Sweetpotato Production, Utilization, and Marketing in Nigeria

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EXECUTIVE SUMMARY

In Nigeria, sweetpotato (*Ipomoea batatas*) production, marketing and utilisation have expanded beyond the traditional areas of the central and riverine zones to the humid, sub-humid and semi-arid regions in the last two-and-a-half decades. The national production figures reported by FAO showed a rapid increase in production and area harvested in the 1990s, surpassing two million tonnes harvested from more than 300,000 hectares annually by the end of the decade. However, estimates of sweetpotato in Nigeria vary widely among different sources, and as such these statistics should be interpreted with caution. FAO estimates of average sweetpotato yield of 5 to 8 t/ha are similar with estimates from farm surveys conducted by state agricultural development projects which reported yields of popular local varieties from 7 t/ha in the southeastern zone, 3.5 t/ha in the northern zone, and 7 to 8 t/ha in Plateau and Bauchi states. Farm yields remain far below that obtained from research plots with improved varieties, however. Estimated yields in the research stations vary from 40 to 70 t/ha for improved varieties while multilocational trials for improved varieties registered 23.5 t/ha yield across seasons and locations. These results suggest there is substantial scope for increasing sweetpotato productivity in Nigeria.

Production is largely rainfed while in the northern zones, planting is done along riverbanks and irrigation canals. Weevil and black rot are among the major obstacles to sweetpotato production and storage. Clones resistant to *C. puncticolis*, sweetpotato virus disease (SPVD) and black rot have been identified by the International Institute for Tropical Agriculture (IITA) and the National Rootcrop Research Institute (NRCRI). Improved agronomic practices were also recommended.

Sweetpotato is traditionally consumed in boiled form with varying accompaniments including cowpea, rice, millet and benniseed. In the semi-arid zone, sweetpotato flour is popularly used for sweetening local foods while in the urban markets of the humid south, sweetpotato fried chips are produced and marketed. Because sweetness of popular clones make them undesirable as staple food in Nigeria, IITA and NRCRI have identified more than 60 non-sweet clones. One non-sweet clone, TIS 87/0087, has an average yield of 40 t/ha. Feed use is limited to damaged or small-sized tubers and leaves and vines for rabbits, sheep, goats and cattle in all the parts of the country.

Return on investments in sweetpotato production is marginal. Production cost of ₦32,000/ha[1] yields an average of 5.16 tonnes, or N6.2/kg. With market prices varying from ₦5/kg to ₦15/kg throughout the year, farmers may sell at a loss when prices are at their lowest. Market prices of sweetpotato compare with maize and yam and are much higher than cassava. Hence, sweetpotato cannot compete favourably as a raw material for root- and tuber-based industries. Transportation accounts for the largest share of distribution cost of sweetpotato.

The following recommendations are made to improve the competitiveness of sweetpotato in the rapidly expanding root- and tuber-based industry in Nigeria:

1. A nationwide diagnostic survey should be carried out to enable effective planning for increased production and utilisation of the crop.

2. Promising varieties should be obtained from the International Potato Center (CIP) and NRCRI collections for field evaluation and dissemination. High-yielding non-sweet clones are needed to enhance acceptance of sweetpotato as a staple food. Distribution of improved varieties must be complemented with training in improved cultural practices.

3. Specific agro-processing industries need to be targeted to expand utilisation of sweetpotato in

[1] US$1=₦83 throughout this report.

Nigeria. The livestock feed, alcohol and sweetpotato chips industries are recommended target industries. Locally available technologies need to be perfected in research stations and selected pilot project sites to convince processors of their commercial viability.

4. Promotional campaigns to link sweetpotato producers and processors to relevant consumer industries should be mounted to facilitate marketing of yield surpluses. Failure to complement the increase in sweetpotato production with adequate promotion and marketing to absorb yield surpluses has been detrimental to the sustainability of sweetpotato production in Africa, as is the case in Cameroon. As women are responsible for the bulk of processed rootcrops in Nigeria, the Women in Agriculture (WIA) programme of the state-level agricultural development projects is strongly recommended as an outfit to facilitate promotion of proven processing technologies among women and multipurpose cooperatives.

CHAPTER ONE

1.1 Background information

Sweetpotato *(Ipomoea batatas)* is only a minor rootcrop in tropical Africa despite its potentials as indicated by its growth in terms of production. Among the root and tuber crops, it is the only one that had a positive per capita annual rate of increase in production in Sub-Saharan Africa.

Sweetpotato has a high yield potential that may be realized within a relatively short growing season and an adaptability to a wide ecological range of 0 to 2000 meters above sea level and 30° N to 30°S (Hahn 1984). Presently, it does not find much use as food in most parts of Africa except in Burundi, Rwanda and Zaire, which accounted for over 46 percent of African sweetpotato production in 1984.

Its high agronomic potential has been demonstrated at the International Institute of Tropical Agriculture (IITA) and the National Root Crops Research Institute (NRCRI), which are both located in the humid zone of Nigeria. Considerable work has also been done through collaboration between IITA and the University of Ibadan on post-harvest utilisation of sweetpotato for humans and animals.

The middle-belt region of Nigeria traditionally grows sweetpotato and it appears that some indigenous post-harvest methods are also practiced. These, however, have not been comprehensively documented.

1.2 Justification

Cultivation of root and tuber crops in Nigeria as in most African countries is threatened by the low prices of the crops and their products. With the rising cost of labour and transportation, rural farmers can hardly sustain their farming systems considering the meagre returns from their harvest. It is therefore advantageous to diversify the use of rootcrops beyond those of the traditional food industry in African countries. Because sweetpotato surpasses other rootcrops in terms of agronomic potentials, diversification into other food, feed and industrial uses will increase demand, ensure attractive prices and consequently encourage farmers to sustain and expand their rootcrop farming units.

Before this can be done, it is critical to have a detailed documentation of the production, utilisation and marketing of this crop in Nigeria so that effective interventions to develop products that will suit the economic limits and socio-cultural habits of the populace can be put in place. The existence of technologies in Asia, USA and other parts of the world will accelerate development of such suitable products as soon as bottlenecks to their production, utilisation and marketing are identified.

1.3 Objectives

This study sought to:

1. Document the current level, locations and systems of sweetpotato production, marketing and utilisation;
2. Identify the constraints to the expansion and sustainability of sweetpotato production;
3. Identify indigenous and other possible uses of sweetpotato;

4. Identify factors in the marketing system of sweetpotato in particular, and root and tuber crops in general, that militate against their profitability; and
5. Recommend strategies for enhancing sweetpotato production, demand and profitability.

1.4 Methodology

A comprehensive survey of institutions concerned with root and tuber crops research and those with established library facilities in Nigeria was conducted to collect and synthesize secondary data on sweetpotato. The following are the institutions where secondary data were collected:

1. The University of Ibadan, Nigeria
2. The International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria
3. Nigeria Institute for Social and Economic Research (NISER), Ibadan, Nigeria
4. National Rootcrop Research Institute (NRCRI), Umudike, Nigeria
5. Ahmadu Bello University, Zaria, Kaduna State, Nigeria
6. Institute of Agricultural Research and Training, Moor Plantation (IART), Ibadan, Nigeria
7. Nigerian Institute for Horticultural Research (NIHORT), Idi-Ishin, Ibadan, Nigeria
8. University of Jos, Plateau State, Nigeria
9. Eight River Basin Authorities in Nigeria

Secondary data complemented primary data on production, utilisation and marketing of sweetpotato in particular, or of root and tuber crops in general, in different ecological zones in Nigeria. Scientists from the University of Ibadan, the NRCRI and the Oyo State Agricultural Development Programme (OSADEP) developed the questionnaires and planned the survey visits to the study areas to gather the primary data.

Experience has shown that some farmers, especially the less literate, were reluctant to respond to questionnaires. Therefore, informal discussions were conducted between the respondents and the enumerators whenever necessary. The details of the questionnaire on production, marketing and utilisation are in Appendix A.

1.5 Time frame of the study

The project commenced in September 1995 when sweetpotato harvesting started in most parts of the country. The field survey lasted for six months, terminating in March 1996, as shown in the following project calendar:

ACTIVITIES	SEPT '95	OCT '95	NOV. '95	DEC. '95	JAN. '96	FEB. '96	MAR-JUNE '96	JULY-DEC. '96
Scientists' meeting			← →					
Questionnaire administration and library search	←	—	—	—	—	—	→	
Data collation and analysis				←	—	—	→	
Draft report compilation							←	→
Final report compilation								← →

1.6 Organisation of the report

This report is presented in four chapters. The first chapter provides the background and methodology of the study. Chapter 2 is a review of literature on the production status, processing and utilisation of sweetpotato in Nigeria. Research on agronomy, pest and disease management, product development and economics of sweetpotato production are presented as much as possible in chronological sequence. Clones that are recommended for specific zones and products are highlighted. Bottlenecks in sweetpotato production and utilisation are also identified.

Chapter 3 reports the results of a pilot survey in different agro-ecological zones of Nigeria. This report provides information on sweetpotato/root and tuber crop production, processing, utilisation and marketing in the humid, sub-humid and the semi-arid zones.

Finally, Chapter 4 summarizes the findings, particularly the variations notes in the parameters across zones. The chapter also discusses strategies to promote sustainable sweetpotato production and utilisation in Nigeria based on a comparison of different scenarios to test the viability of different sweetpotato enterprises.

CHAPTER TWO

2.1 Status of production

Sweetpotato is a minor crop in Nigeria. According to Agboola (1979), it was cultivated in a few restricted areas by farmers for their own consumption. The 1955 to 1960 agricultural sample censuses reported that 37,000 tonnes of potatoes were produced on 14,985 ha of land in Northern Nigeria, without differentiating between figures for sweetpotato and Irish potato (*Solanum tuberosum*). However, after taking into account small amounts of production in all parts of the country, it was estimated that the land area planted to sweetpotato increased from 12,960 to 15,795 ha from 1959 to 1970.

The areas of potato cultivation (sweetpotato and Irish potato) as of 1971 were the middle-belt and riverine states. Agboola (1979) also reported that the ideal planting period in Nigeria was between May and July, depending on the onset of early rains, with the sweetpotato requiring four to six months to mature. The sweetpotato root is a rich source of carbohydrates, the young and tender leaves are useful as vegetables and the vines provide forage for ruminant stock. The Oyun Division of Kwara State in the sub-humid region was reported as the main source of sweetpotato production in Northern Nigeria.

According to FAO, production of sweetpotato in Nigeria increased from 149,000 metric tonnes in 1961 to 2,468,000 metric tonnes in 2000. Area of cultivation increased from 13,000 ha to 381,000 ha while yield decreased from 11 t/ha to 6.8 t/ha over the same period. However, estimates of sweetpotato production in Nigeria vary widely among different sources. The report of the Presidential Task Force on Alternate Formulations of Livestock Feeds (AFLF 1992) set the national production at 530,000 tonnes for 1990, compared with FAO's estimate of 143,000 tonnes for the same year. Nevertheless, FAO statistics did show a major increase in the importance of sweetpotato in Nigeria in the 1990s, with production growing by nearly ten times over the decade.

FAO found that 80 percent of the sweetpotato produced in Nigeria was used for human food (CIP 1994b). In the Offa district in particular, it was the staple rootcrop consumed by most of the people. Details of FAO statistics on sweetpotato production in West African countries are shown in Appendix Tables B.1 to B.3.

Table 2.1 shows sweetpotato production by state in Nigeria for 1990, together with that of other root and tuber crops and some important field crops. States are classified by major agro-ecological zones in Table 2.2. The semi-arid zone accounted for about two-thirds of sweetpotato production in 1990. The humid and sub-humid (middle-belt) zones accounted for 15 and 18 percent of sweetpotato production, respectively.

Table 2.1. Root and tuber crop production by state in 1990

State	Population	Root and tuber crop production (tonnes)						
		Cassava	Yam	Cocoyam	Sweetpotato	Maize	Sorghum	Millet
Abuja	378,671	6,820	80,581	0	218	9,330	3,954	1,135
Akwa Ibom	2,359,736	257,634	120,832	22,668	1,145	31,805	0	0
Anambra	5,929,198	1,154,859	1,327,256	111,946	54,437	137,852	2,197	884
Bauchi	4,294,413	104,440	18,258	10,581	82,558	229,003	223,507	251,939
Bendel	4,730,029	945,042	910,061	25,111	3,201	103,695	3,401	0
Benue	4,879,444	557,349	46,632	15,022	62,783	88,192	90,202	56,156
Borno	4,008,070	6,742	0	0	1,043	30,819	288,077	378,406
Cross Rivers	1,865,604	721,508	237,534	21,590	5,966	70,212	0	0
Gongola	3,604,639	161,297	338,674	66,055	17,282	162,019	149,286	41,853
Imo	4,783,477	1,780,790	1,186,243	202,338	0	219,182	0	692
Kaduna	3,969,252	346,858	322,265	71,331	120,313	341,321	189,483	50,465
Kano	8,461,969	230,174	6,216	804	37,016	227,068	751,791	683,679
Kastina	3,878,344	19,733	28,817	21,152	18,447	473,291	311,493	337,534
Kwara	1,566,469	402,116	256,555	5,692	569	61,108	24,908	1,776
Lagos	5,685,781	266,688	50,702	8,095	1,025	89,123	0	0
Niger	2,482,367	76,389	175,346	12,816	17,212	45,586	85,488	20,516
Ogun	2,338,570	583,554	91,996	43,774	1,281	74,339	0	0
Ondo	3,884,485	1,992,935	193,434	51,263	1,178	140,410	303	0
Oyo	5,691,805	1,960,423	717,149	31,950	8,959	280,859	6,498	0
Plateau	3,283,704	266,197	257,302	31,950	15,950	186,960	146,515	58,965
Rivers	3,983,857	296,824	228,935	32,273	980	55,048	0	0
Sokoto	6,454,617	246,726	0	558	75,663	155,558	503,007	437,061
National Total	88,514,501	12,385,100	6,594,789	786,972	527,226	3,212,781	2,780,109	2,321,062

Source: Presidential Task Force on Alternative Formulations of Livestock Feeds (AFLF 1992)

Table 2.2. Sweetpotato production by major agro-ecological zone in 1990

Humid zone		Sub-humid zone		Semi-arid zone	
States	Production (tonnes)	States	Production (tonnes)	States	Production (tonnes)
Akwa Ibom	1,145	Niger	17,212	Sokoto	75,663
Anambra	54,437	Kwara	569	Kaduna	120,313
Bendel	3,201	Plateau	15,950	Katsina	18,447
Cross Rivers	5,966	Benue	62,783	Kano	37,016
Imo	0	Abuja	218	Borno	1,043
Lagos	1,025			Gongola	17,282
Ogun	1,281			Bauchi	82,558
Ondo	1,178				
Oyo	8,959				
Total	78,173		96,732		352,321
Share of total	15%		18%		67%

Source: Presidential Task Force on Alternative Formulations of Livestock Feeds (AFLF 1992)

2.2 Research highlights

Two institutions have been particularly active in improving the production and utilisation of sweetpotato in Nigeria, namely, the National Rootcrop Research Institute (NRCRI) in Umudike and the International Institute of Tropical Agriculture (IITA) in Ibadan. Research contributions from these and other institutions are summarised as follows:

2.2.1 Germplasm collection, conservation and evaluation

A total of 661 sweetpotato germplasm accessions have been obtained by the NRCRI and the IITA Ibadan from local sources between 1972 and 1991. As of 1992, 208 accessions were being maintained under field conditions (Agbo and Ene 1994). Initially, yields after five months ranged from 900 kg/ha for accession 0304 and 5,580 kg/ha for V 722. Vn 72/5 and 0304, however, established best under field conditions at Umudike. High variability was attributed to soil heterogeneity.

By 1989, only three cultivars/accessions - TIS 8447, TIS 87/0087 and TIS 87/0287 - yielded from 25 to 49 t/ha. Selected accessions with root yields above 10 t/ha in 1990 were documented. In 1991, NRCRI under the long-term project on genetic resources conservation evaluated 304 collections. TIS 87/0087 was found to be the highest in root yield, exhibited good growth habit and was tolerant to virus and *Cylas* attack, especially when harvested at four months.

Multilocational trials were conducted by IITA in 1976 using 25 most promising clones from previous uniform trials. These were grown without fertilizer in Ibadan as well as in Warri and Mbiri (high rainfall areas of Nigeria) and in Mokwa in the Savannah area during the wet and dry seasons. The crops were harvested four months after planting. The highest average fresh yields were obtained at IITA Ibadan with 34.3 t and 24.2 t/ha during the wet and dry seasons, respectively. Next highest yield was from Mokwa with 23.5 t/ha produced during the dry season. Average yields at Mbiri (13.8 and 11.3 t/ha for the wet and dry seasons, respectively) were higher than those in Warri (6.1 t/ha in the wet season) where the soil is sandy and moist and has a higher aluminium concentration on the surface layer.

During the wet season trial at IITA, cultivars TIS 3270 and TIS 3277 produced more than 45 t/ha. During the dry season, TIS 2498 produced the highest fresh yield. Data from multilocational trials showed that TIS 2498 produced the highest fresh yield, averaging 23.5 t/ha across locations and seasons. Similarly, multilocational trials in 1978 and 1979 at the IITA confirmed that TIS 2498 performed best across locations and years averaging 14.2 t/ha in four months followed by TIS 2534, TIS 1499, TIS 2544, TIS 1487 and TIS 3277. The highest average yield for all the cultivars tested was obtained at IITA (1200 mm rainfall per annum, 21.1 t/ha, followed by Mokwa (100 mm rainfall per annum) at 12.7 t/ha, then by Mbiri (2500 mm), Onne (2500 mm) and Warri (2100 mm).

At IITA, cultivars TIS 1499 and TIS 2498 gave average yields of about 29 t/ha in four months without fertilizer application. Results indicated that sweetpotato has lower yields in areas with high rainfall (often poor soil conditions). Results of multilocational trials conducted by IITA at Onne, Zaria and Jos are shown in Table 2.3.

Table 2.3. Performance of some promising sweetpotato cultivars in five agro-ecological zones

Variety	Yield (t/ha)				
	Ibadan	Jos	Mokwa	Onne	Zaria
TIS 9265	53.7	5.3	10.9	N/A	7.8
TIS 2498	45.2	3.6	N/A	10.9	N/A
TIS 8401	29.6	5.4	7.5	14.5	9.7
TIS 8524	29.6	N/A	5.1	N/A	8.1
TIS 70399	26.8	N/A	N/A	N/A	N/A
TIS 8441	26.9	N/A	4.9	9.8	8.2
TIS 8504	N/A	7.9	N/A	N/A	N/A
TIS 70357	N/A	3.8	10.0	15.0	8.3
TIS 8266	N/A	N/A	N/A	11.8	N/A

Onne = a high rainfall zone with poor sandy soil (Humid forest zone)
Mokwa = a dry savanna (Guinea Savanna)
Ibadan = a zone with moderate rainfall and fertile soil (Sub-humid forest zone)
Jos = a cool region
Zaria = in a dry savanna (Sudan Savanna)
N/A = not available

Source: IITA (1982).

Studies were conducted at IITA in 1987 to 1988 with *in vitro* plantlets to determine genetic stability and yield of clones propagated through tissue culture. Five sweetpotato varieties (TIB 11, TIS 2344, TIS 3017, TIS 8250 and TIS 70357) were selected as *in vitro* plantlets and compared with plants of the same varieties from open fields. No differences were observed in morphological characters or in tuber dry matter content. However, there were significant differences between the two types of planting materials in terms of root yield and marketable roots. The increase in yield ranged from 32 to 38 percent except for TIS 3017, which had much lower (8 percent) increase. The higher yield from the *in vitro* materials was attributed to the virus-free status of the planting materials. This is expected to decline through successive planting seasons as the materials are exposed to natural infection. The magnitude of the decline would depend on the disease pressure and the variety, but the yield increase would be sustained for several years if the planting materials are maintained under low disease pressure condition.

At NRCRI, 88 out of 99 original international *in vitro* entries collected from IITA in 1990 were still being maintained at the tissue culture laboratory. Hardening of some of these *in vitro* accessions for field screening has been undertaken to increase the germplasm available for breeding work.

2.2.2 Agronomic research

Fertilizer application has been studied at the NRCRI. In a trial that tested the use of fertilizer (NRCRI 1992), yield increased from 5.5 t/ha to 20.39 t/ha. Studies in 1984 on optimum NPK requirements in two locations (Umudike, Abia State and Igbariam, Anambra State) showed that $N_{45}P_{15}K_{40}$ gave the highest fresh root and saleable root yields, while the highest vine yield was from $N_{90}P_{15}K_{140}$ at Umudike. At Igbariam, $N_{40}P_{15}K_{70}$ gave the highest fresh roots, saleable roots, and vine yields (total yield increased from 2.46 to 7.78 t/ha fresh weight) while at Umudike, yields of roots and vines were higher (total yield increased from 5.38 to 17.44 t/ha fresh weight) than at Igbariam.

Studies on fertilizer placement methods at Umudike showed that ring and side band application resulted in higher root yield as compared to broadcast and furrow application. The top yields (leaves and vines) showed no significant differences across different placement methods. Also, applying

NPK fertilizers at two, four, six, eight and ten weeks after planting had no significant effect on root yield in Umudike and Igbariam.

Time of fertilizer application had no significant effect in Ubiaja, but in Lafia, application at four and six weeks after planting resulted in higher root yields than other application times. Lafia is in the northern (Southern Guinea Savannah) zone while the other three locations are in the southern (Rain Forest) zone. Root yields in the trial ranged between 9.4 and 11.9 t/ha. A uniform yield trial conducted by IITA is shown in Table 2.4.

Table 2.4. Results of sweetpotato uniform yield trials (tons/ha)

Variety	IITA Sub humid	Onne Humid	Mokwa Savanna	Zaria Savanna	Jos Cool	Mean Yield	Dry Matter (Percent)
TIB 4	13.4	1.4	1.3	3.4	0.8	4.1	32.1
TIS 2498	14.9	2.7	1.2	4.2	0.5	4.7	35.6
TIS 7035	14.8	7.0	7.8	5.3	1.6	7.3	40.7
TIS 8266	13.5	3.0	1.7	5.0	0.8	4.8	33.8
TIS 8441	18.6	3.1	2.0	5.4	0.8	6.0	36.2
TIS 8504	22.6	3.9	2.7	11.2	0.7	8.2	31.1
TIS 8524	18.3	5.3	5.3	3.4	0.7	6.6	31.0
TIS 9265	23.4	2.5	1.4	5.9	0.8	6.8	31.6
TIS 9291	15.6	1.9	2.3	7.4	0.7	5.6	38.0
TIS 8250	7.5	2.2	1.1	9.9	1.5	4.4	24.4
SE	1.3	0.8	0.8	0.9	0.2		
LSD (5%)	3.7	2.4	2.2	2.5	0.5		

Source: IITA (1993)

The kind of planting materials used have been shown to affect yield in a study on sweetpotato vines (NRCRI 1974-75). Sweetpotato vine tips as planting materials established best, followed by vine cuttings and then by basal vine cuttings. Sweetpotato vines that were planted the same day that they were harvested had the highest fresh root and saleable root yields. Yields decreased as time from harvest to planting of vines increased, with the lowest yields obtained from vines stored for 4 weeks before planting.

The yield of the tops did not follow the same pattern as that of the roots. In a study of 12 sweetpotato cultivars, it was found that the highest marketable and total yields of tops were realized from planting materials taken from the apical portion, followed by the middle and then the basal cuttings. TIS 8/729 yielded the highest in terms of tops when apical cuttings were used as planting materials.

Results of a trial in 1984 to determine the optimum time of harvesting three cultivars at Umudike indicated increases in dry matter content of leaves and stems from the 6th to 14th week after planting. Dry matter content of starch similarly increased up to the 14th week after planting. The high dry matter and starch yields at 12 weeks after planting showed that the cultivars may be profitably harvested at that time instead of delaying harvest until the 16th to the 20th week. Maturity period ranged from 3 to 4 months among six elite sweetpotato cultivars, as evaluated upon attainment of highest dry matter and specific gravity. Maturity is assessed by the presence of cracks in the roots, which reduce market value and increase the risk of disease infection.

NRCRI (1989) reports showed that weeding done at 4 and 8 weeks after planting (WAP) to sufficiently keep the crop weed-free for good tuber yields could substitute for the farmers' method of weeding at 2, 8 and 12 WAP. At 8 WAP, the crop developed enough canopy to smother the undergrowth.

A study on leaf harvest and tuberous yield showed that detopping plants at 48 and 86 days after planting gave 34 to 42 percent less shoot yield, respectively, than cutting plants to 10 cm from ground levels (IITA 1979). Shoot yields are not affected by detopping at 2-, 3- or 4-week intervals. Compared with non-detopped plants, tuberous root yield was reduced by 31 to 48 percent by detopping and by 48 to 62 percent by cutting plants 10 cm from ground level. The number and sizes of individual tuberous roots were reduced as the frequency of detopping increased. Detopping at four weeks interval is recommended for reasonable yields of both shoot tips and tuberous roots.

Water requirement studies at NRCRI between 1987 and 1989 showed that there was a progressive increase in the yield of sweetpotato with increases in water application. The crop performed best in regions with 750 to 1000 mm of rainfall with about 500 mm falling during the growing season. It was found that providing 4500 m^3/ha of water for irrigation distributed at seven-day intervals would produce more than 20 t/ha of sweetpotato. IITA (1971) reported a dry season evaluation of 500 clones, which showed yield potentials of 20 to 30 t/ha in four months without fertiliser application for some clones. Some varieties yielded 30 to 40 t/ha in five months when grown during the wet season and 10 to 20 t/ha in four months during the dry season. It was suggested that there might be a high genotype x season interaction in sweetpotatoes.

Hill *et al.* (1981) reported on the nitrogen-fixing bacteria associated with sweetpotato roots. Fibrous and storage roots of four varieties of sweetpotatoes were evaluated for rhizospore population *Aspergillum*. Most probable number (MPN) of *Aspergillum* ranged from 0.02×10^6 to 5.4×10^6 cells/g dry root depending on the variety and field sampled. MPN of *Aspergillum* associated with TIS 9265 was consistently higher than MPNs associated with other clones that were evaluated. Mullongoy, *et al.* (1987) reported mycorrhizal infection on ten sweetpotato cultivars that were assessed in potted soils at Fashola, Ibadan and Onne in Nigeria. All cultivars showed mycorrhizal infection by indigenous fungi seven weeks after planting in Fashola soils (24 percent).

Agbo and Ene (1994) noted that most of the sweetpotato in Nigeria were produced and consumed in the north. The crop was systematically planted as a sole or as a mixed crop and was given proper crop management by farmers in the delta banks of the River Niger, as well as in all parts of Northern Nigeria. In terms of total production and consumption, sweetpotato was considered a minor crop. In most localities, it was intercropped with major crops such as sorghum, maize, cassava, yam, cocoyam and millet. The average yield under local conditions was 4 t/ha (Chinaka 1983), but the national average is estimated to be at 13 t/ha (Horton 1988).

2.2.3 Pest and disease management

NRCRI carried out a general assessment and identification of major pests and diseases of sweetpotato using questionnaires and laboratory studies between 1972 and 1974. The results showed that the major field diseases in the then East Central State were viral. One was caused by a virus complex manifested by dwarfing of the plant and a reduction of the leaf area. White fly species of the *Bemisia* group were constantly associated with the infected plants. Local varieties appeared to have a good degree of tolerance except for the cultivar FM 71.

Leaf spot disease was endemic and occurred wherever sweetpotatoes grows, whether in the wild or in the farms. At Umudike, the pathogen causing the leaf spot disease that mostly affected mature and senescent sweetpotato leaves was identified as *Saptona batahcola*. Investigation on the storability also revealed that rot constituted the major storage problem. The rot organisms were, in most cases, parasites that introduced infection through cuts and other wounds on the tuberous roots. *Paisobus* and *penicillium spp* were common agents of tuber rot in storage. The most damage in Nigeria was caused by *Lasiadiplodia thoebramae.*

Foliage insects were mostly *chrysometidae* and *coccinellidae* leaf-eating beetles, which bore holes in the leaves. The most serious insect pests of sweetpotatoes in east central state were termites and sweetpotato weevil (*Cylas puncticolis*). Termites were more prevalent in Umuahia, Onisha, Owerri and Aba zones. In areas where sweetpotato was cultivated in distant farms such as in Abakaliki, Enugu and Agwu, rodents, monkeys and bush fowls caused serious damage to the crops.

Chemical control studies in 1977 on six candidate insecticides showed that soil insecticides (Aldrin and Basudin G.) were effective against weevil and prevented root losses, but were ineffective in preventing losses to vegetative parts of the plants. Foliar insecticides (Didmac, Vetox 85 and Roger 40) were not effective against root damage. Percentage loss in root yield was higher in all treatments with foliar insecticides. Plots treated with Roger 40 also suffered the highest percent loss in fresh weight of tubers than other plots except the control plot.

Screening for resistance to weevil damage using eight cultivars (TIS 065, TIS 2295, JK 70, TIS 499, TIB 4, Vn 74/4, UN 72/4, Anambra local), showed that they have varying degrees of resistance. *C. puncticolis* did not damage roots of TIB4, JK70 and Anambra local, caused negligible damage to Vn 72/4. However, considerable damage was noted in TIS 1499, 2295 and 064. Vn 74/4 was the most damaged.

Ten elite sweetpotato cultivars were screened for storability using the moist sawdust technique (NRCRI 1984). This involved storing freshly harvested tubers in baskets filled with sawdust that was kept moist by watering with 400 ml water every fortnight. Weight loss, rot and sprouting were recorded monthly. Storability in the first month was encouraging with weight loss at only 0.9 to 5.3 percent and rot of 0 to 16.7 percent. For all cultivars, lowest weight loss after four months was observed in TIS 2534 and the highest in *Anoma* cultivar. Highest percentage rot after four months was 76 percent for TIS 2352. Thus, the variety TIS 2534 was the most promising for storage purposes. Sprouting, however, occurred in varying proportions in the first month, with the least sprouting occurring for JK 70 cultivar. Proximate analysis showed that moisture content of the tubers were maintained for four months with slight decrease in dry matter and slight increase in crude protein content of the tubers after storage. It was concluded that cultivars TIS 2534, Dokobo and TIS 2421 performed better than the others in storage.

Sweetpotato weevil was reported to be a major pest in Nigeria (NRCRI 1984). Three monthly field sprays of monocrotophos at 300 to 450 g per liter/ha was recommended where *Cylas puncticolis* is a problem to control the weevil. Another pest of sweetpotato, *Acraea acetata* was reported by

NRCRI (1987). Its damage was noticed six weeks after planting and increased up to the tenth week; after which damage decreased as the plant further matured.

Sweetpotato virus complex disease (SPVD) was found to occur due to an interaction between two separately transmitted viruses: the white fly- (*Bermisia tabaci*) borne and the aphid- (*Myzus persicae* and *Aphid gossypii*) borne. It was further observed that resistance to SPVD did not necessarily depend on resistance to the vector but was more closely associated with resistance to infection. Clones tested and found resistant to SPVD were TIS 2498, TIS 3228, TIS 3053, TIS 2532 and TIS 2744.

Cylas puncticolis and C. brunneus were found to be the most serious of six *Cylas* species of sweetpotato weevil in West and Central Africa. Damage was observed primarily to tubers, but at high population during the dry season, damage to stem and leaves could reach economic levels. Over 20 clones were identified to have moderate to high resistance to *C. punticolis*. These included TIS 3053, TIS 3030, TIS 3017, TIS 2532, TIS 8524, TIS 8266 and TIS 9172. Orange-fleshed clones were found to be more susceptible than white-fleshed clones. Large-scale sweetpotato production encouraged weevil population build up while crop rotation reduced the population. On the other hand, losses from root knot nematode pests ranged between 20 to 30 percent in the tropics. A total of 55 clones were found to have high resistance to root knot nematode.

Sweetpotato tubers have a fairly short shelf life, sprouts quickly after harvest and are susceptible to rot when weevil and nematode infestations are carried over into storage. Leaving tubers unharvested to avoid storage problem led to losses ranging from 12 to 90 percent due to weevil infestation. Underground storage has been proven to be a better option. Under this storage system, pits were dug and lined with a layer of dried grass or leaves. A layer of sweetpotatoes treated with wood ash was placed on top of the dry grass, followed by another layer of dried leaves or grass and at least 5 cm of soil. Tubers could be stored for two to three months under such conditions. The following are some precautionary measures to control the entry of weevil-infected tubers into storage:

1. Immerse tubers in water for 24 hours and air dry.
2. Immerse tubers in hot water at 52°C.
3. Bury tubers under a thin layer of soil for three days when soil temperatures are extremely high.
4. Place tubers in polyethylene bags and leave in the open air for three days.

Varieties that could be stored without sprouting under ambient temperature for about two months were TIS 2153, TIS 2532, TIS 2534 and TIS 3017. Breeding against weevil damage in storage, however, still remained a problem. In addition to sweetpotato weevil (*Cylas punticolis*), which was the most important problem in the field and in storage during dry season, black rot caused by *Macrophomina phaseoli* was also a storage problem.

A seasonal evaluation study conducted by IITA in 1975 showed the importance of tuber depth in preventing weevil damage. The study suggested that an additional layer of soil put on the ridge after planting might protect the developing tubers against weevil. During the wet season, re-ridging after 30 days from planting reduced weevil damage. Dry season tests showed less encouraging results because of soil caking, which made reridging difficult.

There appeared to be clonal differences in susceptibility to both sweetpotato weevil and black rot damage as expressed by some of the 10,000 clones of sweetpotatoes that were produced in Nigeria in 1971. In trials on resistance to weevil at the IITA, the clones that were least attacked were TIS 3013 and TIS 2532. In yield tests over 15 environments from 1976 to 1978, clone TIS 2498 was found to be the best in yield and stability, showing resistance to viruses and moderate resistance to weevil under field conditions and high storability. It also has high dry matter content (33.3 percent) and was highly

acceptable to consumers. *Cylas puncticolis* and *Cylas brunneus* were reported to be the most severe pests of sweetpotato in Africa.

Twenty IITA cultivars were tested for resistance to weevil during wet and dry seasons from 1975 to 1980. The cultivars with the least root damage in terms of tuberous root damage were TIS 3053 and TIS 3030, while the least shoot damage was noted in TIS 2532, LTIS 3017 and TIS 3030. Varieties with higher dry matter and starch content were more weevil-resistant. Two methods of storage were tested to see the survival rate of weevil-infested sweetpotato. The weevil-infested tubers were packed inside polyethylene bags with different amounts of pounded fresh cassava leaves while another pack contained only the weevil-infested sweetpotato. The survival rate of the weevil-infested tubers did not differ significantly between the two methods. The main factor was the temperature within the bags. Also, putting the bags in the open air had a significant positive effect on weevil survival compared with putting the bags under the shade.

Oyenuga (1968) concluded that considering its chemical composition and qualitative nutritive value, sweetpotato deserves much better attention than it presently enjoys as a source of readily digestible and soluble carbohydrate in food and feed in Nigeria. The proximate composition of cassava and sweetpotato chips are shown in Table 2.5. Fetuga and Oluyemi (1976), Job *et al.* (1979), Tewe (1993), Abu and Tewe (1998), and Abu, *et al.* (1998), confirmed the suitability of sweetpotato in the nutrition of livestock.

Tewe (1993) reported the biochemical characteristics of 49 sweetpotato varieties obtained from the International Institute of Tropical Agriculture (IITA). Marked varietal differences were observed in the levels of carbohydrate components, minerals and vitamins (Table 2.6). The levels of tannins, oxalates, phytin and phytin phosphorous showed that apart from the high phytin in some varieties, sweetpotato poses less of a poisoning risk as cassava.

Table 2.5. Proximate composition of cassava and sweetpotato chips

Parameters	Cassava chips	Sweetpotato chips
Dry matter	94.4	93.5
Crude protein	2.3	5.2
Ether extract	1.4	0.5
NFE	84.9	85.7
Crude fibre	3.4	0.14
Ash	2.4	2.6

Table 2.6. Range values of chemical composition of 49 varieties of sweetpotato

Component of Sweetpotato	Range of Values
Starch content	30.80-41.80 g/100g D.M.
Total sugar	3.68-10.40g/100g D.M.
Amylose	21.00-38.40% of starch
Amylopectin	61.60-79.00% of starch
Vitamin A	1.0-8.4 mg/100g D.M.
Vitamin C	4.6-11.4mg/100g D.M.
Tannins	0.02-0.23% of D.M.
Phytin	4.98-14.36 mg/100g D.M.
Oxalate	0.09-1.77%
Crude protein	1.39-9.40%
Ether Extract	0.38-3.03%
Crude Fibre	3.84-5.89%

D.M. = dry matter
Source: Oguntunde (1994) as culled from Tewe (1992)

Six sweetpotato cultivars and some common vegetables, namely, *Talium triangulae* (water leaf), *Telfane occidentalis* ("ugu") and *Cochorus olitorious camiara* ("ewedu"), were subjected to sensory and nutritional evaluation. Results showed that sweetpotato leaves were acceptable as soup ingredient after boiling for three minutes in water. The fibre contents of the leaves were between 3.3 and 6.0 percent while the protein content was 18.4 percent. Sweetpotato leaves were comparable to other vegetables as soup ingredient in terms of flavour, appearance, palatability, softness and acceptability.

Suitability of ten sweetpotato cultivars for *foofoo* (sweetpotato dough) preparation was also evaluated. *Foofoo* is made by pounding roots or stirring 150g flour in 100 ml water over a low to moderate flame. Blending was done at ratios of 1:2, 2:1 and 3:1 sweetpotato and cassava flour. The colour of *foofoo* varied from yellow cream to white with pounded roots, but for the sweetpotato flour *foofoo*, the color was dark brown for all the cultivars. Results indicated a correlation between percentage starch content and texture (hand feel), with the lower starch-containing varieties having better texture. Sweetness of the *foofoo* accounted for low acceptability scores. The blends that were most acceptable were:

Blend	Ratio
Sweetpotato/cassava starch	4:1
Sweetpotato/cassava *foofooo* flour	1:2
Sweetpotato/cassava instant flour	1:2

It appeared that cassava starch was more effective than cassava flour for blending with sweetpotato. It was noted that in Kwara State (now Kogi and Kwara states), sweetpotato roots are pounded and eaten as *foofoo*.

Attempts to make biscuits from four sweetpotato cultivars resulted in biscuits that tasted nice but were soft and poor in colour. The Dokobo cultivar was rated as the most acceptable.

Studies at NRCRI in 1987 showed that:

- Resultant sugar syrup from sweetpotato starch had a dextrose equivalent of 28.30. This moisture-free starch had the potential of producing sugar syrup of 32.34 digestible energy comparable to dextrose, which has 35 digestible energy from potato starch sourced from Europe and America.

- Soaking sliced sweetpotato in analytical 0.2 percent sodium metabisulphite solution and drying in preheated chambers gave sweetpotato meals and flour an acceptable white colour.

- Storing sweetpotato flour in thick gauge white polyethylene bags was better than using enamel cans, plastic cans or calico bags. There was no change in texture and colour and no losses from insect and mite damage after three months of storage.

Biochemical indices on the amylose and amylopectin contents of Nigerian sweetpotato cultivars showed that starch content of NRCRI top-yielders (with yield potentials of 2.5 to 71.7 t/ha) ranged from 15.08 to 24.68 percent. Tests conducted on six sweetpotato cultivars already adopted by farmers gave percentage amylose contents of 23.75 to 28.34 percent. It was concluded that these high-yielding varieties were good sources of starch and amylose for food, paper and the pharmaceutical and textile industries in Nigeria. The figure for sweetpotato amylose was close to those obtained for maize, oat, sago and wheat.

Microbiological studies revealed that culture media were produced from two varieties of sweetpotato, AK/837 and TIS 8504, by peeling and parboiling for five minutes before cooling. Two kilograms of each variety were chopped into little bits (10-15 g. wt.) before drying to constant weight at 60°C using a hot air oven. These were then milled into powder, sieved through a muslin cloth (aperture <0.5mm) and used for media formulation containing dextrose, agar and water in the following three combinations: 10g powder of Ak/83/7 + 1g Dextrose; 12.5g AK/83/7 + 2g Dextrose; and 12.5g TIS 8504 + 2g Dextrose. In 250 ml water, each produced culture media that had clear transparency, consistency and gelling ability that permitted easy inoculation. The culture media had the remarkable ability to allow profuse growth of micro-organisms when inoculated. Accordingly, the sweetpotato media compared favourably with standard laboratory nutrient agar media.

Agbo and Ene (1994) reported that consumption patterns in Nigeria indicated that most people consume boiled sweetpotato roots as food, as well as fried slices or chips and roasted roots. Sometimes, the tubers were eaten in the form of pounded *foofoo*. Sweetpotato flour may be prepared from dried chips and the flour may be reconstituted into *foofoo*. Agbo and Ene (1994) also indicated that bakeries in Nigeria now blend 15 to 33 percent sweetpotato flour with wheat flour for baking bread and 20 to 30 percent sweetpotato flour for pastries. Baby food has also been formulated using sweetpotato flour. The roots are also utilised in brewing local alcoholic beverages while the leaves are eaten as vegetables.

In the northern part of Nigeria, some sweetpotato varieties are used as sweeteners. Despite its widespread use as food sweetener, however, most consumers cannot distinguish between the hard, mealy and starchy types of sweetpotato or the soft types, which contain more sugar and protein and have higher gel strength. Consumers just purchase what is available in the market.

Mouth feel (texture) and flavour were found to be the major factors influencing consumer preference. Besides being "mealy" or "soggy", other textural characteristics were prominent while non-uniformity in texture was observed in many clones. The mealy texture is preferred in West Africa probably because this makes it comparable to yam. Sweetness, on the other hand, was a minor discriminating index. Surveys revealed that varieties that are less sweet are preferred in West Africa

where sweetpotato (a co-staple) is consumed as a major meal, while very sweet varieties are popular as minor meals or snacks.

Preparation of industrial starch from sweetpotato is not widespread in Nigeria. The potential of using peelings and roots in the livestock feed industry exists (Tewe and Ologhobo 1984). Unmarketable roots - which constitute about 20 percent of yield – along with peels and leaves were fed to pigs, rabbits, poultry, cattle, sheep and goats. The leaves, which contain 24 to 34 percent protein, could be incorporated into feed formulations. The use of sweetpotato in the pharmaceutical industry in Nigeria is still non-existent, although it holds much promise because it is a rich source of vitamin A.

As shown in Table 2.7, Almazan (1987) reported selection of non-sweet clones of sweetpotato from the IITA germplasm collection. Of the 570 clones in the germplasm collection, 380 were screened for relative amylose activity, total soluble sugar and increase in reducing sugar. The tubers were baked at 225°C for one hour, peeled, mashed and oven-dried at 55°C before milling and analyses. A total of 60 clones were classified as non-sweet. Since sweetness is not a desirable quality in a staple food in Nigeria, it is therefore imperative to identify clones that do not taste sweet especially after these are cooked. Similarly, it is important to identify clones with high reducing sugar that will not taste sweet after preparation into food. High reducing sugar of sweetpotato has been associated with frequent gastrointestinal disorders usually accompanied by diarrhoea in animals fed with sweetpotato-based rations (Tewe 1993).

Table 2.7. Changes in sugar concentration in flour from non-sweet clones of sweetpotato

Relative clone	Amylase activity	Total soluble sugar (baked tuber) (%)	Increase in total soluble sugar(%)	Increase in reducing sugar (%)
TIS 8027	2	9.68	-0.73	-0.09
TIS 8267	2	8.41	0.04	0.45
TIS 9191	3	19.55	-0.32	2.43
TIS 8504	3	18.57	4.00	-0.46
TIS 84/007	3	20.20	2.56	0.46
TIS 84/0026	3	19.81	2.14	-1.13
TIS 2154	3	14.57	8.22	12.04
TIS 2347	2	12.71	5.97	4.30
TIS 3059	3	15.84	10.34	0.20
TIS 2153	3	19.99	13.40	0.20
TIS 3161	3	17.77	11.74	3.43
TIS 3180	2	17.49	14.39	3.54

Source: Almazan (1986)

Animal feeding studies reported by Tewe (1992) indicated varying optimal levels of dried sweetpotato flour in rations for different livestock species (Table 2.8).

Sun-dried samples were usually infested by microorganisms that depress growth of pigs and poultry. Low levels of sweetpotato for pig and poultry feed was recommended because of the increased incidence of diarrhoea at higher levels of are included in the rations due to the high reducing sugar content and form of presentation. Conversely, higher levels of sweetpotato in the ration using non-sweet clones may also be recommended.

Other limitations in using sweetpotato in the feed ration include the following: it is bulky and needs rapid dehydration to avoid microbial growth, it has impurities as indicated by the "dustiness" of the ration as compared to maize-based rations and it requires more supplementary proteins. To overcome these limitations, fabrication of local dryers and solar drying especially during the dry season, addition of oil or pelleting to reduce impurities in the ration, use of vines and leaves to augment the low protein content in the roots and distribution of non-sweet clones to avoid the incidence of diarrhoea and poor performance are recommended.

Table 2.8. Recommended levels of sweetpotato flour in livestock rations

Species	Processing Method	Inclusion Level for Optimal Performance (%)
Broilers:		
0 - 4 weeks old	Sun-dried	0
	Oven-dried	12
5 - 8 weeks old	Sun-dried	0
	Oven-dried	18
Layers:		
30 wks - 40 wks old	Oven-dried	10
Pigs:		
Weaner Phase	Oven-dried	17
Grower Phase	Oven-dried	17
Sheep:		
Growing/Fattening	Oven-dried	40

Source: Adapted from Tewe (1992)

Oguntunde (1994) reviewed the traditional and industrial processing of sweetpotato as applicable to Nigeria. He noted that traditional utilisation of sweetpotatoes in Nigeria consists of the following: a) boiled and eaten with stew; b) boiled and pounded with either boiled or fermented cassava as *foofoo* or boiled or pounded yam; c) dried and milled for sweetening of gruel or ogi porridge; d) sliced into chips, dried and boiled with beans or vegetables; and e) sliced into chips or dried and then fried in vegetable oil.

Oguntunde (1994) further reported that industrial processing of sweetpotatoes is non-existent in Nigeria. However, it was indicated that industrial processes exist for production of canned, dehydrated and frozen sweetpotatoes and products such as starch, syrup, alcoholic beverages, carotene, protein-enriched pulp, feed yeast, silage and sweetpotato flour.

Constraints in the industrialisation of sweetpotato in Nigeria include:

- Dearth of data on production and demand for raw sweetpotato or its products.
- Lack of storage technology for fresh sweetpotato.
- Manual peeling of sweetpotato.
- Presence of the enzyme polyphenol oxidase in sweetpotato
- Drying of sweetpotato using the sun drying method.
- Lack of processing equipment for sweetpotato.
- Need for proper packaging of sweetpotato products to enhance their quality.
- Quality control/assurance of sweetpotato and its products.

- Consumer education on the utilisation of sweetpotato and its products.

Recommendations to enhance the utilisation of sweetpotato include:

1) Acquisition of current production statistics and effective planning to increase production of the crop.
2) Research and development activities aimed at improving storage, processing, preservation and quality of sweetpotato products.
3) Consumer awareness campaign on crop utilisation.

Agbo and Ene (1994) identified the following constraints militating against sweetpotato production and utilization in Nigeria.

- Food habits that favour consumption of cassava, yams, plantain, rice and cowpeas in the south and cassava, yam, sorghum, rice, millets and cowpeas in the north.

- Farm inputs, which are not readily available and poor extension services to farmers due to low extension agent to farmer ratio (1:2321 as compared to 1:191 for the Netherlands).

- Pests and diseases caused by *Cylas puncticolis* resulted in yield losses of up to 80 percent. Increase in incidence of weevil damage resulted from a decrease in soil moisture. Timely harvesting and selection for early maturity are therefore recommended.

- Storage and marketing problems due to short storage life. Also, bruising during transport and marketing reduces quality and pre-disposes the product to attack by pathogens.

- Maintenance of adequate planting materials as the vines have to be sustained through the dry season. This is expensively done through irrigation in Nigeria. Also, virus-free planting materials are obtained through costly *in vitro* tissue culture.

2.2.4. Marketing

A study on the economics of sweetpotato production was conducted by NRCRI (1989) in the southeastern zone, particularly in Igbariam and Otobi. Four varieties were planted on a 0.01 ha plot. Market prices and labour rates were measured in hours and converted into man-days equivalent to eight hours. It was found cheaper by N500/ha to produce sweetpotato in Otobi than in Igbariam due mainly to warmer weather in the former. TIS 8504 gave the highest yield, while Dokobo gave the lowest yield in both locations with yield varying from 0.63 to 13.1 t/ha. Profit and loss analysis showed that only TIS 8504 can be produced profitably in Otobi. It was also recommended as an elite variety that can be produced both in the rainforest and Guinea Savannah areas if recommended practices were adopted.

Adetunji (1992) carried out an economic analysis of sweetpotato production and marketing in Odo-Otin Local Government Area of Osun State, Nigeria. It was found that both production and marketing of sweetpotato in the study area were profitable ventures. Multiple cropping was the common cropping pattern used. Majority of the farmers in the study area were males from the middle-age to old-age groups. Most of them sold more than half of their farm produce.

More than 50 percent of the farmers had sweetpotato farms of less than one hectare in size with labour cost accounting for over 81 percent of the total cost of production. The problems faced by the sweetpotato producers included inadequate transport facilities, incidence of pests, high labour costs,

inadequate tractor services and lack of credit facilities. Marketing was largely organised around middlemen, mostly women with many years of trading experience including distribution of sweetpotato. Institutions involved in sweetpotato marketing included producers, middlemen, retailers, itinerant traders, transporters and assistants who help in packing, loading and unloading. The distribution costs included transport, middlemen's commissions, storage costs, expenses in packing and loading/unloading. Transport cost accounted for the largest share of the distribution costs. Problems facing the distributors included price fluctuations, inadequate transport and storage facilities, and lack of institutional support and market information.

Figure 2.1. Map of Nigeria showing state boundaries

CHAPTER THREE

This chapter deals with sweetpotato roots production, marketing and utilisation in the major agro-ecological zones in Nigeria. However, for ease of description and convenience, the states in Nigeria are discussed under three major zones: humid, sub-humid and semi-arid zones.

3.1 Production, marketing and utilisation in the humid zone

The humid region consists of the coastal swamp forest and the moist lowland. The coastal swamp region includes creeks, lagoons, the Niger Delta and the coastal plain while the moist lowland is characterised by lowland forest of evergreen hydrophytic plants. This area consists of seven states: Delta, Edo, Lagos, Ogun, Ondo, Osun and Oyo. They collectively cover about 120 km², which is approximately 12 percent of Nigeria's total area. The zone covers an area ranging from swamp forests to western uplands with rain and deciduous forest/savannah mosaic in between. Only 35 percent of the land area is under cultivation with arable tree crops as well as fruits and vegetables. Of the area cultivated, 52 percent (2.4 million ha) is devoted to field and arable crops indicating the potential of increased agricultural production in the zone.

The mean annual rainfall ranges between 880 mm in the northern belt of Ondo, Oyo and Osun states and 2,600 mm in southern Delta, Edo, Ogun and Lagos states. Zonal average is 1,480 mm and rainfall pattern is modal. The potential areas that can be put to irrigation and *fadama* development in the zone have been estimated at 279,000 and 75,000 ha, respectively. Osun State has the highest potentially irrigable land while Lagos State has the highest potential for *fadama* cultivation.

The southeastern zone consists of seven states: Abia, Akwa Ibom, Anabra, Cross Rivers, Enugu, Imo and Rivers. All except Akwa Ibom State are identified as sweetpotato-growing areas. The zone lies between longitude 6° and 9°E and latitude 4° and 7°N. It occupies a land area of about 80,000 km², which represents about 8 percent of the total land area of Nigeria. Its climate is typical, with two main seasons: dry and rainy. The annual rainfall varies from 2,250 mm in the coastal areas to 1,500mm in the north. The average maximum and minimum temperatures are about 32°C and 25°C, respectively. The following distinct vegetation types are found in the area: (i) humid forest; (ii) derived savannah; and (iii) semi-montane. Within the humid forest vegetation are three sub-types: salt-water swamp, fresh-water swamp and rainforest. There are four major drainage systems: the Cross, Anambra, Mamu and Imo Rivers. Rootcrops are dominant in this region of Nigeria.

3.1.1 Production

Mostly local and a few improved sweetpotato varieties are grown in all the states. The major production areas in the humid region are the Oyan division and the areas around the NRCRI at Umudike. The major sweetpotato production areas in Oyan division, which is the largest sweetpotato producing area in Osun State are Ahi, Asaba, Oshogbo, Iree, Okuku, Inisha, Iba, Ikirun, Ila-Odo, Igbaje, Ekoende and Akipata.

Results of a survey conducted in Oyan showed that nearly every household cultivated sweet potato and that the average farm size is 0.4 ha per farming household. Ninety percent (90%) of the farmers are men while the remaining ten percent consists of women and children. Twenty percent (20%) of the respondents were educated up to the First School Leaving Certificate. Ten percent (10%) were full-time farmers while others engaged in trades such as carpentry, trading, smithery, tailoring, and bricklaying. The farmers were aged 18 to 60 years old, or an average of 40 years old. The production data for sweetpotato, yam and cocoyam in Oyo State (humid zone) between 1990 and 1994 is shown in Table 3.1, while the crop budget for 1995 is shown in Table 3.2.

Table 3.1. Production data for yam, sweetpotato and cocoyam in Oyo State

		1990	1991	1992	1993	1994	AVERAGE
No. of households planting	Yam	223,804	195,586	195,590	188,019	193,708	199,341
	Sweetpotato	-	996	1,000	13,101	-	5,032
	Cocoyam	55,241	34,287	34,970	34,128	75,044	46,734
	Cassava	234,818	276,543	277,098	322,630	271,046	276,427
Percent of households planting	Yam	63.1	55.2	55.2	53.0	54.6	56.2
	Sweetpotato	-	0.3	0.3	3.7	-	1.4
	Cocoyam	15.6	9.7	9.9	9.6	21.2	13.2
	Cassava	66.2	78.0	78.2	91.0	76.5	78.0
Area planted to (hectares)	Yam	86,420	89,372	81,681	67,114	67,852	78,488
	Sweetpotato	-	1,050	2,727	8,753	N/A	4,177
	Cocoyam	21,360	8,201	5,707	6,669	1,959	8,779
	Cassava	160,346	131,010	131,643	153,059	130,351	141,282
Total ha. planted (in %)	Yam	16.6	27.1	15.0	16.8	21.2	19.3
	Sweetpotato	-	0.3	0.5	2.2		1.0
	Cocoyam	4.1	2.5	1.0	1.7	0.6	2.0
	Cassava	30.8	39.7	24.2	38.3	40.7	34.7
Estimated production (tonnes)	Yam	1,075,929	1,238,517	1,165,588	1,011,414	845,436	1,067,377
	Sweetpotato	-	2,646	8,317	37,200	-	16,055
	Cocoyam	51,905	25,587	20,146	22,675	5,407	25,144
	Cassava	1,619,495	1,323,201	1,325,645	1,362,225	1,154,910	1,357,095
Mean yield (t/ha)	Yam	12.5	13.9	14.3	15.1	12.5	13.6
	Sweetpotato	-	2.5	3.1	4.3	-	3.3
	Cocoyam	2.4	3.1	3.5	3.4	2.8	3.0
	Cassava	10.1	10.1	10.1	8.9	8.9	9.6

Source: OSADEP (1995)

Sweetpotato is not usually planted as a sole crop but is intercropped with cassava or interplanted with maize. When intercropped with cassava, sweetpotato is planted on ridges while the cassava is planted in furrows. Soil from the sweetpotato is heaped around the cassava stands when the sweetpotato is harvested.

The sweetpotato plots are weeded only once, usually at six weeks after planting. A few farmers apply fertiliser (15:15:15 NPK) four weeks after planting. The tubers mature five to six months after planting although the first harvest is done earlier at three months after planting. The farmers believe that the first harvest, which involves the removal of one or two tubers from each stand, allows the formation of more tubers. Generally, harvesting of the mature tubers is staggered.

Planting of the crop is done twice a year. The first planting is done between February and March while the second planting is done between October and December, usually in waterlogged areas. The vines are planted at 1m x 1m distance. The family is the major source of labour although it is not uncommon to observe farmers from neighbouring countries employed for a season or more with payment made in kind, i.e., bicycles or other household items.

Table 3.2. Crop budget for production and marketing of sweetpotato in Iseyin, Oyo State in 1995

OPERATIONS	COSTS	(₦/ha)
i. Land clearing, packing and burning (80 man days)		8,000
ii. Ploughing		
a. 1st ploughing (15 man days)		1,500
b. 2nd ploughing (15 man days)		1,500
c. Ridging (tractor) (12 man days)		1,200
iii. Vines mainly collected from compost manure areas		500
iv. Planting		
a. Labour to cultivate 10,000 vines with 3-4 nodes (5 man days)		500
b. Planting the vines (25 man days)		2,500
v. Weeding once 6-7 weeks after planting (51 man days)		5,100
vi. Harvesting (60 man days)		6,000
ix. Cost of bags (packaging)		2,000
Total cost of production		26,800
Yield (at 12 weeks)	4.0 t/ha at ₦8/kg	
Revenue		32,000
Gross margin	N32,000 – 26,800	5,200

Labor costed at ₦ 100/man day
Source: OSADEP (1995)

The major problems facing sweetpotato production are rapid deterioration of tubers caused by heat after harvest and sweetpotato weevil infestation especially during the dry season. Sweetpotato weevil (*Cylas spp*) often affects crops planted between October and December. Grasshoppers and rats are also common when sweetpotato is planted late. Farmers rarely apply pesticides but traps are set for the rats, grasscutters, etc., that farm families eat as additional source of animal protein.

Farmers often dispose the sweetpotato roots, at the most, two weeks after harvest. However, sweetpotatoes harvested during the rainy season stay longer and at the peak of the hot season, the tubers only last for a maximum of three days underground. During the hot season, tubers are put in a pit and covered with sand. The pits may also be watered if the ambient temperature is very high. Freshly harvested tubers may also be spread in a well-ventilated space.

Local and a few improved varieties are mostly grown in the southeastern states. The skin colours are white and pink. Sweetpotato with orange flesh is planted in Abakaliki only. The rest are cream or white flesh coloured. The influence of the NRCRI in Umudike has greatly encouraged the planting of improved varieties in Afikpo, Arochukwu, Bende Ohfia and Uklwa local government areas where yields between 2 to 10 t/ha were reported. Mainly women cultivate sweetpotato in the regions and the size of farm holdings hardly exceeds 0.2 ha per farmer. The use of fertiliser is limited, as farmers noted an inconsistent response to nutrient application, a factor further complicated by shading. No pesticides are used except in very few cases of ash application on leaves as a means of controlling

sweetpotato butterfly (*Acraea acerata*). Weeding is usually done only once since its cultivation is part of weed control. Men concentrate on the cultivation of yams.

Other sweetpotato-producing areas in the eastern region of the humid zone include Oguta, Egbema and Orlu (Imo State); Oyi, Anambra and Ihiala local government areas (Anambra State); Ogoja, Yala, Ikom, Obudu and Obubra local government areas (Cross River State); Ikwu, Enugu, Ikwo, Ishiel, Abakaliki and Ohaukwu local government areas (Enugu State); and Port Harcourt, Onne, Oyigbo, Egbema and Odu local government areas (River State).

3.1.2 Marketing

Sweetpotato is usually transported in trucks, trailers and pick-up vans and marketed fresh in Osun State. Farmers sell to customers, which include traders who come from Ibadan, Lagos, Abeokuta, Ijebu-Ode and Ile-Ife. Among the customers are commission agents who are mostly women. Sweetpotato roots are usually scarce between April and September.

Table 3.3 shows the rural and urban market retail prices for sweetpotato, other root/tuber crops and cereals for the period from 1990 to 1994. Between 1990 and 1994, the price of sweetpotato increased from ₦1.13/kg to ₦6.25/kg or by 45 percent. The increase in price is not only due to inflation; it is also a result of increased demand for sweetpotato as market prices of competing cereals and rootcrops are spiralling up.

The relative ease and lower cost of sweetpotato cultivation as compared to cereals and other rootcrops makes it increasingly popular among farmers. This is also attributable to the rising cost of inputs such as fertiliser, which is not usually used in sweetpotato production. The differences in rural and urban prices, particularly in 1994, are largely due to high cost of transportation – an effect of hiked oil prices and automobile maintenance costs. The price of sweetpotato increases considerably from the month of February when harvest from late season planting is usually brought to a close until August when the price starts falling with the harvest from early season planting. Weevil infestation also prevents farmers from leaving the tubers underground in the field and harvesting them only as and when needed. Sweetpotato prices are much higher than cassava and compare favourably with that of yams in both rural and urban markets. Sweetpotato production, therefore, appears more profitable than cassava in terms of revenue generation per unit time and area.

3.1.3 Utilisation

More than 95 percent of the sweetpotato utilised in Osun State, a major producer in the humid zone, are for human food while the spoilt or small tubers are used for animal feed. The fresh tubers are usually boiled, baked, roasted or fried and may also be pounded or mixed with some amount of yam to prepare *foofoo* which is eaten with vegetable soup. The tubers can also be peeled, chopped or sliced, parboiled, sun dried and milled into flour. The sweetpotato flour is then mixed with cassava flour and prepared into food. Sweetpotato flour is usually unacceptable for consumption because of its dark colour and extremely sweet taste. Cassava flour is added to reduce the sweetness and also to improve the colour of the final product. However, in the urban areas, sweetpotato is used as an ingredient for making meat pies.

Table 3.3. Annual prices of agricultural commodities in Oyo State (₦/kg)

NO.	COMMODITIES		1990	1991	1992	1993	1994
1.	Maize, white (shelled)	Rural	1.75	2.97	4.51	4.51	5.72
		Urban	1.67	3.01	4.59	4.59	5.80
		Average	1.71	2.99	4.55	4.55	5.76
2.	Maize, yellow (shelled)	Rural	1.77	3.22	3.13	3.13	4.87
		Urban	1.70	2.93	3.19	3.19	5.64
		Average	1.74	3.08	3.18	3.18	5.25
3.	Millet	Rural	-	-	-	-	5.13
		Urban	-	-	-	-	5.13
		Average	-	-	-	-	5.13
4.	Rice, local	Rural	6.27	7.65	11.70	17.75	23.13
		Urban	5.92	7.71	11.70	17.70	23.26
		Average	6.10	7.88	11.70	17.73	23.20
5.	Rice, imported	Rural	8.58	10.41	15.03	22.17	32.34
		Urban	8.15	10.65	14.95	22.49	32.48
		Average	8.55	10.53	14.99	22.33	32.41
6.	Sorghum	Rural	2.05	3.91	5.20	6.83	7.04
		Urban	2.00	3.11	5.36	7.09	6.72
		Average	2.03	3.51	6.28	6.96	8.88
ROOTS/TUBERS							
1.	Cassava tuber	Rural	0.33	0.38	0.61	2.13	2.37
		Urban	0.30	0.45	0.80	1.98	2.78
		Average	0.32	0.41	0.71	2.06	2.58
2.	Gari	Rural	1.84	1.76	4.35	8.91	6.99
		Urban	1.73	1.74	4.28	8.61	6.64
		Average	1.79	1.75	4.32	8.76	6.82
3.	Cassava chips	Rural	1.56	1.36	2.05	6.86	6.37
		Urban	1.55	1.31	3.58	5.74	6.75
		Average	1.56	1.34	2.82	6.30	6.56
4.	Cocoyam	Rural	1.32	1.33	1.82	-	8.57
		Urban	1.37	1.29	2.69	-	10.94
		Average	1.35	1.31	2.16	-	9.96
5.	Sweetpotato	Rural	1.31	1.22	1.83	2.65	4.90
		Urban	0.94	1.81	2.81	1.22	7.45
		Average	1.13	1.52	2.32	1.94	6.25
6.	Yam	Rural	1.69	1.86	2.92	5.87	7.89
		Urban	1.84	1.89	3.32	6.31	8.91
		Average	1.77	1.88	3.12	6.09	8.40

Source: OSADEP (1995)

It is not the usual practice to feed whole roots to livestock. However, spoilt or small tubers are sometimes fed to sheep and goats. Sheep and goats also relish the leaves and vines from harvested plots. In the past, the local people burned vines and leaves and mixed these with clay and/or sheep or goat dung. The mixture is then mashed and used as plastering materials for the floor or walls of mud houses. This practice has been stopped as a result of modernisation.

1) No industrial uses for sweetpotato were observed in Oyo State. In Osun State, inadequate extension services, lack of organised marketing strategies, lack of post harvest technologies, limited use of the crop, poor cultural practices and pests and diseases were the constraints faced by farmers

In Lagos State sweetpotato is eaten boiled, roasted or fried in vegetable oils. The chips are also packaged and sold as snacks and may also be processed into flakes. The roots are peeled, chopped and boiled and then used as an ingredient in meat pies. Lagos State is unique because there appears to be a big market for packaged sweetpotato chips and flakes. These are often used as snacks for school children during break time. The retail prices of sweetpotato products in Lagos State are shown in Table 3.4.

Table 3.4. Retail prices of sweetpotato products in Lagos

Sweetpotato Product	Weight	Retail price (₦)
Chips	30g	5.00
Chops	60g	5.00
Flakes	N/A	N/A
Tubers	1.5kg	25.00

Note: US$1=₦83

Sweetpotato flour can be mixed with cassava or yam flour to make *amala*, which is eaten with vegetable soup. The tender leaves are also used as vegetables while vines are used as livestock feed especially during the dry season. Rabbit farmers in particular feed sweetpotato leaves and vines to their stock.

The bulk of sweetpotato in Oyo State is consumed boiled or roasted. However, there is a growing proportion of its usage as fried potato chips, particularly in urban households where such fried chips are highly relished by children. Sweetpotato chips are often marketed in attractive small transparent polyethylene packages in supermarkets. Boiled or fried sweetpotato is also eaten with beans in many urban households and industrial centres. The production of sweetpotato flour is largely rural based. The fresh tubers are peeled, parboiled in water at about 60°C for five minutes, then sun-dried. The milled chips are used in combination with cassava flour to make a paste as sweetpotato flour alone gives a dark-coloured, rather plastic and sweet paste, which is highly undesirable. Some fried sweetpotato chips are also marketed in the supermarkets or consumed as breakfast snacks for school children.

Fresh vine leaves are fed to sheep, goat and rabbits. The use of the roots, vines and leaves for compound livestock feed is restricted to research stations, particularly the University of Ibadan.

Table 3.5 compares production, utilization and marketing of sweetpotato in various states of the southeastern zone of Nigeria. Sweetpotato is ranked among other major food

crops based on criteria listed in Tables 3.6 to 3.7. Table 3.8 shows the budget for production of sweetpotato and other crops in the southeastern zone.

Computed means of yield or prices of produce by state show that some states are faring worse than the others. In general, there is only a small margin of profit for cassava and yam farmers, and even losses for maize farmers. The case for maize is different when sold fresh because it allows the farmer to realize a profit.

Table 3.5. Comparative status, utilization and marketing of sweetpotato in the southeastern zone

	Abia	Anambra	Enugu	Imo	Rivers	Cross Rivers
Production practices						
Tillage system	Ridge mound	Ridge mound	Ridge mound flat	Ridge mound	Ridge mound	NA
Source of material	Ratoon	Ratoon	Ratoon	Ratoon	Ratoon small nursery	NA
Vine portion planted	All	All	All	All	Middle/Tip	NA
Fertiliser usage	Yes	-	Sometimes	-	Sometimes	NA
Pesticide usage	Nil (wood ash occasionally)	Wood ash	Rare	Nil	Nil	NA
Pests & diseases						
Pests	Beetle	Weevil	Weevil	Nematode	Weevil	NA
Diseases	Root rot	Leaf spot	Tuber rot	Leaf spot rot	Leaf spot tuber mould	NA
Storage & utilisation						
Storage period	Nil	Nil	Nil/2 months	Nil	Yes	NA
Storage place	-	-	Basket	-	Spread at corner	NA
Family members eating sweetpotato	All members	All	All	All	All	NA
Other parts consumed	-	Leaves	Leaves	-	-	NA
Other uses (feed)	Rabbits Small ruminants	-	Livestock Fowl	Livestock	Rabbits	NA
Labour input (mds/ha)	100+ food	150	200	200	200	NA
Cost range/kg	₦10	₦10-15	₦10-30	₦20-30	₦10-15	₦10-20

Mds = man days
Note: US$1=₦83

Table 3.6. Ranking of crops according to importance in farmers' diet, ease of propagation and economic yield

	Yam	Cassava	Maize	Sweetpotato	Cocoyam
Importance in farmers' diet					
Abia	2	3	1	5	4
Anambra	2	1	3	4	5
Cross Rivers	1	2	3	4	5
Enugu	1	2	3	4	5
Imo	1	3	2	5	4
Rivers	2	1	3	5	4
Ease of propagation					
Abia	2	3	1	5	4
Anambra	-	-	-	-	-
Cross Rivers	2	1	3	4	5
Enugu	4	2	3	5	1
Imo	2	5	3	4	1
Rivers	3	4	2	5	1
Economic yield					
Abia	2	3	1	5	4
Anambra	-	-	-	-	-
Cross Rivers	1	2	3	4	5
Enugu	1	3	2	5	4
Imo	-	-	-	-	-
Rivers	2	4	1	5	3

(Ranking from 1 – 5, with 1 as most important and 5 as least important)

Table 3.7. Other comparisons among crops in selected states

	Abia	Cross Rivers	Anambra	Enugu	Imo	Rivers
Yield (t/ha)						
Cassava	9.0	15.0	20.0	15.0-20.0	18.3	10.0
Yam	8.0	12.0	15.0	7.0-10.0	-	9.0
Maize	2.0	2.4	1.0	1.5-20.0	-	1.5
Sweetpotato	7.0	8.0	10.0	4.0-10.0	-	10.0
Ave. price (₦/kg)						
Cassava	1.5	4.0	1.5- 2.0	3.0	-	2.0
Yam	10.0	10.0	10.0-15.0	20.0	-	20.0
Maize	15.0	20.0	15.0-20.0	20.0	-	10.0-15.0
Sweetpotato	10.0	10.0	15.0-20.0	10.0	-	10.0
Cost of planting materials (₦/ha)						
Cassava	1,500	2,000	2,500	4,000	5,000	
Yam	50,000	100,000		50,000	80,000	
Maize	380	5,000		600	15,000	
Sweetpotato	400	2,000			3,300	
Fertiliser use (₦/ha or kg/ha)						
Cassava	600kg	600kg	400kg	400kg	400kg	400kg
Yam	600kg	600kg	₦200	400kg	400kg	₦300 to N350
Maize	400kg	200kg	₦200	400kg	400kg	₦300 to N350
Sweetpotato	400kg	-	₦200	400kg	400kg	₦300 to N350
Labour cost (N/ha)						
Cassava	2,000	2,000	-	15,000	-	-
Yam	2,000	3,800	-	20,000	-	-
Maize	1,000	2,500	-	12,000	-	-
Sweetpotato	1,000	1,700	-	7,000	-	-

Note: US$1=₦83

Table 3.8. Production cost of sweetpotato, cassava, yam and maize in the southeastern zone (per ha)

	Item	Sweetpotato	Cassava	Yam	Maize
1.	Land clearing, packing and burning	80 mds	80 mds	80 mds	80 mds
2.	Ridging	100 mds	100 mds	100 mds	100 mds
3.	Processing of planting materials	29 mds	20 mds	-	-
4.	Planting	25 mds	30 mds	45 mds	35 mds
5.	Weeding	40 mds	80 mds	80 mds	40 mds
6.	Fertiliser application	10 mds	25 mds	25 mds	30 mds
7.	Roguing of weeds	10 mds	-	-	-
8.	Harvesting	60 mds	75 mds	80 mds	50 mds
9.	Threshing				20 mds
10.	Staking & linking		90 mds		
11.	Total man-days	345 mds	410 mds	500 mds	355 mds
12.	Cost @ ₦100/man-day	₦35,400	₦41,000	₦50,000	₦35,500
13.	Cost of fertilizer	₦1,200	₦1,800	₦1,800	₦1,200
14.	Cost of stakes			₦7,500	
15.	Cost of cassava			₦1,000	
16.	Cost of planting materials	₦200	₦1,500	₦60,000	₦500
17.	Cost of bags	₦3,500			
18.	Total cost of production	₦40,300	₦44,300	₦119,400	₦37,200
19.	Yield (t/ha)	7 tonnes	15 tonnes	10 tonnes	2 tonnes
20.	Price (₦ /kg)	₦7	₦2	₦12	₦18
21.	Revenue (₦ /ha)	₦49,000	₦30,000	₦120,000	₦36,000
22.	Gross margin (₦ /ha)	₦8,700	₦14,300	₦600	₦1,200

Mds = man days

Notes to table:

1.) There are two to three weeding operations for cassava and yam.
2.) Fertiliser application is based on 400 and 600kg/ha (15:15:15) for sweetpotato/maize and cassava and yam, respectively at ₦150/50-kg bag.
3.) The farmer usually survives on his personal and family labour contributions. There is great potential for sweetpotato yield increase in the farmers' field.
4.) US$1=₦83

3.2 Production, marketing and utilisation in the sub-humid zone

The sub-humid region lies south of the semi-arid and arid zones, covering eight states: Niger, Kwara, Kogi, Nassarawa, Plateau, Benue, Gombe and Taraba states. It occupies about 43 million hectares with rainfall ranging from 1000 to 2000 mm. Seventy-one percent (71%) of the arable area is not cultivated due to low population density. The region thus offers the largest area for future expansion. The vegetation consists of open forest in the south and savannah grassland in the northernmost parts of the zone. Rainfall ranges from 1000 to 2000 mm. This region produces the largest quantities of sweetpotato as well as yam, cassava, sorghum, maize, rice and onions.

3.2.1. Production

Cultivation of sweetpotato in this region is largely undertaken by farm families whose farms range from one to three hectares in size. The farms are cleared and ridges 20-40 meters long are made mainly with the use of family labour. Ridges are made from May to July while planting is done from July to August. The vines are planted horizontally at 5-cm depth, leaving a small portion exposed above soil surface. Sweetpotato is usually intercropped with millet and maize and interplanted in

lowlands along riverbanks from September to December. Common varieties are the local, unimproved ones with white and red skin. Fertilisers do not get to these farmers because of their high cost. Harvesting of the roots is done five to six months after planting. Roots are then stored underground after sprinkling wood ash to prevent insect infestation. The budget for cultivation of sweetpotato in Benue State in 1993 and 1995 are presented in Table 3.9.

Table 3.9. Crop budget for sweetpotato in Benue State in 1993 and 1995 (per ha)

	Quantity	Unit Cost (₦)		Total Cost (₦)	
		1993	1995	1993	1995
Operations					
a) Land clearing (man-days)	40	30	80	1,200	3,200
b) Ridging (man-days)	70	30	80	2,100	5,600
c) Planting (man-days)	15	30	80	450	1,200
d) Fertiliser application	15	30	80	450	1,200
e) Weeding, lst (man-days)	40	30	80	1,200	3,200
Weeding, 2nd (man-days)	40	30	80	1,200	3,200
f) Herbicide	0	0		0	0
g) Harvesting	40	30	80	1,200	3,200
h) Transportation	15	100	120	1,500	1,200
Vines		lump		100	250
Fertiliser					1 ,200
Bags (packaging)	125	5	20	625	2,500
Total cost				10,025	25,950
Revenue (1995) (₦)	4.5 tonnes/ha at ₦7/kg			=	31,500
Gross margin (1995) (₦)	31,500 - 25,950			=	5,550

3.2.2 Marketing

Local markets are in place for sweetpotato and other products. Most villages hold the market every five days. Surplus sweetpotato is sold in the farms directly to buyers or in the market places or along major roads. Some dominant markets include Bida market in Niger State, Bukuru, Kuara rata, Gargann, Bokkos and Terminal market in Plateau State and the Offa market in Kwara State. Traders transport sweetpotato from this region to other states including Lagos, Oyo in the southwestern region, Enugu in the southeast region and Sokoto, Kano and Bauchi in the northern regions.

3.2.3 Utilisation

Most of the sweetpotato produced in the region is consumed boiled, roasted or fried and may also be boiled with beans or rice. Sweetpotato is also used to make *kunu* drinks. It is a very popular traditional staple in Offa region of Kwara State. Here, sweetpotato flour, which is prepared from sundried chips, is mixed with cassava and then pounded into *foofoo*. This is then eaten with vegetable soup.

In Plateau State, the roots are boiled, sliced and sun dried for about one week. This product is called *usinsin dankali*, which may be preserved and later boiled with rice or beans, or eaten as snacks. One major use of sweetpotato in the state is for the production of sweetpotato flour called *tsiro*. It is prepared by peeling the roots, slicing, sun drying and pounding using a mortar to obtain flour. The flour is then used as sweetener for *kunu* or *pap*. In the urban areas of the state, like the capital city of Jos, sweetpotato is used for making meat pies. The leaves and vines of sweetpotato are also used in the fresh or sun-dried forms to feed sheep and goats.

3.3. Production, marketing and utilisation in the semi-arid zone

The semi-arid region, which includes the arid sub-region, occupies the northern part of Nigeria and encompasses almost 35 million hectares. It covers the states of Sokoto, Zamfara, Kebbi, Kastina, Kaduna, Kano, Yobe, Borno, Adamawa, Jigawa and Bauchi. The semi-arid region has Sudan, Sahel and Northern Guinea Savannah types of vegetation, consisting mainly of grasses and woody plants. Average annual rainfall varies from 500 to 1200 mm per annum and may be as low as 200 mm in the northern limits. The unpredictability of the onset and end of rains often lead to crop failure. However, as sweetpotato is a short season crop (3-5 months duration), it is usually cultivated along river basin irrigation systems and low *fadama* areas of the region.

3.3.1 Production

Two plantings are practised in this region. In the first planting between May and July, the crop is rainfed. The second planting is done under irrigated or *fadama* conditions and in the flood plains between August and December. Only a few farmers are able to have a second planting because of limited *fadama* areas. Planting under well-organised irrigation systems takes place in Talata Mafara in Sokoto in the northwest. The shores of Lake Chad are also for growing sweetpotato during the dry season in some areas of Borno in the northeast.

Sweetpotato is planted usually as a sole crop. However, it is sometimes interplanted with crops such as maize, soybean, sorghum and millet. Planting materials (vines) are usually obtained from nurseries maintained by some local governments or from previously harvested farms. Varieties are distinguished by skin or flesh colour, leaf shape and sweetness of roots when boiled. The estimated farmland under root and tuber crops cultivation and production level in Kaduna State between 1991 and 1993 is shown in Table 3.10. Farmers in the region generally prefer to plant local unimproved varieties over the high-yielding ones.

Table 3.10. Estimated production, area and yield of root and tuber crops in Kaduna State

Crops	1991			1992			1993		
	production (tonnes)	area (ha)	yield (t/ha)	production (tonnes)	area (ha)	yield (t/ha)	production (tonnes)	area (ha)	yield (t/ha)
Sweetpotato	13,403	3,850	3.5	15,393	4,433	3.4	22,232	6,385	3.5
Yams	145,053	15,110	9.6	116,788	18,503	9.6	185,966	20,514	9.1
Cassava	37,368	7,933	4.7	37,636	11,693	3.2	96,694	19,876	4.9
Irish potato	56,139	9,150	6.2	55,861	9,310	6.0	62,846	10,211	6.2

Source: KASADEP 1991 – 1993.

Sweetpotato is grown on ridges 30 to 50 meters long and one meter apart. Short vines of almost 30 to 40 cm are buried in these ridges at a distance of one cm apart. Weeding is done about three weeks after planting and 3 to 6 weeks after the first weeding. Hilling up is also carried out during the process of weeding. Single super phosphate fertiliser is usually used for sweetpotato but fertilisation is not a widespread practice. The tubers are usually harvested 4 to 5 months after planting. Average yield of about 3.5 t/ha (without fertiliser application) are obtained at the Toro Local Government area of Bauchi State. Yields of up to 10 t/ha are obtained with local varieties particularly when manure from cow dung is used as fertiliser.

Farmers in this region hardly store sweetpotato as most of the harvest is sold immediately. However, some farmers practise in-ground storage by leaving their fields unharvested until the crop is needed. However, roots stored in this way are often infested with sweetpotato weevil if they remain too long in the ground. A few farmers also store fresh-cured roots in dry pits (underground storage). These pits are about 1 m deep and are lined with dry grass and leaves. The roots are then rubbed with ash before being buried in the pit.

3.3.2 Marketing

Most of the sweetpotato produced in this region is marketed fresh. Tubers are packaged in big baskets and jute bags or in small baskets for the retailers. Three major marketing routes are identified: the wholesalers, directly to consumers or to middlemen. Figure 3.1 shows the major marketing channels in the region. The socio-religious and cultural ways of the people generally influence the trading pattern of food. For this reason, men mostly do the marketing of sweetpotato. Sweetpotato is transported by donkeys, as head load (parcels carried on a porter's head) and by vehicles to marketing centres. Price trend of sweetpotato, cocoyam and maize in the region are shown in Table 3.11.

Figure 3.1. Marketing channels for sweetpotato in the semi-arid zone

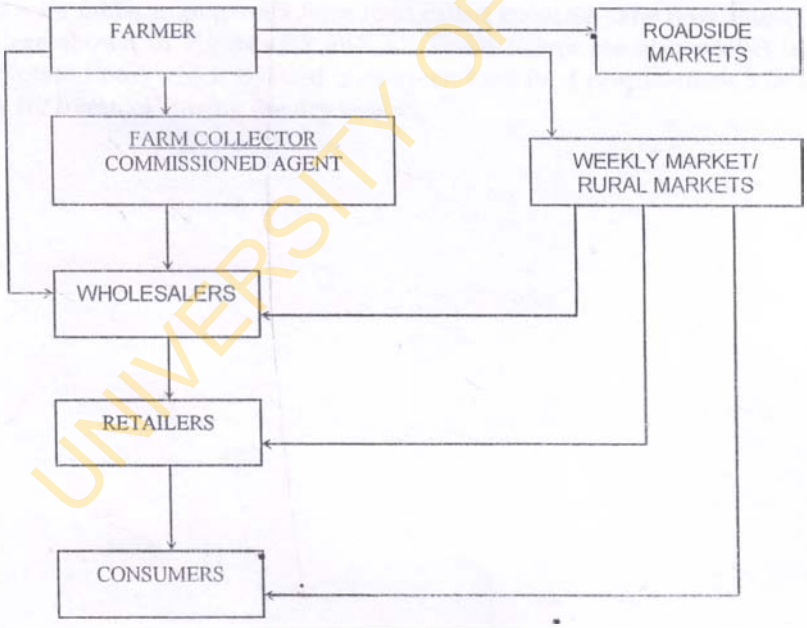


Table 3.11. Seasonal price trend of sweetpotato, cocoyam and maize in Sokoto State (1995)

	Sweetpotato (₦/kg)	Cocoyam (₦/kg)	Maize (₦/kg)
January	6.0	5.0	9.0
February	7.0	8.0	10.0
March	12.0	15.0	11.0
April	9.0	10.0	11.0
May	9.5	13.0	12.5
June	10.0	11.0	13.0
July	13.0	10.0	17.0
August	13.0	8.0	17.0
September	10.0	5.0	16.0

Note: US$1=₦83

Generally, prices of sweetpotato vary from ₦12/kg in the early part of the harvest season to ₦8/kg when harvest peaks. Sale of dried sweetpotato chips is common in the Toro local government area of Bauchi State, an area known for high sweetpotato production. Dried chips are sold in sacks with prices averaging ₦10,000/tonne during harvest. The chips are readily available from October to May.

3.3.3 Utilisation

Sweetpotato roots for consumption are usually boiled and eaten either alone or with beans or groundnut cake. Fresh-peeled roots may also be sliced and deep-fried in groundnut oil. Sweetpotato is as a sweetener. The peeled tuber is parboiled, sundried and then milled. The resulting flour is mixed with millet to prepare a local food called *kunuzaki*. The flow charts for the preparation of this drink are shown in Figures 3.2 and 3.3. Fresh tubers are also peeled, sun dried and milled into sweetpotato flour, which is used to sweeten local food preparations. The leaves and vines are dried as hay for livestock during the dry season.

Figure 3.2. Flow chart for preparation of sweetpotato for *kunuzaki.*

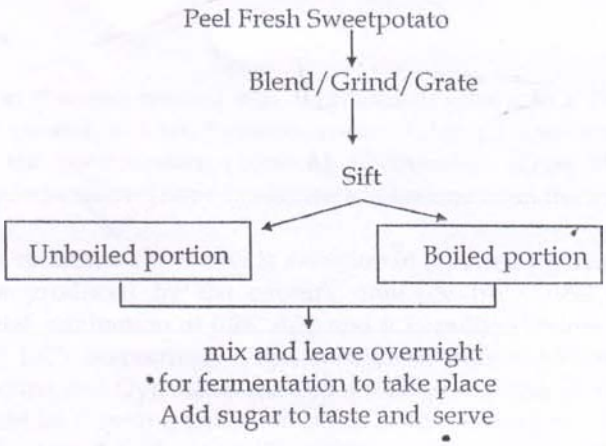
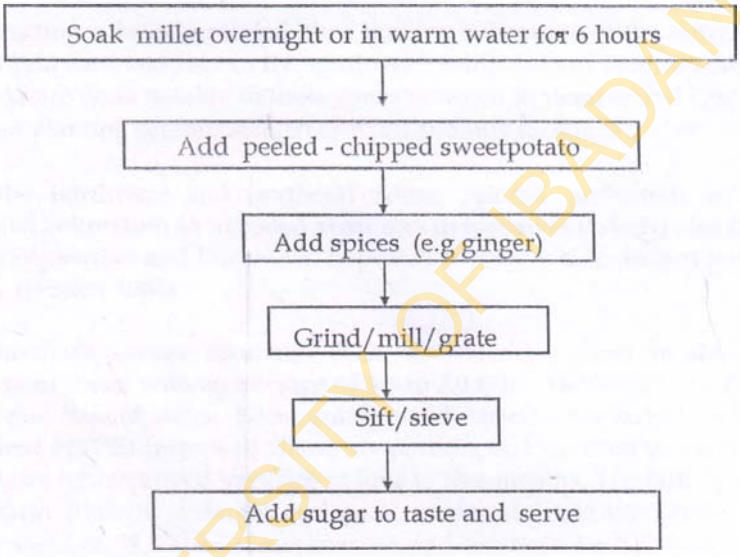


Figure 3.3. Flow chart for preparation of *kunuzaki* drink.



CHAPTER FOUR

4.1 Summary and conclusions

4.1.1. Production

Sweetpotato (*Ipomoea batatas*) was traditionally grown in a few areas in Nigeria in the 1970s, notably in the central and southeastern zones. Table 4.1 shows the present status of sweetpotato production in the northwestern (Zone A), northeastern (Zone B), central (Zone C), southwestern (Zone D) and southeastern (Zone E) regions as obtained from the survey.

Production estimates show a wide variation in reported figures. The FAO estimated a total of 0.04 million tonnes produced by the country annually from 1992 to1994. However, Horton (1988) estimated a total production of 0.26, 0.28 and 0.26 million tonnes from 20,000 ha area for the years 1983, 1984 and 1985, respectively. Figures obtained from the World Bank agricultural development projects in Kaduna and Oyo states showed a total production of 69,432 (0.069 million) tonnes for an area of 15,137.84 ha covering two of 36 states in the Federation. Similarly, NRCRI (1990) and AFLP (1992) gave figures of 0.25 and 0.57 million tonnes per annum in 1990. Although not entirely consistent, these figures show that national production has increased in the last two decades with the expansion in the areas planted to sweetpotato.

Production is largely rainfed, thus limiting cultivation to the rainy seasons. Planting is therefore between February and July in the southwest, southeast and central zones. Additional planting along riverbanks are done notably in these zones between September and December. The south zone enjoys two major planting seasons: March to April and July to August.

In the northwest and northeast zones, rainfed cultivation is between May and August. Substantial cultivation in irrigated areas and in lowlands (*fadama*) also takes place in these two zones between September and December. Reported average yields were at four t/ha (Chinaka 1983) and 13 tons/ha (Horton 1988).

Preliminary survey estimates show a decreasing yield in the southeastern, northeast and northeastern zones with an average of 3.5 to 7.0 t/ha. Yields of 7 to 8 t/ha are, however, common in Plateau and Bauchi states. Local unimproved varieties are largely used except in the southeastern zone where NRCRI-improved clones are prominent. Estimated yields in research stations are from 40 to 71.7 t/ha for improved varieties in four to five months. The NRCRI uses these improved varieties for on-farm trials in different ecological zones. Multiplication trials by IITA in Nigeria gave an average yield of 23.5 t/ha across seasons and locations for TIS 2498 with fertiliser application. The multi-locational trials further identified the IITA-improved clone TIS 2498, to be the best in yield and stability across the different environments of Nigeria. TIS 2498 gave 29.0 t/ha in four months and an average 10.4 t/ha across 24 types of environments in Nigeria.

Table 4.1. Summary of sweetpotato production, utilisation and marketing by ecological zones

Ecological Zones	Major sweetpotato producing areas	Clones available	Production techniques	Marketing methods	Utilisation
Humid	Ogbomoso, Oyan, Ijabe, Okuku, Saki, Ibadan	Orange-fleshed local and improved clones (CIP, IITA, NRCRI)	Rainfed, mixed cropping with maize	Farm collectors buy directly from farmers who bring harvest to weekly markets	Snacks, sweetpotato flour for *lafun*, vines and leaves as livestock feed, especially for rabbits
Sub-Humid	Ajassepo, Dokobo, Agbamu, Offa, Bokkos, Jos, Bass, Wuse, Oturpo, Vandeikya, Makurdi	Local clones (Tomude, Anomo Igangan)	Planted with millet (mixed cropping)	Farm collectors buy directly from farmers who bring harvest to weekly markets	*Foofoo*, vegetables, snacks (*usinsin dankali*)
Semi-Arid	Toro, Balanga, Dass, Kukawa, Marte, Gwosa, Biu, Askira Uba, Zango Kataf, Jema, Igbai, Talata Mafara	Clones such as Bombom, Local varieties with pink skin white flesh, yellow flesh	Usually *fadama* cropping	Roadside sales of sweetpotato are common in this zone	Boiled for food; Sweetener; Dried forage as livestock at the peak of the dry season

Sweetpotato is largely produced by men and women farmers on farms less than one hectare in size. It is usually intercropped with rootcrops, notably yam, cassava and cocoyam in the southern and central zones of Nigeria. Intercropping is done predominantly with maize and millet in the two northern zones. The crop is given proper management as a sole or as part of a mixed cropping system in Delta and Rivers states of the southern part and in most of the northern part of Nigeria. Sweetpotato weevil is a major pest in Nigeria causing up to 80 percent yield loss. *Cylas puncticolis* and *C. brunneus* were the most serious species. Clones identified by IITA having moderate to high resistance to *C. puncticolis* include TIS 3053, TIS 3030, TIS 3017, TIS 2532, TIS 8524, TIS 8266 and TIS 9172. Orange- fleshed clones were found to be more susceptible than white-fleshed clones. At NRCRI, tubers of TIB, JKO and Anambra local were not damaged by *C.puncticolis*. The sweetpotato virus complex, which causes SPVD, was found to result from interaction between two separately transmitted viruses, *Myzus persivae* and *Aphid gossypi*. Varieties found to be resistant to SPVD were TIS 2532 and TIS 2744.

Losses from root knot nematode ranged from 20 to 30 percent. A total of 55 clones have been found to have high resistance to root knot nematode. Another pest, *Acraea acerata*, causes noticeable damage six weeks after planting, increasing up to ten weeks and then decreasing with further ageing of the plant.

Vines from promising clones have been distributed by NRCRI in the southeast zone and Adamawa province in the northeastern zone and by IITA in the Rivers State. Large-sized tubers are prominent in the northeast zone and highest average yield is observed in the southeast zone. TIS 2498 vine cuttings are best preserved in open baskets. Highest yields were obtained when vines were preserved 5 days before planting. Vine tips were found to be better seed stock than middle and basal cuttings.

For best yields, about 500 mm rainfall during the growing season is required. Best yields were noted in regions with 750 to 1,000 mm rainfall. Irrigating with 4,500 m^3/ha water distributed at seven-day intervals resulted in yields of more than 20 t/ha from improved sweetpotato varieties.

Optimum NPK requirement were only reported for Abia and Anambra states. N_{45} P_0 K_{40} and $N_{45}P_{15}$ K_{70} resulted in the highest fresh tuber and saleable tuber yields in Umudike (Abia) and Igbariam (Anambra), respectively. Poultry manure with 9 percent nitrogen content can be used effectively as a substitute for inorganic fertiliser. Didimac insecticide protected the sweetpotato against aerial pests while Aldrin and Basudrin protected the roots from weevils. Varietal characteristics of *in vitro* plantlets were comparable with plants grown in open fields, although higher tuber yield and more marketable tubers were obtained from plants grown *in vitro*.

Overall, the IITA-improved clone TIS 2498 was most stable with highest yield. It has shown resistance to viruses and moderate resistance to weevil under field conditions and high storability. It also has high dry matter content (33.3%) and was most acceptable to consumers.

The major sweetpotato production problems in Nigeria are the unavailability of high yielding and resistant varieties, lack of transport facilities, incidence of pests and diseases, high cost of labour, unavailability of fertilisers, inadequate tractor services and lack of credit facilities.

4.1.2 Storage

Sweetpotato weevil and black rot damage constitute the major obstacles to sweetpotato storage. TIS 2534 remarkably recorded no rot after four months in storage in moist sawdust inside baskets. Leaving sweetpotato unharvested resulted in losses of 12 to 90 percent caused by weevil infestation. Underground storage in pits ensured no weevil infestation for two to three months. These pits were lined with a layer of dried grass, followed by a layer of sweetpotatoes treated with wood ash, followed by another layer of dried leaves or grass and at least five cm of topsoil. This practice is common in the northern zones. Varieties that did not sprout under ambient temperature for about two months are TIS 2153, LTIS 2532, TIS 2534 and TIS 3017. However, breeding for resistance to weevil infestation during storage remains unaddressed.

4.1.3 Processing and utilisation

Sweetpotato is traditionally consumed in boiled form. Therefore its processing is largely limited to peeling and boiling. Roots are peeled before or after boiling. Peeled tubers can be boiled with cowpea, limabean, benniseed or millet to prepare porridge. Sweetpotato is also peeled, sun-dried and milled into flour and used to sweeten local foods such as pap or to make a local fermented drink (*kunuzaki*) in the northern and central zones. Sweetpotato flour is also popularly pounded into a dough (*foofoo*). Or, alternatively, the flour is blended with yam or cassava flour and mixed with hot water to prepare a dough or paste (*amala*). Studies show that cassava starch is more attractive than fermented or instant cassava. A ratio of 4:1 of sweetpotato flour to cassava starch is recommended.

Sweetness of the locally available clones seriously limits consumption of sweetpotato as a staple food in Nigeria. Some 60 non-sweet clones have been identified from IITA collections and a non-sweet variety TIS 87/0087 with yield of 40 t/ha was recommended by the NRCRI.

Fried sweetpotato chips are popular foods in local markets. In Lagos State, chips are packaged and sold in supermarkets or hawked on busy streets or in schools. Sweetpotato flour is also used for making meat pies in some state capitals.

A popular snack consumed in the Plateau State requires boiling, slicing and a week of sun drying of sweetpotato roots. The snack is also sometimes cooked with beans and rice. Attempts to make biscuits from sweetpotato flour at NRCRI gave nice-tasting but soft and unattractively coloured biscuits. The Dokobo cultivar was most promising. Boiling, peeling, slicing and even drying sweetpotato gave presentable, palatable chips and flakes. One cup of the flour plus three cups of wheat flour combined to produce good tasty pancakes that did not require addition of sugar.

Industrial uses of sweetpotato roots in Nigeria are very limited. However, studies show starch content of 15.08 to 24.68 percent from the high-yielding varieties developed by the NRCRI. These are therefore good sources of starch and amylose for food, alcohol, pharmaceuticals and the textile industries in Nigeria. Culture media produced from sweetpotato flour compare favourably with standard laboratory nutrient agar media.

An appreciable amount of sweetpotato leaves is consumed as vegetables. The leaves compare favourably with common vegetables as soup ingredient when assessed for appearance, palatability, softness and acceptability.

Sweetpotato roots as a valuable energy and carotene source compares favourably with maize and cassava chips as an ingredient in livestock rations. Its use in Nigeria is, however, largely limited to experimental stations. Only non-marketable small-sized or damaged tubers are fed to livestock in all parts of the country. The vines and leaves are popularly used either fresh or sun-dried as feed for rabbits, sheep, goat and cattle.

Recommended levels of oven-dried sweetpotato flour in livestock rations is ten percent for layer feeds, 12 percent for broiler starter feeds, 18 percent for broiler finishers, 17 percent for pig weaners and growers and 40 percent for growing fattening sheep. Sun-dried flours are not recommended due to high infestation by micro-organisms during drying, particularly in the wetter regions of Nigeria. Also, high reducing sugar in sweetpotato roots and flour causes diarrhoea, thus limiting its use in livestock rations. The use of non-sweet clones is recommended.

4.1.4 Production economics and marketing

As shown in Table 4.2, the production cost of sweetpotato in the three zones indicated average ₦31,500/ha with average yield of 5.2 t/ha. Revenue generated at farm gate price of ₦7-8/kg indicated an average gross profit margin of ₦6,000, /ha or ₦1,160/ton. Thus, the returns on investment for production of sweetpotato in Nigeria are not large. In spite of this, comparison of production costs and revenue yield for cassava, yam and maize in the southeastern zone indicated higher profit margin for sweetpotato.

Market prices vary from about ₦5/kg to ₦15/kg throughout the year. In Oyo State, at the peak of harvest between July and January, prices varied from ₦5.41 to 9.58/kg. Between February and June, when sweetpotato is usually scarce, market prices ranged from ₦12 to 15.4/kg. Also figures from Oyo State showed that between 1990 and 1995, average market price of sweetpotato rose from ₦1.71/kg to ₦13.82/kg. Figures for the same period were ₦1.77/kg to ₦12.64/kg for yam tubers, ₦1.71/kg to ₦13.82/kg for shelled maize and ₦0.32/kg to ₦1.69/kg for cassava tubers. Therefore, sweetpotato still compares with maize and yam and is priced much higher than cassava tubers.

Production economics shows that variety, yield, labour rates and market prices affect profitability of sweetpotato production. Marketing of sweetpotato is largely organised around middlemen. These are usually women, except in the northern zones where men dominate the trade. Marketing involves producers, middlemen, retailers, itinerant traders, transporters and assistants who help in packing, loading and unloading. The rootcrop is marketed within and outside the sweetpotato-producing

states and large consignments are transported in trailers from Benue, Kogi, Kwara, Osun, Oyo, Rivers and Delta states to the open market in Lagos where they are sold fresh for processing into potato chips, packaged and then sold in supermarkets and by street hawkers. Sweetpotato is also transported in large consignments from the central zone to the northeastern and western zones to supplement local supplies.

Non-sweet clones are preferred by consumers but planting materials are difficult to source out. The sweetpotato available in the market are of the sweet type, so that marketability is seriously limited. There is also a need to explore industrial uses for sweetpotato to increase marketability. Transportation is the single item that accounts for the largest share in the distribution cost of sweetpotato.

Table 4.2. Sweetpotato production inputs, costs and net revenues in central, southwestern and southeastern zones in 1995 (per ha)

Item	Central zone (Benue State)	Southwestern zone (Oyo State)	Southeastern zone (7 States)	Average of 3 zones
1. Land clearing, packing and burning	40 mds	80 mds	80 mds	67 mds
2. Ploughing and ridging	70 mds	42 mds	100 mds	71 mds
3. Processing of planting materials	-	-	29 mds	29 mds
4. Planting	15 mds	25 mds	25 mds	22 mds
5. First weeding	80 mds	51 mds	40 mds	57 mds
6. Fertilizer application	15 mds	-	10 mds	13 mds
7. Second weeding	-	-	10 mds	10 mds
8. Harvesting	40 mds	60 mds	60 mds	53 mds
Transportation	15 mds	-	-	15 mds
Total man days/ha	275 mds	258 mds	354 mds	296 mds
Labor wage rate (₦/day)	₦80/mds	₦100/mds	₦100/mds	₦93 / mds
Cost of labor ((₦/ha)	₦22,000	₦25,800	₦35,400	₦27,733
Cost of planting materials (₦/ha)	₦250	₦500	₦200	₦300
Cost of fertilizers (₦/ha)	₦1,200	-	₦1,200	₦1,200
Cost of bags (packaging) (₦/ha)	₦2,500	₦2,000	₦3,500	₦2,667
Total cost of production (₦/ha)	₦25,950	₦28,300	₦40,300	₦31,500
Yield (tonnes/ha)	4.5	4.0	7.0	5.17
Selling price (₦/kg)	7	8	7	7.33
Revenue (₦/ha)	₦31,500	₦32,000	₦49,000	₦37,500
Profit margin (₦/ha)	₦5,550	₦3,700	₦8,700	₦6,000

mds = man-days of labor
US$1=₦83

4.2 Recommendations

Although sweetpotato is regarded as a minor crop in Nigeria and hence, rated low on the food priority list, the difficulty in securing affordable food for the teeming populace has, in recent times, brought the crop vividly into focus. It is also pertinent to note that cassava, a major staple food, is fast becoming an industrial crop which is increasingly used in the food, alcohol, textile, pharmaceutical and feed industries. Hence, the movement of prices for cassava products is upward. A large deficit in supply is also projected to occur in the near future as the urgency to meet traditional food and industrial needs is far from being matched by production due to the long maturity period of 12 to 18 months for cassava and traditional processing techniques which are too slow to meet production requirements. It therefore becomes imperative to promote the cultivation and use of sweetpotato as food and for other uses to avoid the shortfall that will certainly be created by shortage in cassava supply. Strategies to adopt in accomplishing this are as follows:

1. **Diagnostic survey**. Our study has demonstrated that sweetpotato production and utilisation in Nigeria has increased tremendously in recent times. Data on current production statistics are seriously conflicting. It is therefore necessary to gather comprehensive information through a nationwide diagnostic survey to enable effective planning for increase in production and utilisation of the crop. This is critical to ensure the selection of the most promising markets. The survey will enable gathering of information on eco-specific differences in production, marketing and utilisation. The constant in each region and their respective potentials will also be identified and relatively quantified. Experience on the present study suggests active collaboration with the state agricultural development projects in obtaining realistic data through their extension agents.

2. **Distribution of high-yielding varieties and improvement of cultural practices**. A major constraint that was identified is the low yield of popular varieties resulting in high cost of production per hectare. High production costs, in turn, make sweetpotato unattractive as a raw material for industries. Therefore, making available high-yielding varieties from the IITA and NRCRI collections is essential. Presently, variety 2498 holds very high promise in terms of yield and stability. Another promising variety is TIS 87/0087, a high-yielding non-sweet clone. Varieties TIS 8164 and TIS 87/0087 have been demonstrated to have yields of 12 to 20 t/ha in different ecological zones of Nigeria by NRCRI. It is imperative to distribute the high-yielding non-sweet clones to enhance the acceptance of sweetpotato as a staple food.

   The distribution of the improved varieties must be complemented with the introduction of improved cultural practices to increase the farm yield and income of smallholder farmers who are the target groups. Implementation should also be linked to an effective on-farm adaptive research closely linked to feedback from extension staff of the national research systems. This will enable appropriate interventions that will adapt introduced technologies to specific ecological zones of the country.

   The multiplication of quality planting materials should be promoted first through self-effort and later through contracted out-growers. Where necessary, irrigation should be introduced to maintain moisture needs of sweetpotato beds seeded with vines.

3. **Agroprocessing and utilisation**. In order to enhance the utilisation of sweetpotato, specific industries have to be targeted. Table 4.3 (a-g) presents different scenarios with sweetpotato at various market prices for livestock feed industries. Specifically, the broiler industry cannot accommodate sweetpotato in the ration unless the price of fresh roots is not more than 25 percent of the market price of maize. The cost of production of sweetpotato chips is presented in Table 4.4. Comparable reduction in market price is crucial to increase the meagre profit on recurrent

expenses in the industry. The alcohol industry which presently uses cassava can also utilise sweetpotato.

These are recognised as the immediate markets that should be exploited for expanded industrial cultivation of sweetpotato. It is therefore imperative to select varieties in terms of yield, cost and biochemical characteristics that will enable sweetpotato to compete favourably in such industries. The competition will be on a level playing field because cassava, which is currently used in the livestock and alcohol industries, is faced with scarcity and escalating prices due to longer maturity period and increased demand in the food and feed industries. Using sweetpotato as an alternative will therefore complement cassava use in such industries. Processing technologies for the production of acceptable chips and flour will however need to be developed including the perfection of locally available technologies.

Experiences from the research institutes as documented in chapters 2 and 3 should be collated for this purpose. The technologies to be developed must be user-friendly to enable the processing of sweetpotato by small-scale rural farmers and avoid the problem of transporting fresh tubers to urban areas.

4. **Production, promotion and marketing**. An increased production of sweetpotato that is not matched by adequate promotion and marketing to absorb surpluses from increased yield has been detrimental to the sustainability of sweetpotato production in Africa and in the Cameroon. It is therefore imperative to mount effective promotional campaigns to link sweetpotato producers and processors to relevant consumer industries. It is recommended that for effective promotional activities, pilot projects on the sustainability of sweetpotato-based chips, livestock feed and alcohol industries should be in suitable locations of the country. This should be used to generate data that will convince entrepreneurs of the viability of such industries.

Effective machinery for propaganda must therefore be put in place to create awareness of the existence of such markets. As women are responsible for the bulk of processed rootcrops in Nigeria, the Women in Agriculture Programme (WIA) of the state-level Agricultural Development Projects are strongly recommended to facilitate promotion of such processing technologies among women and multipurpose cooperatives.

Table 4.3.a. Ingredients of experimental diet (broiler starter) containing varying levels of oven-fried sweetpotato as replacement

Ingredients (%)	1	2	3	4	5	6	7
Sweetpotato (%)	0%	10%	20%	30%	40%	50%	100%
Maize	60.25	54.25	48.2	42.17	36.15	30.12	0.00
Sweetpotato	0.00	6.02	12.05	18.07	24.10	30.12	60.25
Groundnut cake	24.00	24.00	24.00	24.00	24.00	24.00	24.00
Fish meal	7.00	7.00	7.00	7.00	7.00	7.00	7.00
Wheat offal	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Bone meal	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Oyster shell	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Vit-min premix*	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Common salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100	100
Cal CP%	22.28	21.99	21.72	21.45	21.18	20.91	19.47
Cal ME kcal/g	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Cost of feed/kg @ varying prices of sweetpotato							
₦30/kg	25.74	26.65	27.55	28.45	29.36	30.26	34.78
₦22.5/kg	25.74	26.19	26.65	27.09	27.55	28.00	30.26
₦15.0/kg	25.74	25.74	25.74	25.74	25.74	25.74	25.74
₦7.50/kg	25.74	25.29	24.84	24.38	23.94	23.49	21.22

US$1=₦83

*Premix supplying the following nutrients/kg of ration: Vit A, 11.785 I.U.; D, 1964.3 ICU; Riboflavin, 5.40 mg; Pantothenic acid, 9.82mg; Nicotinic acid 24.55mg; folic acid 0.98mg; Chorine chloride, 147.32 gm; Vit. E, 4.911.u; Vit K, 2.20mg; Vit B_{12}, 0.01mg; Methionine, 245.53mg; Cobalt, 1.23 mg, Iodine 0.98 mg; Cu, 9.82mg; Mn, 55.0 mg, Zn 49.11mg and Fe, 19.64mg.

Table 4.3.b. Ingredients of experimental diet (broiler finisher) containing varying levels of oven-dried sweetpotato as replacement for maize

Ingredients	1	2	3	4	5	6	7
Sweetpotato (% maize in ration)	0%	10%	20%	30%	40%	50%	100%
Maize	50.25	45.22	40.20	35.17	30.15	25.12	0.00
Sweetpotato	-	5.02	10.05	15.07	20.10	25.12	50.25
Groundnut cake	22.00	22.00	22.00	22.00	22.00	22.00	22.00
Fish meal	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Wheat offal	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Bone meal	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Oyster Shell	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Vit-min premix*	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Common salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100	100
Cal CP%	20.93	20.72	20.49	20.25	20.02	19.79	18.62
Cal ME kcal/g	3.30	3.30	3.30	3.30	3.30	3.30	3.30
Cost of feed/kg @ varying prices of sweetpotato							
₦30/kg	25.79	21.54	22.30	23.05	23.81	24.56	28.33
₦22.5/kg	20.79	21.16	21.51	21.92	22.30	22.68	24.56
₦15.0/kg	20.79	20.79	20.79	20.79	20.79	20.79	20.79
₦7.50/kg	20.79	20.41	20.04	19.66	19.29	18.91	17.02

US$1=₦83

*Premix supplying the following nutrients/kg of ration: Vit A, 11.785 I.U.; D, 1964.3 ICU; Riboflavin, 5.40 mg; Pantothenic acid, 9.82mg; Nicotinic acid 24.55mg; folic acid 0.98mg; Chorine chloride, 147.32 gm; Vit. E, 4.911.u; Vit K, 2.20mg; vit B_{12}, 0.01mg; Methionine, 245.53mg; Cobalt, 1.23 mg, Iodine 0.98 mg; Cu, 9.82mg; Mn, 55.0 mg, Zn 49.11mg and Fe, 19.64mg.

Table 4.3.c. Comparative cost evaluation of varying prices/quantities of oven-dried sweetpotato as replacement for maize in broiler rations

Price of Sweetpotato (₦/kg)	1 0%	2 10%	3 20%	4 30%	5 40%	6 50%	7 100%
a) Starters	Cost of feed per kg weight gain (₦)						
₦30.0/kg	62.85	69.53	65.56	79.09	30.15	115.32	143.95
₦22.5/kg	62.85	68.27	63.27	75.06	89.68	106.14	124.00
₦15.0/kg	62.85	67.17	61.27	71.56	84.14	98.09	106.54
₦ 7.5/kg	62.85	65.99	59.12	67.78	78.26	89.52	87.83
b) Finishers	Cost of feed per kg weight gain (₦)						
₦30.0/kg	77.12	80.97	96.22	94.02	112.41	99.22	141.14
₦22.5/kg	72.12	79.54	92.82	89.41	105.28	91.63	122.36
₦15.0/kg	77.12	78.14	89.72	84.80	98.15	83.99	103.58
₦ 7.5/kg	77.12	76.72	86.47	80.12	91.07	76.39	84.79

Table 4.3.d. Ingredient composition of experimental rations containing varying levels of sun- and oven-dried sweetpotato as replacement for maize (broiler starter)

Ingredients (%)	1	2	3
Sweetpotato component (% of maize in ration)	0%	50%	100%
Maize	60.25	30.13	0.00
Groundnut cake	23.0	23.0	23.0
Blood meal	3.0	3.0	3.0
Fish meal	5.0	5.0	5.0
Wheat offal	5.0	5.0	5.0
Bone meal	2.0	2.0	2.0
Oyster shell	1.0	1.0	1.0
Vitamin mix	0.5	0.5	0.5
Salt	0.25	0.25	0.25

Table 4.3.e. Comparative cost of varying levels of oven- and sun-dried sweetpotato as starter diet for broilers.

Parameters	1 0%	2 50% SD	3 50% OD	4 100% SD	5 100% OD
Feed intake/wt gain cost of feed at	2.448	3.73	3.283	5.30	3.89
N30.00/kg	23.58	28.10	28.10	32.63	32.63
N22.5/kg	23.58	25.84	25.84	25.10	23.58
N7.50/kg	23.58	21.32	21.32	19.06	19.06

Table 4.3.f. Ingredient composition of experimental rations containing varying levels of sun- and oven-dried sweetpotato as replacement for maize (broiler finisher).

Ingredients	Dietary Variables		
	1	2	3
Sweetpotato component (as % of maize in ration)	0%	50%	100%
Sweetpotato	0.00	12	50.25
Maize	50.25	25.12	0.00
Fish meal	4.00	4.00	4.00
Wheat offal	20.00	20.00	20.00
Oyster shell	1.00	1.00	1.00
Vitamin mix	0.5	0.5	0.5
Salt	0.25	0.25	0.25