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Full Length Research Paper

A technical appraisal of potato value chain in Nigeria

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ABSTRACT

The study was commissioned to examine the value chain analysis of Irish potato as an industrial raw material in Nigeria. Potatoes in Nigeria are cultivated mainly by small, rural farmers in marginal areas of the country mostly in the Jos, Manbilla, Plateau and the Obudu Hills. The potato varieties contain a wide range of genetic properties which are relevant for current and future breeding purposes. The research draws attention to the three sub-chains identified within the Nigerian potato value chain; namely the production of potato for immediate consumption, the manufacturing of traditional products, potato production for industrial processing and marketing of fresh potato and potato products. Whilst all the three sub-chains can be used to improve income, the first two contribute greatly towards the conservation of biological diversity and are suitable for small farmers. Further investigation revealed that there are good varieties of potatoes available in Nigeria, although their potency has been reduced due to several usages. However, only a few are suitable for industrial processing based on their requirements with regard to quantity and quality. Nigeria has been identified as the fourth biggest producer of potato in Sub-Saharan Africa with production yield of about 843,000 tonnes per year. Despite the progress made in potato development in Nigeria, there are still some constraints which limit its production, processing and marketing. These include inadequate supply of good quality seeds, inadequate storage facilities, poor diseases, and pests' management which affects the yield and value addition to potato crop. Potato farming for industrial use was identified to have gained momentum, opening the scope for the existence and prospective flakes, starch, flour and chips makers to get the supply of raw materials to boost operations. To improve the value chain of potato the following suggestions were made; to use the value chain approach to fill the gaps through an efficient process technology and increased utilization of potato as an industrial raw materials; encourage more research work on the poor variety of seeds that is currently used by famers; the use of modern agricultural equipment to enhance the mass production of potato; to improve the storage facilities available and to encourage collaboration of relevant organisations to reverse the areas of weakness and boost awareness creation of the importance of potatoes as important energy source.

Keywords: Potato, value chain, raw materials, Production, Processing, storage.

INTRODUCTION

Potato {*Solanum tuberosum L.*} belongs to the tuber crops and there are two main types – Irish potato and sweet potato (*Ipoema batata*) which is raised through Vines, whereas the former are raised through tubers. Irish potato was first introduced in Nigeria in the late 19th Century, through missionary activities (Obigbesan, 1976). The production was encouraged by the British Colonial Government during the Second World War as the tubers were needed to feed their armed forces in West Africa. Since then, the importance of potato has been widely realised such that it is now an important commodity in both local and international trade. Although production of potato has increased by over 120% in the last 10 years in Nigeria (FAO, 1990), it is still grossly below demand. Apart from low quality seed and poor storage facilities, diseases are also a limiting factor to potato production in Nigeria (Ifenkwe and Suchomel, 1983).

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The years 2007- 2008, saw dramatic increase in the world food prices, creating a global crisis that led to political and economic instability in both the developed and developing nations. The initial causes of the late 2006 price increase were due to draughts in grain producing nations and the rising oil prices. The increase in oil price also caused general escalation in the cost of fertilizers, food transportation, industrial and agriculture products. These factors, coupled with the falling world-food stockpiles contributed to the global rise in food prices (Globe and Mail, 2008). In response to the severity of the food crisis and the need for prompt action, the World Bank Group set up the Global Food Crisis Response Program (GFRP) in May, 2008 to provide immediate relief to countries hard hit by food high prices. The Bank's response has been articulated in collaboration with United Nations "High-Level Task Force" (HLTF) on food security (World Bank, 2009). Other international organizations highlighted potato's role in world food production, in the face of developing economic problems. They cited its enormous potentials for boosting food production, being a cheap and abundant crop that grows in a wide variety of climates and localities. Due to its perishability however, only about 5% of the world potato production is traded internationally. This contributed to its stable pricing during the 2007-2008 world food crises (FAO, 2008).

To underscore the importance of potato in addressing the world food crisis, the United Nations officially declared 2008 as the "international year of the potato", in order to raise its profile in developing nations, calling the crop "hidden Treasure" (FAO, 2008). Although potato has been identified to be the fourth most important root crop in Nigeria, after Cassava, Yam, and Cocoyam (Okonkwo et al, 2009) with an efficient tuber crop in the country in terms of tuber yield and days of maturity, not much has been done towards promoting the industrial uses of the crop, thus the need to study the entire value chain of potato. Efficient processing and increased utilization of potato as an industrial raw material will reduce the losses arising from the high rate of perishability of the harvested product. The value chain approach which has been re-discovered recently by the international cooperation community can be very helpful in this regard. Although the value chain intervention is not very new, practical guidelines, best practices or experiences are still largely underdeveloped.

This research therefore, provides technical information for promoting optimal utilization of potato as an industrial raw material in Nigeria, using the value chain analysis approach. The objective of the research was to study the value chain for potato production, processing and conversion to different products in Nigeria and identifying existing technologies and technology gaps in potato processing into different products.

METHODS

The research looked into available information on potato production and the value addition in Nigeria. The empirical materials were gathered from all stakeholders in the potato value chain. These include; relevant Research Institutes; Potato Research Programme, (PRP) Kuru, Jos, National Root Crop Research Institute (NRCRI) Umudike, Plateau State Ministry of Agriculture Jos, Potato Growers Processors and Marketers Associations of Nigeria, the internet and organizations such as Food and Agricultural Organisation (FAO), International Potato Centre (CIP), Lima, Peru, etc., as illustrated in figure 1. The researchers formulated a structured, easy and simply questionnaire that was distributed to some of the farmers and cooperative leaders of potato associations that could read and write while others were interviewed by asking the questions on the questionnaire and filling in the answers based on their response. In some cases an interpreter was used so as to get the write response. The research was extended by looking at the world production statues in particular Africa. The Information gathered included production status, agronomy technologies, products, previous research findings, traditional and modern handling procedures, processing methods, and machines for processing potatoes into different products etc. The details of the methodology for the study can be found in Ugonna *et al*, (2011).

- POGMAN: - Potato Growers, Processors and Marketing Association of Nigeria
- FAO: - Food and Agricultural Organisation
- ADPs: - Agricultural Development Programme
- NRCRI: - National Root Crop Research Institute, Umudike
- PRP: - Potato Research Programme
- RMRDC: - Raw Materials Research and Development Council

RESULTS AND DISCUSSION

Production Yield of Potato in Africa

A brief analysis of potato production in various countries of Africa (Table 1) reveals that Egypt is Africa's No. 1 potato producer, followed by Malawi. Although Nigeria is known to be the fourth biggest producer of potato in Sub-Saharan Africa, it is the seventh biggest producer of potato in Africa.

In the potato world, Africa's most populous country, Nigeria, enjoys a pride of place. It is the fourth biggest producer of potato in sub-Saharan Africa, has almost as much land under potato as Germany, and potato output has grown sevenfold over the past decade, reaching

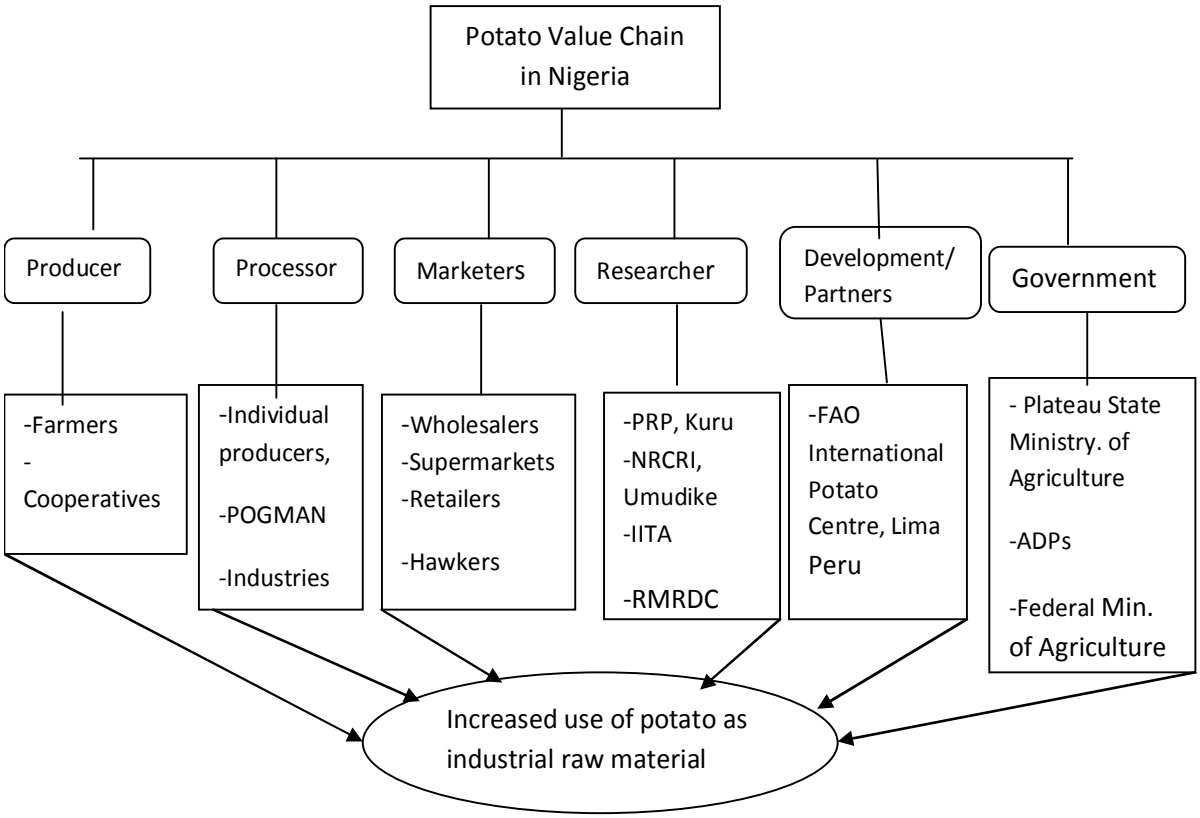

Figure 1. Stakeholders in the Potato Value Chain in Nigeria (Source: Ugonna et al, 2011).

Table 1. Production Yield of some African Countries

	African Countries	*Harvested Areas (ha)*	*Yields (t/ha)*	*Quantity produced (Tones)*
1.	*Egypt*	*105,000*	*24.8*	*2,600,000*
2.	*Malawi*	*185,000*	*11.9*	*2,200,000*
3.	*South Africa*	*58,000*	*34.0*	*1,972,391*
4.	*Algeria*	*90,000*	*21.1*	*2,180,000*
5.	*Morocco*	*60,000*	*26.0*	*1,560,000*
6.	*Rwanda*	*133,000*	*9.0*	*1,200,000*
7.	*Nigeria*	*270,000*	*3.1*	*843,000*
8.	*Kenya*	*120,000*	*6.7*	*800,000*
9.	*Uganda*	*90,000*	*7.0*	*650,000*
10.	*Angola*	*120,000*	*5.1*	*615,000*
11.	*Ethiopia*	*73,095*	*7.2*	*525,657*

(Source: World Bank Report, 2009)

843000 tonnes in 2007. The main potato growing area is the Jos Plateau, where altitudes ranging from 1200 to 1400 m and summer temperatures that rarely exceed 35°C make for a temperate climate, well suited for potato production. However, productivity is constrained by lack of suitable varieties and high land and labour costs. In fact, Nigeria records one of the world's lowest average potato yield/hectare, little more than 3.1 t/ha. Potato consumption is also very low, barely 3.2 kg per capita per year. However, Nigeria's taste for potatoes, especially in

rapidly growing urban areas, is increasing. Since 2000, imports of raw and processed potatoes have risen from less than 9,000 tonnes to 40,000 tonnes a year.

Despite the progress made in potato development in Nigeria, there are still some constraints which limit its production. These include inadequate supply of good quality seed, poor storage, diseases and pests' management, high cost of production inputs, climate limitations, marketing problems and inadequate funding of research work.

Cultivation of Potato

In Nigeria, more than 85% of the potato production is done by farmers who maintain small farms and carry out their operations manually with traditional farm tools, like hoes and machetes. The land is cleared of the debris and the thrash burnt. Ridges or flats are made depending on whether it is rain-fed or irrigated potato production. Only about 36% of farmers use tractors (Okonkwo, *et al*., 2009). This low percentage of farmers is due mainly to the high cost of renting the equipment's, coupled with the fact that the machines are not readily available and are imported. Besides, some farmers complain that the use of tractors in land preparation encourage weed growth in their farms.

Planting of Potato

There are significant differences in the way each type of potato is grown and the type of potatoes they produce. The regular potatoes are grown in a tall bag as they increase their yield and minimize the amount of digging required at harvest. Good potato husbandry can be an arduous task in some circumstances requiring ground preparation, harrowing, ploughing and rolling along with a little grace from the weather and a good source of water. Three successive ploughings, with associated harrowing and rolling, are desirable before planting. Eliminating all root-weeds is also desirable in potato cultivation. In general, the potatoes themselves are grown from the eyes of another potato and not from seed. The recommended planting materials are usually seed tubers of about 40-50mm in size. Tubers less than 25mm or those more than 50mm in size are generally not recommended for planting as yield of potato increases with increase in the size of tuber planted, but up to a point. Planting depth of 8-10cm and plant density of 33, 333plants / ha or stem density of 10-12 m2 resulted in highest ware or table tuber yield (Okonkwo *et al.* 1988).

Crop Protection

In crop protection, fertilizer application and the use of herbicides is required. Fertilizer rate of 100kg Nitrogen, 100kg Phosphorous, 40kg Potassium and micro-nutrients are recommended for crop protection in Jos Plateau. This can be applied by either spot, band or ring method and this is done within the first four weeks after planting of the seed. Potato is sensitive to weed while yield reduction of 50% has been recorded due to weed infestation (Nwokocha, 1987). Manual weeding is therefore recommended during the 4th and 8th weeks after planting. This is to avoid damaging the roots, stolons and bulking tubers. Weed is also controlled by the use of herbicides.

Harvesting of Potato

In Nigeria potato harvesting is done manually using small hoes, forks or potato harvester to lift the tubers from the soil. Potato is harvested between 65-95 Days After Planting (DAP) depending on the variety, physiological stage of seed potato planted and growing conditions. Alpha and RC777-3 varieties mature between 85-95 DAP. Early maturing varieties are ready for harvest between 65-75 DAP. These are done with a lot of care to avoid physical damage to the potato tubers as it affects the market price. The potato yield in Nigeria is more in Jos Plateau State and some of the LGAs where potatoes are grown in large quantities are Bokkos, Mangu and B/Ladi with an average yield of about 2800kg, 2950kg and 2886kg respectively. Although from the FAO report of 2009, Nigeria 3.1t/ha, this has not changed much as the total State production rate is 2.1t/ha Figure 2.

Post-Harvest Handling

The harvested potatoes tubers are carefully collected with bags from the field and care is taken to avoid skin bruises, which create storage problems. The management of potato in the field also affects tuber quality and storability. Also heat and physical damage of tubers during harvest reduces the shelf life of the tubers. Sorting follows, which involves the identification and elimination of visibly damaged tubers, nematode infested tubers, decayed tubers damaged by insects or rodents and tubers with visibly undesirable characteristics.

Sorting and Grading Techniques

The sorting of potatoes are done manually and requires trained staff who can easily identify and eliminate all the tubers with undesirable qualities (Figure 3). This ensures that only healthy and high quality tubers are stored or marketed.

After the sorting, potato tubers are graded into various sizes to separate the ware or table potatoes from

Figure 2. Harvested Potatoes

Figure 3. Sorting/Grading of Potato

seed and tiny tubers. In Nigeria, The Potato Research Programme, Kuru, Jos, grades their potato tubers into the following sizes:-

- Tubers greater than 50mm in diameter. These are used as table or ware potatoes and also for processing.
- Tubers between 40 – 50mm. These are the seed tubers.
- Tubers less than 40mm. These are also used as seed tubers but they are not good and they give a lower yield than the recommended seed size (40-50mm) (Okonkwo, 1991; Nwokocha, 1986).

Packaging and Transportation

Potatoes are packed in creates, jute bags or baskets. This is to allow the free flow of air to avoid damage before it is transported to the market or factory. Figure 4 shows potatoes being transported in bags to the market.

Storage

Storage is an important component of potato production. Potato tubers are living organs. They consume oxygen and give off carbon dioxide and heat. Their living characteristics in storage are influenced not only by the storage environment but also by genetic variety, agronomic practices during growth, pest and disease attacks and particularly by the physical condition of the tuber. In Nigeria, as high as 40 % of the stored Potato seeds are lost within three months of storage as a result of poor storage conditions (Okonkwo et al. 1988). The table potatoes harvested are rarely stored by farmers, rather they are sold as soon as they are harvested.

Industrial Uses of Potatoes

Potatoes are used for a variety of purposes in Nigeria. They are used not only as a vegetable for cooking at

Figure 4. Vehicle for transporting Potato

home, but also for industrial utilization. About 50% of potatoes grown worldwide are consumed fresh and the rest are processed into potato food products and food ingredients, feed for cattle, pigs and chickens, or processed into starch for industry, or re-used as seed tubers for growing the next season's potato crop. Recently, the global consumption of potato as food is shifting from fresh potatoes to added-value, processed food products. One of the main items in that category is the *French fries* served in restaurants and fast food centres. The world's appetite for factory-made French fries has been put at more than 11 million tonnes a year (FAO, 2008). This shows that the packed potato French fries are widely consumed all over the world including Nigeria.

Another processed product, the *potato crisp,* is the long-standing king of snack foods in many developed countries and now can be produced in Nigeria. Made from thin slices of deep-fried or baked potato, they come in a variety of flavours from simple salted to "gourmet" varieties tasting of roast beef and Thai chilli. Some crisps are produced using dough made from dehydrated potato flakes. A popular product of potato crop is marketed in Nigeria as “Pringles”, while the one produced and marketed in Nigeria are known as Monties potato chips, and The Kings.

Non-food uses: Glue, animal feed and fuel-grade ethanol

Potato starch is also widely used by the pharmaceutical, textile, wood and paper industries as an adhesive, binder, texture agent and filler, and by oil drilling firms to wash boreholes. Potato starch is a 100% bio-degradable substitute for polystyrene and other plastics. It is used, for example, in disposable plates, dishes and knives, while the peel and other "zero value" wastes from potato processing are rich in starch that can be liquefied and fermented to produce fuel-grade ethanol.

Process Technology

The process technology for the production of potato chips, starch, flour and Ethanol are shown in figure 5, 6, 7 and 8.

Value Chain Analysis

The value chain analysis of potato for industrial processing deals with the suppliers, producers and consumers while the buyer stand between the producer and the consumers. The supplier and buyer sell the potatoes directly to the processing industry or via intermediate trader, to smaller operation processing by hand, from where the goods may also go to wholesalers and retailers and then finally there, to the end consumers.

Producers: - The main producers of potato are the farmers who are mainly local and small scale farmers. In Nigeria, the main producers of potato are from the following local government areas in Jos, Plateau State: Bokkos Local Government Area, Mangu Local Government Area and Riyom Local Government Area. Potato production is restricted to some areas because it can only be grown where you have cold climate and good humid soil. This has prevented the farmers in other areas from planting potato.

Marketers/ Suppliers: - In Nigeria, most potato farmers bring their produce to village markets and sell them to either local merchants or dealers who transport them to urban markets in cities throughout Nigeria and informally across the border to other West African Countries. Potatoes are sold all year round in urban markets in Nigeria. It is estimated that over 200,000 tonnes of potato tubers are marketed in the major cities of Nigeria and about 100,000 tonnes of table potato are informally sold across the Nigerian boarders in the West African Sub-region.

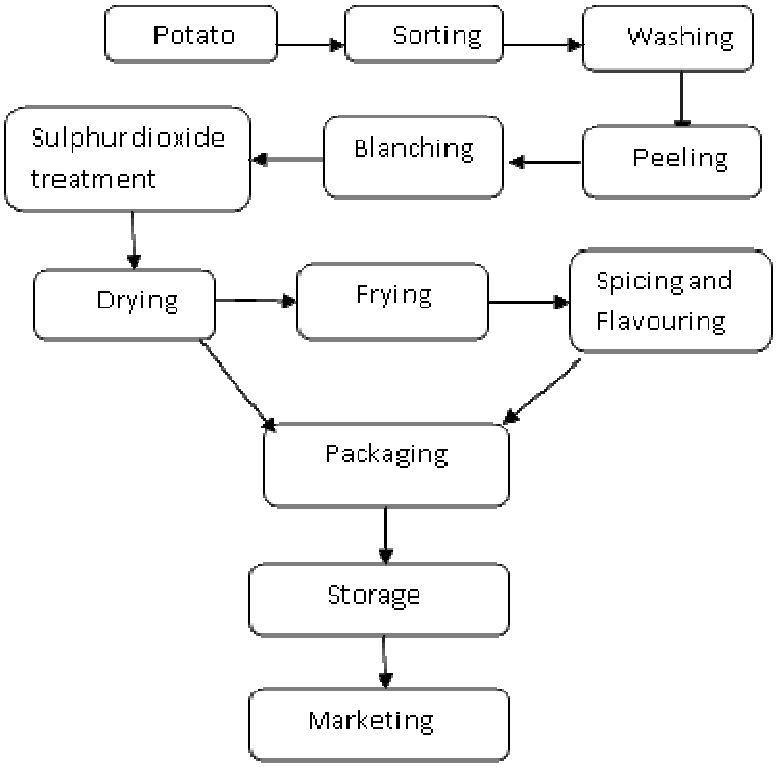

Figure 5. Flow Chart Diagram of Potato Chips Manufacturing

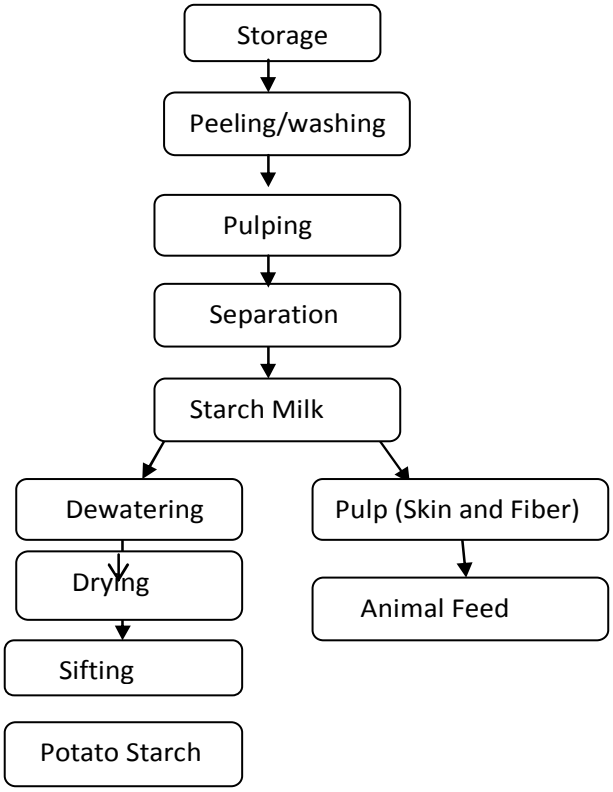

Figure 6. Flow diagram of potato starch production.

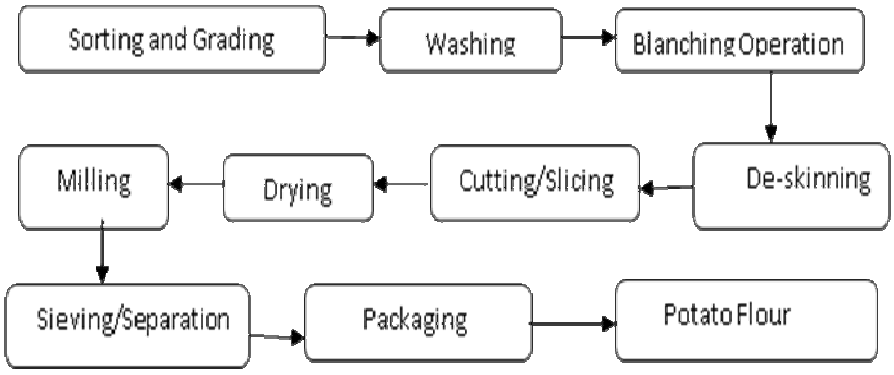

Figure 7. Flow diagram of potato flour production

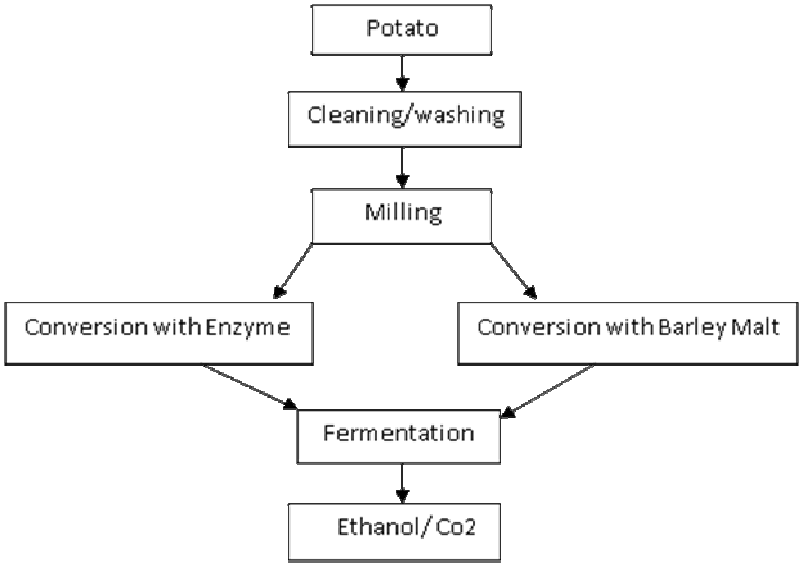

Figure 8. Flow diagram of Ethanol production from potato

Both the ware or table and seed potatoes are marketed. The ware tubers are marketed immediately after harvest in July/August and February/March each year, while seed tubers are marketed at the on-set of planting seasons. Due to the problem of limited processing industries and poor storage system, most farmers sell their potatoes at harvest and store only the seed to minimize storage loss Figure 9.

Processors: - Potato tubers being a highly perishable commodity are difficult to store, thus famers sell off most of their produce soon after harvest to reduce storage losses. Consequently there is a glut of potato tubers at harvest time and scarcity thereafter. Processing therefore is a way of reducing post-harvest losses and adding value to potato. Processing helps to preserve and ensure availability of potato products at times of scarcity and also encourages production through increased demand for tubers. Potato tubers can be processed into the following products namely: potato chips, French fries, potato dice, granules, potato flakes, potato flour, canned potato, potato starch, potato dextrin and ethanol (Burton, 1989). In Nigeria, potato tubers are processed into chips and flour.

Potato cultivars differ in a number of processing qualities such as tuber shape, eye depth, flesh colour, dormancy duration, storability, dry matter, starch and sugar composition. The round shapes and white/cream flesh coloured tubers are generally considered ideal for potato chips while oblong shapes are good for French fries. Sugar and starch composition of tubers play an important role in determining the cultivar usage. Starch is directly related to dry matter and specific gravity since 60-80% of dry matter present is starch (Okonkwo, Amadi, and Nwosu, 2009).

Figure 9. Potato market

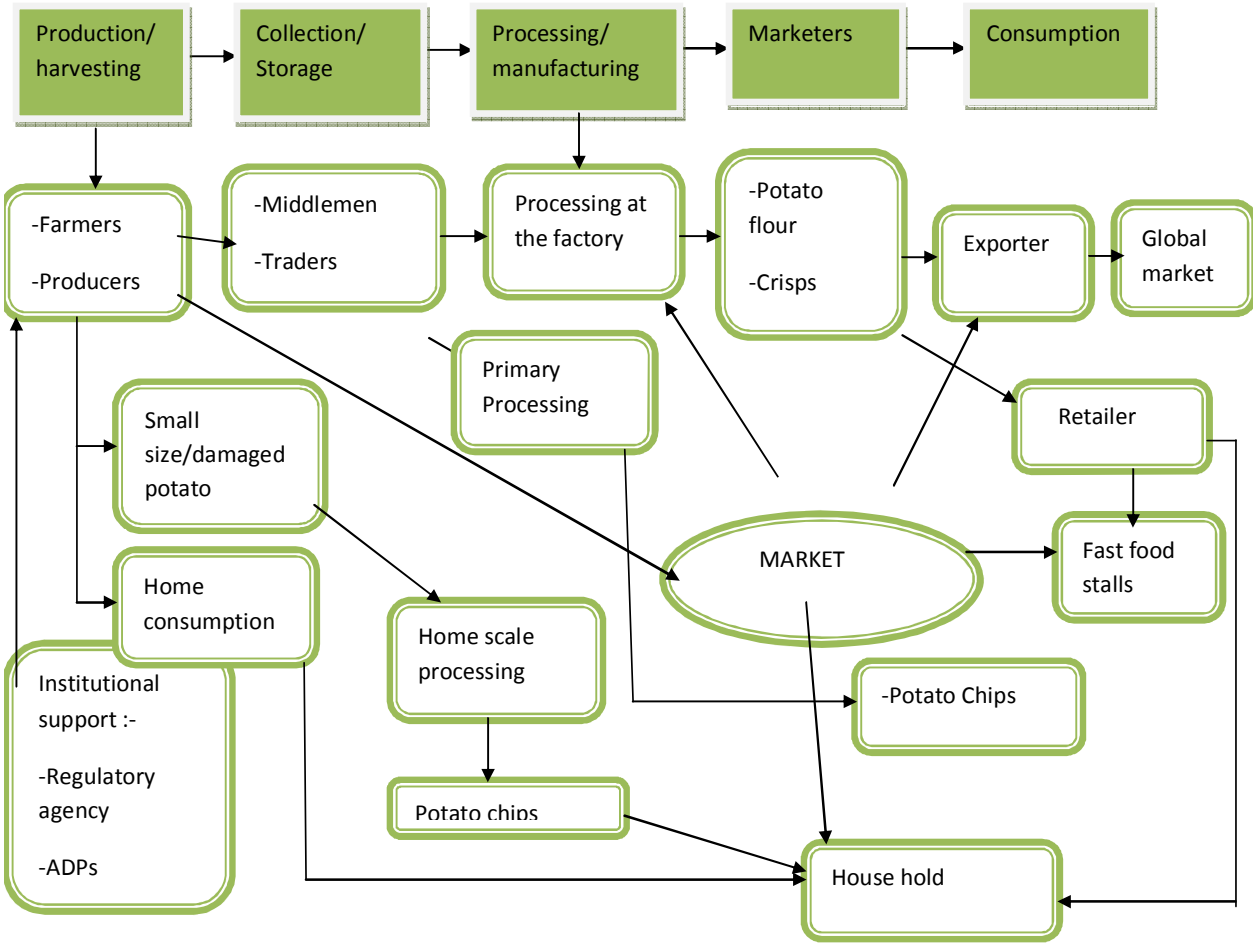

Figure 10. Potato Value Chain Analysis Ugonna *et al*, 2011

Linkages: - There is need for proper linkages among stakeholders in potato value chain: these include producers, collection/storage, processors, marketers and consumers (Figure 10).

Figure 10, shows a schematic description of the value chain for potato. The chain starts with the famers who are producers. The famers harvest the potato and it's sorted. The sorted potatoes are either stored to be sold later or they are sold immediately to the middlemen or traders, or marketing cooperatives who then sell to the processing industries. Potatoes bought by the processing industries are processed into flour, chips, starch, and

ethanol. These are bought by the retailers for local consumption and exporters for export to the global market. We can see that essentially, the different units in the entire chain are production, collection/storage, processing/manufacturing, marketing and consumption. At each of these units, there is need for intervention by the government, regulatory agencies, technology development agencies and financial institutions. Such intervention can lead to optimal production and initiation of potato to become a valuable industrial crop.

Challenges of Potato as an Industrial Raw Material

Despite the progress made in potato development in Nigeria, there are still some constraints which limit potato production, processing and marketing. These include:-

- Inadequate supply of good quality seeds: The quality of seeds available in the country affects the yield of the potato tubers produced. The improved variety of seeds which was imported into the country has been used for a number of times as such the potency is reduced.
- Inadequate storage facilities: The storage facility available is the traditional methods which do not store the potato tubers to last for more than one month. This increases the loss of potato tubers and seeds, therefore hesitate famers to sell off their produce as soon as it is harvested.
- Poor diseases and pests' management: The management of diseases and pest that affect the potato is one of the major problems the famers face as it reduces their potato yield and may even destroy the crop once the farm is affected.
- High cost of production inputs: The high cost of good seeds, labour and farming equipment is a major constrain to the quantity of potato produced. Many farmers cannot afford to buy the equipment which will increase their yield output.
- Climate limitations: Potato has been found to grow only in temperate areas, restricting the areas where potato can be grown to increase the yield.
- Activities of middlemen: The high handling charges by the middlemen affects the price of the potato and also controls the market.
- High perishability of potato tubers.
- Marketing problems: The poor transportation facilities from rural to the urban areas and the use of traditional baskets, sacks and trays for transportation damage the goods.
- Inadequate funding of research work: Lack of funds in caring out research work on potatoes inhibits the finding of solutions to the problems faced by famers.
- Inadequate Agricultural Equipment: Lack agricultural equipment affects the production output, thus leads to reduced quantity produced by farmers.

Strategies for Improvement of Value Chain

Furthermore, the inadequate funding of research work on potatoes inhibits the finding of solutions to the problems faced by famers.

- There is need to encourage more research work on the poor variety of seeds that is currently used by famers,
- The use of modern agricultural equipment to enhance the mass production of potato which could lead to export of potatoes to other country, processing of potato products, e.g. Most of the potato chips consumed in Nigeria are imported and its only two companies (Monties and The Kings) that produce potato chips which is very low for a country of 140 million people.
- There is need to encourage collaboration of relevant organisations to reverse the areas of weakness and boost awareness creation of the importance of potatoes as important energy source and above all a "hidden treasure" in the world food needs.
- The existing research centres established by Government for potato research, namely National Root Crop Research Institute, Umudike and Potato Research Institute Jos should be strengthened to achieve their mandates.
- Also the farmers and processors of potatoes need to be assisted with improved technologies and increased financial assistance to be able to acquire modern equipment for production, processing and marketing of potatoes.

CONCLUSION

Although Nigeria is the fourth largest producer of potato in sub-Saharan Africa with production yield of about 843,000 tonnes per year, there are still some constraints which limit potato production, processing and marketing. Potatoes in Nigeria are cultivated mainly by small, rural farmers in marginal areas of the country mostly in the Jos, Manbilla and Plateau and the Obudu Hills. This is despite some progress in its development in the country. The yield of potato tubers, which showed an increase, is now reduced due to inadequate supply of good quality seeds, because the imported improved variety of seeds has been used over a number of times. This has significantly reduced its potency. Also inadequate availability of such agricultural equipment's as the ridger, planter, harvesters and processing machines that will assist farmers in the planting, harvesting and processing of potato has become a major challenge.

Considering the challenges faced in potato production, the gap in potato processing and marketing is yet to be addressed. The value chain approach could be used to fill the gap, through an efficient process technology and increased utilization of potato as an

industrial raw material to reduce the losses arising due to the perishability of the harvested product.

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