava sector from Farm to Market.
Chapter 3.	Examines the internal and external strengths, weaknesses, opportunities and threats of the cassava production system in Nigeria (SWOT Analysis).

Part Three	***Cassava Industry- Brazil, Colombia and Thailand: a Comparative Study***
Chapter 4.	Positions Nigerian Industry in the global market: Benchmarks the cassava industry against its main competitors, Thailand and Brazil.

Part Four	***Action Plan for the Development of the Cassava Industry in Nigeria***
Chapter 5.	Outlines the actions necessary to achieve the goal of developing the industrial potential of cassava in Nigeria. The Road Map provides in summary, the desired output, course of action, responsible party and timeframe for the successful development.
Chapter 6.	Way forward-implementing the Road Map.
Annexes.	Contain Indicative Business Plans for the industrial level production of various cassava products.

PART ONE:

INTRODUCTORY SECTION

Cassava
–
The World Context

Chapter 1: The World Cassava Outlook

Cassava has been cultivated for centuries in the Americas, initially for human consumption and more recently cultivated for the production of dry chips (used as animal feed), ethanol and starch. With cassava viewed as a food security crop and therefore poorly commercialized, the changes along the **Cassava Value Chain** have been minimal. However, since Thailand commercialized cassava production and processing of animal feed, Asia and Latin America have witnessed rapid changes in the value chain system. Other contributing factors include new government policies promoting the use of cassava based products, improvements in cassava processing technologies resulting in greater outputs and the emerging importance of cassava as an effective industrial raw material for the starch, animal feed and ethanol industries.

1.1. The Value Chain Approach

This Master Plan has been developed using the Value Chain Approach, which can be defined as an organized system of exchange from production to consumption, aimed at increasing value and competitiveness. It is also an alliance of enterprises, working vertically to achieve greater market access.

As firms the cassava industry must compete – even in local markets – with firms and industries across the globe, this document analyses the constraints and opportunities faced by the Nigerian Cassava Value Chain at each stage from the farm to the markets. Subsequently, specific **inputs**, **policies** and **support systems** critical to proper functioning at each stage, and essential for the development of a competitive cassava value chain in Nigeria, have been determined.

Inputs include the raw materials, technologies, financing, institutional support and technical and administrative human resource.

Policies include stage specific and overall governmental efforts in creating an enabling environment essential to proper functioning and success of the entire chain.

Support systems improve and/or monitor quality and enable the delivery of timely services. Some examples are agencies that conduct research, provide product certification and/or promote, generate and disseminate information. These institutions significantly contribute to the overall performance of the target industry.

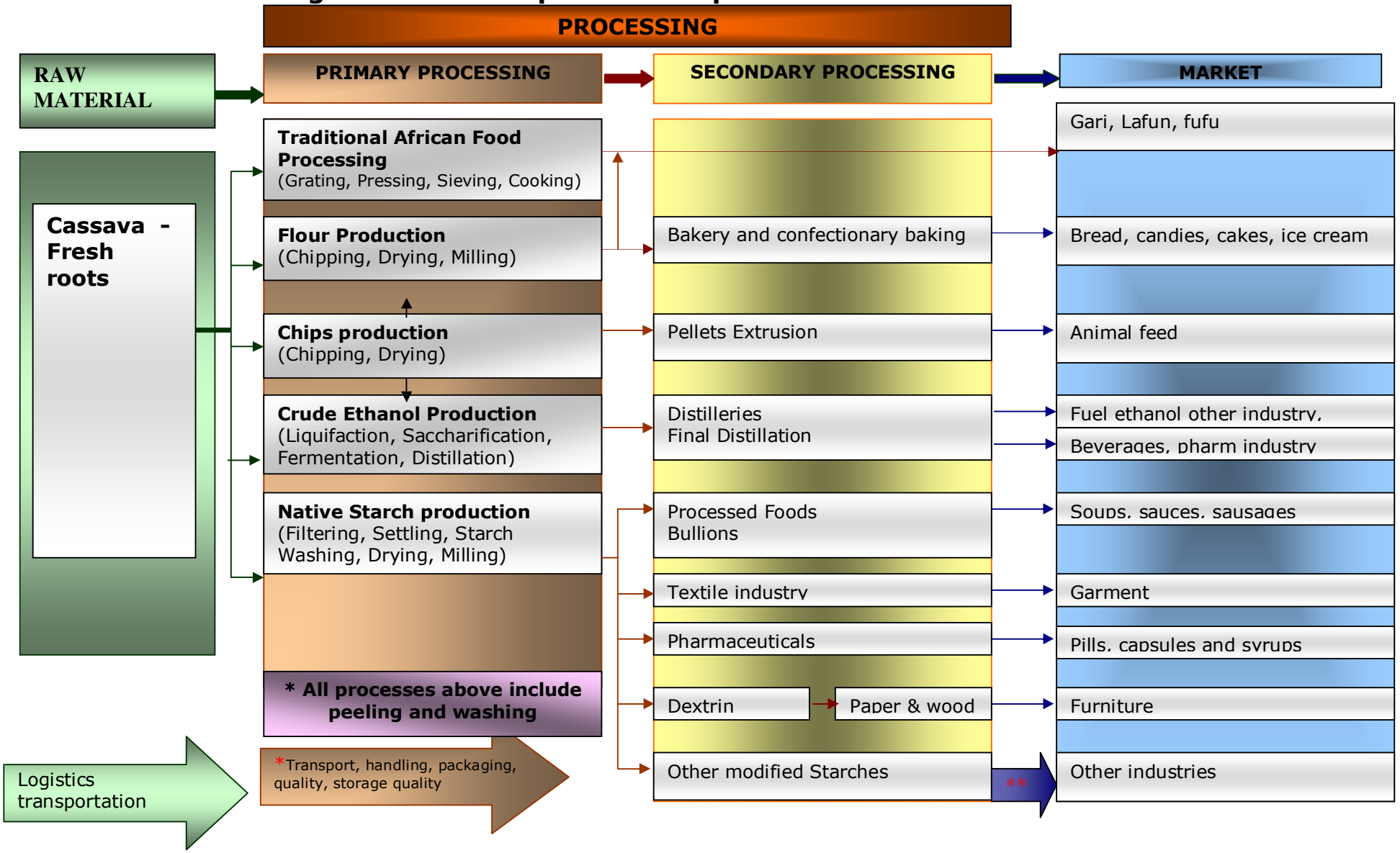
> **Value Chains encompass the full range of activities and services required to bring a product and/or service from its production/conception to its end use. These include the final markets into which a product or service is sold; local, national, regional or global. Actors in the value chain are driven by incentives namely, profit, prices, commissions or**

some other extrinsic factor. It is the incentive in the value chain that encourages private sector investments and oils the wheel of progress for any industry.

For the success in global markets, Value Chains must move a product from production to the consumer more efficiently, with better quality and/or in a unique variation different to Value Chains in competing countries. The competitiveness of the Nigerian cassava industry therefore depends on its ability to develop, and to maintain an edge over market rivals.

The Cassava Value Chain, presented in Diagram 1 begins with the production of the cassava, the primary raw material. The processing component comprises various processing firms who develop a variety of industrial raw material products from the cassava. The market component is either an end user of a finished product, or another processing firm, using the product as industrial raw material.

Diagram 1: A Simplified Example of the Casssava Value Chain



1.2. Dynamic Changes in the Global Cassava Value Chain

Global Trends in the Cassava Value Chain		
Raw Material Production	**Processing**	**Market**
Production Systems -Shift to commercial production of raw cassava tubers.	**Technologies** -Shift from traditional to industrial type processing.	**Diversified Consumer Demands** -Emerging huge global market demand for diversified cassava based products e.g. ethanol, starch, flour (HQCF) and pellets.
Productivity -Higher yields at farm level. -Improved raw material quality. -Ex-farm competitiveness improving. -Increased use of inputs. –Increased Mechanization.	**Competitiveness** -Processing enterprises becoming competitive through efficient production. -Large-scale state of the art technologies used especially in starch and ethanol production. -Emerging Subcontract production. -Small and Medium scale food and animal feed industry processors using more efficient technologies.	**Market Development** -Governmental policies on import substitution and the increased use of cassava based products in developing countries increasing domestic demand. -The Far East, especially China is emerging as a major world market for starch and pellets.
Supply Volumes -Improved capacity to supply the high volumes required by industry. -Subcontract/cluster farmer production on increase. -Plantation production on increase.	**Supply Capacity and Quality Specifications** -Clusters of small-scale processors working to meet market demand volumes. - HACCP/GMP/ISO 22000 implementation at plant level.	**Product Quality Specifications and Product Quantities Demanded** -Consumer demand for high product standard. -Consumer demand for Quality and Safety Certification. -Products demanded in large volumes. **Market Access** -Cassava Products competing against other products (maize and sugarcane). So Cassava based products and ex-factory prices must be competitive.

Table 1.1: Global trends along the Cassava Value Chain

Production

The African cassava production is subsistence in nature - focused on producing enough to feed the family. It is labour intensive, using very little fertilizer or pesticide inputs. However, since the 1990s in Latin America there have been significant shifts toward input-sensitive and large-scale production in regions like Brazil. The Asian production that

targets the animal feed and starch industries are also more commercial and characterized by large plantations, high levels of mechanization, and the use of inputs and irrigation.

Private sector-led subcontract cassava production has also evolved as processing industries strive to maintain sustainable continuous supply of raw material. This has further fueled cassava production and processing and the development of high yielding disease resistant cassava varieties, creating improved productivity and competitiveness at the farm level. For example, in 1999, to regain momentum in cassava research and development, cassava-producing countries in Latin America formed a consortium called CLAYUCA (Spanish acronym). The cassava value chain has also experienced a surge in Latin America and Asia, thanks to strong participation and leadership by the private sector.

Processing

In spite of its economic weakness, Sub-Saharan Africa is now developing small-scale, low cost cassava processing technologies that enable farmers produce high quality cassava-based staple foods. These technologies allow farmers add value to a perceived "famine reserve crop" by producing a higher quality product, allowing them expand sales in their existing markets and the creation of new market opportunities. Conversely, in Asia and Latin America, the industry employ state of the art processing technologies for their industrial production of starch, ethanol, cassava flour and animal feed (cassava pellets). These regions have also developed a viable subcontract processing market where large farms employ smaller firms normally at the farm gate level, to provide them with intermediary products like cassava chips.

Utilization (Markets)

Global consumption of cassava has changed since 1961. Its use as food is its dominant market in Africa and Asia where its consumption has doubled and increased by 70% in these countries respectively. In Latin America where consumption is its second most important market, the consumption rate has increased by 50%.

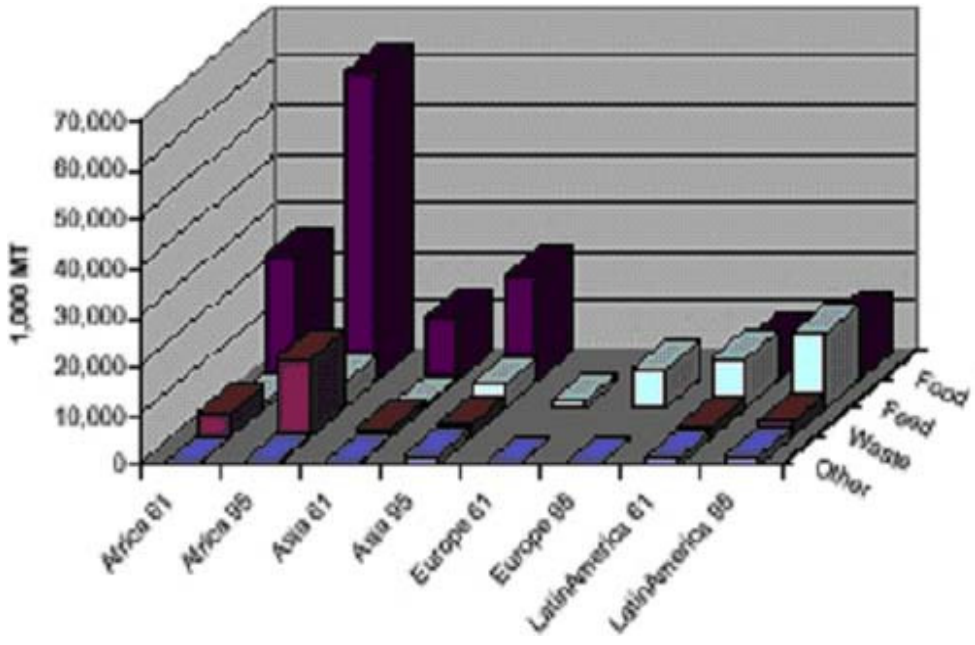


Figure 1. Regional consumption of Cassava 1961 and 1995(tonnes)-FAO, 1999.

More recently, the traditional use of cassava is changing from primarily human consumption to processing industrialized products. In Asia, cassava is a diversified fully commercial crop. Here, its roots are converted into an array of products - human food from the roots, and starch, flour, ethanol and animal feed for industry. In Latin America and the Caribbean, traditional processing and markets have now been dominated by industrial processing. In Brazil for example, starch and ethanol production from cassava is on the increase. Europe, Latin America and Asia have seen the most cassava consumption increase using animal feed for their industries. Africa however continues to lag behind with 90% of its cassava still being consumed as human food.

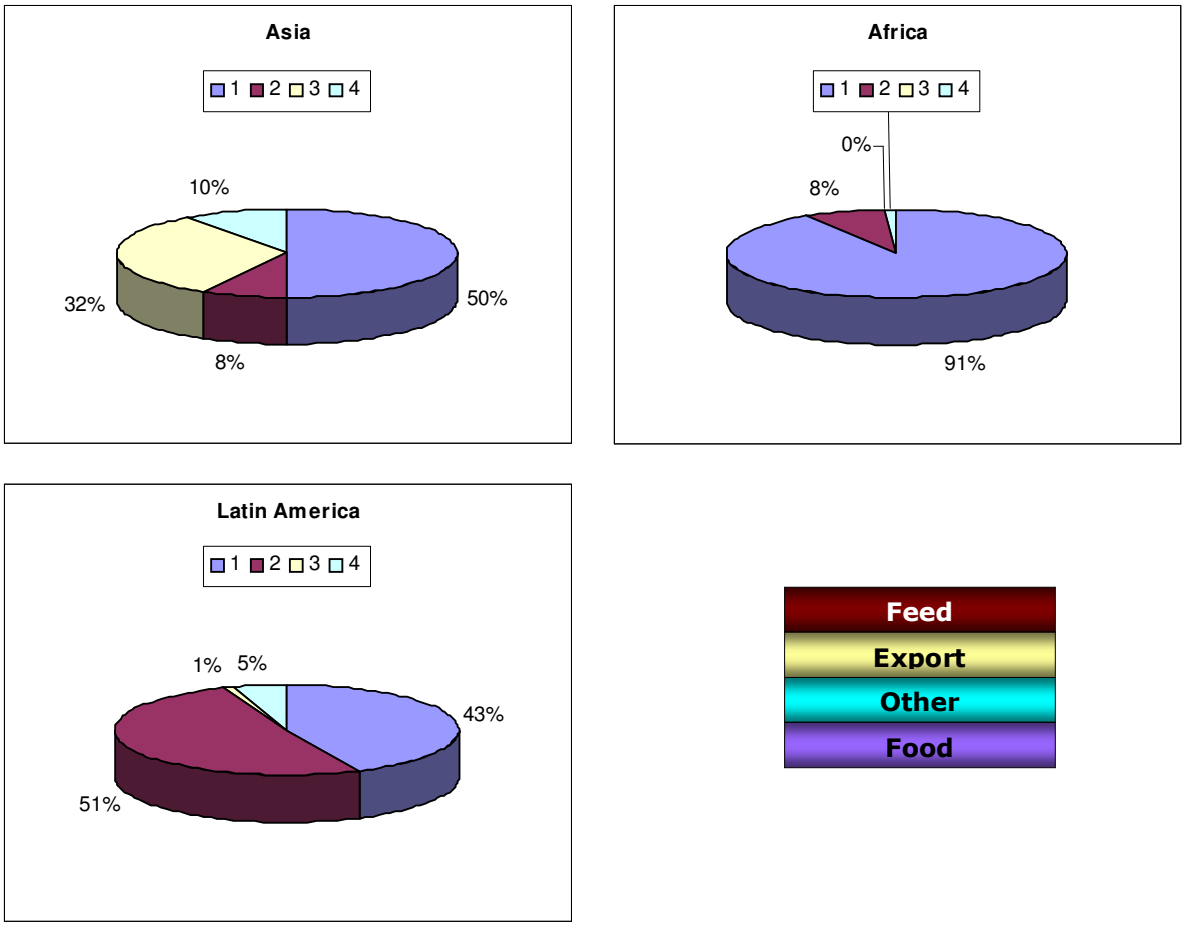


Figure 2. Percentage of Cassava Utilization in Africa, Asia and Latin America

Domestic, regional an global industrial cassava trade is divided into 4 main sub sectors – Ethanol, Starch, Flour and Chips/Pellets. The use of cassava as a raw material for Ethanol production, a more environmentally friendly fuel, is expected to rise with the growing concerns on the future of fossil fuels and their ensuing environmental effects as stated in the 2000 Kyoto Agreement. Therefore member countries to the Kyoto agreement are either producing or using more ethanol or are providing incentives to their industrial ethanol production for its use as fuel.

The world trade in pellets has long been dominated by Thailand, beginning around 1967, a few years after the start of its cassava exports to the European Union (EU). Although Thailand lost her privileged entry to the EU in the 90s, it still exports cassava chips and pellets to other Asian countries, especially China, where pellets are used both for animal feed and for the production of ethanol.

The production and trade in cassava starch has significantly increased in recent years. Cassava starch has product characteristics that are technically superior to those of corn (maize) starch and this sub-sector promises to be a viable new market segment for industrial cassava. Already, in order to meet the global starch demand, large companies specializing in the production of starch and modified starch have invested hugely in Thailand, Brazil and Indonesia.

Cassava flour is widely consumed in Brazil and in most of Latin America as *farinha*, with various levels of sophistication in its processing - from primitive family to large mechanized methods in factories'. A potentially more dynamic market for cassava flour however is in its use as High Quality Cassava Flour (HQCF), a partial (10%) substitution for wheat in bakery products.

1.3. Outlook of Cassava Products in the Global Market

1.3.1 Global Production and Trade

1.3.1.1. Global Production

Prospects for world cassava production are favourable and likely to remain around the 2003 record of 192 million tonnes (FAO, 2004). Preliminary crop estimates from some of the larger producing countries in Africa, the major producing region, point to satisfactory production levels close to the 2003 level of 103 million tonnes. In Angola, the 2004 cassava output is forecast to rise 16% from last year following good weather and increased farming land in the growing season. In the western parts of Zambia, flooding problems may have hindered cassava cultivation but overall production prospects remain satisfactory. The outlook is also generally favourable in Tanzania where the Government announced plans to increase its cassava cultivation in order to export more starch and flour.

Ongoing Food and Agriculture Organisation (FAO) initiatives to distribute fast-growing and disease-resistant cuttings in Rwanda and in the Central African Republic are likely to soon result in increase in output. In Nigeria, a consortium of international agencies supports her commercial cassava programme to the tune of US$11 million. Similarly, production in Ghana and Uganda is expected to rise, following large-scale investment in cassava infrastructure, particularly at the processing level. This combination of governmental promotion of cassava cultivation and the

backing of the international organizations is spurring the expansion of the cassava industry in Africa.

In Asia especially Thailand and Indonesia, which last year accounted for much of the increase in global cassava output, production is expected to rise further largely due to high domestic and export prices. The production outlook for Latin America and the Caribbean is also favourable thanks to good prospects in Brazil. Following a 50% increase in the cassava support price, Brazil's output was forecasted to increase 8% to 23.9 million tonnes in 2005.

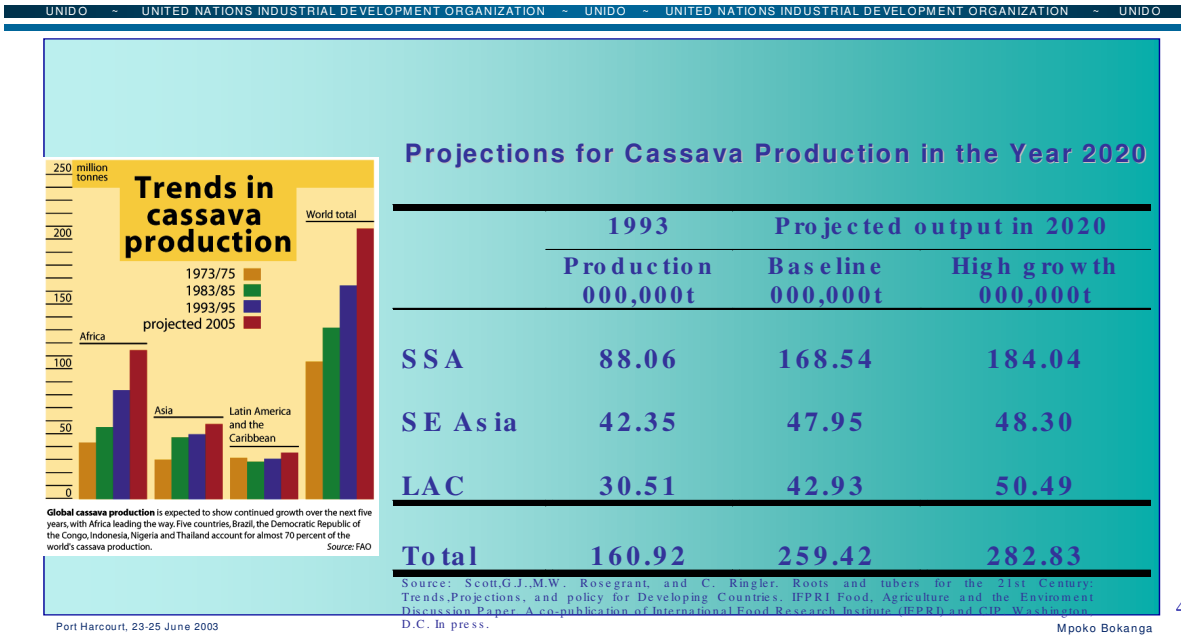


Figure 3: Global Cassava Production.

1.3.1.2. Global Trade in Cassava

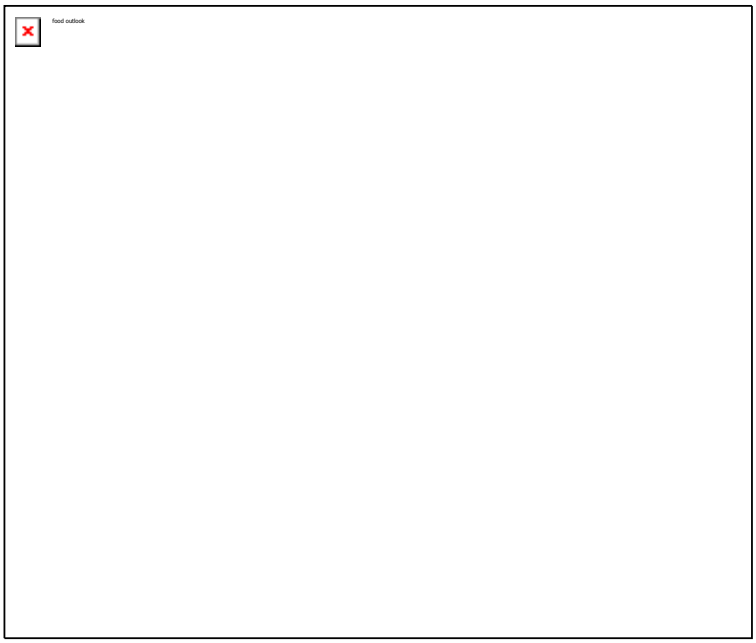
International trade in aggregate dry cassava products (also called tapioca) is currently estimated at 8.4 million metric tonnes (MT), with Thailand and Indonesia as the major cassava exporters, exporting mainly cassava chips, cassava pellets, cassava starch, and flour. The amount of cassava products exported from Africa is negligible despite Nigeria being the largest cassava producer. Africa and Latin America export only on average 400,000T, with Nigeria hardly featuring in this global trade and its first batch of cassava chips exported to China in 2005 was at a loss.

Although Thailand is the world's largest exporter of tapioca with 80% of the total world exports, it is only the third largest tapioca producer behind Nigeria and Brazil. It is noteworthy that Thailand's production has fallen slightly as many farmers switched to other kinds of crops. Cassava production on the other hand, has been increasing in the past 5 years.

	2001	2002	2003
			(Million Tonnes)
World Exports	6.1	4.7	5.9
Thailand	5.8	4.4	5.6
Indonesia	0.1	0.1	0.1
Others	0.2	0.2	0.2
World Imports	6.1	4.7	5.9
EU (15)	2.6	1.5	2.0
China	2.6	2.1	2.5
Indonesia	0.1	0.1	0.3
Japan	0.4	0.3	0.3
Korea. Rep. of	0.2	0.1	0.1
Malaysia	0.1	0.1	0.1
United States	0.1	0.1	0.0
Others	0.4	0.4	0.5

Table 1.2: World Cassava Trade up to 2004

1.3.1.3. International Prices for Cassava Products



According to the graph above, prices for pellets exported to the EU in 2004 were 36% higher than in 2003, while chips to the Far East were 5% up. Prices of flour and starch, although down from the corresponding period last year, have risen by 10% in the past 6 months.

With an anticipated slowdown in EU imports, the outlook for cassava prices in the remainder of the year, will largely hinge on the Far East, particularly China, maintaining large international purchases. The current forecast is that China's domestic grain store will decline; creating its increased imports of non-grain feed such as cassava.

1.4. The Global Market Trend

The international market for cassava products began to develop in the 1950s, with the export of by-products from the cassava flour milling industry by Thailand to the European Community (EC) market. Half a century later, EU was still the main destination, and Thailand the main distributor. In recent times however, new cassava market opportunities have developed, especially in Asia, with cassava products used as functional intermediate products, especially cassava starch. However, Thailand continues to be the principal cassava supplier, with over 80% market share.
International trade in cassava is a rapidly growing industry. Trade volumes between 1995 and 2005 have increased by about 36%. A conservative projection of the cassava trade for the year 2015 at a 40% growth rate is 11.76 million MT.

1.4.1 Predictions and Demands in the Present Decade for the Cassava Sector

Predictions on the global demand for cassava based products in the next decade are based on three key factors: 1) that cassava remains competitive with corn in Asia and Brazil as a source of raw material for processed products especially starch; 2) the possibility of policy developments in the EU opening up wider European markets for cassava based derivatives which will kick start production in Africa and 3) that cassava root yields grow at a rate that at least compensates for increases in real agricultural wages in producing countries, as well as any increases in the profitability of alternative crops. These issues are discussed below

1. ***Cost Competitiveness with Corn in Asia and Future Growth***: The main East Asian consuming countries (Japan, Taiwan, South Korea and China) import corn from the world market for their domestic starch industries. China, which is one of the world's leading producers of corn is expected to become a net importer of corn in the near future. Secondly, the Asian region lacks plentiful supply of carbohydrate raw materials and it is the only region to have a very well established supply of cassava dedicated mainly to industrial processing, supplied largely from South East Asia. While the special properties of cassava starch are recognized in demand countries of Asia, cassava starch is imported as a bulk commodity in competition with corn for starch processing. The future of cassava starch in Asia therefore depends critically on its ability to remain competitive with corn as a source of starch. This in turn, depends on the level of profitability of the crops that compete with cassava in the main cassava producing regions in Asia. Rubber in particular seems to pose a major threat to cassava area especially in Thailand.

2. ***The Role of Policy in creating Growth in the West:*** In the EU and the US, and to a lesser extent Brazil, it is the functional advantages of tuber starches that have given cassava and potato starches an elevated position in the modified starch market. However, the widespread availability of very cheap corn in the US makes it hard to imagine tuber starches ever securing more than a small but profitable niche. In Brazil, cassava starch has gained ground when root prices are low, but has lost market share when root prices are high. In the EU, potato starch has benefited from considerable institutional support. As a result, it has gained a loyal customer base among paper and food producers. However, the future of the EU potato starch regime hangs in the balance, because the EU is currently undertaking a wide-ranging reform of its agricultural policies. This could result in a significant decline in potato starch production and could open up the EU to greater imports of cassava starch. Finally, the EU has recently established the Everything But Arms (EBA) trade initiative that allows for duty free imports from 50 of the world's poorest countries. It is In the process of negotiating a series of Economic Partnership Agreements (EPA) with former African, Caribbean and Pacific (ACP) countries. Important East and West African producers of cassava such as Ghana, Mozambique, Nigeria, Tanzania and Uganda as well as Asian countries like Cambodia are the beneficiaries of these new trade preferences. This raises the possibility that Nigeria could emerge as an important supplier of cassava starch to the EU.

3. ***Export Oriented Growth Potential For Cassava in Africa:*** Africa is the world's leading producer of cassava roots. It is also the region that undertakes the least processing of cassava roots into starch. In Africa, cassava is an important food security crop for millions of people. However, cassava yields vary greatly between and within countries but are generally low and yields have remained stagnant over several years. Despite this careful analysis reveals that there are interesting opportunities for producing

cassava starch in particular within Africa. However, because domestic markets for starch is small, it is likely that the main impetus to the growth of cassava starch production in Africa will be policy reform in the EU. However, for African cassava producing countries to stay in competition in the global market it must reduce its cassava production cost significantly to below the international benchmark cost of $35 per ton of output using a combination of mechanization, use of improved high yield varieties in commercial farms and low farm labor costs. This is the single most important challenge for cassava development in Africa and Nigeria in particular.

Market and Product Demand: Three basic cassava based products are traded internationally. These are cassava chips/pellets, starch, and ethanol. The world market and product demand are discussed below for each commodity.

Pellets: Figure 4 below shows the development of hard cassava pellet export price based on data from Bangkok. The price of cassava pellet fell by about 49% between 1990 and 1999 from US$141 to US$72 per MT. This price slump has been dramatic in the last decade. In 2000, cassava pellet prices fell as low as US$52 and rose slightly to US$62 in 2003. The 1990 to 2003 prices have fallen from a high of US$141 to US$62 per MT. China in the last year, due to its high demand, replaced the EU as the most important consumer of internationally traded cassava pellets.

Presently, the use of cassava as animal feed - in the form of dried chips and pellets - is concentrated in Latin America, the Caribbean, China and the EU. However, China's domestic grain decline could further stimulate the growth of non-grain feed imports such as cassava. The 2003 figures of 54.5 million tonnes usage were 4% higher than the previous year. This increase reflected developments in the EU, in China and other Asian countries, notably Viet Nam and Malaysia, where dwindling livestock feed grain supplies and the consequent price hike, fostered a substitute trade in cassava. In 2003, EU imports increased by 32% to around 2 million tonnes, reflecting the increased competitiveness of cassava feed products compared to domestically produced grains.

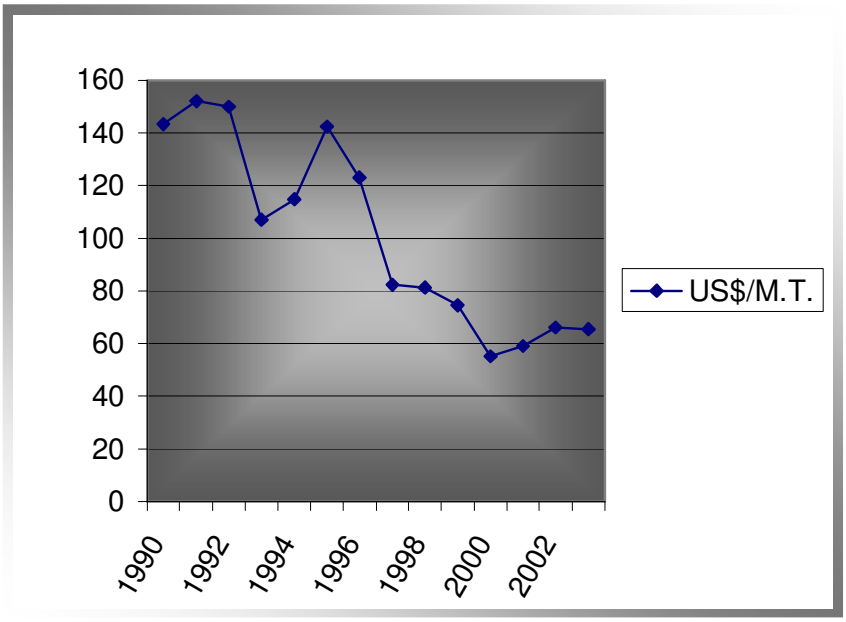


Figure 4. Export Price Trends for Hard Cassava Pellets (Bangkok).

Starch: The world starch production is about 60 million tonnes and its consumption trend is expected to be 70 million tonnes by 2007 (Vilpoux, 2005). The largest producer is United States with 25.2 million tonnes, the Asian countries at 19.8 million tonnes, Europe with 12.2 million tonnes, Latin America with 1.8 million and Brazil with 1.0 million tonnes respectively. The major raw materials used in starch production are corn, 75%, sweet potato, 13% and lastly, cassava at 12%.

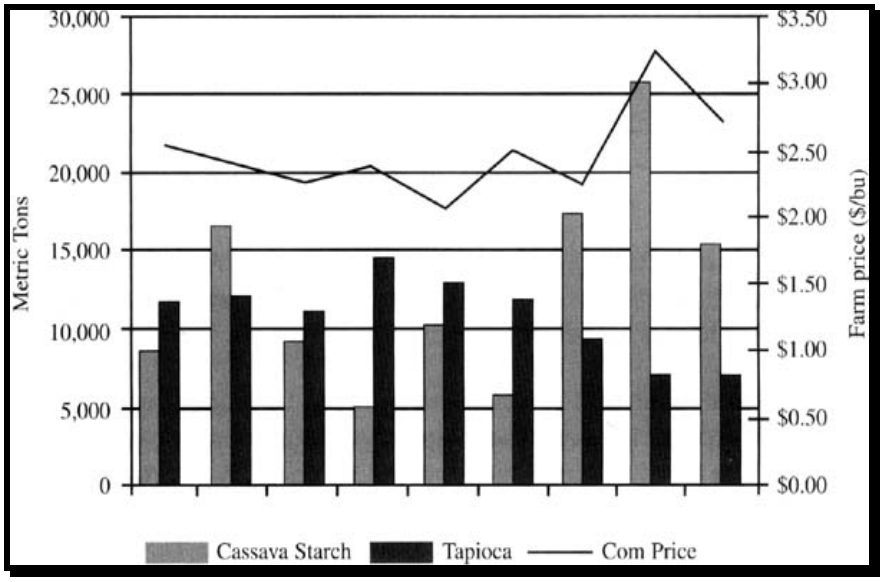
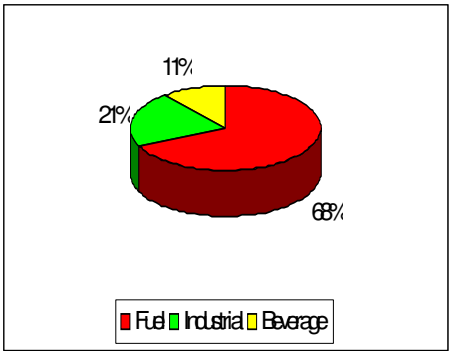


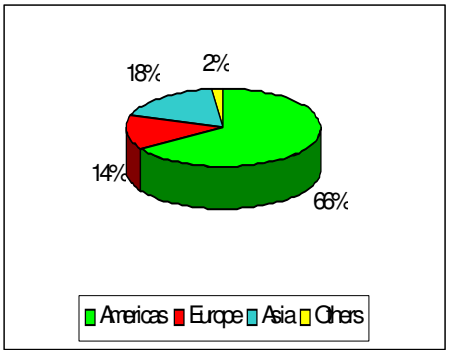
Figure 5- Relationship between Corn Prices and Starch Imports

The current statistics show that maize is still supplying as much as 75% of the global starch market, with cassava starch contributing about 12%. On the international market, cassava starch is able to compete against corn, wheat and potatoes starches. Cassava starch is especially competitive outside the two main markets, US and EU (i.e. in South East Asia). The overall world demand for all starch products grows at an annual rate of 4%. It is expected that this significant growth in demand will continue in the next decade.

A high level of protection characterizes the starch market, as many users protect their local starch industries. Tariffs on cassava starch in the main importer countries range from 0% in Canada, Malaysia, Indonesia and the United States to 480% in the Republic of Korea. In the main markets, starch is imported under preferential access conditions. Japan for instance, has established an overall 200,000 tonnes tariff quota on native starch from maize, potato and cassava, beginning with a 25% duty and reducing it to 15% in 2000.

Ethanol: World ethanol production used primarily for beverage,





industrial and fuel, reached an estimated 32-35 billion liters in 2000.

Fig 6: % Global Ethanol utilized as Fuel ***Fig 7: % Ethanol utilized for fuel by Region***

Ethanol as a clean fuel has been recognized for decades and has clear environmental benefits when blended with gasoline, but was relegated to 2nd position behind the petroleum-based competition. The new product, E10, a blend of 10% ethanol and 90% gasoline, dilutes highly toxic compounds in gasoline, such as benzene and toluene. A life-cycle analysis conducted in 1999 by the Argonne National Laboratory estimated that each gallon of 10% ethanol blended with gasoline cuts greenhouse gas emissions by up to 19 percent%, with higher blends yielding greater benefits.

To date, one of the most impressive renewable energy initiatives undertaken anywhere in the world is Brazil's ethanol programme. The country is the largest ethanol producer in the world, with a figure of 11.9 billion liters in 2001. (The US is second, producing an estimated 2.7 billion gallons in 2003, up 21% from the previous year using mostly cornstarch (http://www.eesi.org/)). Small quantities of blended ethanol are currently used in other developing countries like South Africa, Ethiopia and Malawi. With the growing market for alcohol in Australia, Japan, China, India and other countries, and the recent volatility in the oil market, Brazilian alcohol production is likely to be boosted in the immediacy.

China has initiated a corn-to-ethanol project, with the intention of introducing ethanol-gasoline fuel blends. Current production in the province of Jilin alone is about 0.4 billion litres, and total production throughout China may reach 1.2 billion liters in 2005. The Government of Thailand has meanwhile introduced ethanol production based on cassava and cane molasses, which it will also use for ethanol-gasoline blends. In India, the Government is setting up pilot projects to study the use of such blends as transport fuel, with initial trial of a blend made using 5% ethanol, derived from sugar cane molasses.

Demand for ethanol is growing. Nigeria, Ghana and Cote D'Ivoire respectively import more than 80, 8 and 8 Million liters per annum. The Nigerian Government is poised to start the implementation of the E10 policy on ethanol in 2007, developing the ethanol production from cassava and sugar cane.

Food: Global cassava production as food was estimated at 103 million tonnes in 2003, approximately 2 million tonnes more than in 2002. Increase in the population in Africa and Latin America, alongside improved processing, quality, packaging and food safety practices is expected to spur increase in the demand for cassava as a food source.

1.4.2. Cassava Imports

Global imports of cassava is dominated by Europe, China and South Korea accounting for more than 90% of total trade in dried cassava and China and Japan import two thirds of the globally traded cassava starch. In recent years, China has become the single most important market for cassava derivative imports in the world.

Asia is indisputably the world leader in cassava derivatives trade. In fact with respect to dried cassava, Asian regional flows make the most of global exchanges with the exception of Europe (which however is

getting smaller). Competing openly for these import markets with giants like Thailand or emerging Vietnem seems very daring but feasible for Nigeria.

Figure 12 indicates the trends in Cassava imports between the EU and China.

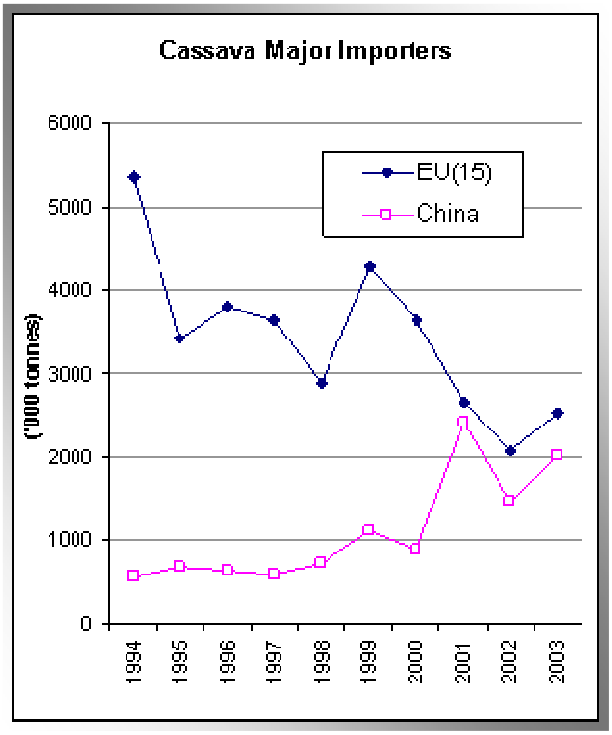


Figure 8: Trends in Global Cassava Imports.

1.5. Processing Technologies

Development agencies in Africa have generated a range of low cost, crop and cassava processing technologies to meet the needs of small-scale farmers and entrepreneurs. With the support of the International Institute of Tropical Agriculture (IITA), cassava drying processing technologies that enable farmers to produce high quality flours from cassava have been developed. The cassava processing technology (namely the grater), which was first introduced into Nigeria, is now being actively promoted in East and Southern Africa. Increased research in cassava processing technologies in Latin America, Asia and Africa is expected to significantly improve the processing technologies currently available for small- scale processes while state of the art technologies exist for large-scale production of starch, ethanol, flour and pellets.

However, several principles should guide the acquisition of cassava processing equipments for SME scale processing. Apart from efficiency due consideration should be given to the technical details of machinery that are imported or sourced locally for cassava agribusiness enterprises. Machinery should be sourced from reputable organizations from within and outside Nigeria with a history, it is also necessary to consider technical details like overall yield, water use efficiency, power consumption, labor requirements, degree of automation, price and size of the plant. For instance any plant sourced for starch, ethanol, of flour

should be able to yield nothing less than 25% starch, 30% flour and 400 liters ethanol per ton of flour. Plants with low water use efficiency are preferred because this means less effluent to manage. Preferred power consumption should be low especially in terms of electricity, diesel or gas given the limitations from public electricity supply in Nigeria and the rising cost of energy. The less labor required the more the degree of automation. Therefore as a matter of policy (given the bourgeoning youth population that are predominantly unemployed) equipments that can employ more personnel should be preferred to that which employs less. Low cost equipment should be sourced and many such types of equipment also exist in Nigeria. Finally, the scale of the processing plant is important. Large scale mega plants are not recommended Instead preferred installed capacity of plants for the respective products should be less than 120 tons fresh root/day for starch plants, less than 8 ton per day dry product for cassava flour and less than 10,000liters per day for ethanol. Other wise it will become difficult to meet supply requirements within the production context for Nigerian commercial farmers (Ezedinma 2005).

PART TWO:

CHAPTERS TWO AND THREE

The Present Situation of the Nigerian Cassava Sector

Chapter 2: The Nigerian Cassava Production System

The Nigerian cassava system, characterized by small-scale farmers/holdings cultivating less than 2 hectares of cassava (average of 0.5 ha), is subsistent in nature, primarily cultivated for the traditional food market, is subsistence in nature and not oriented to the industrial market. Any surplus cassava is either processed on the farm, or sold to local processors. The average production figures per hectare in Nigeria were 10.5 MT/Ha in the early 1970s, 11.5 MT/Ha in the 1980s, 10.5 MT/Ha by the end of 1980s, and 11.5 MT/Ha in the 1990s and up to 17.3 MT/Ha in Ondo in 2004 (Table 2.1).

State	Annual HA planted (x1000)	Annual MT produced (x1000)	Mean yield (MT/HA)	Rank
	1	2	3	
Benue	261.1	3551	13.6	1
Kogi	184	2605	14.2	2
Enugu	186.5	2085	11.2	3
Imo	156.5	2052	13.1	4
Cross River	177.5	1958	11	5
Kaduna	206	1835	8.9	6
Rivers	167.5	1735	10.4	7
Ondo	73.2	1267	17.3	8
Ogun	75.7	1178	15.6	9
Oyo	121	1019	8.4	10
Osun	66	915	13.9	11
Akwa-Ibom	117.8	893	7.6	12
Delta	70	811	11.6	13
Ekiti	41.2	651	15.8	14
Anambra	53	627	11.8	15
Edo	45	545	12.1	16
Niger	73.5	535	7.3	17
Bayelsa	30	459	15.3	18
Ebonyi	29	435	15	19
Kwara	30	425	14.2	20
Plateau	26.9	345	12.8	21
Lagos	25.1	300	12	22
Abia	15.7	265	16.9	23
Nasarawa	25	248	9.9	24
Taraba	12	111	9.3	25

Table 2.1: Cassava Production Area and Yield by States in Nigeria.

Source: PCU Abuja 2002; ICP-IITA Ibadan, 2004

The FGN has commissioned various opportunities for the industrial development of cassava in Nigeria. Presently, the Federal Government of Nigeria supports the development of cassava varieties that are

resistant to the virulent Ugandan strain that currently threatens to devastate Nigerian production. The project coordinated by the International Institute of Tropical Agriculture (IITA), National Root Crops Research Institute (NRCRI), Root and Tuber Expansion Program (RTEP) and other stakeholders, led to the release of five new cassava varieties in September 2005 by the National Release Committee under the Federal Ministry of Agriculture. These released varieties - 98/0505, TME 419, 97/2205, 98/0581, 98/0510 - with quality attributes like yields greater than 25 T/HA, dry matter greater than 30% and mosaic disease resistant can satisfy the food, industrial and livestock demands. The United States Agency for International Development (USAID) and the Shell Petroleum Development Corporation (SPDC) also support the Presidential Initiative under a Global Development Alliance.

2.1. The Nigerian Cassava Belt-Potential

IITA's data shows that the north central zone (Benue, Nasarawa, Plateau, Niger, Kogi, Taraba, and Kwara States) produces the largest quantity (about 29%) of cassava in Nigeria (Figure 13), thanks to their longer sunshine months and a mono-modal rainfall pattern (better than the southern States), making the north-central zone the best area to source cassava used for livestock feed and to locate pilot plants for cassava chips or pellets. The southern area of Kaduna State and the northern parts of Oyo, Ekiti, Ondo, Enugu, Ebonyi, Edo, and Cross Rivers States are also conducive for cassava chips production(Azogu et al, 2005).

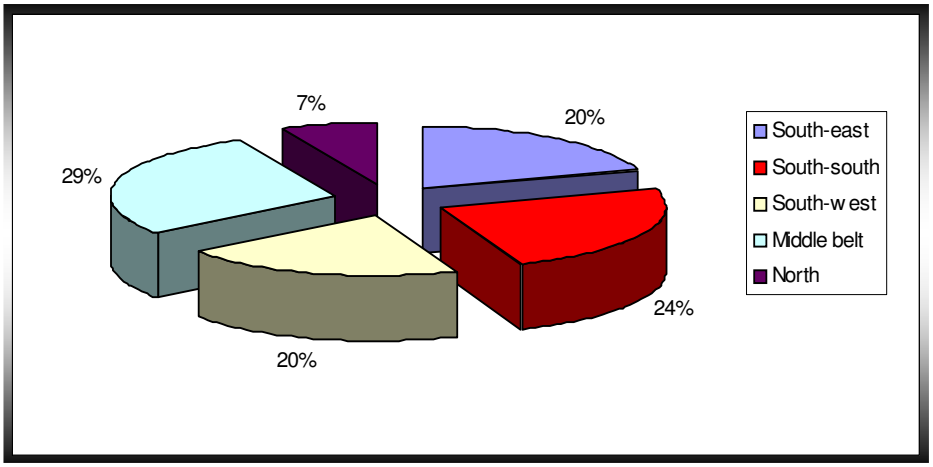
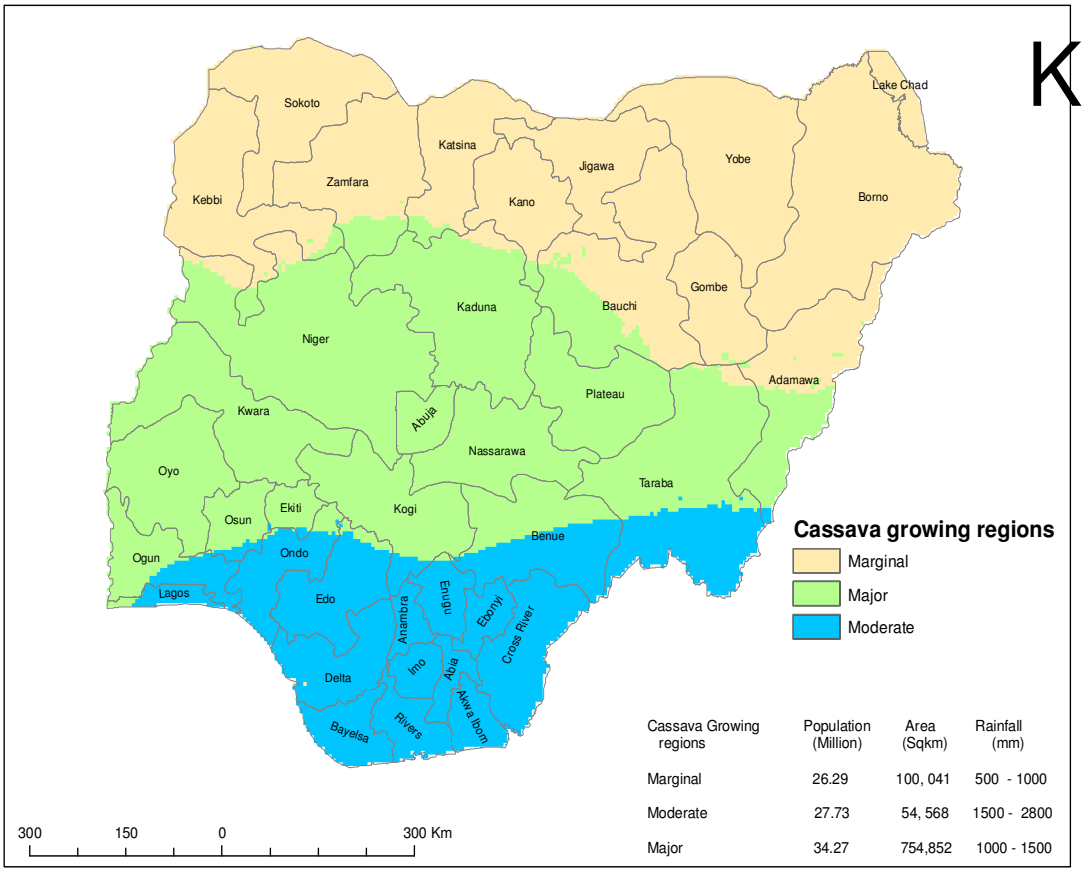


Figure 9: Relative Production of Cassava per region (in percentages of total production)
Source: IITA



Cassava Growing regions	Population (Million)	Area (Sqkm)	Rainfall (mm)
Marginal	26.29	100, 041	500 - 1000
Moderate	27.73	54, 568	1500 - 2800
Major	34.27	754,852	1000 - 1500

Figure 14: Nigerian Cassava Growing Belt -Source: IITA

2.2. The Concept of a "System Approach"

The Systems Approach examines the internal linkages, i.e. interactions between the industrial and social economic components of the system as well as those between the system and the external environment. It provides an integrated view of the behaviour of the system and is useful in the formulation of policies. A first step in any Systems Analysis is the identification of the major market actors that interact with each other in commercial transactions. Another step involves the identification and analysis of the institutions and organizations, role players and stakeholders in the development of the Nigerian cassava sector.

Key players	Function	Current status
1.Consumers of products fabricated using cassava based ingredients	**Final market** -Determine market dynamics for the final product fabricated with cassava ingredients. -Determine product standards, pricing. -Create demand.	-Demand is currently being satisfied by imports.
2.Primary consumers are mainly textiles, Pharmaceuticals, plywood, paper, glue and adhesives, bakeries, petroleum and animal feed processing industries	**Provide direct Market for cassava ingredients** -Create demand for cassava based products. -Establish market Quality. -Determine pricing.	-Some Industries exists. -Demand is being met by imports. -High product quality standards. -High volumes needed.
3. Secondary cassava processors - (Industrial medium sized and large-scale processors) – - Processors of ethanol, starch and flour and pellets.	**Primary market for intermediate cassava products (mainly chips)** -Determine, quality, pricing and volume of intermediary products.	-Few uncoordinated, inefficient and uncompetitive. -High volume demand of industrial raw material. -Low ability to supply market demand.
4.Primary cassava processors, producing mainly chips, but also flour, crude ethanol, and starch from cassava roots	**Primary market for tubers** -Determine quantity of tubers that can be processed daily and the price of tubers.	-Numerous, scattered uncompetitive and inefficient. -Low supply capacities.
5. Farmers -Small –scale and Mechanized farmers.	**Supply of raw material** -Determine quality and quantity of cassava supplied to the industries. -Determine farm gate pricing.	-Small scale, labour intensive and subsistence in nature. -High production costs. -Low supply capacities. - Limited Commercial farmers
6. Input suppliers	**Supply of seeds, fertilizers and pesticides.** -Determine quality and yield at farm level.	-Low supply. -High prices.
7. Equipment suppliers	**Fabrication and supply of farm and processing equipment.** ---Determine affordability, efficiency and durability of equipment.	-Low efficiency. -Expensive when imported. -Lack of standardization. -Repair and maintenance problematic.
8.Professional associations	**Contribute to innovations in the sector.**	-Low research output. -Low dissemination of research outputs.
9. Distributors	**Storage and distribution of intermediate and final product of inputs equipment etc.**	-Made expensive by poor infrastructure.
10. Government	**Create an enabling business environment.**	-Poor Infrastructure, (road, rail, water networks). -Poor provision of utilities. -Cost of utilities high. -Existing policies that favour cassava production not effectively implemented.
11. Finance institutions	**Provide investment Credit**	-Credit unaffordable. -Difficult to access credit.

Table 2.2: Main Actors Along the Nigerian Cassava Value Chain

2.3. Vision - Strategies

The Cassava Expert Group Meeting organized by The African Agricultural Technology Foundation (AATF)/IITA, Nigeria in Nov 2005, developed guiding visions and strategies for the industrialization of cassava in Nigeria, and Africa in general. These include:

- The promotion of a multi-sectoral development plan for cassava to provide increased food security, contribute to poverty eradication and economic growth in Africa;

- Exploit the great potential of cassava as a raw material for the production of a range of high value food, feed and industrial products;

- Develop a strategic framework for mobilizing resources and formulating policies that will sustain the drive towards the development of various industries that will use cassava as raw material and stimulate export of high quality cassava products.

In summary, the vision behind the Nigerian Cassava Action Plan consists of building an efficient and competitive domestic-regional-international market for industrial cassava products. This strategy will be driven by domestic demand on a short term, regional market on a medium term and international market on the long term. This may not be the case for all cassava products as simultaneous actions may take place by cassava investors and markets across levels. For example the starch industry could focus on the export market in the short run.

2.3.1 Policies

Concerned about its singular dependence on a mono product (oil) for its foreign exchange, since her independence in 1960 the Nigerian Government has made several forays at policies for the development of its agricultural and business sector. Various government policies on agricultural development have been developed and more recently, geared towards the cassava sub-sector, in particular, the Presidential Initiative on Cassava launched in July 2003. The objective of the Cassava Initiative is the expansion of production and use of cassava to satisfy domestic demand and also as foreign exchange through its products' export. Existing and new policies aimed at supporting investment and market in the cassava industry include:

- **Policy on national strategic food reserve**. The Food Reserve policy is aimed at ensuring food security, guaranteeing food and industrial raw materials and providing employment opportunities for the rural labor force. *"Gari",* the most produced and traded cassava product, has recently been added to the list of products. This should stimulate the *gari* production industry, creating more cassava plantation, essential for the growth of the overall cassava industry.

- **Policy on Pioneer Status Investment Incentives:** Companies can obtain Pioneer Status in several ways: if

they produce products declared 'pioneer products' under the Industrial Development (Income Tax Relief) Act No. 22 of 1971 as amended in 1998; if the NIPC has declared it a deserving enterprise; of if the company locates in an 'economically disadvantaged' area. The Pioneer Status provides a five-year tax holiday to qualified investors, with a two-year extension for those located in economically disadvantaged areas. These areas are defined in the Nigerian Investment Promotion Council's (NIPC) guide to investment incentives in Nigeria (NIPC, Investors Guide to Nigeria 1998). However, it must be noted that pioneer status is not automatic and must be applied for and even with a pioneer status such companies must report taxes to the Federal Inland Revenue Service (FIRS) but the tax is not taken from the company.

- **Policies on Export Incentives for non oil sector:** These include (a) a 10% tax concession for 5 years for industries exporting no less than 60% of their products, (b) retention of export proceeds in foreign currency, (c) Export Development Fund (EDF), that provides financial assistance to private sector exporting companies, (d) Export Grant Fund Scheme (EEGF): provides cash inducement for exporters that have exported a minimum of N50,000 worth of semi manufactured products, (e) Duty Drawback/Suspension and Manufacture-in-Bond Scheme, (f) Export Adjustment Fund Scheme provides supplementary export subsidy to compensate exporters for the high cost of local production arising mainly from infrastructure deficiencies, and other negative factors beyond the control of the exporter; (g) Nigeria Export/Import (NEXIM) Bank Foreign Exchange facilities and (h) Capital Assets Depreciation Allowance which is an annual allowance of 5% on plants and machinery to manufacturing exporters who export at least 50% of their annual turnover provided that the product has at least 40% local materials content or 35% value added. All these incentives are also applicable to cassava-based industries (e.g. starch or ethanol) that produce for export purposes.

- **Policy on the provision of credit loans for agriculture producers** through specialized banks like the NACRDB.

- **Policy on mandatory substitution of 10% wheat flour with high quality cassava flour** in the baking industry. This policy will ensure increased production of cassava flour.

- **Policy on provision of gainful employment** for the country's population. The present government of Nigeria strongly supports a growth-oriented economy with the capacity to create jobs.

- **Policy on blending of 10% Ethanol in fuel**. The Nigerian government as part of its commitment to the 2000 Kyoto Agreement has decided to implement a policy of blending fuel with 10% Ethanol. Ethanol's blended

fuels will lower the emission of carbon dioxide in the earth atmosphere.

The above listed government policies, are not exhaustive. For a comprehensive assessment of the Nigerian policy environment for private sector investment we strongly recommend the 254 paged document titled The Nigeria Investors Roadmap and Enabling Environment Strategy prepared for the Government of Nigeria in 2002 under USAID funding.

2.3.2. Inputs

The Cassava Value Chain is supported by various inputs/resources. These include planting material, land, finance and access to information.

2.3.2.1. Inputs and Resources

Raw Materials. Because of the Research and Development (R&D) work by IITA and National Root Crop Research Institute (NRCRI) scientists, Nigeria has the advantage of improved, high-yielding disease-resistant varieties. The challenge is to multiply these varieties and to make them available to farmers who supply the cassava processors. The average starch percentage for Nigerian cassava varieties is about 20%. The IITA varieties average around 25%. However, selected farmers in Brazil have the competitive advantage of varieties with 30% starch. To compete effectively, Nigerian research institutions should aim to develop higher starch varieties immediately. Another critical input is fertilizers. With subsidized fertilizers provided through the Agricultural Development Programmes (ADPs), its availability is limited and unpredictable. Private sector agents provide additional fertilizers at free market prices, but are unwilling to store large amounts, which they might not sell, thanks to the uncertainty about the quantity of subsidized fertilizer that may become available.

Human Resource Development (HRD) Labour force and training: Even though Nigeria has more than 45 Universities and a similar number of higher educational institutions (polytechnics, colleges of agriculture and education, etc) the content and depth of training in available such institutions are not considered adequate to transform current small scale orientation in cassava farming to the large scale production systems. There is a dearth of skilled manpower in the technical and managerial aspects of large-scale farming and post harvest processing.

Physical Infrastructure – the local, state and federal government supplies these. Their state of disrepair contributes to high transportation costs, making the cassava products uncompetitive. Additionally, poor information dissemination across value/supply chain prevents decision makers' direct access to market partners, support institutions, price sources and technical information.

Utility costs- Electric power supply is unreliable and inconsistent. Processing industries pay high-energy costs

through the use of expensively run generators. Furthermore, the constant switching from public power supply to generators damages equipment and lowers productivity.

Legal - Under the present Land Use Act, it is easier for foreigners to lease land than the Nigerian investor. The processing industry must ensure a constant supply of raw materials. This can be achieved if plant owners can have or lease large tracts of land over relatively long term periods (10 – 15 years) for their mechanized large-scale farming. The challenge with the Land Use Act is to delineate agricultural land as separate from other land uses as it has been done in other countries; and to provide such agricultural land on a tradable basis backed with the legal capacity to represent its value in the market without necessarily depriving the original owners of their long standing usufruct rights similar in line with the recommendations of de Soto (2000).

Finance - The majority of cassava farmers and processors live in areas that are resource-poor, highly heterogeneous and risk prone. Consequently, conventional financial institutions are not inclined to provide loans to these without collateral. In order to support poor smallholder farmers, in 1989 the Federal Government introduced a policy to liberalize their access to credit. The measures included the recapitalisation and consolidation of commercial banks as a matter of policy, the establishment of micro finance institutions and community banks, and the reforms in the National Agricultural Credit and Rural Development Bank (NACRDB), and the Bank of Industry (BOI). Several other financial incentives and initiatives are also under consideration by the Central Bank of Nigeria.

Investment Climate - The investment climate in Nigeria is gradually improving with the advent of political dispensation. The success stories from the communication industry, growing stock market, and the capitalization of Banks by CBN are positive indicators for investment. Specifically, the government programs on State Economic Empowerment and Development Strategies (SEEDs) and National Economic Empowerment and Development Strategy (NEEDs), and special programmes and commitment, have helped the investment culture of the country. The Cassava industry sub-sectors have been the most promoted by the Presidency, NGOs, and development Agencies in Nigeria and in Sub-Saharan Africa (NEPAD). The most pursued Nigerian Government Initiative in the cassava sub-sector are the 10% inclusion of cassava flour in composite flours and 10% ethanol in the petroleum industry. These policies are positive but their implementation is unpredictable. With stable policies, the Nigerian cassava industry has a future. However, there is the need to harmonize activities of the following special programs:

- *Special Program on Food Security (SPFS)* -- The SPFS is a deliberate policy to stimulate the growth of the food sector and thereby facilitate the elimination of poverty, hunger and the host of vicious tendencies that persist in food insecure nations. It is viewed as

paramount for the development of the food sector and as a means to usher social and economic development in Nigeria. The wide geographical spread of SPFS projects in Nigeria makes it a viable program for the growth of the cassava sub sector.

- *Small and Medium Enterprises Development Agency of Nigeria (SMEDAN)* – This was established by the provisions of the Small and Medium Industries Development Agency (Establishment) Act of 2003. The Act empowers SMEDAN to demand and obtain relevant information and data available in the small and medium industries sub-sector focused on the promoting and facilitating of development of small and medium scale enterprises. SMEDAN is appropriately positioned to facilitate the sustainable development of the emerging industrial users of cassava in Nigeria.

Resource	Current Status	Costs
Raw material	-Low yields. -Low volumes. -Poor quality.	-High farm gate prices.
Labor -Farm level	-Farm level -Unskilled and unavailable as youths move to towns.	-$55 /month.
-Industry level	-Industry level –Unskilled.	-$70/Month.
Infrastructure	-Poor.	-High transportation and distribution costs.
Utilities	-Poor unreliable supply. -Expensive.	--Contributes 20-25% of total processing costs.
Investment climate	-Unconducive. -Investment costs and charges too high.	Policies enacted not effectively implemented.
Land	-Land Tenure not conducive to expanding the production of cassava.	-Land development for commercial agriculture is too expensive
Finance	-Limited access to credit and financing.	-Credit costs are high.

Table 2.3:Summary of the Status and Costs of Resources required in the Development of the Cassava Sector

2.3.3. Institutional Infrastructure

The Nigerian Support Institutions needed for the development of the cassava sector include:

- Research and Development (R&D) Institutions
- Finance Institutions
- International organizations
- Regulatory Institutions
- Private Associations and NGO's
- Ministries Government and Parastatals
- Universities and Polytechnics

The role of each Institution is described below:

NATIONAL R&D INSTITUTIONS	R O L E S
Production Institutions	
National Root Crops Research Institute (NRCRI), Umudike.	R & D into the development of high yielding, pest and disease resistant/tolerant genotypes; cassava process technology for chips, pellets and poultry feeds production.
I A R & T, Ibadan.	R & D on sustainable agricultural production.
Sheda Science and Technology Complex (SHESTCO), Abuja.	Research into production of zero-to-low cyanide cassava; production of genetically improved cassava; production of industrial starch and starch derivatives; fructose and glucose syrup and citric acid.
National Center for Genetic Resources and Biotechnology (NACGRAB), Ibadan.	Research and mass production of disease-free, pest resistant and high yielding cassava plant through micro-propagation techniques.
Industrial/ Equipment Institutions	
Federal Institute of Industrial Research (FIIRO).	R & D on industrial products, equipment design and development.
National Center for Agricultural Mechanization (NCAM), Ilorin.	R & D into machinery and equipment (M&E) fabrication (e.g. cassava lifter, tuber harvester, peeling tools, root washer, root grater, screw press, sifter, *gari* fryer, chipper, dryer, etc).
Project Development Agency (PRODA), Enugu.	R & D and design and fabrication of some M & E.
African Regional Center for Engineering Design and Manufacturing (ARCEDEM), Ibadan.	Design, fabrication and commercial production and marketing of cassava-based M & E.
Nigeria Machine Tools Limited (NMT), Osogbo.	Design and fabrication of machine tools and components.
Scientific Equipment Development Institute (SEDI), Enugu.	R & D and production of cassava-based M & E.

R&D INSTITUTIONS (contd)..	R O L E S
Packaging & Storage Institutions	
Nigerian Stored Products Research Institute (NSPRI), Ilorin.	R & D facilities for storing fresh cassava roots and cassava products.
Livestock Research Institute	
National Animal Production Research Institute (NAPRI), Shika, Zaria.	R & D of cassava-based feeds for poultry, pigs, cattle, sheep and goats.
Veterinary Research Institute, Vom, Jos.	R & D on livestock health (cattle, goat & sheep).
Raw Materials Institutions	
Raw Materials Research and Development Council (RMRDC), Abuja.	R & D on raw materials development including cassava .
Academic Institutions	
Universities and Polytechnics.	Training, Research & Extension on Cassava with model villages.

Table 2.4: Research Institutes & Universities.

FINANCE INSTITUTIONS	ROLES
Development finance institutions	
Nigerian Agricultural Credit and Rural Development Bank (NACRDB).	Provides loan credit with no collateral to rural farmers.
Community Banks.	Provides loan to rural farmers.
Banks of Industry.	Enhance infrastructural facilities through loans.
Nigerian Export Import Bank (NEXIM).	Import & Export promotion & financial support (loan, guarantee/insurance).
SMEIS.	Loan to SME investors.
Commercial Banks	
Commercial Banks (Union Bank, UBA, First Bank).	Loans and/or insurance to investors with collateral.
Insurance company	Loan, leasing but no physical cash.

Table 2.5: Finance institutions.

INTERNATIONAL ORGANISATIONS	R O L E S
International Institute of Tropical Agriculture (IITA), Ibadan.	IITA is a CGIAR Center based in Nigeria with over thirty years of experience in research and technology development. It has the Africa mandate for Cassava development including research for development, with the aim of increasing agricultural productivity, through R & D development of high yielding, pest and disease resistant/tolerant genotypes and post harvest development including better cassava process technology for chips, foods, industrial, pellets and poultry feeds, process technology, cooperation in the fabrication of cassava chips/pellet, industrial starch, cassava bread and confectioneries, ethanol production, market development.
International Fund for Agricultural Development (IFAD).	Loan repayment to Federal Government and assisting the multiplication program (Roots and Tuber Expansion Program Board) on the improved cassava varieties released by IITA and NRCRI.
United States Agency for International Development (USAID).	Focuses on developmental projects to stimulate industrial growth, job creation, gender balance, stable governance and reduce restiveness.
Department of International Development (DFID), UK.	Focuses on developmental projects on sustainable agriculture, stable governance, job creation and food security.
International Development Research Council (IDRC).	Focuses on developmental projects to stimulate industrial growth, job creation, gender balance, stable governance and reduce restiveness.
Bernard Van Lur Foundation (BVLF).	Focuses on funding with the Federal Government and extension of the works on cassava.
United Nations Industrial Development Organization (UNIDO).	Focuses on industrial development through policy change, sustainable production and processing centers and capacity building.
Food and Agriculture Organization (FAO).	Focuses on agricultural development projects & food security. It also carries out surveys on production, processing and marketing.
World Health Organization (WHO).	Focuses on the promotion of health, Nutrition and gender issues.
United Nations Children Education Fund (UNICEF).	Focuses on the promotion of educational, awareness, population and advocacy on health, Nutrition and gender issues.

Table 2.6: International Organizations.

PRIVATE ASSOCIATIONS and NGO's	ROLES
Cassava Growers Association of Nigeria.	Promoting cassava through investments in production, processing and marketing.
Cassava Exporters Association of Nigeria.	Promoting and exporting cassava-based products.
Cassava Processors Association of Nigeria.	Processing and promoting cassava processing.
Cassava Equipment Fabricators Association.	Promoting and fabricating cassava machinery and equipment.
PRIVATE ASSOCIATIONS (contd)..	**ROLES**
Cassava Produce Promoters & Exporters Association of Nigeria (CASPPEANS).	Promoting cassava export trade.
Nigerian Association of Small and Medium Enterprises (SMEs).	Promotion of viable environment for the growth of SMEs.
Nigerian Association of Small Scale Industrialists (NASSI).	Promotion of viable environment for the growth of SMEs.
Chambers of Commerce, industry, mines and agriculture.	Trade group.
Manufacturing Association of Nigeria.	Provide the umbrella body for all manufacturing companies including cassava-manufacturing industries.
Winrock International.	Consulting units working in Nigeria on various issues including cassava.
Citizen International (CI) .	An NGO involved in extension work on cassava.
New Nigeria Foundation (NNF), Lagos.	An NGO involved in the Cassava competitiveness project in Akwa Ibom to promote cluster development concept.

Table 2.7: Private Associations and NGOs.

MINISTRIES, GOVERNMENT PROJECTS and PARASTATALS	ROLES
Ministry of Agriculture (Federal, States, ADP).	Promote cassava cultivation and the supply of input materials e.g. fertilizers and planting materials.
Root and Tuber Expansion Program (RTEP).	Mass production and extension on cassava improved varieties.
Projects Coordinating Unit.	It provides project coordinating services in the agricultural sector with a view to ensuring successful implementation.
Ministry of Commerce	Coordinates the envisaged cassava export program
Nigerian Export Promotion Council (NEPC), Abuja.	Facilitates and promotes export of cassava-based products.
Nigerian Investment Promotion Council (NIPC), Abuja.	Promotes investments (amongst other industries) in the cassava industry.

Ministry of Industry	Regulates and supports industrial development
Ministry of Environment	Enforces EIA and ensure that Environmental standards are met
Special projects by FGN	
National Directorate of Employment (NDE).	Tackles the problem of mass unemployment in the skilled and unskilled labour force. The NDE provides an opportunity to use existing institutions to influence cassava supply and demand.
National Poverty Alleviation Programme (NAPEP).	Focused on job creation & poverty eradication. Also like NDE, NAPEP can be used to create net gain in the cassava industry.
Small and Medium Enterprises Development Agency of Nigeria (SMEDAN).	Promoting and facilitating the development of small and medium scale enterprises.
Special Program on Food Security (SPFS).	The SPFS is a deliberate policy to stimulate the growth of the food sector as a means of alleviating poverty, hunger and other needs in food insecure nations.

Table 2.8: Ministries Government Projects and Parastatals.

REGULATORY AGENCIES	ROLES
Standard Organization of Nigeria (SON).	Determines standards for cassava and cassava products (e.g. cassava flour, cassava bread, cassava starch, etc).
National Agency for Food and Drug Administration and Control (NAFDAC), Abuja.	Enforces compliance of standards for cassava-based products.
Phytosanitary Agency (Quarantine).	Ensures that biological products introduced into this and other countries do not introduce diseases or parasites into the country.
Consumer Protection Council.	Provides an avenue to hear consumer complaints about products, practices or processes that may result in loss, injury or damages for the consumer or simply impinge their rights.
The Weights and Measures Division.	Ensures uniformity of standards, through the provisions of regulation on units of weight and measurement, packaging etc.
Federal Environmental Protection Agency	Enforces compliance to environmental standards and laws

Table 2.9: Regulatory Agencies.

Institutional Coordination Mechanism

Presently there does not exist a coordinating body or mechanism for the Support Institutions that are directly linked to the development of the cassava sector. Considering a cassava coordinating body will strengthen the roles of the institutions, harmonize all activities at the public level, and coordinate experiences by the private sector. The FGN should encourage the establishment of this body. Following the successful examples of Thailand and Brazil, this body should be private sector led and be responsible for providing services to its members which include the provision of market and technical information, convening of regular meetings and seminars, organization of trade fairs, the promotion of capacity building, and the facilitation of investment opportunities.

2.4. The Nigerian Cassava Industry

Cassava in Nigeria is currently used for two main purposes: 90% as human food and only 5-10% as secondary industrial material (used

mostly as animal feed). About 10% of Nigeria's industrial demand consists of HQCF used in biscuits and confectioneries, dextrin pre-gelled starch for adhesives, starch and hydrolysates for pharmaceuticals produces and as seasonings. 70% of cassava processed as human food is *gari*. Other common cassava products human foods are *lafun* and *fufu/Akpu.*

Processed products can be classified into primary and secondary products. The former, e.g., *gari*, *fufu*, starch, chips, pellets are primary products which are obtained directly from raw cassava roots, while the latter are obtained from the further processing of primary products (e.g. glucose syrup, dextrin, and adhesive are obtained from starch).

Primary Products from Cassava

Four primary industrial products from cassava stand out as important for Nigeria. These are (a) cassava flour, (b) crude ethanol, (c) native starch, and (d) animal feed/cassava chips and pellets and are discussed below. These products are commonly traded and show the highest potential for growth in demand, and are associated with medium and large scale processing. The Enterprise Analysis for the development of processing plants for each of these sub-sectors is presented in Annex I.

In the domestic market, industrial cassava products compete with traditional cassava products, mainly gari. Furthermore, each of the main industrial products (cassava flour, chips for animal feed, chips for food grade ethanol, and cassava starch) faces competition from (a) identical imported products, and (b) substitute products that are either being imported or locally grown. For domestic cassava flour the main competitive product is wheat flour. For cassava chips/pellets it is feed grains. For ethanol it is ethanol from other sources, and for starch it is corn/maize starch.

Based on the enterprise analysis, the cost of raw materials (fresh cassava) in Nigeria for the various cassava products are indicated below:

- Flour : 65%
- Starch : 63%
- Pellets : 58%
- Ethanol : 59%

Quite clearly, significantly lowering the cost of raw materials (ex-factory price) would greatly reduce the cost of the final product, making them more competitive. One strategy to achieve this is the vertical integration of commercial farms to each processing plant. This strategy is discussed extensively in a later section as one of the action plans for the development of the cassava industry in Nigeria.

2.4.2. Secondary Products from Cassava

Cassava can be processed into various secondary products, including modified cassava starch, glucose syrup, extra neutral alcohol, noodle, bakery and confectionery industries, meat and textile processing. It is also industrially processed as a raw material in the coating of pharmaceutical products,

the manufacture of glues and adhesives and oil drilling starch. (EFDI-Techno Serve, 2005).

Glucose syrup is a concentrated aqueous solution of glucose maltose and other nutritive saccharines made from edible starch. Glucose or dextrose sugar is found naturally in sweet fruits such as grapes or honey. It is less sweet than sucrose (cane sugar) and is used in large quantities in fruits, liquors, crystallized fruits, bakery products, pharmaceuticals, and breweries.

Noodles are a long thin extruded food product made from a mixture of flour, water, and eggs usually cooked in soup or boiling water (Sanni *et al*, 2004). At 12.5%, cassava starch/flour forms an integral part of the final product.

Cassava based adhesives, like the cereal starch adhesives, are of three main types:

- **Liquid starch adhesives** are supplied by the adhesives manufacturer in liquid form usually in plastic or lined metal drums, jerricans and bottles.

- **Pre-gel starch adhesives** are produced in dry flakes and milled to specific particles sizes. They are packed in waterproof lined multi-wall paper bags/sacks and are very suitable for export.

- **Dextrin based adhesives** are delivered to consumers in liquid and dry forms depending on specification and requirement. The liquid dextrin adhesives are packed as the liquid starch adhesives, while the dry dextrin adhesives are packed as the milled pre-gel adhesives. Dry dextrin adhesives are very suitable for export as intermediate raw materials used especially in Europe and America by the food and industrial companies.

(Insert Diagrams on the industrial uses of cassava starch and derivatives as sent by email)

2.4.3. Cassava By-Products

Cassava by-products are widely used in most tropical areas for feeding pigs, cattle, sheep and poultry.

Dried peel of cassava roots are fed to sheep and goats. Raw or boiled roots are mashed with protein concentrates such as maize, sorghum, groundnut, oil palm kernel meal and mineral salts and used for livestock feeding.

Cassava leaves and stems of the cassava plant are considered a waste product. However, analytical tests have shown that cassava leaves have a protein content equivalent to that of alfalfa (17-20%) [Azogu *et al* (2004); Tewe (2004)] and can be used at 100 percent substitution to replace alfa alfa as a protein rich source for animal feed.

Cassava meal is the powdered residue of the chips and roots after processing is done to extract edible starch. It is generally inferior in quality to chips, pellets, and broken roots, has lower starch content and usually contains more sand. Its demand by the European Economic Community (EEC) has declined following a shift to the other cassava products. However, small-scale farmers who produce their own feedstuffs ensure its continued use by blending it with other ingredients.

The above list of cassava products indicates the large variety of intermediate and end products within the cassava industry.

2.4.4. The Cassava Flour Industry

2.4.4.1. High Quality Cassava Flour (HQCF)

Nigeria imports over one million tonnes of wheat annually. At 10% substitution of cassava flour in wheat flour and with the current national demand, 300,120,000 metric tonnes of HQCF (assuming the national demand for wheat flour is 1.2 million tonnes), is required. IITA has confirmed that 30% of the total wheat can be replaced by cassava flour in bread making, and 100% cassava flour is currently being used in pastries and confectioneries (Onabolu et al). However, with poor regulation and standardization, some bakeries have complained about problems, including:

- Presence of impurities such as sand;
- Odour;
- Shorter product shelf life (e.g. biscuits);
- Brittleness;
- Gradual change of colour (biscuits turning pale);
- Unreliable supply;
- Poor final product quality in cases where the cassava flour had partially fermented.

The process of flour production is described below.

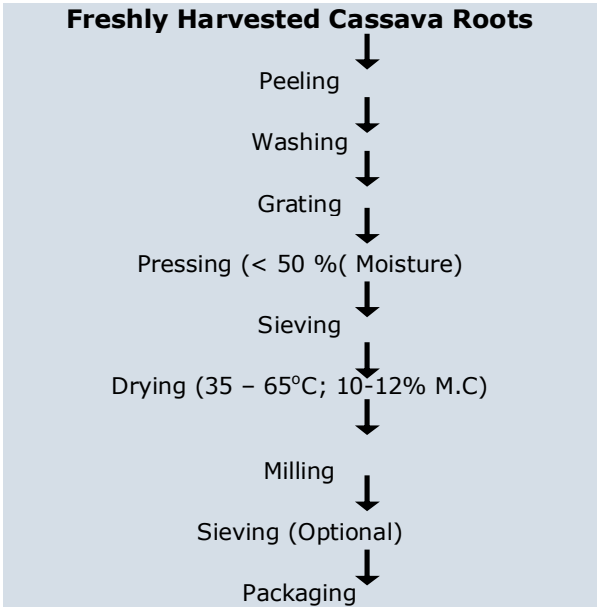


Diagram 2: Process Flow Chart for High Quality Cassava Flour

With other domestic uses for cassava flour in snacks, a more realistic estimate for the annual demand of cassava flour is therefore 250,000 – 300,000 MT, a figure impossible for small holders to supply.

2.4.4.2. The Ethanol Industry

Most of the ethanol consumed in Nigeria is imported. Her current annual demand for the industrial, pharmaceutical and beverage industries is estimated at 160 million liters, a figure however expected to rise exponentially to 900 million liters once the E10 policy on ethanol in fuel is fully implemented.

Ethanol is produced by the fermentation of sugar related materials such as molasses and sugar juice, or starchy materials. Cassava stands as one of the richest fermentable substances for the production of crude alcohol/ethanol, with dry chips containing up to 80% of fermentable substances (starch and sugars). The process of cassava based ethanol production is described below.

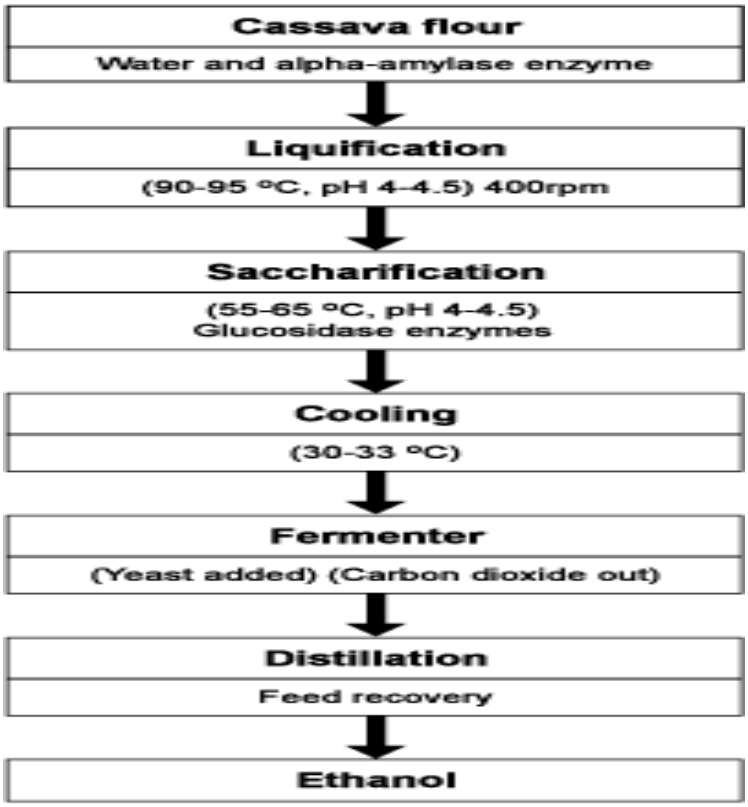


Diagram 3: Flow Chart showing the Production of Ethanol from Cassava Flour

2.4.4.3. Starch

The Nigerian demand for starch is estimated at 230,000 tonnes per year. Out of the 5 modern large-scale cassava starch factories existing in Nigeria, only two are in operation.

Cassava starch is an important domestic and industrial raw material used in the manufacture of various products including food, adhesives, thickening agents, paper, and pharmaceuticals (IITA, 1990). It has many remarkable characteristics including high paste viscosity, high paste clarity and high freeze-thaw stability, which are advantageous to many industries. To make cassava starch, its roots being highly perishable, with enzymatic processing accelerate their deterioration within 1-2 days, it needs to be processed almost immediately after harvest. The process flow chart is described below.

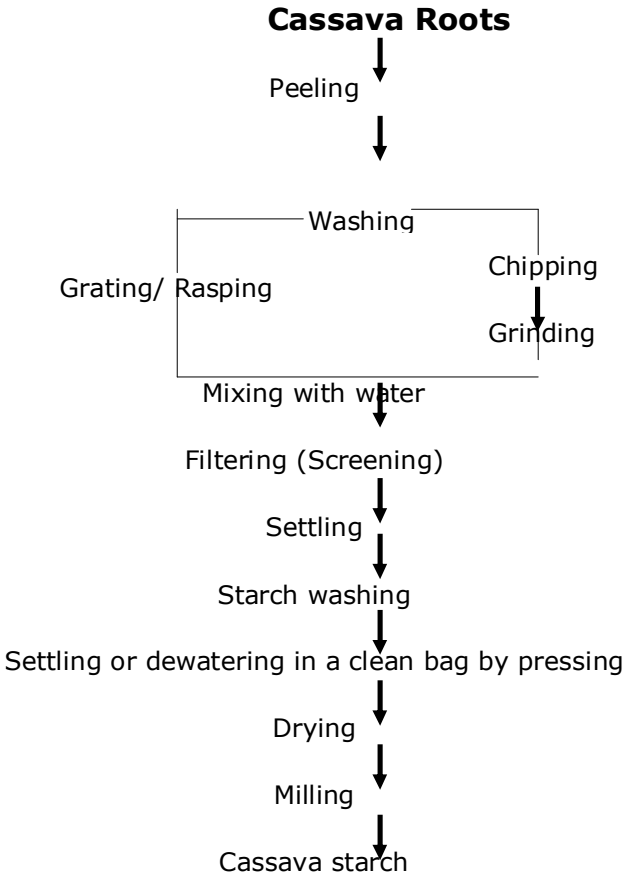


Diagram 4: Process for Cassava Starch Production

2.4.4.4. Animal Feed/Chips/Pellets

Cassava chips are dried irregular slices of roots, which vary in size but should not exceed 5cm in length (CIAT, 2004). The tuberous roots, either peeled or unpeeled, are cut up into chips (*cossettes*) and dried. Chips from peeled roots are used for human consumption and in animal feed industry and generally store better than flour (IITA, 1990). Chips are the most common form in which dried cassava roots are marketed and most exporting countries produce them. The standard method of processing chips consists of peeling, washing, chipping the cassava roots, and then sun drying the slices. The recovery rate of chips from roots is 20-40% depending on the initial dry-matter content of the cassava roots and the final moisture of the chips. In Nigeria, cassava

chips were processed into animal feed and some animal feed millers continued the practice until the late 90s when the price of cassava became too expensive vis-à-vis the price of maize. Presently, no major livestock feed mill uses cassava as a raw material, although smaller mills and large farms that blend their own feed use cassava chips or meal when these are locally available at low prices. The livestock sector in Nigeria is rapidly expanding and a continued demand for animal feed is predictable. In view of the relatively high-income elasticity for meat products, it is likely that this trend will continue during the reminder of this decade. Processing cassava chips into cassava pellets will further reduce transport costs and enhance product quality. Current estimates put the industrial use of chips in Nigeria at 5% (Tewe, 2002).

During a survey of livestock mills, Knipscheer *et al* (2004) found three main problems with the use of cassava chips as raw material: unreliable supply, fluctuations in quality, and uncompetitive prices.

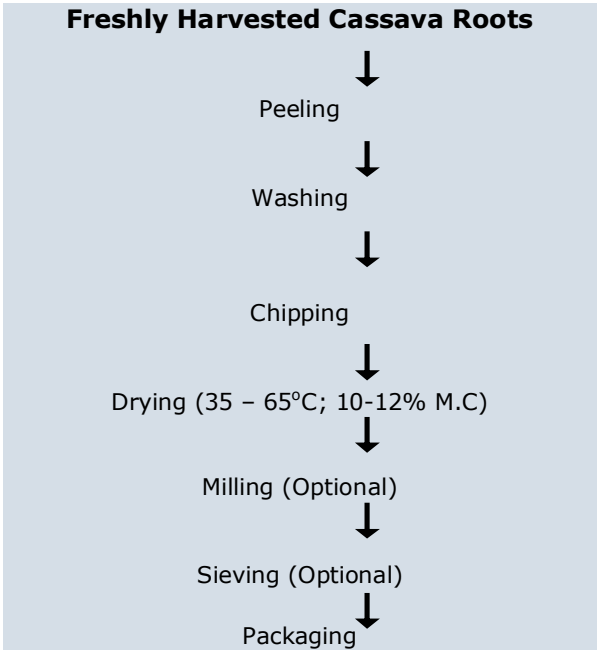


Diagram 5. Production of High Quality Cassava Chips

Cassava Pellets for Animal Feed. Substituting maize with cassava in animal feed have been made using linear programming, saving of up 10% in poultry feed costs and about 20% for pig feed. With the Nigerian livestock industry currently using up to 1.2 metric tonnes of maize annually, substituting 10% of this figure with cassava would involve setting up of at least 200 cassava chip making factories processing about 10 tonnes of cassava roots per day.

Pellets can be made either from cassava chips or flour. An indigenous Nigeria company, B & T Ventures, Ibadan, in collaboration with the cassava project at IITA, has designed and created a pelleting machine that can produce three different types of cassava pellets: hard, soft, and floating.

The hard pellets are used for feeding poultry, the soft ones for feeding ruminants, and the floating ones for feeding fish. However, the machinery is still undergoing R&D, as it is not as efficient as imported pelleting machines.

2.4.4.5. Staple Foods (*Gari*, etc)

In Nigeria, *gari* is the most consumed and traded of all food products made from cassava roots. It is a creamy-white, partially gelatinized, roasted, free flowing granular flour with a slightly fermented flavor and sour taste. It is consumed either soaked in cold water or stirred in boiling water to make a stiff paste. Its wide consumption is attributed to its relatively long shelf life and its easy preparation as a meal. (Oduro *et. al.*, 2000). The process flow chart is described below.

Process	Notes
Harvest cassava	Select fresh, mature cassava roots without rot.
Peeling	Peel by hand and remove woody tips.
Washing	Wash in clean water to remove pieces of peel, sand etc.
Grating	Use motorized cassava grater.
Fermentation	Pack into baskets made from cane, bark or palm branches and leave for 48 hours at room temperature.
Pressing polypropylene	The fermented paste is filled into Hessian or sacks and placed in a jerk press.
Sifting	Using a wooden sieve, separate fibrous materials to control the size of the particles
Garifying	Roast and stir constantly in a large, shallow cast-iron pan over a fire, with a piece of broken calabash (gourd) or a wooden paddle for 20-30 minutes, or with a rotary dryer (300kg/day).
Cooling	To room temperature.
Sieving (optional)	Sieve to obtain uniform granules size. Larger particles of gari that are separated on the sieve may be sold as a cheaper grade.
Packing	In polythene bags.
Storing	In a cool, dry place.

Diagram 6: Process Flow Chart for Gari from Cassava

Other Foods

Food	Description
Fufu	A fermented wet paste widely consumed in eastern and south-western Nigeria, and in other parts of West Africa such as Sierra Leone. It is ranked next to *gari* in importance. Lately the use of dried *fufu* flour has become popular (Sanni *et al*, 1998a). Apart from its ease of preparation, dried *fufu's* advantages include longer shelf life, convenience of storage and its compact size.
Lafun/elubo	It is a fibrous flour made from fermented dried cassava roots (Sanni *et al*, 1998b).

Kpokpo gari	It is a common food in the mid-western section of Nigerian. Its only difference from *gari* is that the grated fermented mash is not sieved before roasting.
Abacha	*Abacha* is eaten as a snack with nuts or eaten as a delicacy with a palm oil source and smoked fish or meat. It is also a ceremonial food served during indigenous festivals such as agricultural festivals, funerals and naming ceremonies.
Tapioca	In Nigeria, this is a roasted granular product made from partly gelatinised cassava starch, (although the cassava crop itself is called tapioca in some places (Oyewole and Obieze, (1985); Sanni *et al,* 1997)), heat treated to a moist mash in shallow pans. Its shapes are irregular lumps called flakes, or perfectly round beads. It is consumed in many parts of West Africa, soaked or cooked in water with sugar and/or milk added. High labour processing steps make it quite expensive. **Note that in international trade statistics, the term "tapioca" is used for the aggregate dry cassava products.*

Table 2.10: Nigerian Cassava Food Products.

2.5. The Nigerian Cassava Industry in the World Context

2.5.1. World Market

Philips *et al* (2004) had assessed the Nigeria Cassava industry in the world context in an earlier publication. In their view, global cassava production is expected to rise with increasing demand for cassava based industrial products. In Nigeria alone, in order to actualize the President's Initiative of US$5 billion a year by 2007, 150 million tonnes of cassava would be needed by the end of 2006.

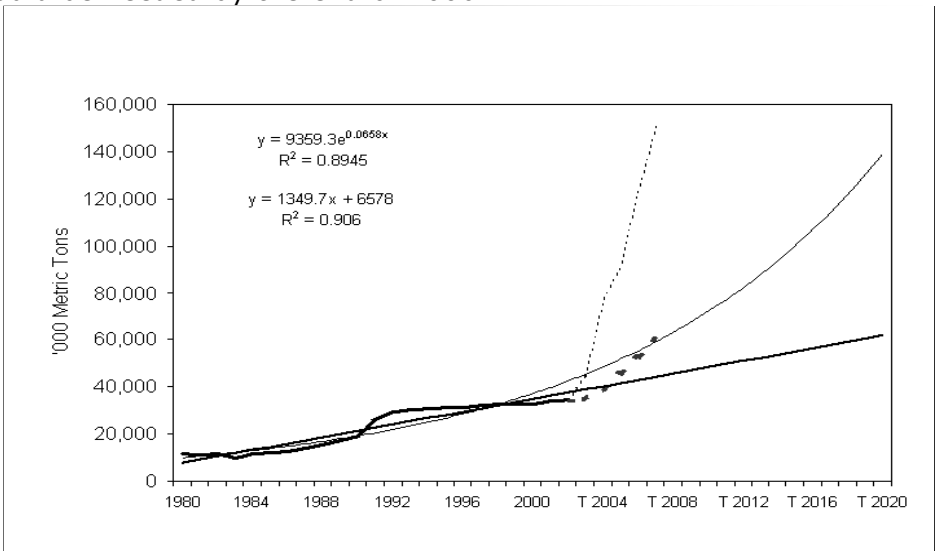


Figure 10: Production Scenarios for Cassava to 2020

With production being a function of area and yield, this target requires an expansion from 2 million hectares (ha) of land to 3 to 5 million ha and an average yield of 30 tonnes per ha.

Research institutes such as International Food Policy Research Institute (IFPRI) and FAO suggest a more conservative target. Extrapolating from estimates of current cassava production in Africa (Scott, Rosegrant, and Ringler, 2000 and FAO, 2004), Nigeria's production is targeted at 40 million tonnes by 2005 and 60 million tonnes by 2020 (IITA, 2002). This target relates well to the mapping of a simple linear time trend on historical production levels (Phillips et al., 2004).

An alternative 'middle of the road' production target was generated by mapping an exponential time trend to historical production levels. This one suggests an intermediate production target for 2007 of 60 million tonnes (a doubling from the 1990 production levels) to 150 million tonnes in the year 2020.

Implications of the 'middle road' scenario of 60 million tonnes by 2007 on Area are illustrated in Figures 9-11. Meanwhile, applying a simple linear time trend to national cassava area illustrates an increase of 1 million ha or 4 million ha by the year 2007 (Phillips *et al.,* 2004).

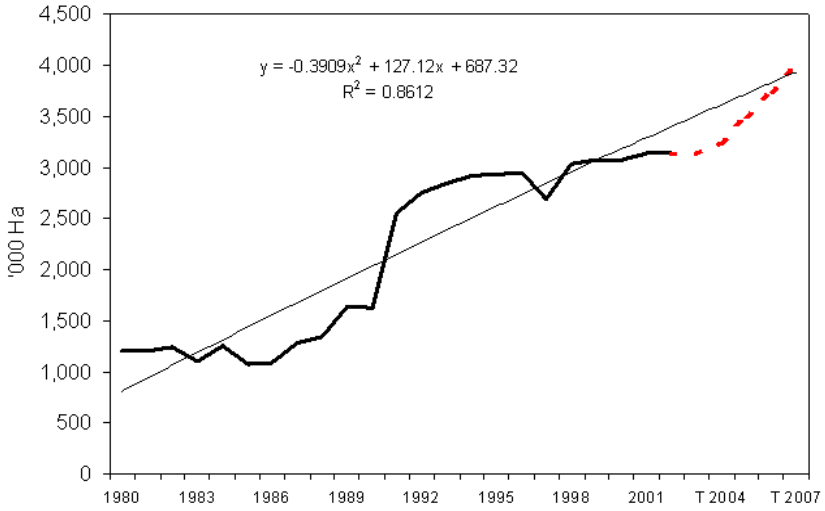


Figure 11: Cassava Area 1980 to Targeted 2007

Given these two targets in production and area, a significant increase in national yields is required. Sixty million tonnes on 4 million ha would require an average yield of 15 tonnes per ha. Current yields in Nigeria have been stagnant at just over 10 tonnes per ha since the early 1990s (Phillips *et al*., 2004).

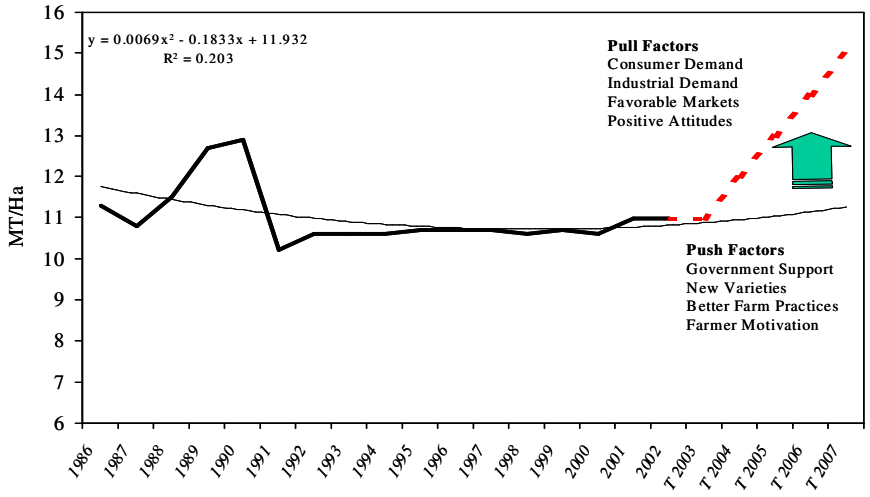


Figure 12: Cassava Yields 1980 to Targeted 2007

This targeted yield, compared to international levels, places Nigeria close to international levels. At 15 tonnes per ha, Nigeria is on the same linear growth path as Thailand.

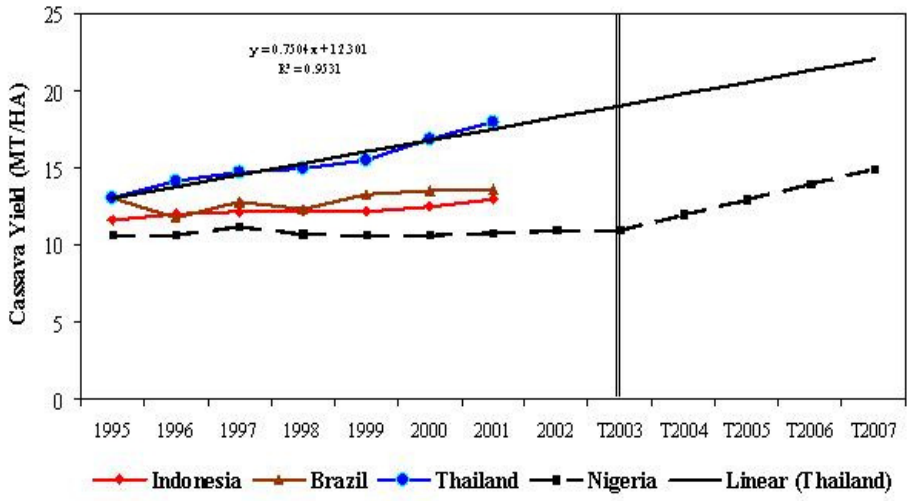


Figure 13: Comparison with International Yields

2.5.2. Regional Market

There are export opportunities for Nigerian cassava products (e.g. *gari*) from and to countries in the West African sub-region (such as Niger and Mali). In these cases, Nigerian cassava products will compete with cassava products from neighboring countries. (Ghana and Benin). Coastal West African (Cote d'Ivoire, Ghana, Togo, Benin) countries are both competitors and the potential markets for Nigerian products. The determining factor is the price of the raw material. There are some indications that prices in Ghana are similar to those in Nigeria, while the prices of cassava products in the Republic of Benin are generally lower. The latter observation explains the periodic presence of Benin *gari* on the Lagos, Nigeria market. *Gari* prices fluctuate in all West African coastal countries, and not necessarily at the same time. Recent market surveys by the West Africa Trade Network (www.wa-agritrade.net) and MISTOWA (www.mistowa.org) confirm that Nigeria cassava products do not yet enjoy a significant price advantage over those in competing West Africa countries. Nevertheless, a cross-border trade study (Ezedinma *et al,* 2005d) in Northern Nigeria showed a substantial cassava export to Niger (mostly *gari*, but also chips), especially during the "hungry season" (February through April) when the new grain crops in Niger are not yet harvested (see: www.cassavabiz.org).

2.6. Economic Outputs

As the main food staple for urban and rural people in the south and the central States of the country, cassava already makes a major contribution to the Nigerian economy. Additionally, the market for industrially processed cassava is growing - Estimates indicate the potential short-term demand for industrial cassava at about 8.8 million MT of fresh cassava annually. This domestic shortfall in demand provides Nigerian cassava farmers an increase in demand of more than 20%. Assuming a well-managed cassava farm that yields 20 MT/hectare, this untapped domestic demand implies an increase in acreage of over 440,000 hectares.

Sector	Current domestic demand	Substitution	Potentials (MT/product)	Fresh root
Starch	230,000 MT	50 %	115,000 MT	1,150,000 MT
Flour	330,000 MT	10 %	330,000 MT	1,320,000 MT
Ethanol E10	1.1billion L	50 %	550,000 MT	4,400,000 MT
Ethanol Industrial/ Beverage	160,000,000 L	10 0%	160,000 MT	1.040,000 MT
Animal Feed	1,200,000 MT	20%	240,000 MT	960,000 MT
Total required				8,870,000 MT

Table 2.11: Potential Market for Cassava-derived Products in Nigeria
Conversion factor: 1t of starch = 400L Ethanol (98% efficiency). Starch: 5: 1 (raw: *starch). Livestock: 4: 1 (raw: chip).*
Land required: 356,250ha@20t/ha
Conversion factor for ethanol: 1: 8
Source: Personal Field observations, Phillips et al (2004), Kormawa et al. (2003)

From the domestic demand analysis presented in Tables 2.11 and 2.12, the necessary economic inputs can be estimated. Based on the capacity figures (small to medium scale), and the cost estimates provided in Annex I, the number of processing plants, and the associated investments can also be estimated. The analysis shows that the domestic demand has the potential to motivate investments in nearly 500 small to medium scale plants in the foreseeable future, with at least 100 such plants in the short run – If supporting policy measures are in place. Assuming an average investment of about N20 million per plant, the associated investment would amount to about N10 billion in the foreseeable future (or N2 billion in the short run). This value of investment excludes the associated investments at the farm level and the multiplier effects that would be created through other activities and services along the value chain.

Sector	Fresh root (million)	Plants	Short Term 1-2yrs	Medium Term 2-5 yrs	Long Term >5 yrs
Starch	0.6MT	17 plants (24T/daily)	20%	40%	40%
Flour	1.2MT	Turn key: 50 plants	20%	40%	40%
		Batch: 100 plants	60%	40%	
Ethanol E10	3.6MT	214 plants			100%
Ethanol Industrial/ Beverage*	1.0 MT	60 plants	60%	40%	
Animal Feed*	10MT	52 plants (10% cassava)	33%	33%	34%
Total new plants		***493***	***126***	***108***	***259***

Table 2.12: Expected Fresh Roots Demands and Processing Plants to be established

Land: 370,000ha (20t@ha).
Current Cassava: 45mMT. Land area: 4.9million ha. Fresh root: 46mMt.
Conversion factor: 1:5
Conversion factor: 1: 4 (4 x 300 x 10 = 12,000MT/yr; 6,000MT/yr)
Ethanol Conversion factor: 1: 8
56 t root will give 6500L ethanol daily x 300 = 16,800MT (16t/day).
Conversion factor: 240t fresh root x 10 = 2.4mT/feed (Pellets with 16 ton feed/daily).
4800t/plant daily x = 19.2.

Chapter 3: A SWOT Analysis of the Nigerian Cassava Industry

The overriding goal of this process is the development and maintenance of a well functioning market for Nigerian cassava and cassava products that is able to successfully compete with cassava products from other countries. A strategic analysis of factors essential to its success include:

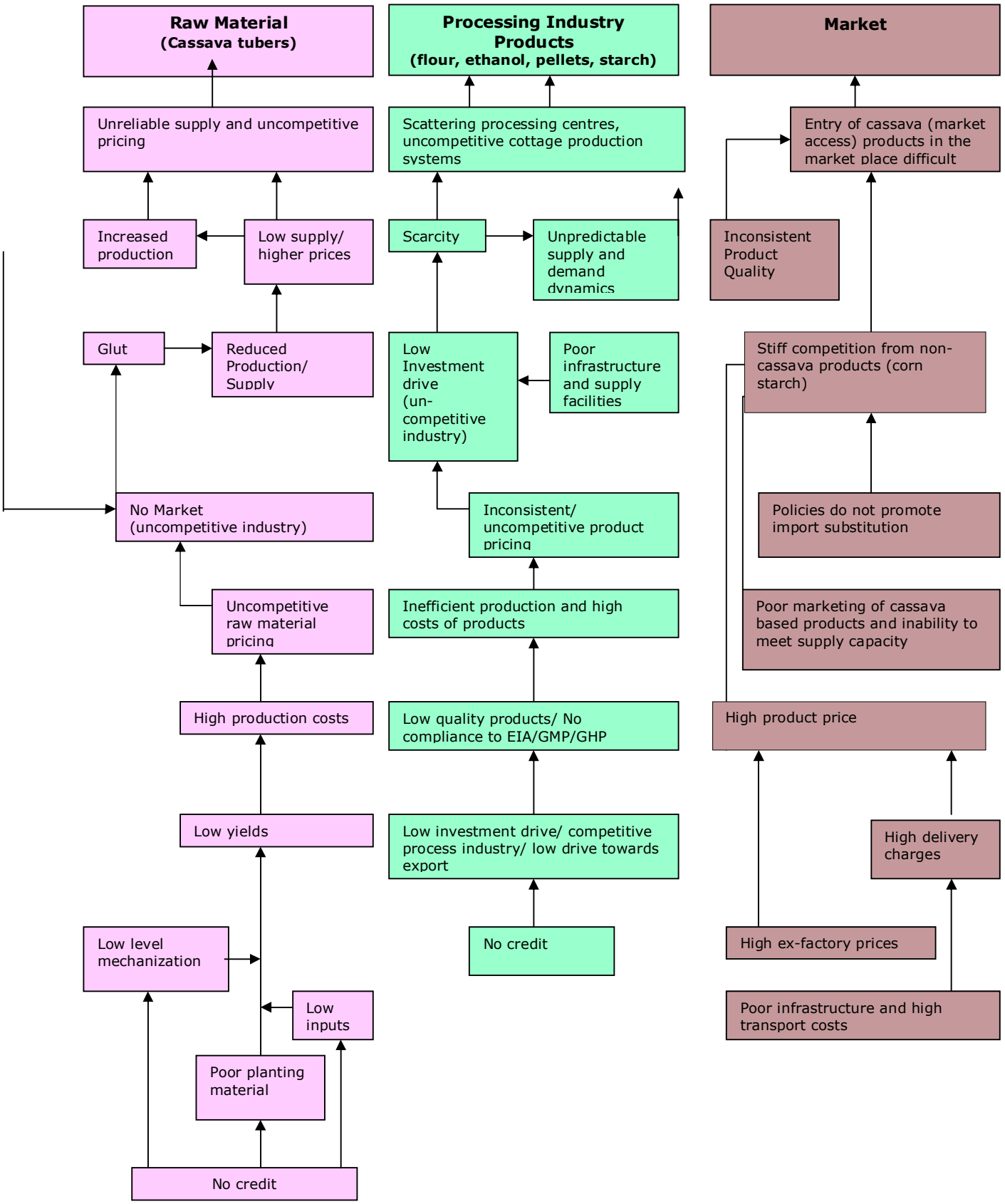
(a) the approach in successful cassava producing countries;
(b) the most appropriate strategies for Nigerian cassava;
(c) how can Nigeria penetrate the international market.

A SWOT Analysis responding to these crucial questions will identify the internal and external factors (strengths, weaknesses, opportunities and threats) within the Nigerian cassava sector, followed by a benchmarking exercise against its major competitors, Thailand and Brazil. Barriers to development will be removed by a series of activities and outcomes. The expected end result would be new efficiencies gained, economic incentives identified, opportunities for product development and use realized and finally, the industrial growth of the cassava industry.

3.1. Analyzing the Cassava Industry as a "Problem Tree"

The problem Tree method identifies constraints, problems and bottlenecks that directly or indirectly affect the competitiveness and efficiency of operations within the cassava sector and is essential as constraints never happen in isolation and usually affect processes higher in the value chain. The Use Chain situation in Nigeria is analyzed in the Problem Tree Diagram below.

Diagram 7: Problem Tree



3.2. The SWOT Analysis (Within the Value Chain)

3.2.1. Strengths

The Nigerian cassava industry has strengths namely:

- **Domestic Demand**. The presence of a huge domestic market is her greatest strength.
- **Climate**. Her climate is excellent for growing cassava.
- **Suitable land**. Even on marginal soils, cassava thrives and grows in every state within Nigeria. Nigeria has abundant suitable cassava cultivation lands, much more than the approximately 3 million hectares currently under cassava.
- **Familiarity with Cassava Cultivation**. With cassava the main food staple in Nigeria, farmers are very familiar with its cultivation.
- **Presence of R&D Institutions**. Nigeria has a core of well-informed and competent cassava scientists, furthered by the IITA and NRCRI in Nigeria.
- **High Yielding Varieties**. Thanks to the work by IITA and NRCRI researchers, high yielding cassava varieties are available for multiplication and adoption.

3.2.2. Weaknesses

The major constraints identified as affecting the production of cassava in Nigeria are:

- **Land Tenure**. Insecure land tenure may hamper the development of large-scale mechanized farming.
- **Fragmentation of Cassava Farms**. The ineffective Land Tenure system makes access adequate large farmland difficult, and in turn prevents large mechanized cultivation.
- **Non-Mechanized Cassava Production, Harvesting, Processing and Preservation**. Apart from a few hired tractors, cassava farming is generally done with crude farm implements. These constraints in planting and harvesting are, according to Nweke (2004), caused by the cost of mechanized machinery processing (peelers and dryers), resulting in low quality end products.
- **Low Yields and Low Starch Content of Common Cassava Varieties**. The current cassava production yield is not high enough to compete with other crops within Nigeria (e.g. maize), or with cassava products from other countries (e.g. Thailand).
- **Poor Infrastructures.** Infrastructure weaknesses throughout the country and in particular in rural areas adversely affect the cassava industry. The roads are bad and transportation costs of moving the cassava is high.

Electricity and water are in short supply and communication links are also very poor.

- **High Transportation Costs**. Cassava is highly perishable with a shelf life of 2-3 days. Once harvested, it must be either consumed immediately or processed into more stable product forms. Urgent transportation needs mean higher transportation costs. In view of its limited shelf life, cassava processing should occur close to the production areas.
- **Fluctuation in Market Prices**. With informal marketing channels and poor information flow, cassava farmers are often unable to process the harvested roots and sell these at very low prices to middlemen who can reach the processors. Additionally, the supply of cassava greatly influences market prices - When cassava is scarce and the prices high, farmers increase production. The subsequent oversupply then lowers the market price and farmers plant less cassava, which results in fluctuating price cycles of approximately two to three years (Nweke *et al*, 1994; Ezedinma *et al,* 2005a).
- **High Raw Material Costs**. Inputs and other expenses make the cost of fresh cassava roots expensive and uncompetitive against competing countries.
- **High Inputs Costs**. High transportation costs increases the cost of fertilizers and other inputs.
- **High Energy Costs.** Poor public utilities like electricity, mean reliance on generator and diesel, increasing the total energy costs.
- **Lack of Social Capital**. Relationships within the Nigerian society are usually characterized by distrust. This short-term perspective often impedes lasting business relationships.

3.2.3. Opportunities

- **Government Policy**. The present Governments' protective duties on competing cassava imports and the mandated 10% use of cassava flour create an enabling cassava industry.
- **Urbanization** creates a demand for value added cassava products in the internal markets, especially in the bakery industries following the mandatory 10% inclusion of high quality cassava flour.
- **Regional Markets**. Seasonal opportunities exist in the regional markets for staple quality food products.
- **By-products**. Markets for by-products and wastes create opportunities for more integrated cassava systems.
- **Production of Modified Starches**. Processing starch into high value modified starches such as dextrin, offers further opportunities for domestic substitution and will position Nigeria as a key supplier in the regional market.

- **Lowering Cassava Prices**. Lower cassava tuber costs mean lower cost of food in Nigeria. The added benefit is that it makes the cassava industry more competitive.
- **Rural Employment**. In view of the high transportation costs and the limited shelf life, initial cassava processing should occur near production areas, and along with the expected employment opportunities in the petroleum business following the introduction of E10, will improve rural employment.
- **Vertical Integration**. New organisational arrangements within the food chain (e.g. clustering system, sales of intermediate cassava products to medium & large scale drying centres) offer opportunities for smaller farmers/processors to link to growth markets.
- **Economies of Scale**. Business opportunities exist for improved transportation services that take advantage of growing internal and regional trade in cassava products.
- **Technology Development**. Building a strong cassava processing industry will stimulate technology development.
- **Savings in Foreign Exchange**. Import substitution will reduce imports of products such as cornstarch and wheat flour, and will reduce the need to buy foreign exchange.

3.2.4. Threats

- **Smuggling**. Building a strong industrial cassava sector requires at least a temporary set of tariffs on competing products. Such tariffs are only effective if smuggling will be prevented. A similar situation exists in the textile sector.
- **Globalization of the International Market**. Nigeria cassava products will face competition through increased imports of competitively priced cassava products.
- **Temporary Gluts**. A glut occurs when the prices are so low that farmers choose not to harvest their roots. It is generally a location specific problem that fuels price fluctuations.
- **Unpredictable Changes in Government Policy**. Through adequate governmental policies, cassava post-harvest capacity can be developed. Should the reverse occur or following inconsistent implementation and lack of transparency, the industry will remain ineffective.
- **HIV/AIDS**. While HIV/AIDS is not yet a major problem in the country, the threat for the immediate future is likely to affect the availability of labor.
- **Domestic Maize Prices**. Domestic maize competes with cassava, as many industrial cassava products can also be made from maize.
- **Pastoralist Clash**. Clashes between cassava farmers and trespassing pastoralists may affect the supply of fresh roots.

- **Poaching on Cassava Farms**. Inadequate farm security results in theft.
- **Corruption**. Extortion and unnecessary roadblock delays increase the cost of doing business, as the drivers give bribes to avoid the cassava spoiling on route.

3.3. SWOT Analysis for the Production of Specific Cassava Products

3.3.1. A SWOT Analysis of High Quality Cassava Flour

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
High domestic and regional demand.	As a food product, it must meet high regulatory food safety standards.	Enabling Government Policy.	Possibility of "politics" in world market for wheat and negative effects of globalization.
Availability of local expertise and processing equipment.	Requires extremely high quality specifications and compliance standards when used as substitute in wheat flour	Savings in foreign exchange.	High competitive uses for cassava tuber, which is the sole raw material for the product.
Can be used as a substitute in wheat flours and in the processing of composite flours.	Its yields of 20% are poor when compared to other cereal-based flours.	Rural employment and income generation.	Competitive prices of similar flours in the market especially cereal flours which are also used for baking.
Has comparable properties with other flours in terms of shelf- life and its use as food meal.	Lack of appropriate dryer.	With urbanization, more opportunities for its use in convenience food products (baked).	Fluctuation in market prices.
Potential foreign exchange earner as an import substitute for wheat	Manual peeling.	Feasible as a cottage, small, medium and large scales enterprise.	High cost of cassava roots.
It can be a foreign exchange earner through export to the sub- region in the immediate future.			Skepticism about the policy on importation.
			Conformation to Quality.

Table 3.1. High Quality Cassava Flour SWOT Analysis

3.3.2. A SWOT Analysis of Cassava Starch

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
Domestic, regional & international demand exists.	It yields lower quantity of starch (20%) compared to other raw material sources such as cereals.	Market exists especially for the production of modified starches.	High competitive prices of other starches in the domestic and international markets.
Local expertise available.	No national standard exists.	Opportunities for integration exists e.g. waste liquor converted to alcohol.	Competitive uses of the major raw material, cassava, for alternative products.
Has several both food and industrial uses cutting across many industries – food, pharmaceutical, textile, wood,	Currently more expensive than other starches (e.g. corn) on the market.	Savings in foreign exchange.	Fluctuation in market prices.

battery, etc.			
Have comparable and preferred properties, when compared against other popular starches –corn, potato.	Processing requires lots of water.	Diversified products and Value addition.	High cost of cassava roots.
Lower quality starch can be processed using simple technology. Unlike cassava flour, starch can be dried using several types of dryers and achieve good quality products.	High energy cost.		Skepticism about the policy on importation.
Can be produced on cottage, small, medium and large scales.	High cost of processing equipment.		Conformation to Quality.
Can be a foreign exchange earner in the future from exportation to the international market and more recently, to the African sub-region.			

Table 3.2. Cassava Starch SWOT Analysis.

3.3.3. A SWOT Analysis of Ethanol

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
A major intermediate industrial raw material whose uses cut across several industries – alcoholic beverages, food, pharmaceutical, chemical, cosmetics, etc.	Large capital investment outlay for food and pharmaceutical grade alcohol, and for the development of medium and large scales enterprises.	Enabling Government. Policy.	Government policies may change, especially with change in Government e.g. 2007.
E10 policy has created huge market for ethanol as fuel.	Can be produced from alternative raw material sources like carbohydrate materials and molasses.	Savings in foreign exchange.	Skepticism about the policy on importation.
Can be produced on cottage and small scales for the crude grade and medium and large scales for high industrial grades.	With its low conversion ratio of 1:8, it requires large quantities of raw materials.	Employment opportunities in petroleum business sector can be expanded.	As the percentage of ethanol inclusion increases, international market in ethanol will increase.
Process technology on cottage and small scales is simple, and uncomplicated machines are required.	Product Standards not yet established.		Can be produced from other raw material like carbohydrate materials and molasses.
	High energy cost.		High cost of cassava roots.
	Lack of distillers.		Conformation to Quality.

Table 3.3. Ethanol SWOT Analysis.

3.3.4. A SWOT Analysis of Cassava Food Products

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
Domestic Demand - The large population of the country (over 120 million) ensures a large domestic market for cassava staple foods.	Production processes are generally laborious and result in high production costs.	Urbanization is creating opportunities for domestic market expansion as some have become convenience food e.g. *gari.*	Competitions from regional markets as other Sub Saharan countries like Ghana, are also developing their cassava industries.
Regional Demand- There is a regional market for Nigeria's traditional staples foods, especially *gari*.	At 20-25%, yields are generally low.	Inclusion of *gari* currently on the list of food Reserves will create production expansion.	Globalization in the international market encouraged by government policies may result in an influx of competing foreign products such as rice and convenience foods.
Exports market available as demand increases from West African communities living abroad.	Production is mostly on cottage scales resulting in limited quantities.	Rural employment and income generation.	Fluctuation in market prices.
High shelf life.	Scanty produce standardization and quality enforcements.	Low energy cost.	Fluctuation in market prices
Convenience.		Potential for export.	High cost of cassava roots.
Availability of small and affordable processing equipment.			
Products can be produced on cottage, small and medium scales.			

Table 3.4. Cassava Food Products SWOT Analysis.

3.3.5. A SWOT Analysis of Cassava Based Animal Feeds

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
Domestic demand high.	Fluctuation in weather conditions for sun drying the products.	Rural employment.	High cost of cassava roots.
Availability of small processing equipment.	Competition from maize based feeds.	Income generation especially from cassava waste.	
Local expertise available.	Lack of appropriate pelletizers.	Low energy cost (Solar).	
		Improves pollution control from other cassava industries.	

Table 3.5. Animal Feed SWOT Analysis.

PART THREE:

BENCHMARKING

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Cassava Industry – Brazil, Colombia and Thailand : a Comparative Study

Chapter 4: Benchmarking the Nigeria Cassava System

4.1 What is Benchmarking

Benchmarking is the continuous process of measuring products services and practices against the toughest competition recognized as Industry leaders in a given sector. It is also the process of determining who is the very best, who sets the standard, and what that standard is.

4.2. Benchmarking of the Nigerian Cassava Chain Against Competing Countries

In order to compare the competitiveness of the Nigerian cassava industry on the industrial market, both the productivity of the sector and the prices of the end products are compared.

Figure 15 compares domestic Nigerian prices for cassava starch and cassava chips against the world market prices. The substantial difference shows that Nigerian farmers cannot currently compete on the world market – The short-term outlook for a rapid expansion of industrial cassava products is therefore bleak.

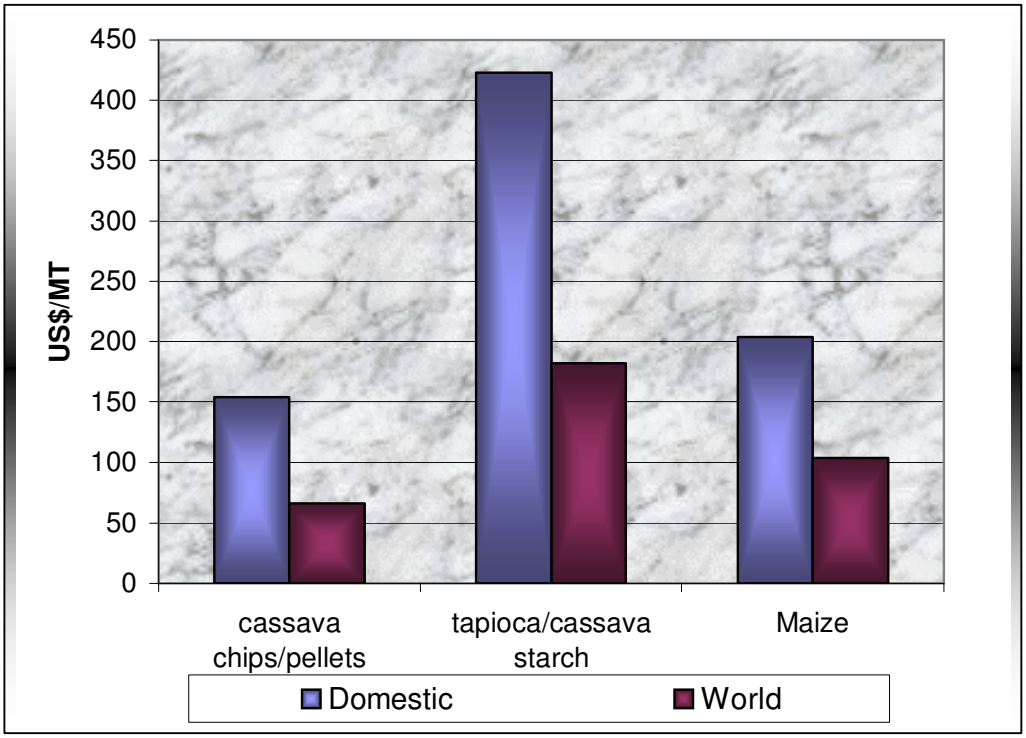

Figure 15: Comparison of Domestic and World Market Prices for Cassava Chips, Cassava Starch and Maize (Knipscheer et al, 2004).

Figure 15 offers another illustration of the lack of competitive advantage of the Nigerian starch on the world market. Nigerian prices are converted into US $ at an exchange rate of Naira 135 per US

dollar. Starch prices are estimated at Naira 55,000 per MT (US $407). Factory cost prices ranged from Naira 55,000 to Naira 80,000 per MT starch (US $407-$593). Fresh root cost prices were assumed to be Naira 8,100 (US $60) per MT at the factory gate. While in Brazil, a recent survey of her producers showed that in Northern Brazil dominated by small holder farming system, the 2005 cost price for fresh roots was $45/MT while in the south, dominated by large scale farming, fresh roots cost $40/MT – This has made Brazil more competitive. (Ezedinma, personal communication, Cardoso 2003)

4.2.1. Brazil

South America countries, Brazil and Colombia have advanced cassava development systems, which play a vital role in their successful industrialization. With 70% of the South American market share, these two, especially Brazil, has become a leading world producer, processor and marketer of cassava and its products. Brazil and Colombia are very similar to Nigeria in several ways, including (Kupoluyi, 2005):

- Location in the low land tropical latitudes, with similar climate, vegetation and ecology.
- Have the same soil types and topography with similar crops cultivated including roots, cassava and cereals.
- Similar food and feeding patterns.
- Classification as developing countries using international yardsticks.

Despite Nigeria's similarities to both Brazil and Colombia, the latter have developed their industrial cassava sectors, proving cassava can be transformed from a staple food to a multi-use industrial raw material. The factors (Kupoluyi, 2005) for the Brazil and Colombia success stories in cassava production, processing and marketing include:

- **Yield.** Between 1986 and 1998, the Brazilian cassava yields averaged 13 MT per hectare. The planting of improved, higher yielding, disease resistant, pest resistant and high starch content varieties of cassava resulted in increased yields. Low out-put small hold farmers average about 15 MT per hectare, with better lands yielding about 20 MT per hectare. Using mechanized technology yields average 45 MT per hectare. With only 2.2 million hectares under cassava, Brazil produces about 24,000,000 MT per year.

  Columbia, despite its agro-ecological challenges, diversity, various systems of cultivation and utilization and other biological problems, averages 12 MT per hectare. With cassava farming in Nigeria only on smallholder farms, her average yield is less than 11 MT per hectare. (FAO, 2005)

High Starch Content

The average starch content in the cassava varieties cultivated in the State of Sao Paulo (Fiber, Branca de Santa Catarina, IAC 12, and Mico) were never below 30%, and were on average 33% annually (Sarmento 1997). In comparison, the starch content in cassava from Thailand is around 26% and in Nigeria only around 20%. However, some of the newly released IITA varieties in 2005 have more than 25% Starch content.

Institutional Support

Closely linked to success in yields is institutional support. A combination of research firms and institutions has been identified as responsible for the production, extension and marketing strategy successes of these countries. These institutions are: **(a)** State Agricultural Development Programs; **(b)** State, National and International research Centers – e.g. the state owned Institute of Agriculture (IAC) of the Sao Paulo State in Brazil and the Brazilian National Research Centre for Cassava in Salvador (CNPMF/EMBRAPA);

(c) The International Centre for Tropical Agriculture (CIAT), a centre of excellence for cassava research and development, similar to the Institute of Tropical Agriculture (IITA) in Nigeria (**d)** CLAYUCA Centre (Latin American and Caribbean Consortium to Support Cassava Research and Development) located in Colombia. These institutions work together to ensure success for the cassava (and other crops) farmers, processors and marketers.

Vertical Integration

Producers are encouraged and, assisted in integrating with cassava processors. In Brazil, medium to large-scale cassava plantations (averaging about 500 hectares per family) are integrated with processing facilities, especially in very intensive farming areas. For example, a starch company requires raw material from a large number of suppliers. With large land cultivation the company reduces its number of suppliers and business contracts, and with fewer suppliers, has improved raw material.

Availability of Large Areas

Over 70% of producers in Brazil are small-scale holders. Unlike Nigeria however where all the producers are small-scale holders, 30% of Brazilian farmers operate medium and large-scale farms, producing the bulk of the aggregated output. This dual cassava system in Brazil has a small-scale production, processing, and marketing system called "low input-low output" system. The second phase is the medium to large-scale integrated production, processing, and marketing called "high input-high output mechanized system". This is what makes Brazilian cassava competitive. Colombia also employs a similar dual farming system. The advantages of large scale farming which include economies of scale in production and processing, efficient use of production inputs, larger outputs and easier access to product markets, play a vital role in the Brazilian and Colombia success stories.

Diversification Factor
Unlike Nigeria that consumes 95% of its cassava production as food, processing 5-10% for industrial, 70% of Brazil's production is industrial; with 50% of this quantity used as livestock feed.

In spite of the advances in cassava development, Brazil and Columbia still face challenges some of which could be lessons in the development of the Nigerian cassava industry. These include:

4.2.1.1 Low level of Mechanized Cassava Cultivation

A comparison of production costs between cassava and corn shows that corn employs better inputs and automation in its production. Mechanization when carried out in the cassava industry significantly lowers labor costs, the cassava root price and allow economies of scale for cassava farmers.

4.2.1.2 Market Concentration

Only two companies in Brazil produce about 700,000 MT of cornstarch with their size and share enabling them invest in product research, reach major customers, and reduce production costs. In comparison, the cassava industry is made up of more than 60 firms, many of which have diversified into higher level value added products especially in the modified starch sector.

4.2.1.3 Price Fluctuations

Most agricultural raw materials face seasonal price fluctuations. However, cassava prices are subject to great seasonal variations. They typically reach a minimum price level during the main harvest period (between May and August) and increase again by the end of the year. In Brazil, cassava starch competes directly with cornstarch and a price comparison of their raw materials provides a good illustration of their fluctuations. Despite great variations in corn price, the instability of cassava prices is much greater.

4.2.1.4 Drying Technology

One of the greatest limitations for cassava producers in Colombia is the way drying technology is applied. With sun drying the most common method applied, the process becomes cyclic and depends on the times of the year with the most sunshine. This is also the cassava harvest period. They are unable to dry outside these climate windows due to lack of sunshine, and small amount of roots. This, in turn, hampers continuous cassava supply and fails to meet the demands of the various secondary industries. An additional problem is poor root quality control. Dirty and unprocessed roots are used and dried, creating poor quality chips which do not meet industrial standards and/or consumer expectations.

4.2.1.5 Slow Adoption of Technologically Higher Yielding Varieties

In Colombia the slow introduction of new cassava varieties had hampered the development of the cassava industry. Farmers have been hesitant to adopt technological changes, refusing to seek varieties with higher yields and quality.

4.2.2 Thailand

Thailand is often cited as a tropical country that has successfully transformed cassava into an industrial crop (Plucknett *et al*, 2000). This transformation was driven by a unique export opportunity to the EU with the transformation occurring in two phases:

- In the first phase, the Thai cassava sector accelerated during the late sixties, increasing during the seventies and the eighties. With high feed import duties, the EU turned to Thailand for its cassava and soybean meal, as a ratio of 80:20 is equivalent in energy and protein to grain feeds such as maize and barley. Thus, Thai cassava meal was exported to the EU countries. In the late 60s, Thailand shifted its focus to cassava pellets processing. The processing into pellets reduces its volume by about 20-25%, thereby reducing transportation costs. There are approximately 200 pelleting factories in Thailand, with an average total capacity of 10 million tonnes per year.

- Following the EU's withdrawal of its preferential treatment for Thai cassava/tapioca pellets in the 90s, and the end of its export to the EU, Thailand entered into the second phase of its transformation. Having already established a competitive industry, it was able to diversify into starch and starch-based products, with starch processing done at large-scale factories. Starch and starch-based products are now exported to Australia, Taiwan, Japan, China, and Malaysia.

- In Thailand, cassava marketing and distribution occurs between smaller producers and export brokers, the latter responsible for shipping the goods to the importing country, usually through an import agent in the importing country. The products get to the final end-users through a network of wholesalers, distributors, re-exporters. These major players determine the product flow, control trade volumes and also dictate prices.

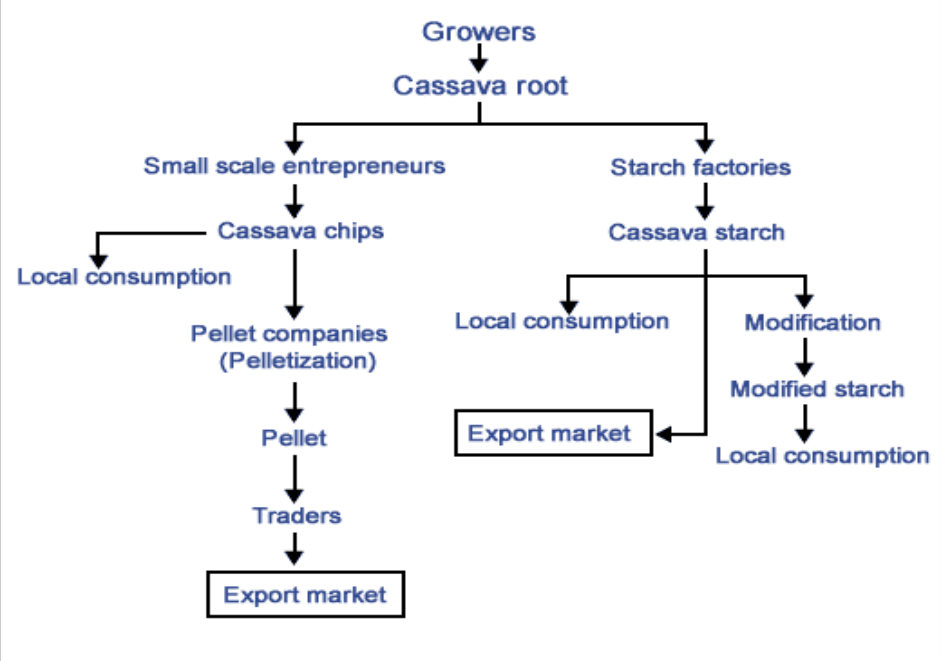

Diagram 8: Organization of Thailand's Cassava Sector

During the last decade, the Thai starch industry has exploded, with half of its starch production for export. (For local consumption, modified starch and syrup industries are the biggest local starch consumers). The cassava trade in Thailand remains, typically export driven. It further seeks to increase its yield of fresh root per hectare, and improve its efficiency (Klanarong Sriroth, 2004). With its unusual export beginnings, it cannot serve as a development model for Nigeria. Nonetheless, it highlights two development lessons:

4.2.2.1 Organization of the Private Sector

The Thai private sector is well organized and has developed a highly efficient transport and processing system. The trade associations, the two most active being Thai Tapioca Trade Association (TTTA) and the Thai Tapioca Flour Industries Trade Association (TTFITA) interrelate and develop policies and R&D into native and modified starch. While the TTTA is focused on developing local and international trade, by providing its members with information on export procedures, prices and market linkages, the TTFITA has registered 41 modern starch factories with a production capacity of 2 million MT, producing top quality cassava starch each year.

4.2.2.2 Processing Technology

The comparative advantage of the Thai cassava industry lies in its efficient processing, not the low cost of its raw material. Development of the processing industry was stimulated by a need to improve the uniformity in shape and size of cassava chips required by compound feed producers/users. In addition, during transportation, loading and unloading of chips, the dust generated caused serious air pollution, placing pressure on European importers to improve

the nature of cassava products handled by the ports. Soft and hard pellets were created from chips. Thailand began exporting pellets in 1981, and by 1989, it was virtually the only pellet product exported to Europe. This Thai processing technology can be adapted to Nigeria. A review of the manufacturing of cassava starch showed that to achieve efficient manufacturing and quality product, important factors included: **(a)** the quality and quantity of processing water, **(b)** the energy consumption, and **(c)** the separation and drying processes. For the production of 1 ton of cassava starch, about 15-33 cubic meters of processed water are required. The maximum power demand for factory with capacity of 200 tonnes of starch per day is 1,500 Kw (» 2,010 HP).

4.2.3. Lessons Learned from Benchmarking Exercise

Although immediate export opportunities are modest, opportunities for the expansion of the Nigerian cassava sector exists. The domestic market offers numerous new uses of cassava products that can successfully compete against alternative products such as corn, potatoes, and sorghum.

Table 4.2 demonstrates that Nigeria must develop higher yielding cassava starch varieties. A comparative analysis of prices of cassava among the four countries highlight the need for mechanized and therefore competitive, cheaper produce at both the farm and enterprise levels in Nigeria. Finally, Nigeria must embrace innovative research and market development.

Above all, Brazil and Thailand have both demonstrated that through collaboration by stakeholders, effective leadership of the private sector, support by research institutions, and an enabling government, an industrial transformation in the rural, urban, national, regional and international markets will occur.

Nigeria's competitiveness in the world cassava market should be developed in two phases. In the first phase, a domestic vibrant cassava based industry, helped along by government trade policies, should be developed, and used also in substituting products which compete with cassava based ones. Once a healthy cassava industry has been established, regional and worldwide export opportunities should be aggressively pursued.

Table 4.2: Comparison of Parameters used for Benchmarking Exercise (special reference to starch)

Country	Nigeria	Thailand	Brazil
Yield/Acre	8 MT/hectare	20-45 MT /hectare	20-45 MT tonnes/hectare
Production system	-Subsistence, labor intensive, scattered holdings Little if any use of inputs.	-Commercial-large scale and vertical integration. -Highly mechanized. -Extensive use of inputs and high yielding varieties.	-Commercial mix: small scale and large-scale clustering and vertical integration. -Some use of inputs. -Use of high yielding varieties.
Roots price factory gate ($/MT)	-60	-40	-45-55
Technology in Use at enterprise level	-Mainly low efficiency technologies.	-High efficiency, state of the art technologies.	-Mixed technology withlow level at the small-scale level and high level efficiency at the large scale level.
Conversion roots into starch	-20%	-25%	-25%
Starch factory cost price ($/MT)	-370-590	-210-220	-350
Starch price factory gate($MT)	-407	-225-250	-400
Market access	-Low supply capacity -Poor product quality and high ex-factory price. -Poor market access.	-Ability to supply and dominate major world market in price and quality. -Product diversification as part of market strategy to cope with fluctuating markets.	-Ability to supply high quality products but less competitive than Thailand.
Marketing	-Not coordinated with no organized marketing.	-Highly organized and export oriented.	-Highly organized.
Institutional Support	-Limited.	-Intensive research and results dissemination.	Intensive product research and result dissemination by CLAYUCA.

*Guy Henry and Andrew Westby, 2000
**Survey results (Knipscheer *et al*., 2004)

PART FOUR:

NIGERIA'S CASSAVA EXPORT

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Action Plan For The Development of The Cassava Industry in Nigeria

Chapter 5: Course of Action - Developing the Nigerian Cassava Industry

As shown earlier, considering the successful implementation of cassava development in Brazil and Columbia, the cassava development in Nigeria will also evolve using the **Dual System.** For sustainability and diversification of operation, first of all, the "low input-low output" smallholder production, processing, and marketing system will remain. The second phase would be the development of a medium to large scale integrated production, processing, and marketing system, practicing "high input - high output mechanized" cultivation, using highly efficient processing technologies.

The Dual System development may evolve as follows:

The Private Sector (dictated to by market trends and demand) is the main player in guiding the development of the cassava sector in Nigeria; through its investment in all stages of the cassava processing in order to initiate a cassava led economic growth. Areas requiring investment are the development of large-scale mechanized plantations for the various processing stages, and investments in consumer industries like textiles, dairy and wood.

The Role of the Government would primarily be the provision of an enabling environment in infrastructure especially cheap electricity and other energy sources, favorable investment climate and the implementation of policies supporting the development of a viable competitive cassava industry.

Research Institutions as support institutions would provide improved varieties of cassava planting stems for planting. The resultant higher yield would ensure an average national yield of 15 MT per hectare for smallholder farms and an average minimum of 20 MT per hectare in the more productive farms. Using full mechanization, yields will average 45 MT per hectare. The average starch content in Nigerian cassava is only 20%. The Research Institutions should begin to disseminate high starch content cassava varieties (>25%), which are already available at IITA and theNRCRI.

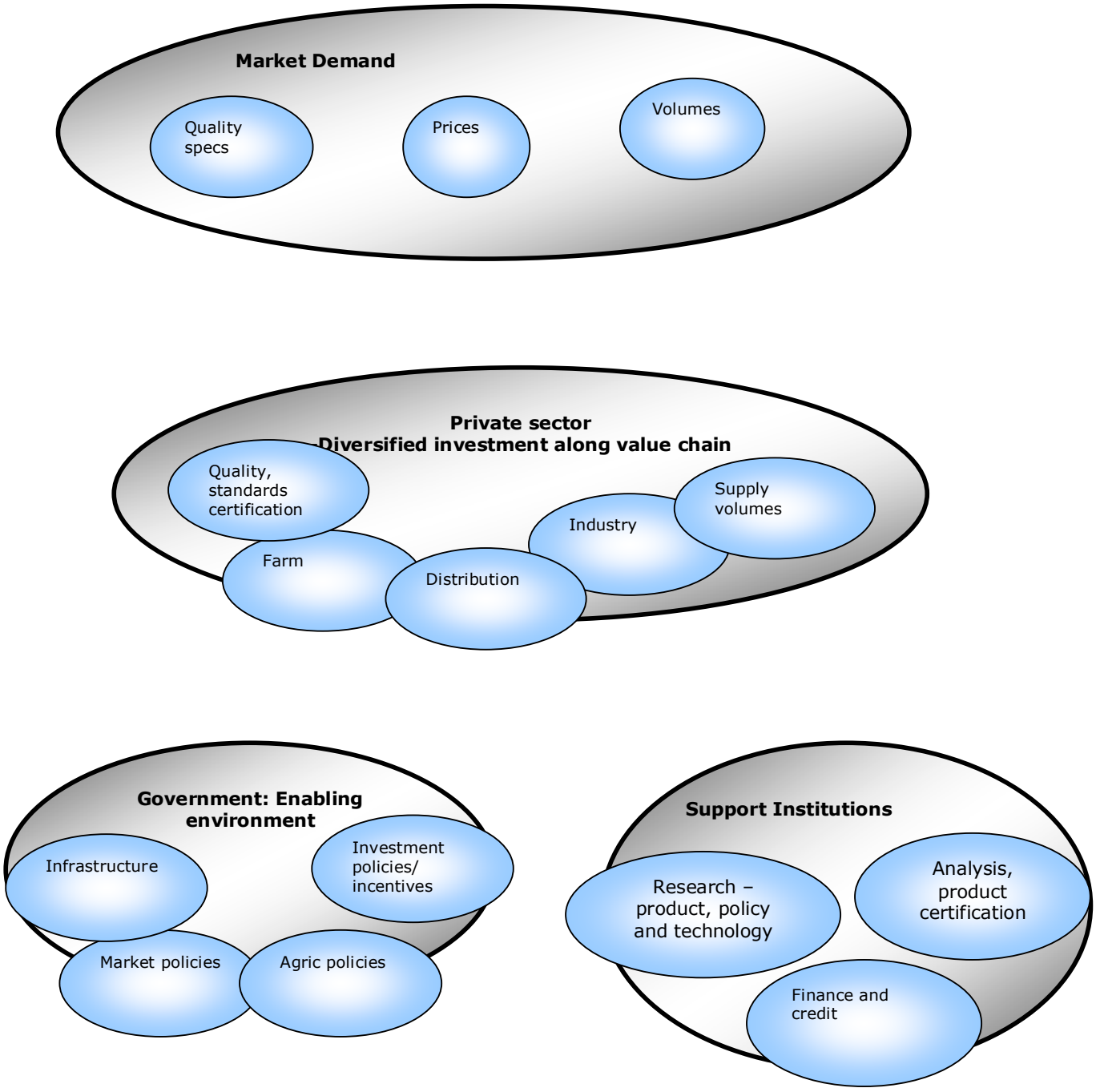


Diagram 9. Interdependencies (demand-response dynamics) between Actors in the Development of the Cassava Sector

TRY AND DEMONSTRATE A MARKET PULL AND GOVERNMENT PUSH ON THE DIAGRAMS BELOW-GOVERNMENT PUSHING INDUSTRY AND MARKET PULLING INDUSTRY AND INDUSTRY PULLING SUPPORT INSTITUIONS (BE CREATIVE)

5.1. Actions

5.1.1 Policies

The policies that should be formulated and implemented immediately that favor the development of the cassava sector should:

- Address the demand for industrial products without jeopardizing the availability of traditional cassava food products.
- Support private sector investments in vertically integrated agribusiness ventures involving large-scale farms and agro-industries.
- Address the current Land Tenure System and the use of land (development) for large-scale farming.
- Address issues relating to affordability and access to investment credit along the value chain.
- Address access to technological advances, using in the short term, imported time-tested techniques, while developing the domestic capacity and technologies in the long term.
- Propose a mechanism to support research along the value chain.
- Develop the domestic market, then pursue regional market access.
- Incentives to cassava enterprises should include tax breaks and repatriation of profit.
- Policies on industrial waste management and environmental protection should be enacted and enforced.

5.1.2. Infrastructure

Provision of infrastructure (e.g. energy, electricity, water, roads, communications) in the areas of greatest industrial potential for cassava should be prioritized.

5.1.3. Promote Vertical Integration and Cluster Development

The previous chapters have demonstrated that in Nigeria a significant domestic demand for industrial cassava products exists, that Nigeria has the resources to produce and process cassava, and that other, comparable countries have been able to develop an efficient and competitive cassava value chain. One of the lessons learned from Thailand and Brazil is the importance of a reliable supply of raw materials (fresh roots and/ or chips). In Nigeria the quantity of cassava

cultivated primarily by smallholders is inefficient and subsistence oriented rather than market driven. The consequence is inconsistent and costly supply of raw materials. In turn, insufficient supply means the processing industries have to interrupt production, which results in their operating below their capacity and at high costs. The development of a viable cassava market in Nigeria demands therefore, a reliable supply of low cost cassava tubers, and a viable relationship between suppliers and plant.

One approach that has contributed to reliable supply of raw materials in other sectors and in other countries is called Vertical Integration. Vertical integration refers to the development of contractual links between primary producers (farmers) and industrial processors of agricultural commodities, e.g. cassava. Vertical integration is based on a long-term mutually advantageous relationship where the processors not only guarantees a minimum price to the farmers but also provides a series of services, including technical services. In return farmers commit to delivering all, or a significant portion of their production to the processor. In Nigeria, this link is largely missing, but the building of this link is central to the successful development of the cassava economy both as local food and for industrial uses or for export. Alongside improving market linkages, further recommendations include:

1. Dissemination of information through distribution of literature and the organization of workshop, to potential industrial end-users on the available cassava based products.

2. Supply of adequate samples of cassava raw material to industries (e.g., poultry feeding industry, bakeries, and biscuit manufacturers) interested in trials.

3. Lowering of the input supply industry planting materials, fertilizers and credit costs.

4. Sustainable surplus production of good quality raw material, including processing of roots into dried chips and flour where required.

5. Information of how to link farming communities and industrial end users.

There are three main ways to establish links between farmers and the industrial sector:

- **Developing Large-scale Farms** that are co-owned by processing plants. In addition to Out-Grower schemes, the development of large-scale cassava production requires industrial level processing and not reliance on small-scale farmers. In Brazil, medium to large-scale cassava plantations averaging about 500 hectares per family are integrated with processing facilities, especially in very intensive farming system. This integration has proven successful in Brazil with many farmers currently cultivating more than 1000 hectares of cassava. Nigeria can still develop large farms. For the growth of the industrial market, industrial processors should be supplied by large-scale producers as the latter are more likely to apply cost efficient cultivation methods, and to honor

existing supplier contracts. Smaller scale Out-Growers can learn improved cultivation methods from neighboring large-scale farmers.

- **Out-Grower Schemes** based on contract arrangements with smallholder farmers. Some industrial companies (e.g., the maize production for cornflakes and tobacco leaves for the Nigerian Tobacco Company) have attempted out-grower schemes in the past, which failed. These schemes could fail due to difficult production conditions (i.e., drought), low yields, insufficient extension services, higher prices offered elsewhere by other buyers, and default by farmers. To ensure its effectiveness, the prices offered should be attractive enough to the farmers to ensure their commitment. To this end, both parties must agree to the price formulae reflecting prevailing market prices, farmers' need of sufficient margins, and end-users' demand for relatively inexpensive raw materials (Oyewole 2002). The precondition of sufficient surplus production requires efficient extension services, including, if necessary, the provision of adequate planting material. Feed millers have indicated the possibility of part-using their sales agents based at district level as extension link. Given the size of most farms in the cassava-producing communities in Nigeria, the formation of farmer groups is necessary to reduce high transaction input supply and output marketing costs.

- **Private Intermediaries** (i.e., Traders and small-scale Processors) provide the missing link between farming communities and industrial processors, especially where Out-Grower schemes encounter difficulties. Local traders currently supply the textile industry with comparatively modest quantities of cassava starch. If industries, like flour mills should require larger quantities of cassava and do not wish to engage in Out-Grower schemes, private entrepreneurs should then provide the missing link. For example, traders who already deal in starch or fufu could be encouraged to invest in chipping and drying units. Traders could then either purchase fresh roots from farmers and sell dried chips to industrial users, or pay the farmers to do them. The implementation of Out-Grower or private intermediaries schemes will require facilitation by research institutions, NGOs, and extension services. For example, research and extension services have to play a proactive role by introducing appropriate cassava chipping and drying technologies, with industrial end-users committing to strengthening market linkages by related investments. And lastly, by Government providing an enabling economic environment (including an appropriate regulatory and legal framework).

The Cluster Development Approach involves the identification, coming together, and operation of different stakeholders at different levels to achieve a common goal. Clusters should be market-driven. Therefore it should be led by the private sector. The advantages that would accrue from a Cassava Cluster Development include improvement in efficient production and processing. It also enhances rural development through provision of infrastructure, e.g., good networks of road.

5.1.3.1. Clusters Disputes Settlement – Business Associations

These Cluster stakeholders provide a forum for dispute settlements in order to avoid a major commercial or trade conflict. It has a defined leadership structure, maintains regular meetings and ensures compliance with codes of conduct. Most of the markets and trade groups in Nigeria use this structure.

5.1.4. Investment Promotion

Polices relating to investment and agro-sector financing should be reviewed, with the Government providing the necessary infrastructure and incentives. She should additionally promote investment in the cassava sector by creating awareness amongst potential investors, farmers and financial institutions on the potential of cassava as an industrial crop for ethanol, starch, flour and feed. The types of information investors need include investment costs and profits, raw material availability, Government incentives, and access to credit. Financiers need information on investment risks, while farmers need to know the different cassava varieties with greater yields, quality and market acceptance.

5.1.5. Promotion of Research

In prioritizing cassava sector development, continued dynamic research on developing cassava will continue. It must be viewed as the future cash crop for the Nigerian economy and treated as such. Research efforts need to be concentrated on improving varieties that are resistant to diseases and the selection of varieties most suitable for the various industrial products. It should also focus on developing processing technologies and conducting marketing research.

5.16. Market Development

A private sector led cassava marketing association would improve the marketing and data dissemination sectors, essential for developing the domestic market. To improve market access, market channels and information on available products and prices must be established.

Chapter 6: ROAD MAP

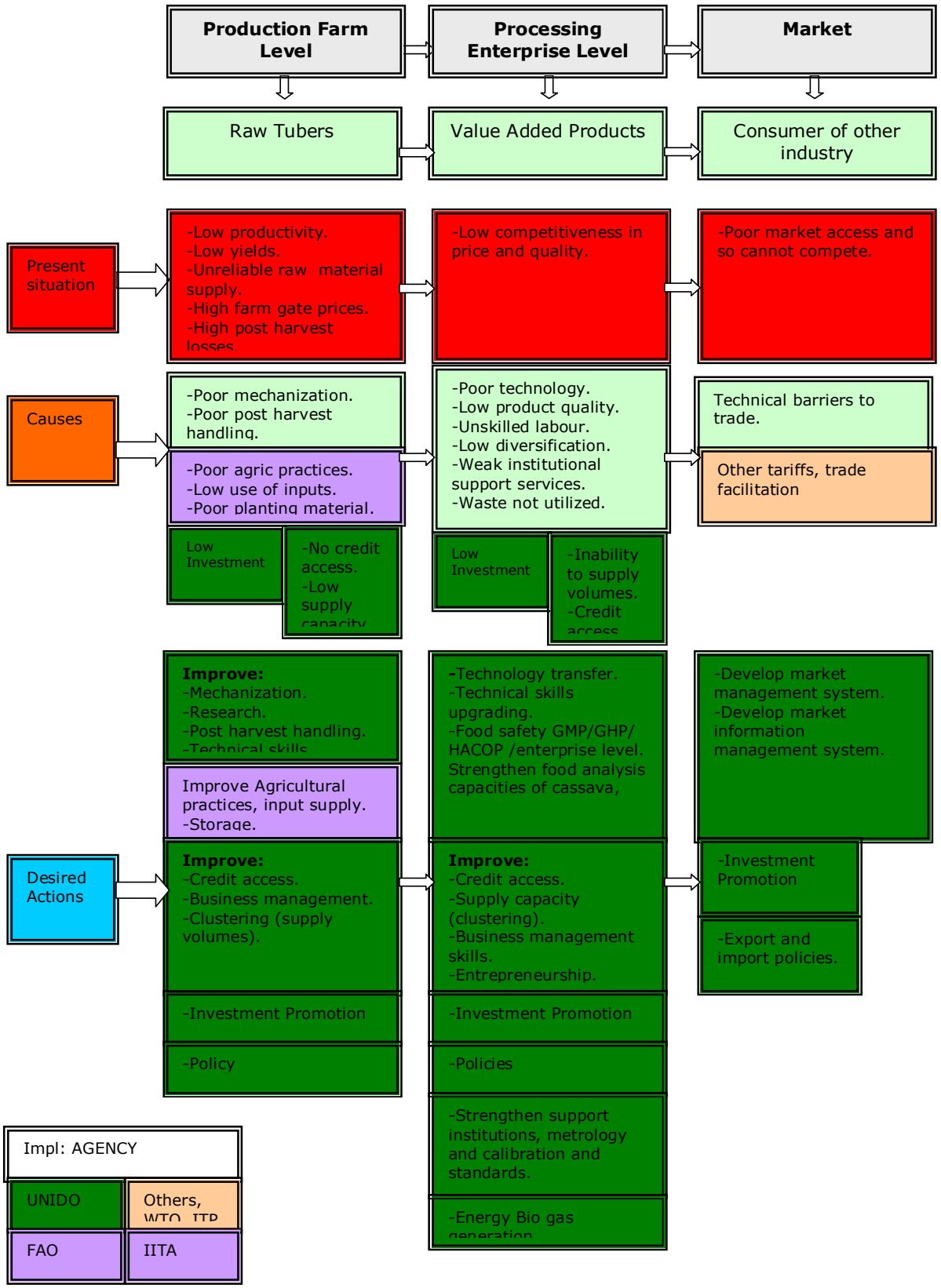
PROBLEM	CAUSES	REMEDY ACTIONS	RESPONSIBILITY	EFFECT
PRODUCTION Low productivity at farm level.	- Low mechanization. -Poor post harvest handling. -Poor agricultural practices. -Low use of input. -Poor planting material -Poor infrastructure -Low investment. - No credit access. - Low supply capacity. -Labor not readily available.	**Implement Policies on** -Equipment import and fabrication. -Investment at farm level. -Finance and credit lending. -Research financing. -Land Tenure. -Provide agricultural extension services. -Provide infrastructure. -Youth training and migration to cities.	**Government**	-Increase in acreage and improved investment climate.
		Research on -Equipment, yield, disease resistance, fertilizers and herbicides.	**Research institutions and private sector**	-Access to more efficient equipment, inputs and high quality planting material and products.
		Investment in -Finance institutions. -Agriculture-cassava sector. -Inputs manufacture and input imports and distribution. -Equipment fabrication. -Cluster development.	**Private sector**	-Improved productivity and capacity to supply volumes demanded by the market. -Competitive farm gate price.

Table 6: Foreseen responsibilities of the various stakeholders in the implementation of the cassava sector interventions.

PROBLEM	CAUSES	REMEDY ACTIONS	RESPONSIBILITY	EFFECT
ENTERPRISE Low productivity and competitiveness at the enterprise level	- Poor technology. - Low product quality. - Unskilled labour. - Low diversification. -Weak institutional support services. -Low investment capacity (finance and information not available). -Inability to supply volume required. -Credit access. -Waste not utilized. -Poor infrastructure.	**Implement favourable policies on** -Processing Equipment import and fabrication. -Investment in agro-processing. -Finance and credit access for entrepreneurs. -Research financing. -Provision of quality and food safety infrastructure and support services by analysis and certification of products. -Transparent investment procedures. -Investment securities. -Provide infrastructure. -In service skills upgrading. -Financing and accreditation of technical institutions providing technical training.	**Government**	-Enabling investment environment. -Well-equipped support institutions. -Development of domestic market.
		Research on -Equipment, product diversification.	**Research institutions and private sector**	-Access to more efficient equipment, inputs and high quality planting material and products.
		Investment in -Finance institutions. -Diversified cassava processing activities. -Inputs manufacture and input imports and distribution. -Equipment fabrication. -Quality infrastructure e.g. Laboratories. -Cluster development. -Waste management systems.	**Private sector**	-Improved overall competitiveness by competitive ex-factory prices and product quality. -Improved ability to supply.

PROBLEM	CAUSES	REMEDY ACTIONS	RESPONSIBILITY	EFFECT
Market Inability to access and compete in markets	-Uncompetitive product price. -Poor product quality. -Inability to supply in quantities demanded.	**Implement favorable policies on** -Cluster development and dispute settlement. -Domestic utilization of major products such as ethanol, flour, animal feed and starch. -Provide infrastructure.	**Government**	-Development of clusters, sub contracting and domestic markets.
		Research on -Product quality and Equipment innovations to improve product quality. -Subcontracting in the Nigerian context. -Market trends and needs.	**Research institutions and private sector**	-Access to more efficient equipment, subcontracting and market information and projections.
		Investment in -Transport and distribution services. -Quality infrastructure. -Market information development and dissemination.	**Private sector**	-Market information accessible. -Higher quality products. -Timely delivery of products in market.

DIAGRAM 10
Improving the Productivity and Competitiveness of the Nigerian Cassava Value Chain-



Four main areas of Intervention emerge as follows-

- Provision of adequate infrastructure to support industrial development.
- Improvement in the quality and quantity of the raw material supply.
- Promote Investment in Primary, Secondary and Tertiary Cassava Processing.
- Development of the domestic market in the short run and the global market in the medium and long term.

Intervention 1: Provision of Adequate Infrastructure to Support Industrial Development

CURRENT SITUATION	ACTIONS UP-TO-DATE	MILESTONES	PRIORITY MEASURES
Communication in many regions is satisfactory	GSM. Fixed wireless, internet services available.	Services available in target cassava producing regions.	Expand services to rural cassava producing areas.
Rural road network is poor. Additionally, poor farm roads make transport costs high	Rehabilitation of main roads is ongoing.	All weather roads exist in target regions, lowering transport costs.	Expand rehabilitation to cassava growing regions.
Poor rail network. More competition in hauling large volumes	Rehabilitation in progress.	Good network of rail lines.	Expand railway line to target regions.
Lengthy Port clearing process	Adherence to Automated Systems for Customs Data (ASYCUDA) procedures in progress	Port Clearing process within 24 hours	Dedicate one port in Nigeria for agricultural imports and exports
Electricity supply is poor and disabling	Privatization of the energy sector is in progress.	Rural grid network established.	Provision of reliable energy to industry by use of alternative power sources e.g. gas.
Water supply is poor	Tubewells and boreholes are being established in some regions.	Water for irrigation and industrial utilization available.	Expand boreholes to target regions.

Intervention 2: Improvement in the quality and quantity of the raw material supply

CURRENT SITUATION	ACTIONS UP-TO-DATE	MILESTONES	PRIORITY MEASURES
Low yields/ hectare	-New varieties released and being multiplied by IITA but not enough quantities.	-Increased yield /hectare from currently 8 tonnes to at least 15 tons/hectare in 50% of commercial cassava farms.	-Rapid multiplication of better varieties - promote investment in seed multiplication.
Land not available to extend expansion of cassava production	-None – Land Use Decree not being implemented.	-Increased acreage under cassava.	-Policy on Land Tenure to be reviewed. -Link land allocation to cassava Cluster development.
Inadequate supply of inputs-herbicides, pesticides and fertilizers	-Input subsidies introduced, input imports ongoing-private sector led, privatization of fertilizer plants ir progress.	-Stable and competitive supply of cassava inputs.	-Promote private sector investments in agro chemical industries.
Low level of mechanization	-25% subsidy of farm equipment such as tractors ongoing. -Tractor assembly plant established. -Zero duty on machinery and tractor.	-Affordable farm equipment more accessible to lease or to own.	-Enact policies to increase imports and affordability of farm equipment. -- Promote private sector investments in equipment hiring services. - R&D to develop farm machinery.
Labor intensive and labor expensive/not available	-No solution.	-Increase in labor supply.	-Incentives to reduce rural urban migration.
Poor supply of high yielding planting material	-Agencies established to distribute planting materials are not very effective.	-Stable and affordable supply for planting material in volumes demanded by the market.	-Promote private sector led supply of planting material in the long run.
Cassava farms are scattered	-Cluster formation has been initiated albeit on a small scale.	-Increased backward integration and large-scale farms.	-Increase clustering of small scale farmers. Promote investment in large scale farms.
Poor agronomic practices	-Increase in the provision of extension services and promotion of good agronomic practices.	-Improved productivity, yields etc.	-Improve the provision of extension services. -Promote producer organization participation in extension services.
Credit not affordable or accessible	-N40B SMES-equity funding for micro and SMEs.	-More farmers have access to credit.	-Promote private sector led credit provision.

Intervention 3: Promote Investment in Primary, Secondary and Tertiary Cassava Processing

CURRENT SITUATION	ACTIONS UP-TO-DATE	MILESTONES	PRIORITY MEASURES
Low investment in cassava sector. Processing characterized as uncompetitive largely micro and small scale	-Conducive investment climate under development eg. 5 year tax holiday for pioneer industrialists.	-Increased investment in cassava industry and value chain.	-Develop other incentives to encourage investment. -Provide better infrastructure.
Inability to meet supply volumes	-Clustering has been introduced.	-Clusters of small scale processors visible and functioning more efficiently.	-Provide incentives to promote clustering at the processing level.
High ex-factory prices uncompetitive in global and domestic arenas	-High yielding cassava varieties introduced and better infrastructure developed.	-Ex factory prices reduced and competitive with main competitors.	-Reduce utility, transport, and raw material costs.
Technologies in use in the small scale operations are inefficient with limited access to more efficient technology	-R&D on cassava equipment fabrication at local level on the increase.	-Locally fabricated equipment is efficient. -Increase use of locally fabricated equipment at the industry level.	-Support private sector led R&D in the development of affordable and efficient technologies. -Enforce intellectual property right, copyright and patent laws.
Investments costs for the more efficient technologies are high	-Promotion of partnerships. -Tax breaks introduced, 5-year tax holiday for industrialists.	-Market led investment in cassava processing increased	-Organize investment promotion, partnerships and cooperatives. -Provide investment incentives. -Implement policies on agro sector credit facilitation.
Skilled labor not readily available	-Polytechnics and technical institutions established but have low capacity to provide highly qualified personnel.	-More qualified personnel available.	-Upgrade technical training institutions.
Poor product quality	-Standards for cassava products under development.	-Products of consistent quality in the market place.	-Enforce cassava product standards and regulation.

Intervention 4: Development of the Domestic Market in the Short Run and the Global Market in the Medium and Long Term

CURRENT SITUATION	ACTIONS UP-TO-DATE	MILESTONES	PRIORITY MEASURES
Individual marketing products unorganized		-Cassava marketing body is registered and functioning.	-Establish a private sector led cassava marketing body.
Market information no available		-Market and sector wide data available.	-Mandate of the body to be established above includes generation and provision of market and sector wide data.
Existing domestic market-dependant on imports	HQCF: Policies on: 10% cassava flour substitution in wheat flour-not fully implemented	Increased demand for cassava flour in the domestic market.	-Enforce 10% regulation. -Through Research, diversify the use of flour.
	Starch: Tax on imported corn starch	-Increase in supply of locally produced starch.	-Introduce surcharge on starch imports.
	Ethanol: E10 policy enacted to be enforced in march 2006	-Increase in number of plants producing ethanol and in the quantities of locally produced industrial ethanol.	-Enforce regulation. -Promote imports in short run.
	Pellets: no policy yet	-Increase in demand for cassava chips and by products to be used in feed.	Introduce and formulate policy on 10% inclusior of cassava in animal feed.
Poor international market access due to uncompetitive products	Export expansion grant (30-40%)	-More Nigerian products in the international market.	- Provide incentives that enable industry to produce at competitive ex-factory price. -Enforce food safety and product quality regulations at plant and processing levels. -Improve investment in provision of credit. -Implement policies that encourage diversification for the domestic, regional and international markets.

6.1. Proposed industrial development by Region

As indicated in Chapter 2, cassava is cultivated in nearly all the regions of Nigeria, with each region's climate and topography aiding a specific area of industrial cassava farming. The important criteria are:
(a) sun light (for drying);
(b) water (for starch processing);
(c) cost of land and labour (for raw materials);
(d) distance to the market.

For instance Nweke (1994) observed that the processing of chips and flour decreases in frequency from 80% in the north and southern guinea savannah zone where sunshine is abundant, to only 25% in the humid zones where sunshine is limited. Additionally, Northern Nigeria regions have abundant sunlight and proximity to regional markets like Niger and Mali. The Central States such as Kogi, Benue and Nassarawa with low labour rates, produce cassava roots at low costs and their long dry season forestalls expensive drying technology. The advantages of the Southern States are their proximity to the urban and export markets and their abundant water supply is excellent for starch processing. However due to its longer rainfall and higher humidity patterns, processing costs are higher, necessitating the use of mechanical drying.

Table 6.2 summarizes by cassava sub-sector, the advantages of each region. As the Table shows, flour and pellets can be produced in all regions and moved to local bakeries and feed millers.

	SS	SE	SW	NC	NE	NW
Starch	X	X	X	X		
Flour	X	X	X	X	X	X
Chips				X	X	X
Ethanol	X	X	X	X*		
Pellets	X	X	X	X	X	X

Table 6.2: Regional sub-sector cassava development

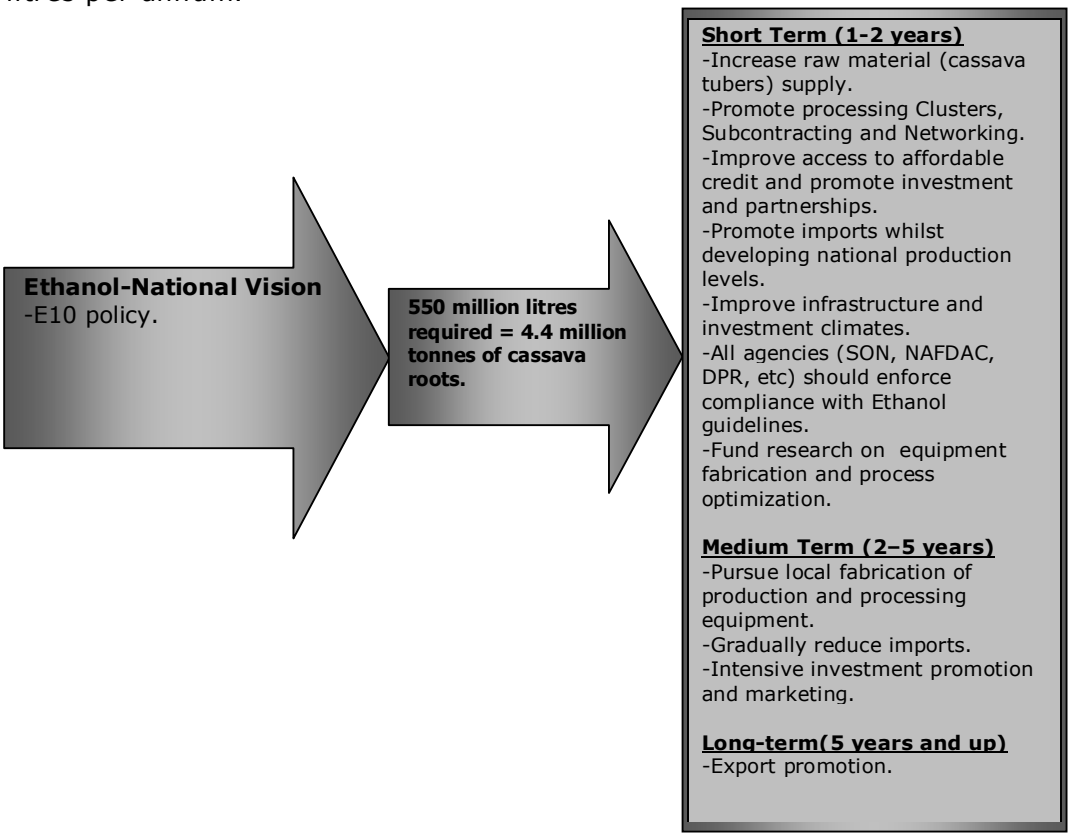
**Table 6.2 is only illustrative and potential industrial investors should conduct proper feasibility studies themselves.*

Criteria:
1. Infrastructure: energy, water and transportation.
2. Proximity to markets (Urban and Export).
3. Low price raw materials and labour.
4. Sun light.

6.2. The Strategic Development Plan for each Cassava Sub Sector in the Short, Middle and Long Terms

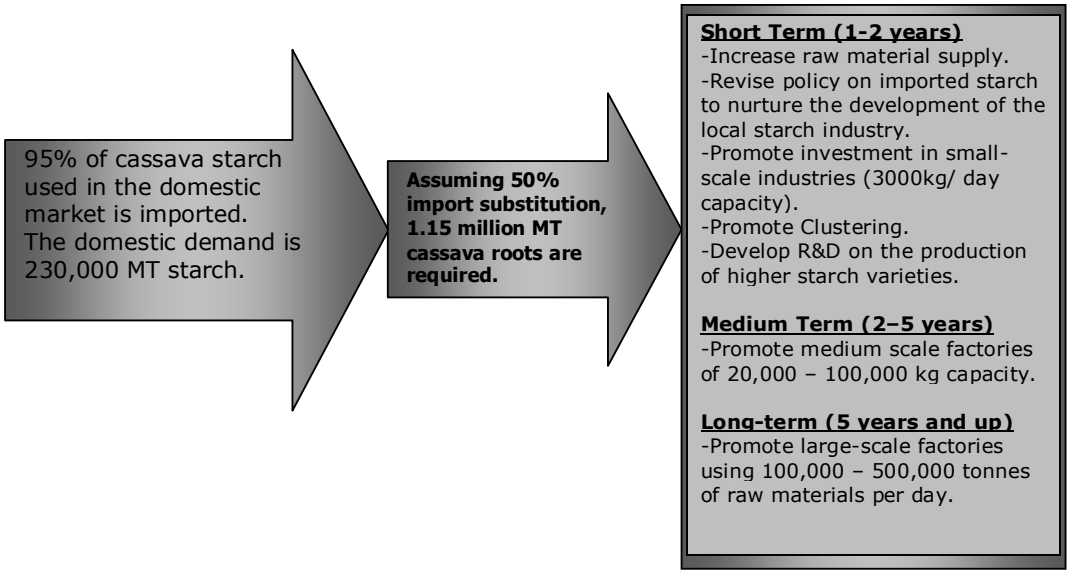
6.2.1. Ethanol

Facts:
In view of the Kyoto Protocol Agreement to which Nigeria is signatory, Ethanol is emerging as an important environmentally friendly motor fuel and its use provides an opportunity for Nigeria to qualify for carbon credits under the Clean Development Mechanism (CDM). Having established an E10 policy, (10% ethanol in all motor fuel beginning 2007), she must produce 550 million litres per annum.



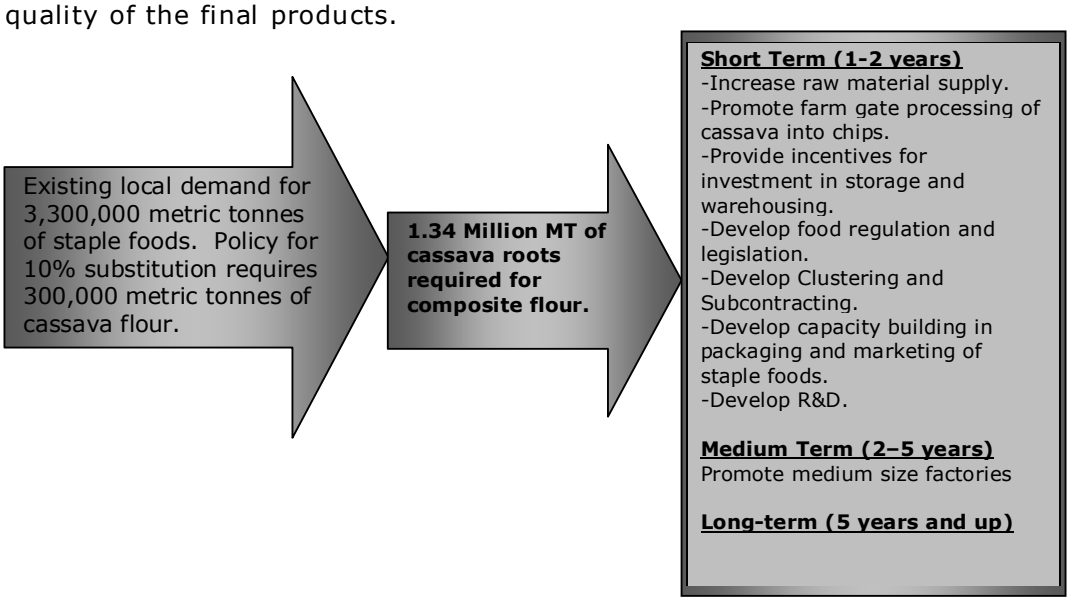
6.2.2. Starch

Facts:
Cassava gives the best quality of starch and has the highest volume per unit of raw material. Compared to other native starch sources, it is the cheapest to produce and would be very competitive if produced efficiently.



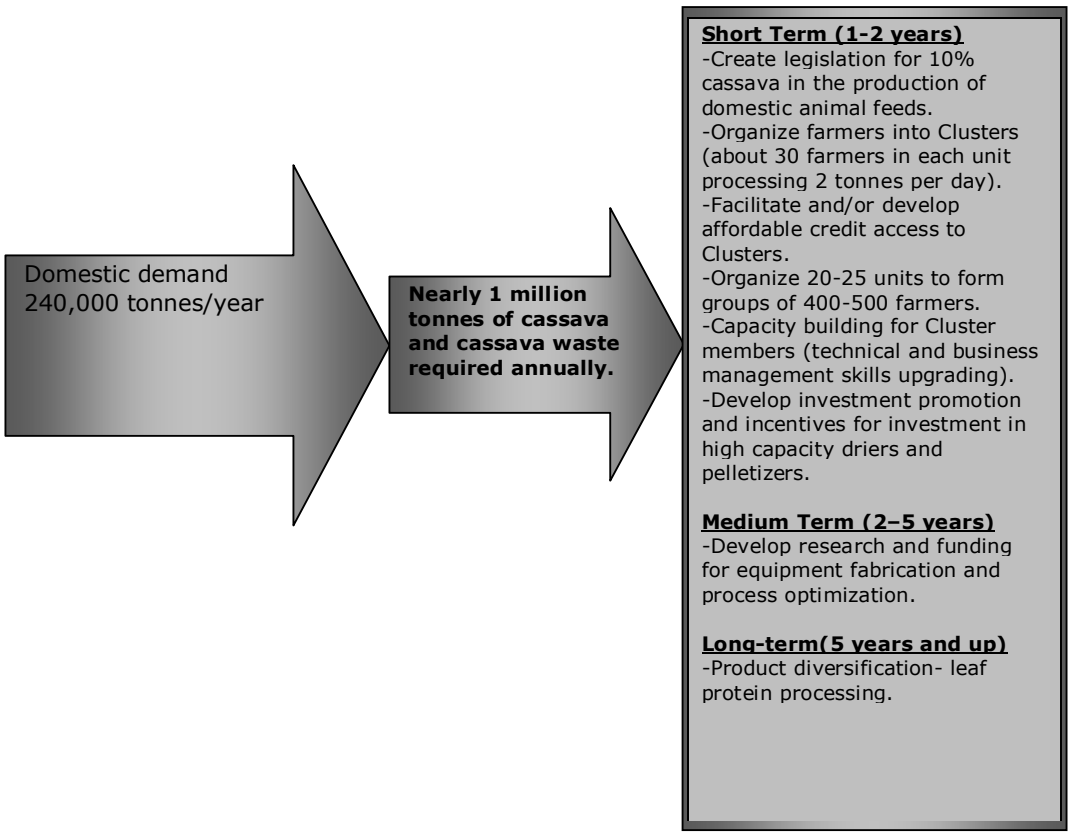
6.2.3. Traditional Food and HQCF

Facts:
-Cassava is the most widely consumed staple in Nigeria and in most of West Africa. Its flour can be used in composite flour (10% substitution for wheat flour) without significant change in the quality of the final products.



6.2.4. Pellets/Chips

Facts:
There is growing domestic demand for animal feed made from cassava pellets and this demand can be improved with policies requiring inclusion of cassava in animal feed production.



6.3. Mechanisms for Coordination and Implementation

The responsibility for the coordination of the Master Plan and its implementation lies with the Ministry of Commerce. An important non-governmental partner will act as the private sector responsible for providing market and technical information, and in assisting the Ministry in developing effective private-public sector collaboration. Being a private sector-led and market based approach, the successful implementation of the Master Plan will rest largely on the consultations, negotiations and direct involvement of the private sector in the decision-making in policy review and investment incentives. They will ensure issues on political stability, transparent investment procedures, regulations, security guarantees (personal and investment) for investors, will be addressed, as these form the bedrock for attracting investments.

6.4. The Way Forward

The Master Plan was designed with the objective of making the Nigerian cassava sector competitive in the global economy. To that end, the global and domestic demand for cassava products have been analysed, and compared with the performance of the cassava industries in competing countries, notably Thailand and Brazil. Through this study a number of concrete actions have been proposed for each sub-sector (starch, flour, ethanol and animal feed). It must be noted that it is only through the effective application of the proposed interventions and guidelines that the development of a competitive cassava sector will occur.

An integrated approach in the implementation of the proposed interventions will determine the success of this Plan. For example, providing access to affordable credit without the provision of pre-requisite infrastructure, security and investment incentives will not deliver the desired results. Additionally, promoting investment in processing sector without addressing issues of raw material supply, or promoting cultivation without putting in place guarantees for a market of the fresh tubers, are ineffective. Therefore, the key to the successful execution of the Plan is the simultaneous actions by various ministries, agencies, local governments and private entrepreneurs.

This Master Plan also includes indicative Enterprise Analysis for the cassava processing industries. The willingness of private entrepreneurs to invest in the cassava sector is the key to its success. These industrial leaders will need the continuing support of the Government of Nigeria. This support, especially the provision of an enabling investment environment, improving infrastructure near new plants locations and development of the new products for the domestic market, will be vital for the effective implementation of the Plan.

In preparation of the Master Plan, UNIDO has ensured that all private and public stakeholders have been fully consulted with regard to the functionality of the Plan. Therefore UNIDO will be able to assist the Government of Nigeria in ensuring that all private and public stakeholders collaborate in its implementation. Finally, UNIDO proposes in collaboration with the Ministry of Commerce and Agriculture, to provide support in the implementation of this Master Plan.

BIBLIOGRAPHY

Adebayo, K., 2005. Traditional Institutions and Market Information in the cassava *fufu* market: a Case Study of Ifo, Ogun State. A Component of the Investigations on Building A Food Marketing Policy Evidence Base In Nigeria. (DFID).

Anyanwu, R.C. and Jukes, D.J. 1991. Food systems and food control in Nigeria. Food policy pps 16,2, 112-126.

Azogu I, O Tewe, C Ezedinma and V Olomo. 2004. Cassava Utilisation in Domestic Feed Market, Root and Tuber Expansion Programme. Nigeria. pp 148.

Ayinde, A. O. Dipeolu, K. Adebayo, O. B. Oyewole, L. O. Sanni, J. Adusei and A. Westby. 2004. A cost-benefit analysis of the processing of a shelf stable cassava fufu in Nigeria IN. Page 6 IN: Book of Abstracts of the Sixth International Scientific Meeting of the Cassava Biotechnology Network. CIAT:Cali: Colombia.

Berry, S.A. 1993. Socio-Economic aspect of Cassava Cultivation and use in Africa: Implications for development of appropriate technology. *International Institute of Tropical Agriculture, Ibadan, Nigeria*, COSCA Working Paper No. 8. Collaborative Study of Cassava in Africa.

Blanshard, A.F.J., Dahnya, M.T., Poulter, N.H. and Taylor, A.J. 1994. Quality of cassava Foods in Sierra Leone. J. Science of Food and Agric. pps 64, 425 - 432.

Cardoso C. E L,, 2003. Competititvidade E Inocacao Tecnologica na cadeia Agroindustrial de Fecula de Mandioca no Brasil, Tese apresentada a Escolar Superir de Agricultura 'Luiz de Queiroz', Universidade de Sao Paulo, para obtencao do titulo de Doctor em Ciencias, Area de Concertacao: Economica Aplicada, Julho, 2003

Cock, J.H. 1985. "Cassava – New potential for a neglected crop". IN: IADS/Winrock International Development Series. edited by S. Breth. Westview Press.

Codex Alimentarius Commission (CAC/RCP 1-1969, rev/2-1985, Vol. 1B).

Codex Alimentarius Commission (CAC/RS/100-1978).

Clark, G. 1994. Onions Are My Husband: Survival and Accumulation by West African Market Women. Chicago and London: University of Chicago Press.

Dahniya, M.T; Akoroda, M.O ; Alvarez, M.N.; Kalndaneh, P.M.; Ambe-Tumanteh, J.; Okeke, J.E.; and Jalloh, A. 1994. Development and dissemination of Appropriate Root Crops Packages to farmers in Africa IN: Proceedings of Ninth Symposium of The International Society of Tropical Rot crops. 20-26 October 1999, Accra, Ghana. 1994, edited by Ofori, F. and Hahn, S.K. International Society of Tropical Root crops, Wageningen:The Netherlands, pps 2-9.

De Soto H 2004. The Mystery of Capital: the role of property rights in creating wealth and alleviating poverty, Sir John Crawford Memorial Lecture CGIAR, Mexico DF October, 19p

Dried cassava and its By - Products. *Centro internacial de Agricutura Tropical (CIAT)*, 2004. Available from < www.ciat.cgiar.org/agroempesas/ sistema yaca/english/ dried cassava.htm. > Accessed on 03/11/05 at 6.30pm.

EFDI-Technoserve 2005. Assessment of different models of cassava processing enterprises for the south and south-east of Nigeria, including the Niger Delta. Draft Final Report submitted to IITA-CEDP, March 2005.

Ezedinma, C., L. Sanni and R. Okechukwu. 2005a. Marketing of *Gari* in Benin City and Enugu, Nigeria. A Component of the Investigations on Building A Food Marketing Policy Evidence Base In Nigeria. Department for International Development (DFID).

Ezedinma, C., M. Patino, L. Sanni, R. Okechukwu, P. Ilona, M. Akoroda, A. Dixon. 2005b, Investment options in the High Quality Cassava Flour (HQCF) Enterprise.. Presented at the Stakeholders meeting on Strategies on sourcing high quality cassava flour – H. R. Albrecht Conference Center, IITA, Ibadan, Nigeria, Jan 2005.

Ezedinma, C., O. Bamikole, M. Patino, L. Sanni, R. Okechukwu, J. Lemchi, F. Ogbe, M. Akoroada, E. Okoro and A. Dixon 2005c. Cassava Ethanol Industry in Nigeria. IITA, Ibadan, Nigeria (In Press).

Ezedinma, C., R.U. Okechukwu, L.O Sanni, E. Okoro, J Lemchi, F Ogbe, M Patino, and A Dixon, 2005d, Cross border trade in cassva based productsPoster paper presented to the IITA board of Trustees, June 2005, IITA, Ibadan

Ezedinma, C. 2005. Agribusiness Investments in the cassava sub sector in Nigeria: some critical considerations, Paper presented at a workshop on Guiding Investments in the Cassava sub Sector in Nigeria held at IITA Conference Center IITA Ibadan, August 2005

FAOSTAT data (2004). http://faostat.fao.org/faostat/collections?subset= agriculture

Fetuga, B. L. and Tewe, O. O. 1985. Potential of agroindustrial by – products and crop residues as animal feeds. *Nigeria Food Journal 3: 136 – 142.*

FOS Nigeria Federal Office of Statistics. 1998. National Consumer Survey, Lagos.

Grace. M.R. 1977. Cassava Processing. *FAO Plant Production Series No 3. FAO*, Rome. Available from <http:/www.fao.org/inpho/vlibrary/x0032/X0032E00.htm>.

Knipscheer, H.C., C Ezedinma, P Kormawa, G Asumugha, K Makinde, R Okechukwu and A Dixon. 2004. Opportunities in the Industrial Cassava Market in Nigeria. IITA/UNIDO.

Kupoluyi, C.F. 2005. CSF Nigeria: Economic Development Through Poverty Alleviation:Promoting Competitiveness and Sustainable Export of value Added Products. UNIDO.

IITA. 1990, "Post Harvest Technology". In: Cassava in Tropical Africa A Reference Manual. edited by IITA Ibadan. pp. 82 – 120.

Le Clus, K. and Mwale, J. 2004. Development Plan for the Zambian maize market, ZAMTIE in conjunction with the Ministry of Agriculture and Co-operatives and Zambian National Farmers' Union, Lusaka.

Lemchi, J.I. 1999. The Marketing System for Cassava in Nigeria *Ph.D. Thesis, Department of Agricultural Economics and Extension, Federal University of Technology, Owerri, Nigeria*..

Nakatani, M. and Komaki, K. (eds.) 2002. Proceedings of the Twelfth Symposium of The International Society for Tropical Root Crops: Potential of Root Crops for Food and Industrial Resources.. *International Society for Tropical Root Crops*

Nweke, F. I. 1994. Processing potentials for cassava production and growth in Africa. *COSCA Working Paper No 3. Collaborative study of cassava in Africa, IITA, Ibadan, Nigeria*.

Nweke, F.I and P. M. Kormawa. 2005. A wide range of cassava snack foods; Another guided secret in West Africa *NIFST Food Forum Vol 3 (1*) . pps 24-33.

Nweke, F.I. and M. Bokanga, 1994. "Importance of cassava processing for production in sub-sahara Africa", IN: Acta Horticulture 375, on International workshop on cassava safety. edited by Bokanga, M., Essers, A.I.A., Poulter, N., Rosling, H. and Tewe, O. Ibadan, Nigeria, pps 401 - 412.

Nweke, F.I., Spencer, D.S.C. and Lyam, J.K. 2002. The Cassava Transformation, Africa's best-kept secret. Michigan State University Press.

Oduro, I., Ellis, W.O., Dziedzoave, N.T and Nimakoyeboah, K. 2000. Quality of *gari* from selected processing zones in Ghana. *Food Contro*l 11. pps 297-303.

Okafor, N; Umeh, C, Ibenegbu, C; Obizoba, I and Nnam, N. 1998. Improvement of gari quality by the inoculation of micro-organisms into cassava mash. *International Journal of Food Microbiology*, 40, pps 43-49..

Oke, O. L. Cassava: Yesterday, Today and Tomorrow. 2005. Paper presented at the Postgraduate College, Obafemi Awolowo University, Ile-Ife, Nigeria. Pp 31.

Onabolu. A., A Abass, and M Bokanga 1998, New Food Products From Cassava, International Institute of Tropical Agriculture, Ibadan, Nigeria 40p

Oyewole, L.O. 2002. Contract farming for root production and supply. Paper presented at the International Workshop on Cassava Competitiveness in Nigeria, IITA Conference Centre, Ibadan, November 18-20.

Oyewole, O.B, Sanni, L. O., Dipeolu, O. A., Adebayo, K. and Ayinde, I. A. 2003. Development of the small and medium scale enterprise sector producing cassava based products to meet emerging urban demand in West Africa. . *Annual Report submitted to EU/NRI, December 2003.*

Oyewole, O.B. and Obieze, N. 1985. Processing and Characteristics of "Tapioca" meal from cassava. *Tropical Science* 35, pps 19-22.

Phillips T.P., D.S.Taylor, L. Sanni,. and M.O. Akoroda 2004. A cassava industrial revolution in Nigeria The potential for a new industrial crop. . International Institute of Tropical Agriculture, Ibadan, Nigeria. International Fund For Agricultural Development, Food And Agriculture Organization of The United Nations, Rome, Italy.

Phillips, P.P., G. Henry, A. Graffham, O. Vilpoux, Boonjit Titapiwatanakun, and D.S. Taylor. 1999. Global Cassava Market Study: Business Opportunities for the Use of

Cassava.. Assembled by DTP Studies Inc. and funded by IDRC, Ottawa, and IFAD, Rome.

Porter, G., 1999. Access to market opportunities in Ghana's off-road communities. Report to the UK Department for International Development, 1999, pp. 50.

Porter, G. 2004. Marketplaces in Nigeria: patterns of continuity and change. *The Nigerian Field 65 (1-2):*pps 92-100..

PriceWaterHouseCoopers 2002. The Nigeria Investors Roadmapand Enabling Environment Strategy Final Report, Prepared for the Government of the Federal Republic of Nigeria, USAID Nigeria, December, 254p

RIM, 1992. Nigerian Livestock Resources. *Vol 1: Executive Summary and Atlas*. *Resource Inventory and Management Limited, Jersey, U.K*.

RTEP., 2003. *Report of the mission on identification of domestic markets for cassava products* Agro-industrial Development Unit, Federal Department of Agriculture,. Abuja,

Sanni, L. O., Charles, A. and Kuye, A. 1992. Moisture Sorption isotherms of *fufu* and tapioca, Journal *of Food Engineering, 34*, pps 203-212.

Sanni,L.O. 2005. Cassava Utilisation and Regulatory Framework in Nigeria..UNIDO.

Sanni, L. O. 2002. Trends in the drying of cassava in Africa. 12th Symposium of ISTRC-Tsukuba Japan, Nakatani and Komaki editors. pps 113-120.

Vilpoux 2000

ANNEX: Indicative Investment Budgets for Cassava Processing Plants

A. Investment Analysis of HQCF Production

	SMALL-SCALE
Capacity	3.5t/day
Output per annum (metric tons)	980
Price (Naira/t)	75000
Number of working days/year	280
Conversion factor	4:01
Total Income/annum (Naira)	**73,500,000**
Variable costs	
Raw material required/annum (metric tons)	3,920
Raw material costs @N10000/t	39,200,000
Transport costs @ N500/t per annum	1,960,000
Machinery, fuel and repairs (N)	7,500,000
Casual labor expenses for peeling (10 persons @N1000/day)	2,800,000
Other expenses	3,000,000
Total Variable Cost	**54,460,000**
Fixed costs	
Administrative and Personnel Costs (manager, Plant operators, security)	3,500,000
Interest on capital	2,458,125
Total Fixed Cost	**5,958,125**
Investment	
Grater (2t/hour)	190,000
Hydraulic Press (500kg/hr)	400,000
Flash dryer 3.5t/day output (or 6t/day for import option)*RD	3,000,000
Hammer Mill	150,000
Pneumatic sieve	180,000
Bag sewing machine	55,000
Water borehole	500,000
Processing building	5,000,000
Weighing Scale	25,000
Installation & other expenses @15%	1,425,000
Total Investment, TI	**10,925,000**
Total production cost (Total variable cost +Total fixed cost) TP	**60,418,125**
Net profit/annum (Naira) NP	**13,081,875**
Return to investment (NP / TI)	**1.20**

**** Source: Ezedinma et al- 2005***

B. Investment and Cost Structure for a 6500 liters/day Ethanol Plant

Items	**Cost**
Number of Production Days in a year	300
Conversion factor (ethanol per ton of cassava flour*)	450l/ton
Daily total production of 96%v/v of ethanol	6500
Annual Production (liters)	1,950,000
Daily cassava flour required (tons)	14
Cost of cassava flour (Naira/ton)	18000
Revenue from CO_2	49830000
Revenue from DDG	6600000
Price of extra neutral alcohol (N/Liter)	82
Revenue from extra neutral alcohol	159900000
Total Income/annum (Naira)	**216,330,000**
Net Income	**72,660,419**
Variable costs	
Raw material (cassava flour) required/annum (metric tons)	4200
Raw material costs @N18000/t	75,600,000
Transport costs @ N800/t	3360000
Yeast	150,000
Enzymes	4500000
Chemicals	900,000
Plastic drums (disposable)	24,000,000
Total Variable Cost	**117,210,000**
Fixed costs	
Machinery maintenance & repair	3,000,000
Operating expenses	7500000
Administrative and Personnel Costs (8 nos)	1,824,000
Interest on capital @ 22.5%	4,362,525
Total Fixed Cost	**9,186,525**
Investment	
Distillation Column (20years)	2,850,000
4 nos Hydrolysis tanks (15 yrs)	200000
Ethanol Storage tanks (15 years)	80,000
CO_2 Purifier (15 years)	2,000,000
CO2 Storage Tank (10 years)	1,000,000
Ware House (15 years)	250,000
Land and Building	2,000,000
Water borehole (2 nos)	1,600,000
Pumps (5 nos)	500,000

Items	Cost
Electric Generator (250 kva)	5,000,000
Mash Buffer Tank (3 nos)	800,000
Water Storage Tanks (1 million liter capacity)	580,000
Furniture	45,000
Delivery vehicle	700,000
Vehicle fuel & maintenance	1,200,000
Generator (diesel)	1800000
Total Investment (TI)	**21,934,000**
Total production (Total variable cost +Total fixed cost) TP	**126,296,525**
Net profit/annum (Naira) NP	**89,933,475**
Return to investment (NP / TI)	**4.10**

Source: Ezedinma et al (2005)

NOTES

1. The estimate above gives the pure grade of ethanol at 96%v/v ready for use as beverage and industrial uses in accordance with the EEC specifications on ethanol.

2. Cassava flour milled from cassava chips. Additional investments in milling machines may be necessary if the investor wishes to buy chips and mill in the factory before fermentation.

3. Transport cost for raw material is estimated at 800/T for an ethanol plant within 50 km of a cassava processing area.

4. Minimum personnel includes a production manager (600000/annum) accounts clerk, (180,000.annum), two (2) security guards (240,000/annum), sales executive/purchasing officer (300,000/annum), fermentation/distillation operator (N180000) a maintenance technician (180,000) and a driver (144,000/annum).

4. The distillation column is made of high temperature tolerance steel, capable of delivering 6500LPD of ethanol with 22 years economic life span.

5. Tanks made of stainless steel, for the hydrolysis and fermentation numbering four (4) are arranged in series. Two of the tanks for hydrolyses and two for fermentation. The conversion of the starch in the cassava flour takes place in two stages (i.e. liquefaction and saccharification) in these tanks. Each tank has a capacity of 5000L and 15 years of useful life. This can be sourced locally from Salami Engineering, Ibadan or any other reputable engineering firm. The ethanol storage tank will have a holding capacity of 30,000L. One mash buffer tank (25000L capacity) that will continuously feed the distillation and a raw water tank that will hold 1000,000L are needed.

6. The CO2 purifier cleans up the CO2 liberated from the fermenters into a marketable form with specification in line with the specs mention in this report. This purifier needs to be imported from Louisiana Chemical company (www.icec.com). The economic life span is 15 years while the CO2 storage tank is sourced locally with a minimum useful life of 10 years.

7. The land, building, and warehouse (about 5000m^2 in all) will be adequate for this size of plant. The warehouse, which is estimated to have a useful life of 15 years, will be adjacent to the main building where the ethanol will be produced. The economic use of the building is estimated to be 20 years.

8. Borehole, water and electric generator. Water is important for the ethanol plant. The water table/topography of the ethanol site must be considered before locating the ethanol plant. Two boreholes will give adequate water yield to cope with the water requirements in the plant such as for production, cleaning and housekeeping. The Sulzer brand of pump with a flow rate of 70m^3/hr is recommended for filling a 1,000,000L water storage tank within 14 hours. Durable electric generating sets can be obtained from Leventis Engineering or John Holt Engineering.

9. Heat exchangers with plates can be purchased locally in Nigeria.

10. A highly coordinated supply chain of the cassava flour suppliers/farmers is the highest challenge in this project. Periodic training of the suppliers on the cassava flour specifications with adequate record keeping is a must to make this project successful. One of the advantages of this is the ability to trace raw material and product sources. The yeast required is the common bakers' yeast. The strains saccaromyces cerevisae and Novozymes enzymes are strongly and highly recommended for optimum and consistent yield. Other chemicals include chlorine for disinfections and antibiotics such as penicillin and viginiamycin and can be sourced in Nigeria from Morrison Plc, Ikeja.

C. Investment Analysis of Cassava Starch Production

ITEMS	STARCH
Capacity	3.0 T/day
Output per annum (Metric Tons)	840
Price (Naira/T)	102,500*
Number of working days/year	280
Conversion factor	4:1
Total Income/annum (Naira)	**86,100,000**
Variable costs	
Raw material required/day (Metric Tons)	12 T/day
Raw material required/annum (Metric Tons)	3360
Raw material costs @N10000/T	33,600,000
Transport costs @ N500/T per annum	1680000
Machinery, fuel and repairs (N)	7,500,000
Casual labor expenses for peeling (10 persons @N1000/day)	2,800,000
Other expenses	3,000,000
Total Variable Cost	**48,580,000**
Fixed costs	
Administrative and Personnel Costs (manager, Plant operators, security)	3,500,000
Interest on capital	1,125,000
Total Fixed Cost	**4,625,000**
Investment	
Grater (2t/hour)	190,000
Two Hydraulic Press (500kg/hr) (optional)	800,000
Flash dryer 3.5t/day output	3,000,000
Mill	400,000
Pneumatic sieve	180,000
Bag sewing machine	55,000
Water borehole	500,000
Processing building/Training Hall/Fence/gate/Shed/security	12,850,000
Weighing Scale	25,000
Installation & other expenses @10%	2,000,000
Total Investment, TI	**20,000,000**
Total Production cost (Total variable cost +Total fixed cost) NP	**53,205,000**
Net Profit/annum (Naira) NP	**32,895,000**
Return to investment (NP / TI)	**1.64**

**** The mean price per MT of the addition of the prices for food and industrial starch grade was used here. Source: Ezedinma et al. 2005.***

D. Enterprise Analysis for Cassava Chips Production for Livestock

ITEMS	Option 1. Peeled Chips	Option 2. Unpeeled Chips
Capacity	15T/day	16T/day
Output per annum[1]	1170T	1560 T
Price Naira/T	35,000/ T	32,000/T
Number of working days	180 days	180 days
Dry loading density	10kg/m^2	10kg/m^2
Conversion factor	3:1	2.5:1
Total Income/annum (Naira)	**40,950,000**	**49,920,000**
Variable Cost		
Raw material required/annum	3510T/annum	3900T/annum
Raw material costs @N10,000/T	35,000,000	35,000,000
Transport costs @ N500/t per annum	1,755,000	1,950,000
Machinery fuel and repairs (N)	80,000	80,000
Drying labor expenses p.a. (15 persons@N500/day)	585,000	585,000
Peeling labor expenses p.a. (25 persons @N500/day)	975,000	N.A.
Packaging and storage material[2] (32,000 50kg bags, ropes, packaging funnel (3), wooden pallets)	50,000	50,000
Fixed cost		
Interest on capital	3,497,175	3,000,000
Total Variable Cost	**39,445,000**	**37,665,000**
Investment Costs		
Processing building	2,500,000	2,500,000
Chipping machines (4 units double chipper of 2t/day)	640,000	640,000
Concrete floors 1500m^2@N800/m^2	1,200,000	1,200,000
Drying materials (e.g. 20 rakes, 20 shovels, wheel barrow, etc)	100,000	100,000
Weighing Scale	25,000	25,000
Basins/tanks for washing and chipping (10 Nos)	30,000	30,000
Installation & other expenses	1,413,000	1,200,000
Well (water source)	20,000	20,000
Total Investment, TI	**5,928,000**	**8,715,000**
Total Production cost (Total variable cost +Total fixed cost) TP	**39,194,217**	**40,665,000**
Net profit/year (Naira) NP	**350,992**	**9,255,000**
Return to investment (NP / TI)	**0.06**	**1.06**

Source: Azogu et al (2004)

E. Investment Analysis for Small Cassava Pelleting Plant for Animal Feed

Items	Option 1. With Concrete Floor	Option 2. With Wooden Tray
Capacity	2.5t/day	2.5t/day
Output per annum[1]	195t	195t
Price Naira/T[1]	23000/t	23000/t
Number of working days	180 days	180 days
Dry loading density	10kg/m^2	15kg/m^2
Conversion factor	3:1	3:1
Total Income/annum (Naira)	**4,485,000**	**4,485,000**
Variable Cost		
Raw material required/annum	585t/annum	585t/annum
Raw material costs @N3000/T	1755000	1,755,000
Transport costs @ N500/t per annum	292500	292,500
Machinery fuel and repairs (N)	20000	20,000
Drying labor expenses p.a. (3 persons@N500/day)	117000	117000
Peeling labor expenses p.a. (3 persons @N500/day)	117000	117000
Packaging and storage material[2] (3000 50kg bags, ropes, packaging funnel (1), wooden pallets)	50000	50,000
Drying material (e.g. rakes, shovels, wheel barrow, trays[2] etc)	15000	50,000
Fixed cost		
Interest on capital @ 22.5%	594371.25	603033.75
Total Variable Cost	**2,351,500**	**2,401,500**
Investment Cost		
Processing building	750,000	750,000
Chipping machines (1 units double chipper of 2t/day)	160,000	160,000
Concrete floors 250m^2@N800/m^2	200,000	NA
Weighing Scale	25000	25,000
Basins/tanks for washing and chipping (10 nos)	10000	10,000
Installation & other expenses @10%	240,150	243650
Well (water source)	20,000	20,000
Pelleting machinery (steam conditioner, mill, pelleting press, cooler/dryer)	1,735,000	1,735,000
Total Investment cost	3,140,000	2,943,650
Total Production Cost	**2,954,533**	**3,004,533**
Net Profit (loss)	**1,530,466**	**1,480,467**
Return on Investment	**0.49**	**0.50**

1. Price for cassava pellets is estimated at 65% the price of maize. 2. Cost of trays are included only for option 2. Source: Azogu et al (2004).

F. Investment Analysis for Production of *Gari*

ITEM	GARI
Capacity	3tons/day*
Output per annum (metric tons)	840
Price (Naira/t)	70,000
Number of working days/year	280
Conversion factor	4:1
Total Income/annum (Naira)	**58,800,000**
Variable costs	
Raw material required/day (metric tons)	**12t/day**
Raw material required/annum (metric tons)	**3360**
Raw material costs @N10000/t	**33,600,000**
Transport costs @ N500/t per annum	1,680,000
Machinery, fuel and repairs (N)	7,500,000
Firewood at N1000 per day	280,000
Casual labor expenses for peeling (15 persons @N1000/day)	4,200,000
Other expenses	3,000,000
Total Variable Cost	**50,260,000**
Fixed costs	
Administrative and Personnel Costs (manager, Plant operators, security)	3,500,000
Interest on capital	1,000,000
Total Fixed Cost	**4,500,000**
Investment	
2Graters (2T/hour) at N100,000	200,000
4 Hydraulic Press (2.5T/day) at N100,000	400,000
10 Community fryers (1T/day) at N65,000	650,000
Pneumatic sieve	180,000
Bag sewing machine	55,000
Water borehole	500,000
Processing building/Training Hall/Fence/gate/Shed/security	5,000,000
Weighing Scale	25,000
Installation & other expenses @10%	2,000,000
Total Investment	**9,010,000**
Total production Cost (GC) (Total variable cost +Total fixed cost)	**55,760,000**
Net profit /year (Naira)	**3,040,000**
Return to investment (NP / TC)	**0.34**

: Output for 10 community fryers producing 1 ton per day
Source: Ezedinma et al (2005)