Journal of Engineering and Applied Sciences 1 (2) : 117-124, 2006

Research and Development in Cassava Production and Ruminant Nutrition in Nigeria: An Overview

P.O. Okaiyeto and O.S. Lamidi
National Animal Production Research Institute Ahmadu Bello University,
Shika PMB 1096, Zaria, 810001, Nigeria

Abstract: Research and Development (R&D) achievements leads to increases in both quantitative and qualitative production levels or shifts of supply curves to the right and *Ceteris paribus,* should lower prices. For cassava, R&D has for example, made this happen but without lowering its prices. This is because apart from increased human consumption needs, its requirements for industrial use and exports have been rising. Also, downstream costs associated with its processing, storage and transportation has been rising too. Thus, its use for Ruminant nutrition has remained low and strategies are required to ameliorate the situation. This is because Trend analyses and dendogram constructed on 1982-2003 data, did not indicate significant similarity levels (less than 40.00%) between cassava production and meats outputs. However, there are R&D recommendations showing how cassava foliage, peels, chips and pellets could be used for ruminant nutrition without any adverse impacts on performance but as a good substitute of maize and crop residues. This is a contextual paper aimed at presenting an overview of these scenarios so that strategies can be recommended. It is assumed that urban and peri-urban ruminant producers, with profits maximization as their main goal, disposed to the adoption of improved management and ownership of upgraded breeds; could readily adopt the strategies if such cassava products are regularly available. This could lead to reduced importation of milk and dairy products, increased milk and meats supplies and enhanced crops-livestock linkages (economic surpluses). Also, rural empowerment, small-scale enterprises growth and sustaining incidental multiplier impacts between cassava producers and its: Processors, transporters and marketers (social gains) could prevail. Therefore, it is recommended that the three government tiers should evolve strategies that are in line with concepts postulated.

Key words: Ruminant nutrition, cassava, development, Nigeria

INTRODUCTION

General overview: Research and Development (R&D) achievements in cassava production (*upstream*) have been in the areas of introduction of High Yielding Varieties (HYV) or Tropical Manioc Selections (TMS), institutional supports and biological control of its diseases. These are linked to *downstream* ones especially in the areas of labour saving, processing and packaging; transportation and marketing activities, Nweke[1]. For example, its widespread adoption lead to both rising qualitative and quantitative production levels and were reported as: Land area put under cassava production is projected to increase at 1.3% P.A., from 2.9 million hectare in 1993-1995 to 3.3 million hectares in 2003…[2]. Two institutions, the National Roots Crops Research Institute (NRCRI), Umudike, Abia State and IITA Ibadan and some universities have made giant R&D achievements in HYV provision. It also lead to cassava being one of the six Presidential Initiatives set up by Federal Government aimed at addressing both upstream and downstream issues. The cassava initiative alone seeks to generate US$5 billion in export revenue by 2007. Since its launch in July 2002, great excitement has been generated, creating new hopes and even greater expectations. Phillips *et al.*, in Project Coordinating Unit, Report further expatiated on these by stating that:

So far 34 of the improved cassava varieties have been registered and released to farmers. The list of these varieties and their HCN levels are shown in Table 1. These improved varieties yield between 25-40 t/ha, are resistant to pests and diseases and have acceptable culinary and industrial qualities (Breckelbaum *et al.*, 1978, NRCRI, 1982-1997, IITA, 1976-1996). In comparison, local varieties yield between 5-10 t/ha and are very susceptible to pests and diseases. (Project Coordinating Unit-PCU-2003, 2004 Reports).

Table 1: Actual production of cassava in the states of Nigeria for (2000-2004)

S/N	State	2000	2001	2002	2003	2004
1	Akwa Ibom	539,170	549,870	544,520	547,195	574,550
2	Anambra	613,260	639,750	700,580	740,400	972,400
3	Bayelsa	466,990	481,060	441,720	455,790	495,130
4	Benue	3,526,380	3,554,300	3,547,320	3,544.92	35307.77
5	Borno	135,000	130,000	860,000	750,000	500,000
6	Cross River	-	-	1,994,000	2,006,720	2,000,000
7	Delta	750,300	872,140	- -	-	
8	Ebonyi	720	976.11	1.050	1,129.11	1,633.
9	Edo	539,170	549,870	544,520	544,520	574,550
10	Ekiti	716,000	584,710	584,710	590,020	600,000
11	Enugu	2,048,273	2,120,660	2,164,730	2,194,300	2,216,240
12	FCT	6,370	8,190	10,205	17,650	21,180
13	Imo	2,052.6	2,951.64	2,251.0	2,284.77	2,364.74
14	Kaduna	178,430	1,960,065	1,980,000	1,980,000	-
15	Kogi	2506	2704	2785.12	2854.832	-
16	Kwara	498.460	321.820	542.066	510.000	-
17	Nasarawa	250.000	210.000	240.000	204.670	207,740
18	Osun	2,800,000	3,100,000	3,000,000	3,500,000	4,000,000
19	Oyo	920,300	1,116,710	1,200,140	1,325,760	1,500,000
20	Rivers	-	-	-	1,080,399	827,627
21	Taraba	126,510	18,743	100,000	110,000	603,485
22	Sokoto	10,160	10,180	10,000	93,300	-
23	Zamfara	798.20	801.95	805.22	902.24	3.66
	Total	13,383,138	12,914,214	17,689,069	15,947,485	15,132,574

Source: State ADP Submissions

Cassava has immense potentials of increasing productivity in ruminants (cattle, sheep and goats). This is because R&D has shown that it can substitute adequately for maize, maize silage and crop residues by over 75.00% by feeding graded levels of its foliage, peels, chips and pellets. While it can be said that major ruminant owners (pastoral Fulani) may not be fully disposed to its procurements at visible costs for their herds; the 0.36 (49,50 cattle) and 16.96, 3.079 (1.024 million) and 93.41; 4.79 (1.098 million) and 83.01% of urban and village ruminant owners could opt for it in view of declining forage availability and rising prices of maize especially in the dry seasons[2-6].

Conceptual framework: The management concept parameters of Strength, Weakness, Opportunities and Threats (SWOT) are embedded in the inferences used in this study. Strength to turn cassava into an industrial commodity to satisfy growing domestic food and industrial requirements is assumed to prevail. The weaknesses that may reduce its impacts are in the areas of funding research of continuous R&D. This is linked with prevailing and potential opportunities for it to lead to stability of prices, qualities and quantities of processed and packaged products. Threat could arise from comparatively; high production and transportation cost (Table 2) that could reduce opportunities in view of the low cost and large volumes production pedestals of Thailand and South America.

Nonetheless, these SWOT scenarios would require minimum levels of expertise, facilities and continuous but adequate funding for R&D. These and other issues were further expatiated by Phillips *et al.*,[2] as:

A number of strategic interventions are required for sustained agricultural development. There has to be a conducive policy environment backed by rural infrastructure and support services. The farmers have to be empowered and provided with the knowledge and skills needed for increased production and the sustainable management of their farm products. Agricultural research and development(R&D) should be geared towards accelerated crop production, improved management of post harvest handling and processing of the crops to value added products. In addition, agricultural R&D should aim at strengthening both the human and institutional capabilities necessary to position agriculture for contributing adequately to national economic growth. Most of the agricultural researches that have taken place in developing countries have been concerned with technical themes-the genetic characteristics of species, adaptation to a variety of ecological environments, nutrient availability and utilization, protection of the species against pests and diseases, technologies for storage, processing and utilization. The concern is legitimate considering the pressing need to increase agricultural production in an often-hostile environment and against the background of a rapidly increasing population. Yet a wide gap continues to exist between the supply of and demand for, agricultural products.

Further importance of R&D could be shown using theoretical frameworks in economics and specifically, the concepts of economic surplus embodying consumers and

Table 2: Transportation routes and unit costs

Route	km	Tonne	Cost per km and tonne	Type of Vehicle
Ibadan-Abeokuta	77	14	3.25	3-Seater Bus
Ibadan-Abeokuta	77	18	3.25	Mazda Bus
Ibadan-Abuja	645	30	5.68	Trailer
Ibadan-Bauchi	1070	30	4.98	Trailer
Ibadan-Ilorin	162	14	2.47	3-Seater Bus
Ibadan-Ilorin	162	18	2.47	Mazda Bus
Ibadan-Iseyin	75	18	3.33	Mazda Bus
Ibadan-Iseyin	75	14	3.33	3-Seater Bus
Ibadan-Jos	928	30	4.49	Trailer
Ibadan-Kaduna	756	30	4.41	Trailer
Ibadan-Kano	1005	30	4.64	Trailer
Ibadan-Kano	1005	30	3.98	Trailer
Ibadan-Katsina	1065	30	4.07	Trailer
Ibadan-Lagos	141	30	3.55	9 11 Lorry
Ibadan-Maiduguri	1532	30	3.70	Trailer
Ibadan-Ogbomoso	100	14	3.00	3-Seater Bus
Ibadan-Ogbomoso	100	18	3.00	Mazda Bus
Ibadan-Oyo	42	18	3.57	Mazda Bus
Ibadan-Oyo	42	14	3.57	3-Seater Bus
Ibadan-Saki	165	14	2.73	3-Seater Bus
Ibadan-Saki	165	18	2.73	Mazda Bus
Ibadan-Sokoto	890	30	4.49	Trailer
Ibadan-Yola	1545	30	3.67	Trailer
Ibadan-Zaria	827	30	4.43	Trailer
Owerri-Lagos	574	15	8.13	9 11 Lorry
Owerri-Lagos	574	15	6.97	9 11 Lorry

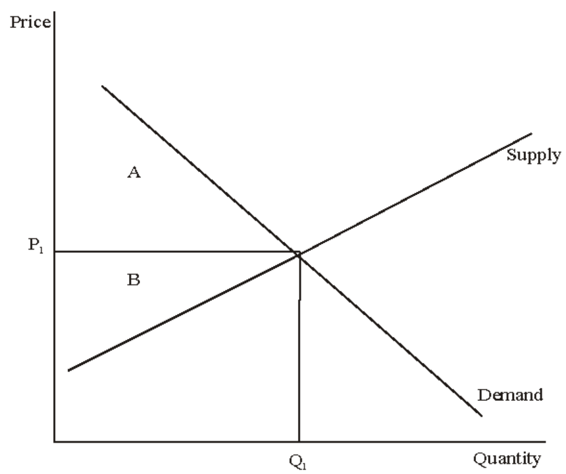

Fig. 1: Economic and consumer surpluses consumers and producers surpluses (triangle A and B)

producers' surpluses. To show it, concepts in Training Manual of the National Agricultural Research[7] and implied in Ahearn, *et al.*,[8] were used to explain how R&D shifts supply curves to the right and all things being equal-*ceteris paribus*-lowering of prices should follow it. This has not been the case in Nigeria. Prices of staples rose by between 75.00 and 100.00%.

Thus and conceptually, R&D achievements could be regarded as *endogenous* depending on other *exogenous* factors such as: weak Naira vis-à-vis USA-Dollar leading to inflationary pressures, high import contents of inputs emanating from use of fuels and oils; funds` costs due to Naira-volumes required vis-à-vis Foreign exchange components of inputs, spare-parts machineries, chemicals, drugs and other products required to sustain any productivity levels (triple Fs.). For example, rising prices of fuels (petrol and diesel) have lead to transportation costs escalations (Table 2) and enhancing the vicious impacts of triple Fs.

These concepts are shown in four Figures. Figure 1 is divided into Consumers and Producers surpluses. R&D achievements provides innovations that enables producers to supply a larger quantity at the same price, or supply same quantity at a lower price, *Ceteris paribus*. These benefits would be higher if the demand curve is flatter (elastic).

Nweke[1] showed that the income elasticity of demand for cassava is relatively high. All cassava, Fresh Roots, Gari, Dried Roots, Maize Rice and Yam had 0.78, 1.24, 0.85, 0.55 and for non-cassava (starting with maize): 0.71, 1.12 and 0.91, respectively. In the Low Income and High Income households surveyed, he reported 0.84 and curves relatively elastic. Convergences of staples` consumption limits substitution possibilities and hence, demand for it tend to remain inelastic 0.76, 1.28 and 1.21, 0.85 and 0.77, 0.57 and 0.53 and for non-cassava (starting with maize) 0.74 and 0.65, 1.13 and 1.13 and for Yam, 0.91 and 0.92, respectively. These elasticity coefficients could imply that given population (its size and structure), upward changes in disposable incomes; convergence of food products consumption Nationwide, unless a strategic plan is in place, there will be little or no cassava available for ruminant nutritional packages development. Or, its competitive edge (lower price) vis-à-vis maize and offal would be diminished adversely.

Figure 2 is showing the scenario without and with R&D. Its import is already implied above as not necessarily leading to lower prices. Figure 3 is a situation where the shift in effective demand far exceeds that of supply due to population increase, its tastes and disposable incomes. The change is being accommodated by increase in supply arising from R&D achievements.
In this scenario prices will still rise but not as much as without R&D achievements. This is the possible scenario in Nigeria.

Figure 4 shows the dendogram of Crops and Meat Similarity Levels. Years (1982-2003), production of sorghum, cassava, maize and meat were the independent variables that were used. Similarity levels are viewed in conjunction with coefficients of distances. It also shows the distance variables and it is clear that the linkage between meat and other variables have higher coefficient (1.247). The similarity levels between Years, sorghum and

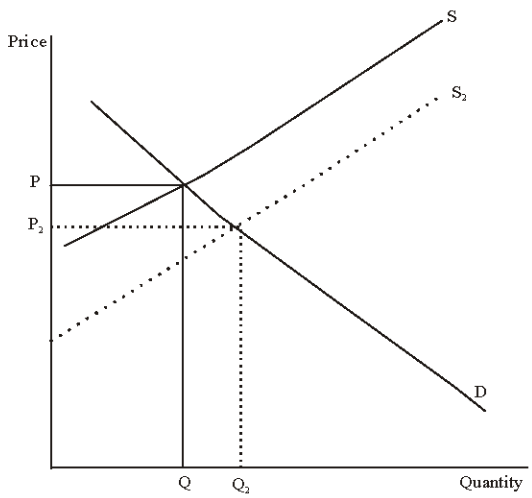

Fig. 2: Shift in Supply Curve to Right (R&D Achievement) Shift in supply to the right leads to lowered prices (*ceteris paribus*). Flatter-elastic-demand curve reduces consumer surpluses but the obverse for supply. Consumers and producers surpluses are higher with R&D induced shift-economic and social gains. R&D tendencies are to make supply

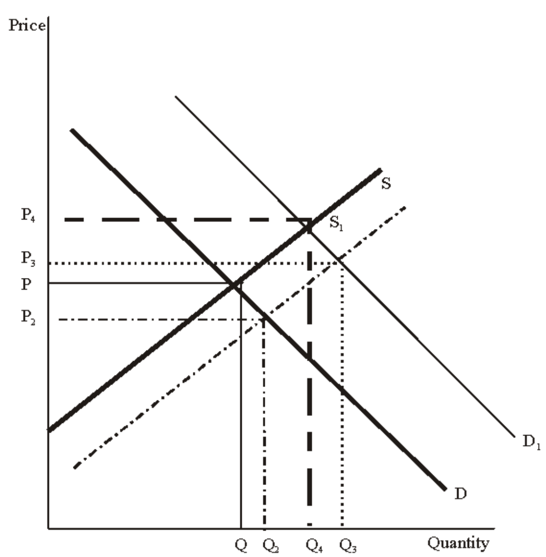

Fig. 3: Shift in Demand Greater than R&D induced Supply Original equilibrium demand and supply are P and Q. Demand has shifted from D to D_1 leading to possible price to be P_4 . R&D achievements shifts supply to S_1 and hence price to P_3 (instead of P_2 if demand has not shifted to D_1 while quantity produced will have been lower at Q_4). Although prices have risen, consumers and producers surpluses still prevailed

Table 3: Alternative uses of cassava

Sector	Current alternative product use	Substitution (%)	Equivalent in fresh cassava roots (tonnes)
Food	1180 000	20	1 000 000
Starch	67100	100	350000
Livestock	1200000	20	1000000
Ethanol	20900	100	2000000
Total			4500000

cassava production were high at above 95.00%. Maize and cassava had relatively higher similarity levels at above 75.00%. What it is showing is the immense *Opportunities* available for its use for ruminant nutrition.

The primary objective of this study is to show the achievements of R&D as it pertains
to cassava production in Nigeria. Other specific objectives are:

- Show that R&D achievements has shown that cassava products can be aptly used for ruminants nutrition especially, cattle and
- Postulate some plausible strategies that could enhance its sustainable use for increased ruminant productivity and thereby, economic and social gains.

MATERIALS AND METHODS

Sources of information/data are published materials and are listed below. Apart from it there are many other ones with foci mainly on its utilization for monogastrics (swine and poultry) and very few on ruminants especially, the Zebu breeds of cattle[10-14].

MINITAB[15] Clustering of Variables was the main analytical tool used for graph and dendogram construction. This is because it performs agglomerative hierarchical clustering of variables that can help to classify variables into groups when the groups are initially not known.

RESULTS AND DISCUSSION

Four Tables are presented and are: Table 3 that shows actual production of cassava in Nigeria. As could be noted from the Table, virtually all States in Nigeria can produce cassava. Table 2 shows the transportation costs and could be viewed as a menacing cost centre. Long distances have ranges in excess of N3.00 to N4.00 and these would be apart from other rising transaction costs arising from the impacts of triple fs.

Table 3 shows alternative uses of cassava products including livestock and hence growing and expanding opportunities. Table 4 shows the number of plants that would be required to attain its alternative uses. These Tables are indicators to the SWOT concept implying that

Table 4: Number of plants required to meet estimated demand

	Scale of operation			
Market	Small	Medium	Large	World
Food for urban	96969	-	-	-
Food for rural	29992	-	-	-
Food for export	12500	-	-	-
Food as flour	12823	-	-	-
Livestock chips	4623	2 312	-	-
Livestock pellets	-	-	39	12
Starch	4589	-	-	92
Ethanol	1145	57	29	2

cassava production when integrated with livestock production would lead to greater economic surplus and social gains. Philips *et al.*,[2] gave a succinct situation of cassava production in Nigeria when they stated that:

Previous studies have shown that there has been a steady increase in both the cultivated land area for cassava and the cassava tuber output in Nigeria between the periods of 1986 to 2001. However, the yield of the crop has been on the decline since 1991 except in 1997 when higher yields were recorded. A number of factors may contribute to this among which include losses due to pests and diseases as well as declining soil fertility. Declining interest of farmers to embark on large-scale cassava farming may also be a contributory factor. The major cassava producing areas of the country are the Southern states and the North Central geo-political zone. However, there is still some degree of cassava production in the other parts of the country such as Taraba, Gombe and Kaduna states. Within the period 1998 to 2002, Benue state with an average out put of about 3.2million tonnes of cassava from an average of 226.56 ha, showed the highest level of cassava production in the country. This was followed by Kogi state with an average of 2.72 million tonnes from 151.64 ha, Imo state, 2.44 million tonnes from 164.30 ha, Enugu, 2.43million tonnes from 153.64 ha and Osun with 1.67 million tonnes from74.94 ha. The levels of production in other states of the country varied between the lowest average Fig. of 0.16million tonnes from 5.56ha produced by Katsina state and the highest Fig. of 1.36 million tonnes from 138.74ha produced by Cross River state. However, the highest average yield of 17.08 tonnes/ha within the period was shown in Kogi state while Edo state showed the lowest average yield of 7.73 tonnes/ha among the major cassava producing states. The findings of the present study showed an identical trend in the production of cassava in the sates as Benue state was still identified as the highest cassava producing state. However, the Fig. reported for Osun state was higher than that for Kogi, while Enugu state still retained its 3rd position in the production of the crop. Although the information provided by the survey is incomplete with submissions not made by the ADP from as much as 14 states namely; Abia, Adamawa, Bauchi, Gombe, Jigawa, Kebbi, Katsina, Kano, Lagos, Niger, Ogun, Ondo, Plateau and Yobe states, the present survey showed identical trend in the production capacity of cassava in the states with that indicated by the study.

Nweke[1] started by showing that in Nigeria, utilization of Dried Roots, Gari and Pasty Products for food accounted for 48.00, 39.00 and 13.00%, respectively. Consequently, should human consumption be on the increase, the competition would be stiffer. Apart from these major ones, there is its rising demand for industrial starch, malt, pharmaceutical and ethanol uses (Table 3). He suggested the need to internalise the use of chips and pellets for livestock because of depressed international market for cassava products. Like other scholars before him, the issue of toxicity of cassava was highlighted and the required processing enumerated. Equally, types of crop protection requirements for good yields were mentioned. TMS with high yielding capacities and being able to be harvested between one and two years (low bulking period) were presented. In addition, he mentioned limitations arising from the root structure/conformity of cassava as not being adaptable to mechanization (harvesting and peeling). These are within SWOT concept parameter of weakness.

Phillips *et al.*,[2] dwelled on R&D areas enunciated by Nweke[1]. They also showed those releases (TMS) by both IITA and NCRI that have been adopted and levels of HCN toxicity being acceptable and should be preferred when chips and pellets making are in view. Production and utilization of foliage, peels, chips and pellets were discussed machineries and equipment for its production presented. They stated that:

Chip production involves the simple technique of cutting peeled or unpeeled cassava roots into smaller pieces and allowing the pieces to dry. Sun drying is the most common technique, while different types of chipping machines or choppers are used. Pellet production was stimulated by the need to improve the uniformity in the shape and size of cassava chips required by the users and animal feed producers. In addition, during transportation, loading and unloading of chips, dust generation caused serious air pollution, placing pressure on the importers in Europe to improve the nature of cassava products handled by the ports. Production of pellets involves pressing chips and extrusion through a large die. The heat and moisture in the chips help in the formation of pellet-like shaped product known as soft pellets. Later process developments involved grinding of chips followed by steam extrusion. This process produces strong pellets upon cooling. These types of pellets are known as hard pellets. The NRCRI in collaboration with Product

Development Institute (PRODA) Enugu assembled a machine that could effectively convert cassava mash into pellets. A third of the dewatered mash mixed with double its volume of boiling water and stirred into a very viscous materials, was added to the remaining two third of the mash to get a viscous dough which was then fed into a hopper of the pelleting machine for pellet production. The machine, has a calculated through put of 257 kg/hr (using screw extruder), produced pellets of 20mm (length) by 10mm (diameter). With cyanide levels of 1.35-2.12 mg kg^{-1} the pellets could be used as a carbohydrate source in livestock feed. Low mean moisture content (approx. 9%) also makes for storability with good packaging.

Also, these authors presented lists of research institutes, universities and others that are involved in its R&D in all aspects of cassava as an economic crop. The core experts working on it were listed. Finally, there is the list of locally made machineries and equipments needed in cassava processing (into chips and pellets). Therefore, there are structures and facilities, albeit at growth stages, that can enhance integrated cassava products utilization.

These presentations and Presidential Initiative on Cassava has shown the wider implications of applying SWOT concept parameters to it. In terms of exports opportunities, there are threats embedded in it. As already stated, re-entry of Thailand (now restricted as a result of avian-related infestations) could lead to global price depressions for cassava products. Presently, semblance of price stability is maintained by the china-effect arising from her phenomenal demand for non-South East Asian Nations cassava chips and pellets. This supports the view of Nweke[1] that Nigeria should evolve strategies that would increase internalisation of cassava products utilization. Further expatiations are by Phillips *et al*.,[2] when they stated that:

It has been observed that some inter-and intra-regional trade on cassava exist in Africa. However, there has not been any documented record on the volume and nature of these trades. Indications are therefore to the effect that the trades have been more on illegal trans boarder transactions. A growing interest have recently been indicated for commercial approach on intra African trade on cassava following the initiative of President Olusegun Obasanjo through the Presidential Committee on cassava for Export. Besides the national use of cassava, several West African countries have ventured into the export of cassava products to the European Community (EU) with mixed success. The major limitation to this export market is the fixed 145,000 tonnes quota granted for ACP countries by the EU. In Asia, very little cassava is utilized for direct human consumption (except in Indonesia) and most is processed into chips and pellets. The cassava starch industry is most important and most dynamic in Thailand, followed by Indonesia, China, India and Vietnam. Relatively new entrants into the Asian cassava starch industry are Vietnam and China. Since their respective initial free market policy implementations, very significant investments have been made on cassava starch based, largely export oriented industries. Most of the starch products are destined for the food processing (MSG, noodles etc), soft drinks and pharmaceutical industries. For this purpose, both China and Indonesia originally, exporters of cassava presently import cassava products in the form of chips and pellets for their growing processing industries. In fact, China is fast replacing EU as a major importer of cassava chips with over 1million tonne import of the commodity in 2002. Other importers of cassava chips in the Asian region include Japan, South Korea and Malaysia.

The major cassava products exported to the EU are the chips and pellets. Thailand is the major supplier contributing about 90% of the products requirements of these markets. In Latin America and the Caribbean, cassava continues its transition towards a market oriented product and raw materials for the processing industries. The utilization of cassava both as food and for the processing industries have significantly been on the increase in Brazil, followed by Colombia, Venezuela and recently Paraguay. The export of cassava roots to the US and the EU (for food consumption by mainly ethnic groups) is presently dominated by Costa Rica.

The relevance of cassava products for ruminant production is inferred from Nestel and Graham[3] and Hahn *et al*.,[4]. The high proximate values of cassava. His Table 1 showed the chemical compositions while trials were reported in his Tables 3 where he quoted Olaloku as showing that with 71.00% cassava roots and a basal diet of hay, maize, groundnut cake and palm kernel cake, White Fulani cows indicated increase in milk and fat yields. These were supported by Hahn *et al*.,[4] who cited authors that showed how cassava foliage, its peels, chips and pellets have no adverse but benefiting impacts on livestock performances. They listed types of machineries / equipments required for its processing. The advantages of chips and pellets in terms of lowering of weight and ease of transportation and given the poor storage of fresh roots, optimum means of its preservation were also listed.

Alli-Balogun[16] concluded that feeding cassava foliage or groundnut haulms as a supplement to gamba hay, improved weight gain but the combination of both supplement gave better weight in goats. The reason for scarcity of works on ruminants could be because in the humid and Sub-Humid ecological zones incidences of endemic and epidemic diseases limits ruminant management. Cassava could be grown all the Zones, but the arid and semi-arid ones have lower comparative advantages. Finally, there is very low awareness on its use as its leaves and TMS and NR (bitter) varieties are viewed as toxic. Its processed products chips are processed for human consumption and pellets, generally not available.

FAO/UNO citing PCU showed that Nigeria has potentials for internalising the effective demand for chips and pellets to prevail. This is shown on Table 4. What would be required are extension packages` deliveries on its appropriate use and its regular supplies especially to areas of very low comparative advantages in its production. With these in place, ruminant producers would possibly opt for it and the Presidential initiative would have enhanced its exports and increased productivity of ruminants.

Muller, in Nestel *et al.*,[3] continued in the same realm showed that cassava root products have lower amylase content than maize - 17.00 versus 21.00%, respectively but quite satisfactory for ruminant nutrition as long as Non Protein Nitrogen (NPN) compounds are added to it and continued by showing that 10-40 tones per hectare of cassava leaves can be harvested within 4-5 months and used for livestock feeding. Thus, cassava can be grown for primarily harvesting of its foliage for ruminant nutrition while the bulking limitation of its roots development waits future harvesting. Citing the proximate analyses by Hohn he presented the protein values of cassava foliage of Thailand varieties that showed crude protein levels of 24.8, 22.8 and 24.1 when harvested in the wet season at four, six and eight weeks. The Fig. for dry season are 25.8, 29.0 and 25.4 %, respectively. Further, he showed that cassava when sliced dries better with quicker within 16 hours and loss of between 13.8 and 13.1% moisture when it is on white concrete floor at 28-30^{o}Centrigrade – ambient temperature. Also faster drying will occur if black cement floor and at 31-32.5^{o} Centigrade when moisture can be reduced to between 10.6 and 6.9%, respectively. Nigeria has institutions that can construct various types of solar dryers relying mainly on the sun or integrating it with mechanical or electrical assistance. UDU, Sokoto and NPRI/ABU, Zaria is among the institutions with wide and cogent experiences in this area.

Oguntimein in Hahn *et al.*,[4] showed the flow chart for mechanical processing of cassava into chips and pellets. It starts from upstream activities to downstream ones. That is, with harvesting that will require washing or sent to chipping machinery directly. Drying, milling and then pelleting follows it. Packaging could prevail from drying and at the end, packaging, storage and marketing. Different types of dryers that can be used such as static, moving bed and rotary dryers some with motorised and external moisture extraction equipments and machineries were also discussed. There are many private organizations in Nigeria apart from IITA, PRODA Enugu and NCRI, National Centre for Agricultural Mechanization (NCAM Ilorin); universities and polytechnics that can construct these facilities satisfactorily[9].

The Nigeria Cassava Growers Association has suggested that each Senatorial district in the major cassava producing areas should have processing facilities for chips and. The Association showed that for cassava production, $400,000.00 (USA Dollars) would be required to establish 100 farmers/centres at $4,000.00 each in the Senatorial Districts. The breakdown of costs are: 8.00, 3.60, 2.00, 14.00, 33.00, 2.00, 12.00, 1.50, 10.00 and 14.00% of total costs for: ploughing (double), harrowing, planting, planting materials, fertilizer, its application, Herbicide, its application, Weeding (twice) and Miscellaneous Costs. The total was N50, 000.00 per hectares and for 100 farms/centres N5.00 million.

CONCLUSIONS

This study has shown the importance and achievements of R&D especially and within the concepts-parameters of Strength, Weakness, Opportunities and Threats (SWOT) as it impacts upon economic surplus and social gains. It also raised and discussed two possible scenarios. These are in the areas of cassava products exports and strategies toward its utilization for ruminant production. The strategies recommended are as follows:

- States and Local Government Authorities (LGAs) not having comparative advantages in cassava production should enter into formal agreements with those with it for chips and pellets supplies at guaranteed minimum prices.
- Solar dryer development should receive greater impetuses so that drying of fresh cassava products (foliage, roots and chips) can be done optimally. Five communal drying centres each Ward of an LGA is recommended.
- Presidential Initiatives should integrate holistically, all aspects of cassava utilization and especially its processing into chips and pellets for ruminants.
- Funding of R&D should be comprehensive and approved funds timely released in order for mandates to be duly pursued by research institutes.

In summary, nutritional packages using cassava foliage, its peels, chips and pellets could raise ruminant productivity and thereby internalising the SWOT concept-parameters of R&D achievements. It would lead to enhanced crops-livestock linkages, rising rural empowerment, small-scale enterprises growth and sustain various levels of multiplier impacts between cassava producers, processors, transporters and marketers. These could be simultaneously attained with exports drives of Government. But the latter could face periodic global excess supplies and price depressions.

REFERENCES

1. Nweke, F., 2004. Challenges in the Cassava Transformation in Nigeria and Ghana. Environment and Production Technology Division. IFPRI, 2033 K Street, NW Washington DC 20006, USA, pp: 1-118.
2. Phillips, T.P., D.S. Taylor, L. Sanni and M.O. Akoroda, 2004. IFAD/FAO of the UNO, Rome and University of Abeokuta, Nigeria in PCU- Federal Ministry of Agriculture and Rural Development, Garki, Abuja, pp: 1-62.
3. Nestel, B. and M. Graham Editors, 1977. Cassava as animal feed. Proceeding of a Workshop held at the University of Guelph, pp: 107-125.
4. Hahn, S.K., L. Reynolds and G.N. Egbunike, 1988. Cassava as Livestock Feeds in Africa. Proceedings of the IITA/ILCA/University of Ibadan, pp: 39-103.
5. Federal Department of Livestock and Pest Control Services, 1984-1992. Unpublished Annual Reports of FDL&PCS, FMA and R&D, Garki, Abuja.
6. Fricke, W., 1979. Cattle Husbandry in Nigeria. A Study of its Ecological conditions and Sociogeographical Differentiations. Heidelberger Geographische Arbeiten, Germany, pp: 23-126, 87-93, 120-121, 133-159.
7. National Agricultural Research Program-NARP, 1998. The Economic Impact of Agricultural Research: A Practical Guide. NARP Headquarters, Ibadan, pp: 6-35.
8. Ahaern, J.Y. and W. Hufnan, 2002. Research and Development, Productivity and Structural Change in United States Agriculture, 1960-1995. Economic Research Services, 1800 M Street, NW Washington DC 20036, pp: 1-35.
9. Nigeria Cassava Growers Association, 2003. Costs Analyses in Cassava Production in Nigeria. Unpublished mimeograph submitted to Federal Ministry of Agriculture, pp: 2-18.
10. Nweke, F., 2004. International Food Policy Research Institute, Washington, USA. Extensive upstream and downstream strength, weakness, opportunities and threats to expanded cassava production and processing are shown, 12: 1-118.
11. Phillips, T.P., Taylor, D.S., Sanni, L. and Akoroda M.O., 2004. IFAD/FAO of the UNO, Rome and University of Abeokuta, Nigeria. Similar approach with Nweke above, 18: 1-62.
12. Nestle, B. and M. Graham, 1977. Cassava as Animal Feed. Proceedings of a Workshop held at the University of Guelph, pp: 22-109.
13. Hahn, S.K., Reynolds, L. and G.N. Egbunike, 1988. Cassava as Livestock Feeds in Africa. Proceedings of the IITA/ILCA/University of Ibadan, pp:39-103.
14. Nigeria Cassava Growers Association, 2004. Costs Analyses as accessed from the Internet. The association showed costs analyses for cassava production but not utilization for ruminant nutrition, 8: 1-5.
15. MINITAB Inc, 1994. Windows Operated Software. 3081 Enterprise Drive, State College, Pennsylvania, 16801-3008, USA.
16. Alli-Balogun, J.K., C.A.M. Lakpini, J.P. Alawa, A. Mohammed and A.J. Nwante, 2003. Evaluation of Cassava foliage as a protein supplement for Sheep. Nigerian J. Anim. Production, 30: 7-46.