Chapter 19
Sweetpotato in West Africa

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Historical Background

West Africa (17° 15 min E, 17° 15 min W and 26° 52 min N, 15° 35 min S) with 16 countries forms the Economic Community of West African States (ECOWAS) excluding Mauritania. Mali, Burkina Faso and Niger are land-locked. The region, north of Gulf of Guinea, had a long history of slave trade, Portuguese presence, colonial exploitation of human and natural resources by European nations during 1460–1960. Her southern forests, forest-savanna transition, northern savannas agro-ecologies suit many crops using traditional techniques. However, rapid un-checked growth in human population implies greater food production. West Africa's 2000 population density was not uniform (Fig. 19.1); grew 2.5% annually to 273.5 million

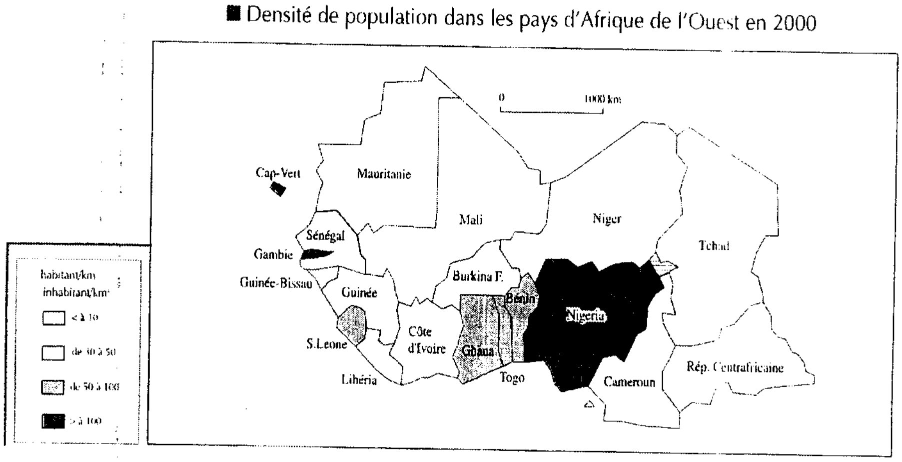

Fig. 19.1 West Africa population density in 2000

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G. Loebenstein, G. Thottappilly (eds.), *The Sweetpotato*,
DOI 10.1007/978-1-4020-9475-0_19, © Springer Science+Business Media B.V. 2009

inhabitants in 2006, with 51.1% in Nigeria. Population density partly influences the economy through food, feed, and industry.

Introduction of Sweetpotato to West Africa

Sweetpotato, *Ipomoea batatas* (L.) Lam is not known wild but of Tropical Central American origin. Cassava, sweetpotato, *Xanthosoma* and potato introductions from Tropical America to Africa were recent through Iberian voyages of Portugal and Spain. Christopher Columbus took sweetpotato to Spain in 1492. Portuguese brought it to their settlements or trading stations in Africa along Gulf of Guinea: Sierra Leone, Sao Tome and Principe, and Fernando Po [Bioko in Equatorial Guinea]. Sweetpotato cultivation was first mentioned in Africa in Sao Tome in 1520 (Mauny, 1953). In the 16th century, Portuguese navigators introduced sweetpotato to Africa, Europe, India, and Indonesia (Janssens, 2001); and were widely cultivated in West Africa by end of 17th Century (Leon, 1977). In the 1800s, freed slaves returning to Gulf of Guinea; brought Latin America crops. Local diet preferences dictated the share of farm resources allotted each cultivated crop.

Sweetpotato is one of over 60 common crops Table 19.1 Its spread was slowly by farmer-to-farmer diffusion involving no colonial crop dispersal agencies. Its sweetness makes it less preferred to bland starchy staples [yam, cassava, rice, cowpea, cocoyams, and acha]. Consequently, early breeding at International Institute of Tropical Agriculture (IITA) (1970–1988) screened out orange-fleshed and sweet types. New trends seek varied populations to satisfy different end-uses (Akoroda et al., 2000). Tubers contain per 100 g: 70 g water, 1.5 g protein, 0.3 g fat, 26 g carbohydrates (30.8–41.8 g starch and 3.68–10.4 g sugar), 1 g fibre, 25 mg calcium, 1 mg iron, vitamin A potency of 0–4000 international units, thiamine 0.1 mg, riboflavin 0.04 mg, nicotinamide 0.7 mg, ascorbic acid 30 mg (Tindall, 1968; Tewe et al., 2003). Africa's sweetpotato hectarage is highest in West Africa (Table 19.2). West Africa with East Africa region account for 77.4% of the continent's production.

Table 19.1 Common plants cultivated by West African farmers

Cereals: maize, rice, sorghum, millets, acha (*Digitaria exilis*), wheat
Roots and tubers: cassava, yams (10 species), sweetpotato, cocoyams (2 species), potato, carrot
Pulses and legumes: groundnut, soybean, cowpea, bambara nut, sunflower, pigeon pea, sesame,
Trees and Shrubs: oil palm, cocoa, coffee, kola, tea, cashew, coconut, rubber, shea, star apple (*Chrysophilum albidum*), Ogbono (*Irvingia gabonensis*), African pear (*Dacrodes edulis*), pepper fruit, raphia palm,
Vegetables: amaranth, telfairia, bitter leaf, celosia, corchorus, tomato, pepper, onion, garlic, roselle, cabbage, green beans, okra, watermelon, egusi, carrot, pumpkin, ginger, eggplants
Industrial: sugarcane, tobacco, kenaf, cotton
Fruits: citrus (5 species), pawpaw, banana, plantain, pineapple, guava, mango, avocado

Table 19.2 Sweetpotato production in regions of Africa (FAOSTAT, 2005)

Region (countries)	Tuber yield (kg/ha)	Harvested hectares ('000)	Production ('000 tonne)	Percent of Africa's total
West (12)	7594	1200.42	3801.44	31.6
Central (5)	4054	123.43	499.22	4.2
East (9)	7222	1065.22	5506.42	45.8
South (8)	5823	700.50	1909.90	15.9
North (2)	21474	10.58	307.51	2.6
Mean/Total	6591	3100.15	12024.48	100.0

Nigeria

More sweetpotato is produced in central humid savanna [700–1000 mm of annual rainfall] than in forests or dry savanna states (PCU, 2004). Food preferences vary between localities, northerners appreciate sweet snacks—sugarcane, sweets-toffee, date palm nuts, and sweetpotato tubers whose sweetness depends on sugar [2–9% means, 3.9–5.0% median] (IITA, 1984). Sweetpotato is a small fraction of local food-basket. Farmers' rank of its relative importance in diet base on ease of propagation and economic yield, decreasing from: yam (28), maize (34), cassava (39), cocoyam (55) to sweetpotato (69) in SE Nigeria.

Ghana

Farmers plants 65,000 ha yearly of sweetpotato that comes after cassava, and yam in importance among root crops (FAOSTAT, 2006); Grown mainly on mounds and ridges in coastal savanna and forest-savanna transition zones having two rainy seasons and two plantings in April–May (major season) and August–September (minor season); and Guinea savanna zone (one growing season with planting in June–July).

Sweetpotato has huge potential as food (boiled, fried, or roasted), shoots supplement livestock feeds, and could provide starch and flour for industries. Leaves are eaten as vegetables in Guinea and coastal savanna zones. Ghana being Vitamin A deficient (VAD); consuming orange-flesh sweetpotato (OFSP) rich in beta-carotene would help fight VAD among children.

Mali

In 1980, farmers produced 10,000 t of yams, 20,000 t of cassava and 50,000 t of sweetpotato. Malians consumed 16.8 kg sweetpotato/person in 1989, and an expected 21.4 kg in 2005 (Traore, 1994). Planting after March in some zones gives no tubers due to sweetpotato's sensibility to photoperiod. Sweetpotato is not supported by research towards supplementing cereals.

Table 19.3 Released and popular early sweetpotato varieties moderately resistant to weevil in Ghana

Cultivar name	Tuber flesh colour	Total tuber yield (t/ha)	APM	Reaction to SPVD**	Market-ability	Dry matter content (%)	Overall tuber acceptance‡
CRI-Apomuden	Reddish (deep) orange	30	Low	3	2	21.9	3
CRI-Otoo	Light orange	23	High	3	2	32.2	3
CRI-Ogyefo	White	20	Medium	3	3	40.1	3
CRI-HiStarch	Cream	18	Medium	3	2	40.0	3
Sauti	Yellow	19	Medium	3	3	40.2	4
Faara	White	22	High	4	3	36.1	4
Okumkom	White	20	Medium	3	2	30.7	2
Santom pona	Light yellow	17	Medium	3	2	34.4	2
Jukwa orange‡‡	Light orange	30	High	3	3	35.0	4

* Early – reaches maturity 4 MAP; Medium – 5 MAP; Late – 6 MAP. ** 0 – Not a problem; 1 – Susceptible; 2 – Low resistance; 3 – Moderate resistance; 4 – Resistant; 5 – High resistance; † 1 – Low; 2 – Medium; 3 – High. ‡ 1 – Bad; 2 – Fair; 3 – Good; 4 – Very good. APM: Ability to retain planting material after periods of extended drought ‡‡ – Not officially released variety, but popular in coastal savanna.

Ghana

Varieties: Farmers grow six improved white-fleshed and two OFSP varieties (Table 19.3) commonly yielding 8–10 t/ha, reaching 15–30 t/ha. Improved varieties were released in 1998 (Tables 19.4 and 19.5) after wide testing and evaluations of yield and culinary acceptances.

Planting material multiplication and distribution: Primary multiplication fields [2.5 ha] were established and 500,000 cuttings distributed to Ghanaian growers.

Ghana's Genetic Improvement

Germplasm maintenance and characterization: In 2007, germplasm of 136 accessions (6 OFSP; 89 local) were backed-up at Plant Genetic Resource Research Institute Bunso); 8 released varieties (with 2 OFSP) and 39 introduced genotypes (33 OFSP) were maintained and characterized at Fumesua.

Crossing block: Fumesua crossing block has nine flowering parents including 5 OFSPs: (Apomuden, Otoo, Beauregard, Resisto, TIS 83/0138); yellow-fleshed Sauti; and white-fleshed: Faara, HiStarch, and Excel. Major desired traits are: high dry matter, high beta carotene content, and tolerances to SPVD, weevils, and millipedes. Seeds from controlled and open-pollinated crosses are being collected for evaluation.

Multi-locational adaptability and acceptability testing: Forty OFSP and some white-fleshed varieties from CIP in 2004/05 were assessed in preliminary yield, advanced yield, and multi-locational on-farm trials. Two clones are being nominated to the National Varietal Release Committee for release after 2008 on-farm trials. A genotype x environment trial of local popular varieties, being evaluated

Table 19.4 Characteristics of sweetpotato varieties officially released on 13 Nov. 1998 in Ghana

Characteristics	TIS 8266 (Okumkon)	TIS 84/0320 (S. Pona)	TIS 3017 (Faara)	Sauti (Sauti)	Local Red	Mean
Leaf shape	Cordate	Cordate	Angulatus	Palmatus	–	–
Tuber skin colour	L. purple	Cream	D. purple	Cream	–	–
Tuber flesh colour	White	C/Y	Cream	Yellow	–	–
Tuber flesh shape	Round/ Elliptic	Long E/ Round	Long Elliptic	Long Irregular	–	–
Fresh tuber yield (t/ha) 3MAP [1996, 1997]						
Coastal savanna [CS]	8.0	6.9	5.5	5.8	3.8	–
Forest [F]	11.2	9.2	10.5	8.7	6.0	–
F/S transition [T]	5.8	4.7	4.3	3.4	1.9	–
Dry matter (%) of tuber 3MAP [1996, 1997]						
Coastal	29.0	31.5	35.3	32.5	31.1	–
Forest	32.6	29.4	33.4	34.5	33.9	–
Transition	32.8	33.8	37.0	37.3	32.8	–
Fresh tuber yield (t/ha) 4MAP [1995–1997]						
Coastal	12.5	11.1	13.8	10.0	8.5	11.2
Forest	19.9	16.7	16.9	15.4	13.5	16.5
Transition	12.0	10.2	9.3	8.5	5.9	9.2
Guinea savanna	17.8	19.9	18.9	18.7	18.3	18.7
Fresh vine yield (t/ha) 4MAP [1995–1997]						
Coastal	8.5	8.7	14.9	15.2	10.4	11.5
Forest	17.1	18.3	23.1	27.8	21.7	21.6
Transition	8.4	12.5	15.1	18.5	8.6	12.6
Guinea savanna	11.5	20.0	27.8	32.7	16.5	21.7
Fresh tuber yield (t/ha) on-farm [1996]						
Coastal	13.5	12.1	12.6	19.1	8.3	11.3
Forest	17.4	13.8	14.9	12.3	10.2	13.7
Transition	16.2	14.4	11.7	10.7	6.8	11.4
Tuber dry matter [1995, 1996]						
Coastal	29.0	36.0	37.6	35.5	37.3	36.1
Forest	32.7	31.9	34.4	36.2	36.5	34.3
Transition	30.3	35.3	36.5	38.3	36.5	35.2

S = Santom; W = white, C = cream; L = light, Y = yellow.
Source: Otoo et al. (2000).

across 11 other sub-Saharan countries within Sweetpotato Harvest-Plus Program, was established at 4 locations in 3 agro-ecologies of Ghana. The 15 genotypes include: Mayai, Gweri, K135, Zambezi, 199062.1, SPK004, K566632, Pipi, Carrot C, Ukerewe, K118, Naspot 1, Resisto, Ejumula, and a local check CRI-Apomuden.

Planting material multiplication and distribution: Primary multiplication fields [2.5 ha] were established and 500,000 cuttings distributed to Ghanaian growers.

Togo

Farmers grow sweetpotato as secondary crop to enhance household food security and diversify income sources through selling tubers. Nationally, cassava and yams are the principal tuber crops.

Table 19.5 Virus and pest infestation, sensory tests, and protein content of the first four sweetpotato varieties officially released on 13 November 1998 in Ghana

Characteristics	TIS 8266 (Okumkon)	TIS 84/0320 (S. Pona)	TIS 3017 (Faara)	Sauti (Sauti)	Local Red	Mean
Virus symptoms (1–5 scores SPVD) [1995–1997]						
1991	2.0	2.0	–	–	–	–
1995–1997	1.0	1.0	0.5	1.0	2.8	–
1998	2.0	2.0	1.5	2.5	4.0	–
Tuber attack (%) by *Cylas* sp. 4MAP [1995–1997]						
Coastal	15.9	10.9	6.0	14.5	21.3	13.7
Forest	3.0	5.7	7.2	6.1	7.1	5.8
Transition	1.1	1.1	0.0	0.6	2.8	1.1
Millipede attack (%) of tubers. [1995–1997]						
Coastal	1.7	1.7	1.8	2.3	3.8	2.3
Forest	19.4	23.4	24.4	20.4	30.8	23.7
Transition	19.0	23.6	9.6	13.8	14.4	16.1
Vine attack (%) by *Alcidodes* sp. [1995–1997]						
Coastal	9.1	2.1	1.7	1.7	3.3	3.6
Forest	0.8	0.7	0.7	0.0	4.0	1.2
Transition	1.5	4.6	0.5	0.1	9.0	3.1
Sensory test of boiled + fried tubers on-farm (T/F/C scores) 1997						
Appearance	11/12/8.5	14/13.5/19	9/17/15	38/29.5/27	0/4/18	–
Taste preference	15/22/14	17/9/17	2/18.5/8	35/26/39	5/6.5/6	–
Overall	12.5/19.6/15.4	–	17/18/14	4/11.6/8.2	50/20/35	–
	0/11.1/8.6					
Protein content [% dry matter]	5.1	4.8	7.0	5.3	4.2	–

S = Santom; W = white, C = cream; L = light, Y = yellow. T/F/C = Transition/Forest/Coastal.
Source: Otoo et al. (2000).

Cote d'Ivoire

Sweetpotato is grown nation-wide, with 76% of the 40 300 t from northern districts in 1985 (MINAGRA, 1990). Tubers are economically important for containing 15–25% starch, 1–2% protein, and 1–2% sugar (Onwueme and Sinha, 1991) and vitamins and minerals; providing food calories for poor populace who eat tubers boiled, fried or fufu (pounded dough); and flour could be used in bread and pastries, thus diversifying diet, and providing industries inputs. Leaves are used as vegetable. Left-over tubers unfit for food are used as feed.

Chief constraints are sweetpotato weevils, nematodes, viruses, black fungi rots affecting stored tubers, inadequate planting materials, land shortage causing restricted cultivated hectares; low yielding varieties, marketing problems, and narrow utilization.

Land shortages due to expansion of settlements reduce length of fallow for soil regeneration. Sweetpotato does not yield high in poor soils, in intercropping, or under irregular rainfall.

Tuber conservation lasts for 60 days followed by depreciation in quality and value due to sprouts and rots. Though tubers keep well at 13–16 °C at 85–90% RH (Onwueme and Sinha, 1991); such conditions are not achievable among farmers.

Commercialisation and consumption. About 10% of tubers are sold (Scott and Ewell, 1993). Difficult farm access and expensive transportation raise tuber prices and reduce profits. In some areas, its food use is restricted to hunger periods when preferred staple foods are lacking. Utilization as flour, starch, sugar, and ethanol are limited or uncommon.

Guinea

Sweetpotato is grown by small farmers as an important subsistence staple (Ibrahima Mafoulé Camara, personal communication, August 2007); more intensively in high rainfall areas than in semi-arid zones; although sweetpotato tolerates drought and diverse soils. It plays a major role during hunger period when other crops fail. It is well adapted to diverse traditional cropping system and agro-ecologies. Low sweetpotato research in national programmes puts earlier varieties at risk of being lost among farmers (Table 19.6).

These varieties entered the pool of varieties nationally and in adjacent countries but may no longer be identifiable; but continue to contribute to overall sweetpotato production. Often-times, they are planted and sold as mixtures of varieties. Usually, varieties move from one community to new localities through sales of tubers that are replanted to supplement vine supply for planting whenever farmers encounter good varieties.

Table 19.6 Sweetpotato clones previously at CRS Foulaya, Guinea 1993

Sweetpotato Variety	Origin/Source of introduction into Guinea	Crop growth cycle (month)	Mean number tubers/plant	Mean tuber diameter/plant (cm)	Fresh tuber yield (t/ha)
Burkina	Burkina Faso	2–4	–	–	–
Chinoise (1)	China	3–4	5.75	6.25	32.88
Chinoise (2)	China	3–5	–	–	–
Chinoise (3)	China	3–4	5.00	5.50	21.25
Chinoise (4)	China	3–4	–	–	–
Chinoise Bamban	China	3–5	–	–	–
CDH 30	Senegal	2–3	–	–	–
Coréenne	?	?	5.25	5.00	17.50
CIAM 8030	Cape Verde	3–4	–	–	–
Ivoirienne	Côte d'ivoire	3–5	–	–	–
Kaagbeti Wuré	Guinéa	3–4	–	–	–
Kemp	Sierra Leone	3–5	–	–	–
Molé Molé	Guinea	3–4	5.75	5.00	13.75
N'Körö	Guinea	3–5	–	–	–
Sabouya	Guinea	2–3	4.75	4.88	17.50
Sosoe Wuré	Guinea	3–5	4.00	3.50	10.75
Sweet red	USA	3–4	–	–	–

The importance of a crop-plant may be *partly* measured by efforts allotted to its research, development, improvement, and promotion. Sweetpotato research institutions and agencies in West Africa lack vigour. They are few, poorly staffed and funded relative to cassava, yam, cowpea, and cereals.

Major Growing Areas and Acreage, Yield and Economics

Sweetpotato is grown across West Africa; although Nigeria harvests 79.1% of the sweetpotato hectares. Besides high tuber yields from 5,212 ha in Sahel ecologies of Senegal, Mali, and Niger—yields average 3600 kg/ha (Table 19.7) or 10% of farmers' potential yield (36 t/ha).

Sweetpotato plots are intercropped with cassava, maize, sorghum, and vegetables or as sole crop in peri-urban holdings. As available farmland reduces, farmers tend to grow more profitable crops that require less labour and inputs, provide household food *first* and *also* generate income. Being a secondary intercrop tends to hide sweetpotato's enormous potential; thereby calling for re-education of farmers, processors, and consumers through targeted campaigns to demonstrate benefits of sweetpotato for food, feed, and industry.

Purseglove (1968) reported sweetpotato was "gradually ousting yams because of quicker return with *less work*, but yielding place to cassava due to higher yields with even lesser work". Current situation needs review by zones of each country through surveys to enable stakeholders chart future strategies.

Table 19.7 West Africa sweetpotato production statistics, 2005–2006 (FAOSTAT)

Country	2006 human population (million)	National land area (million hectares)	Fresh tuber output (tonne)	Usage per person (kg/yr)	Tuber yield [t/ha]	Total hectares harvested to the crop
Cape Verde	0.5	4	4,000	8.00	5.556	720
Senegal	12.0	197	27,000	2.25	24.281	1,112
Mauritania	3.1	1031	2,000	0.65	1.000	2,000
Gambia	1.5	11	–	–	–	–
Guinea Bissau	1.4	38	–	–	–	–
Guinea	9.8	246	60,000	6.12	6.000	10,000
Sierra Leone	5.7	72	26,000	4.56	2.476	10,500
Liberia	3.4	111	–	0.00	–	1,900
Cote d'Ivoire	19.7	322	43,000	2.18	2.150	20,000
Mali	13.9	1240	50,000	3.60	16.667	3,000
Ghana	22.6	239	90,000	3.98	1.385	65,000
Burkina Faso	13.6	274	40,864	3.00	6.917	5,908
Togo	6.3	57	3,500	0.56	1.167	3,000
Benin	8.7	113	50,018	5.75	4.477	11,171
Niger	14.4	1267	30,000	2.08	14.286	2,100
Nigeria	140.0	924	2,516,000	17.97	4.876	516,000
Total	273.5	5115	2,942,382	10.76	7.018	652,411

Best Field Practices and Cultural Methods

Field practices vary by field-size and agro-ecology. Growers' manuals stating essential steps and best-bet practices to maximise labour and inputs lack required details. Otoo et al. (2000) described sweetpotato growing, but did not quantify inputs, produce, or any specifics as to what is adjudged most suitable for each agro-ecology of Ghana. Chinaka (1983) provided no costing or inputs limits for profitable production. Both cases do not emphasize field production as an area-specific combination of quantified inputs. Thus, growers are inadequately guided on how to exploit sweetpotato's potentials.

Diversity of soils and rainfall variables superimposed on genotypic variation among sweetpotato varieties strongly require sustained research and development efforts which have been lacking for a long time. Sporadic attempts by individual scientists with little funds would only lead to under-exploitation of sweetpotato in West Africa.

Land Productivity

Acquiring or inheriting farmlands makes land selection untenable under traditional cropping systems compared to commercial enterprises. Tuber yields respond to native soil fertility. Surface soil is usually scrapped into mound, heaps or ridges into which several crops are planted. Seedbeds [20–30 cm of loose soils] facilitate tuber bulking through less resistance to penetration. Well-drained sandy loamy soils are best; whereas heavy clayey soils produce rough bad-shaped tubers.

Planting

Growers utilize planted: tubers to produce sprouts; vines from old plants; and or sprouts of varied lengths. Planting actively growing 15–30 cm apical vines with 4–6 nodes are best. Older vines establish poorly, causing missing stands in fields thus reducing yields.

Planting begins when rains start, continuing till two months before rains cease. Temperatures at planting should exceed 20 °C to spur early sprouting. Planting towards the end of rains in high rainfall areas for sweetpotato cannot tolerate excessive moisture in soil or drought without irrigation. Some varieties tolerate drought or low soil moisture; but never plant vines into dry soils. Some varieties tolerate moist soils near water ways and wetlands. Plant vines to expose two nodes and bury two nodes (7–10 cm) on *raised* seedbed to lift tubers from excessive moisture zone, as well as avoid dehydration and exposure as rains wash soil off.

Cultivars

Sweetpotato cultivars with farmers are difficult to identify because they have not been systematically characterized nationally. Small collections are maintained by research stations with little documentary and pictorial means of distinguishing them from any apparently similar types in common use. Often, new introductions enter cultivation without formal variety release. Even in marketing, cultivars are sold without labels; retailing needs only knowledge of some local varieties as to skin colour, shape and flesh colour. Variety names are as variable as their provenances; thus, one variety may possess several names according to where it was sourced.

IITA had assembled 1000 sweetpotato accessions by 1988 (IITA, 1989) including 50 non-sweet clones. Tuber yield declines when varieties are subjected to natural disease pressures; though varieties react differently to varied pest pressures. Virus-free tissue cultures stored for 6 years produced 33% higher tuber yield than stands planted with field vines (Table 19.8) but was 80% more in TIS 1499 (Table 19.9).

CRI Fumesua, Ghana assembled 136 sweetpotato genotypes, but released nine to cultivator (Otoo et al., 2000). NRCRI evaluated 358 accessions of local genotypes for tuber shape, yield, latex flow, flesh colour, and sugar content at Umudike, Nigeria (Okoli, 1980). Annual losses of germplasm by various factors are oftentimes irretrievable. Expensive *repeated* collecting expeditions under limited funding greatly retard the release of superior varieties.

There is need for descriptors for released sweetpotato varieties in West Africa that show photographs, characteristics, and field performance across diverse agro-ecologies of each country. Without such information, statistics of hectares cultivated; distribution flow of vines and produce would be difficult to track. National official variety release systems are not formally established in West Africa.

Table 19.8 Sweetpotato tuber yields (4MAP) from field cuttings (FC) and virus-free cuttings (TC) at Ibadan

Sweetpotato Variety	No. of Sellable Tubers/plant		Tuber weight (gram/plant)		Percent weight increase
	FC	TC	FC	TC	
TIB 11	3.8	4.6	450	770	32
TIS 2544	2.6	3.5	270	590	32
TIS 3017	1.4	1.9	330	410	8
TIS 8250	4.5	5.2	720	1100	38
TIS 70357	3.2	3.2	320	680	36

Source: IITA (1987)

Table 19.9 Effect of virus on performance of. sweetpotato (TIS, 1499)

Single plant aspect	Virus free	Virus	% Reduction
Fresh tuber yield (g)	1284	257	80.02**
Dry matter (%)	23.53	22.71	3.48 ns
Dry yield (kg)	302	59	80.46**
Fresh shoot weight (g)	743	154	79.27**
Dry shoot weight (g)	103	37	73.57**
Number of leaves	384.2	184.0	52.08 ns
Dry leaf weight/10 leaves (g)	3.31	1.33	59.81**

Source: IITA (1974)

Table 19.10 Important characteristics for selecting sweetpotato genotypes

1.	Fresh and dry shoots yield at harvest
2.	Fresh and dry tuber yield (formed within seedbeds)
3.	Tubers qualities (culinary and sensory – texture, taste/smell)
4.	Number of tubers per stand
5.	Tuber shape and size distribution
6.	Tuber flesh colour
7.	Tubers nutrients composition at optimum harvest date
8.	Tolerance to pest and disease (especially weevil and virus complex)
9.	Tuber storability in usual conditions
10.	Days to maturity for optimum tubers yield
11.	Depth of tubers at maturity (affecting harvest and weevil damage)

Sierra Leone released improved sweetpotato varieties (Dahniya et al., 1994); multiplied them at Njala for farmers in 35% of chiefdoms surveyed replacing imported potato. Few farmers (0.6%) grew sweetpotato in 1961 for market compared to 10% in 1991. Table 19.10 indicates essential breeding objectives.

Planting Density

Traditional farmers adopt varied spacing for sweetpotato in intercrop. Sole stands are 30–50 cm along rows, 80–120 cm between rows. Well-managed commercial farms seek 3:1 rectangularity (30 cm × 90 cm giving 37,037 plants/ha).

Weed Management

Sweetpotato fields should be weed-free within 6 weeks after planting (WAP) with hoeing at 3–4 WAP and 8–9 WAP (Chinaka, 1983). One spray of Glyphosate (2.4 kg a.i./ha) 4WAP; DS2 or PE Chloramben 3.4 kg a.i./kg control weeds (Unamma et al., 1984). Cost, convenience, labour availability, comparative tuber yields, and logistics appropriate to farm size should be considered before making weed control decisions.

Irrigation

Sweetpotato in West Africa is grown rain-fed. When planted some weeks before end of seasonal precipitation cease, sweetpotato matures 4–5 weeks into a dry period. Source of water and cost of labour for irrigation operations, pipes, and pumps incur new expenditures. Sweetpotato needs 530 mm of water during November to February with monthly requirements of 75, 122, 189, 145 mm respectively; but 503 mm if irrigated in South-eastern Nigeria (Chukwu, 1995).

Fertilizer

Little or no fertilizer is used by West African farmers due to poor and irregular supply and high prices. Sweetpotato responds to applied organic manures; but research on fertilizers, tuber yield, and quality for common cultivars is inadequate to guide usage. Fertilizer price and production regimes determine profits from fertilisation.

Fertilizer is applied on both ridge sides during first weeding (4–5WAP). Monitoring NPK levels in sweetpotato fields is essential in commercial farms. Rendle and Kang (1977) found P content of 0.22% in petiole of index leaves at 9 WAP indicates P is not limiting. Nitrogen levels should be low to avoid promoting shoot growth than tubers.

Organic materials should be applied *first* before supplementing with little fertilizers. Wise fertilization necessitates we consider storability and taste quality of end products, and cost-benefit ratio for each farm blocks. Rates of 125–700 kg/ha NPK (Chinaka, 1983; NRCRI, 1992; Korieocha et al., 2006; and de Geus, 1973) or 27–54 kg N, 72–120 kg P, and 72–120 kg K may be *adjusted* to satisfy local soil nutrient shortages after *soil test* of farm parcels to precisely make-up for nutrient deficiency (Table 19.11).

Most West African farmers cannot afford soil tests; thus, grading soils into low, medium, high nutrient levels using soil test kits is a first step in the right direction. Nutrients removal by each variety should be determined. Farmers should be aware of different nutrient ranges for highly productive sweetpotato yields (Table 19.12).

Length of Growing Season

Length of season depends on agro-ecological conditions of the farm site. Varieties mature early (3–4 MAP) or late (6–7MAP) according to combinations of moisture, soil fertility, weather, altitude and shading. Harvest readiness and crop life may be prolonged or shortened by the genotype-specific responses to the growth environment. Drought-tolerant varieties continue to grow actively whereas others senesce.

Table 19.11 Soil test values (STV) to guide fertilizer recommendation (***R***) for sweetpotato in Nigeria

Soil test variable	Low STV	***R***. rate (kg/ha)	Medium STV	***R***. rate (kg/ha)	High STV	***R***. rate (kg/ha)
Total NO3-N (%)	<0.10	90	0.10–0.15	45	>0.15	20
Brays P I (mg/kg)	<10	50	10–20	25	>20	0
Brays P II (mg/kg)	<15	50	15–25	25	>25	0
Exch. K (cmol/kg)	<0.15	90	0.15–0.25	48	>0.25	0
Available Zn (mg/kg)	<1.0	–	1.0–5.0	?	>5.0	–
Organic C (g/kg)	20.0	–	20.0–30.0	?	>30.0	–

Source: FFD (2002) and Chude et al. (2004).

Table 19.12 Critical levels at the 7th–9th opened leaf blade from shoot tip sampled 28 days old plants and nutrients removed by sweetpotato

Nutrient taken up by crop	Adequate nutrient range (%)	—12 t/ha Tuber	yield— Tuber/Vine	—50 t/ha Tuber	yield— Tuber/Vine
Nitrogen	4.2–5.0	26	52	110	215
Potassium	0.22–0.45	6	9	25	38
Potassium	2.6–6.0	60	90	250	376
Calcium	0.9–1.2	3.6	16	15	65
Magnesium	0.15–0.35	3	6.5	12.5	27
Sulphur	0.35–0.45	1.8	4.3	7.5	18
Chlorine	<0.9	10	18	43	75

Source: O'Sullivan et al. (1997).

Vine Removal and Sellable Tuber Yields

Dual use of field-plots to provide vines and tubers at harvest is common. Shoot removal reduces tuber yields (Table 19.13). Percentage of sellable tuber yield is an essential attribute for selecting varieties. Cultivars with many small un-sellable tubers are un-adapted to local cultural practices and or agro-ecology. Tiny un-sellable tubers constitute losses to growers; because they are sold cheaply for use in livestock feeds. Low prices make sweetpotato enterprises uncompetitive. Therefore, varieties with more sellable tubers are preferred by growers, provided consumers accept their culinary and sensory characteristics.

Table 19.13 Tuber yield (t/ha) and (percentage of sellable tubers) of improved and local sweetpotato clones according to week of vine removal

Vine pruned (at WAP)	TIS 2534	TIS 146/3092	TIS 2498	TIS 8504	Anoma (local variety)	Pruning week mean	Percent of zero pruning
0	13.0	12.6	7.7	15.6	5.4	10.9	100
	(84)	(83)	(79)	(86)	(70)	(82)	
2	14.0	9.8	6.9	13.2	5.4	9.9	90.8
	(76)	(72)	(77)	(86)	(69)	(77)	
4	10.0	9.1	8.9	13.4	4.3	9.1	83.5
	(82)	(80)	(76)	(84)	(47)	(78)	
6	9.4	6.5	5.0	11.6	3.7	7.2	66.0
	(81)	(74)	(76)	(84)	(59)	(78)	
8	7.2	4.9	4.0	8.8	2.1	5.4	49.5
	(82)	(69)	(75)	(83)	(57)	(78)	
10	6.5	5.7	3.6	7.1	3.1	5.2	47.7
	(65)	(68)	(58)	(77)	(68)	(69)	
Clone	10.0	8.1	6.0	11.6	4.0	7.9	–
mean	(79)	(77)	(75)	(84)	(63)	(76)	

Planted July 1987, Spaced 100 × 30 cm. Harvested plot: 22 m^2.
Source: 1987 Annual Report, NRCRI, Umudike, Nigeria.

Pest and Disease Management

In West Africa, sweetpotato pests and diseases occur on leaves, vines and tubers, and after harvest, on transit to store, and within market stores before sales. Two frequently cited constraints to sweetpotato production and storage are: virus and weevil (*Cylas puncticollis*). The Sweetpotato virus disease complex [SVDC] has four viruses [mosaic, mottle, feathery mottle, and vein-clearing] that depresses yields and distorts tubers, especially when repeatedly planting vines from the same source. Rossel and Thottappilly (1985) recommended varieties with good resistance to SVDC as control besides planting virus-free vines as often as possible.

Improved drought-tolerant varieties are needed for farmers in drier savanna zones with precipitation under 500 mm in West Africa (Fig. 19.2). High moisture-tolerant varieties are required for wetter localities with rainfall over 1000 mm.

Weevils threaten sweetpotato systems; attacking tubers in shallow soil or exposed from soil at maturity. Adult weevils lay eggs on stems and tubers; larvae bore into tubers; pupate on stems, and are transferred on shoots. Once established in a crop, they are difficult to control. Consequently, before planting, dip vines in insecticides. A fallow or another crop after each sweetpotato helps break cycles of weevil incidence. Eggs develop into adult weevils within 25 days; therefore, one month of careful scheduling of harvesting reduces weevil damage even if eggs have been laid on tubers. The degrees of field tolerances observed suggest there are no resistant varieties. Early harvest at 4 MAP had fewer (1–2) weevils on tubers compared to

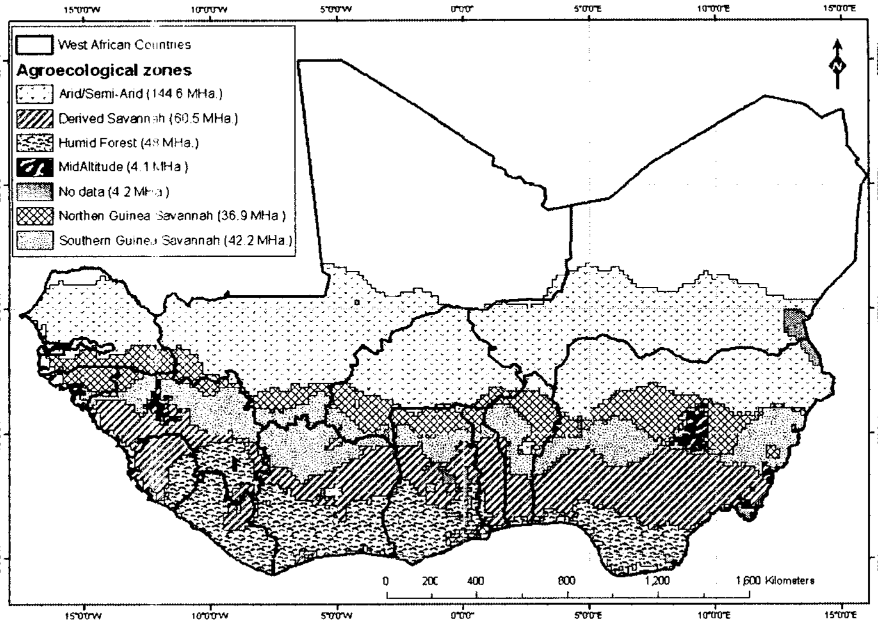

Fig. 19.2 Agro-ecological zones of West Africa suited to sweetpotato production particularly northern and southern Guinea savanna, and derived savanna zones

Table 19.14 Percentage of sweetpotato tubers rendered unmarketable due to weevil damage

Variety	Early harvest (4 MAP)	Late harvest (6 MAP)
	— Early planting (March–April) —	
TIB 4 (susceptible)	0.0	0.0
TIB 2532 (Moderately resistant)	0.0	0.0
TIS 70357 (Moderately resistant)	0.0	0.0
	— Late planting (August–September) —	
TIB 4	41.2	58.7
TIB 2532	5.0	27.5
TIS 70357	17.5	12.5
LSD (5%)	6.6	7.7

Unmarketable tubers among 20 randomly selected tubers per replicate for each variety (means of 4 replicates).
Source: Lema (1992)

delayed harvest [6 MAP] with 15–34 weevils (IITA, 1984). Deeper tubers suffer less weevil damage (IITA, 1975) suggesting re-heaping ridges helps. Adding more soil on tubers at first weeding (1MAP) introduces new expenses.

Sweetpotato farmers rarely mention nematode problems; not even associating their symptoms. In Nigeria. Fawole and Cole (2000) found *Meloidogyne incognita*, *Rotylenchus reniformis* and *Pratylenchus brachyurus* on sweetpotato tubers under mixed cropping, with maize and or cassava in holdings under 0.25 ha. Nematode damage of tuber quantity and quality depreciate food and sales; although they concluded nematodes do not seriously constrain sweetpotato production in southwestern Nigeria.

Of six species of *Cylas* feeding on sweetpotato tubers in Africa, *Cylas puncticolis* is most rampant. Late planting and harvest rendered 58.7% of tubers unmarketable through weevil damage of a susceptible variety but less so (12.5–25.5%) for moderately resistant varieties (Table 19.14). Thus, the choice of variety, appropriate planting and harvest dates minimize weevil damage.

Harvesting, Marketing, and Profitability

Harvesting. Sweetpotato tubers are harvested manually without machines in West Africa. High labour costs affect farm profits. Delaying harvest after tuber maturity, for some varieties, make tubers crack, grow too big, becoming unmarketable. Early and late varieties are harvested as they mature; evidenced by shoot senescence and drying, and sap exudation by tubers. In highlands, low temperatures delay maturity of most genotypes.

Harvesting entails cutting off shoots, carefully digging out tubers avoiding bruises, using fork shovel [from ridges sides], long wooden sticks, metal rod with flattened ends, and hoes. Under subsistence, only heaved tubers are harvested for home-use or market day. Small tubers are left to continue bulking, thereby increasing yields due to favourable source-to-sink relationships. Knowing when to harvest enables farmers obtain tubers with desirable composition (Table 19.15).

Table 19.15 Mean dry matter and starch content of fresh tubers of selected sweetpotato varieties (TIS 000A, TIS, 2534, TIS 000B) at different harvesting dates at Umudike, Nigeria

Harvest date (weeks after planting)	Leaf dry matter (%)	Stem dry matter (%)	Tuber dry matter (%)	Starch in fresh tuber (g/100 g)
6	17.47	10.74	–	–
8	15.23	8.57	–	–
10	17.33	10.60	29.60	16.85
12	18.80	15.60	33.87	23.03
14	18.73	19.53	33.87	25.56
16	20.93	18.73	33.87	21.67

Source: NRCRI (1984).

Fresh tuber yield estimates vary with growth conditions, variety, season, spacing, crop growth duration, harvest technique, and harvested area in each trial. Each factor accounts for different percentages of the total variation among tuber yields. Tuber yield range is 1–40 t/ha in 3–7 months. In Nigeria, farmers get 3–6 t/ha researchers get 30–40 t/ha in experiments; 21–38 t/ha at Ibadan, (Hill et al., 1990); 8.8–11.1 t/ha (Korieocha et al., 2006) in Umudike, and 2.4–3.5 t/ha in Asaba (Akparobi, 2006). Even delays before weighing tubers after harvest affects estimation. Until yield estimation is formally harmonised, it will continue to generate variant estimates that confuse rather than guide farmers and investors.

Tuber storage. Fresh sweetpotato tubers store poorly. In large farms, early disposal helps reduce losses to rots (wet/soft/hard/dry); sprouting; weevil damage, rodents, evaporation, and respiratory use of stored carbohydrates, skin cracks and injuries in-transit from farm to store to market; besides changes in nutritional quality. Conserving output is essential to halt tubers decline in market and culinary value during storage. About 14% of output spoils within 90 days, after Okwuowulu and Asiegbu's (2002) data were *re-analysed* and transformed to spoilage index (Table 19.16). Losses of 10–15% of weight occur 2–3 weeks after harvest

Table 19.16 Spoilage index (SI) [percentage of tubers spoilt each month] of sweetpotato tubers harvested at different months of harvest and duration of storage in baskets in barn at Nuke, Nigeria

Months of *storage*	Tuber harvest at months after *planting*			
	3	4	5	Mean
1	13.97	15.63	28.85	19.48
2	12.28	12.28	12.86	12.47
3	17.09	10.66	2.42	10.06
Mean	14.61	13.08	14.99	14.22

SI = sum of mean percentages of rots, sprouting, and weight losses excluding loss in quality caused by weevils. Mean of 3 replicates, 4 elite varieties, 3 phosphorus fertilizer levels, and 2 seasons. Baskets were covered with 2.5 mm mesh to prevent rodents.

(Table 19.16), although quality changes make tubers undesirable to buyers and consumers.

Marketing. West Africa's sweetpotato is usually sold wholesale in rural markets in baskets or sacs weighing 20–70 kg. Urban traders may contract local farmers to produce tubers, for bulking, and weekly transport in vehicles (<10 t) to meet urban demand. Tubers are brought to village markets by farmers or by middlemen traders who buy from scattered farms during piece-meal harvests that tally with local market days. Retailers sell in heaps or few tubers in containers without long-term storage.

Tubers are sold unsorted un-graded at local markets on bare ground. All sizes and shapes are mixed; sometimes including varieties with different skin colours. Traditionally preferred tastes vary from bland to very sweet according to ethnicity and age groups. Generally, larger tubers attract better prices and 20–33% of tubers are tiny or malformed. Any association of skin colour to a choice variety in a locality is based on past experience as most communities distinguish few varieties. Breeders, agronomists, and processors should manage sweetpotato systems to reduce the percentage of yield to tiny low-valued tubers.

Uniform tubers in bags or cartoons will in future be the way to market sweetpotato. The USA sweetpotato market standards have four tuber diameter grades – ***No. 1*** (4.4–8.9 cm, 7.6–22.9 cm long); *Canner* (2.5–4.4 cm, under 22.9 cm long); *Jumbo* (over 8.9 cm); and *Cull* (malformed or distorted tubers) (Schultheis and Jester, 2002). Sale standards are non-existent in West Africa. No sorting by standards before sale of tubers in heaps, the least diameter measured is about the combined width of the last two fingers (3–4 cm); and are as big as potato (3–5 cm thick, 5–7 cm long). There is, therefore, no way to relate prices to tuber quality characteristics as in developed economies.

Economics and Enterprise

Optimally combining production factors to achieve the highest gains is the chief aim of sweetpotato enterprises. Applying business skills with technical knowledge is critical for managing every essential step. In dynamic environments, continued changes create challenges for any sweetpotato grower, processor, or marketer. Few sweetpotato enterprises operate at large scales or business-like. Hence, high profits are unattainable appropriate inputs are never or irregularly available or if available, are expensive relative to product prices.

Economics. Production and sale of sweetpotato tubers requires that output values exceed production costs. Whole system integration should be considered before fixing prices of tubers or processed products (Table 19.17).

Varying input levels and prices affect level of profits from sweetpotato farming. In south-eastern Nigeria, input prices are ranges: seed: 400–3300 Naira/ha; fertilizer: 200–400 kg/ha; labour 1000–7000 Naira/ha, [US$1 = N83] (Tewe et al., 2003); implying no generalization of costs is possible, **local data** are needed for guiding farmers.

Table 19.17 One hectare field production cost of some arable crops in south-eastern Nigeria

Item	Sweetpotato	Cassava	Yam	Maize
1. Land clearing, packing and burning (md)	80	80	80	80
2. Ridging (md)	100	100	100	100
3. Processing of planting materials (md)	29	20	–	–
4. Planting (md)	25	30	45	35
5. Weeding (md)	40	80	80	40
6. Fertiliser application (md)	10	25	25	30
7. Roguing of weeds (md)	10	–	–	–
8. Harvesting (md)	60	75	80	50
9. Threshing (md)	–	–	–	20
10. Staking & linking (md)	–	–	90	–
11. Total man-days	345	410	500	355
12. Cost @ N100/man-day (Naira)	35,400	41,000	50,000	35,500
13. Cost of fertilizer (Naira)	1,200	1,800	1,800	1,200
14. Cost of stakes (Naira)	–	–	7,500	-
15. Cost of cassava	–	1,000	–	–
16. Cost of planting materials (Naira)	200	1,500	60,000	500
17. Cost of bags (Naira)	3, 500	–	–	–
18. Total cost of production (N)	40,300	44,300	119,400	37,200
19. Fresh tuber yield (t/ha)	7	15	10	2
20. Price (N/kg)	7	2	12	18
21. Revenue (N/ha)	49,000	30,000	120,000	36,000
22. Gross margin (N/ha)	8,700	14,300	600	1,200

Notes: md = man-day; 1.) 2–3 weedings for cassava/yam. 2.) Fertilization based on 400 and 600 kg/ha (15:15:15) for sweetpotato/maize and cassava and yam, at N150/50 kg bag. 3.) Farmer use personal and family labour. 4.)US$1 = N83.
Source: Tewe et al. (2003)

Ghana's annual production of sweetpotato is small compared to cassava and yam; though expanding in Upper East, Upper West, and Northern Regions (Adjekum, 2003). Sweetpotato's contributions to food security and exports to Burkina Faso and Togo are rising. Farmers perceive sweetpotato as profitable as its 3–6 months life fits the savanna rainfall pattern. Key issues for improving sweetpotato enterprises include: (i) screening assembled germplasm for superior varieties, widespread multiplication, and distribution of quality planting materials of new varieties; (ii) cleaning and sanitizing vines against virus; (iii) enhancing seed supply systems to assure year-round availability; (iv) promoting improved tuber processing and storage to reduce losses; (v) improving the marketing chain to more appropriately price tubers at farm gate; thereby empowering farmers to continue in profitable production.

Farm gate prices depend on: season, accessible road network to demand centres, local production costs, and labour availability. Yield estimates by farmers are difficult to verify when sold in truck-loads or harvested by field-area measured in "ropes" [acre/0.4 ha]. Traditional farmers keep no records of labour that accounts for most of the production budget. Vines are produced on-farm without agro-chemicals or fertilizers and are *not sold for much*.

Table 19.18 Returns (cedis) to resources used in production of various food crops in Ghana

Crop	Investment/ hectare	Gross revenue/ hectare	Gross margin/ hectare	Gross margin/ man-day	Gross margin/cedi invested
Cassava	1,407,038	2,837,319	1,479,156	8,913	1.08
Maize	2,907,500	4,000,000	1,292,500	26,377	0.44
Yam	10,344,090	14,000,000	3,855,910	16,270	0.37
Sweetpotato	2,390,500	9,378,240	7,174,830	49,737	3.00

[10,000 cedis = US$1 in 2008].
Source: Nurah and Ahiale (2005)

Profitability. Assessing total production cost plus the cost of capital invested in sole-crop sweetpotato is complex because few farms grow sweetpotato sole. Also profitability fluctuates periodically with prices of inputs and tubers. In Ghana, producing sweetpotato costs US$29–49/tonne with good gross margins of US$95–149/tonne (Table 19.18). However, without processing and marketing problems—storage losses constitute major risks to production (Nurah and Ahiale, 2005). Processing tubers into storable dry products and promoting manufacturing that tally with tuber production schedules would spur sweetpotato economies.

In Ghana, returns from yields (adjusted to 80% of actual on-farm tuber yields) varied with agro-ecology. Incremental net returns from existing varieties were 564,000–1,392,000 cedis in forest areas; 348,000–1,332,000 cedis in forest/savanna transition; and 192,000–636,000 cedis in coastal savanna (Otoo et al., 2000). Accounting for every expense helps determine right prices for tubers and shoots (Table 19.19).

Table 19.19 Average variable costs of sole sweetpotato crop in wet season of 2000 for Jigawa, Nasarawa, Katsina, Kebbi and Akwa Ibom States of Nigeria

Items/Operation	Cost (Naira/ha)	
Planting materials	4500	
Fertilizer	7600	
Packaging bags	1750	
Simple tools	500	
Land clearing	300	
Land cultivation	3600	
Planting	1000	
Fertilizer application	800	
Weeding/thinning	4500	
Harvesting	3000	
Bagging	250	
Transportation	1800	
Total variable costs	29600	
Fresh tuber yield (kg)	7200	
Farm gate price of tubers (Naira/kg)	8.00	
Output revenue		57,600
Enterprise gross margin		28,000
Gross margin benefit/cost ratio		0.950

(US$ = 130 Nigerian naira)
Source: PCU (2002).

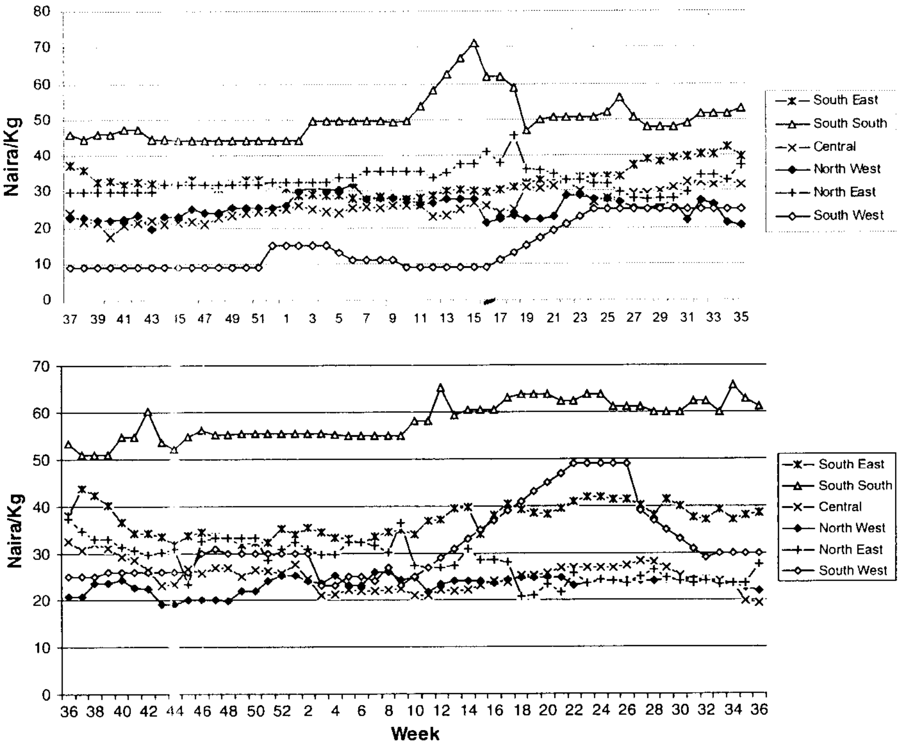

Fig. 19.3 Weekly prices of sweetpotato tubers (Naira/kg) averaged across markets in six geo-political zones of Nigeria during 2004–2006 (prepared by Paul Obasi, IITA Ibadan, 2008)

Prices of sweetpotato tubers varied periodically among geo-political zones of Nigeria (Fig. 19.3). From week 1 (1–7 January) till week 52 (25–31 December) tuber price trebled from N20/kg [N120=US$]. Exclusive use of fresh tubers will discourage higher outputs.

Various Uses of Tubers and Foliage

Every sweetpotato tuber is usable for humans or livestock. Owori et al. (2007) described 52 recipes using leaves, tubers, and derived products for Eastern and Central Africa but most are yet to enter West Africa. Tubers contain 20–35% dry matter and peels vary with shape and surface smoothness. Discounting moisture content and peels, tuber yield is 18–20% usable; although higher if peeling is not obligatory. This is an aspect requiring research as for potato where the skin need not be peeled for certain food preparations where peel fibre is incorporated.

Sweetpotato Sensory Quality

A key factor in sweetpotato selection is *sensory quality* of boiled tubers. The first annual report of IITA (1971) states: "About 10,000 clones of sweetpotato were produced from seedlings ... including varieties collected in Nigeria. It is believed that sweetpotato are **not** extensively grown and utilized for food in Tropical Africa because they are *sweet and moist when cooked*"—a true assertion even to date (2008). Some clones are less sweet, blander, and more dry-textured when boiled tasting like yam (a preferred staple).

Over 95% of sweetpotato in Osun State, Nigeria, a major producer, is for food while tiny tubers are feed to livestock (Tewe et al., 2003). Tubers are utilised boiled, baked; roasted; fried; pounded (mixed with yam) into *fufu*; or peeled chopped, sliced, parboiled, sun-dried, and stored or milled into flour sometimes mixed with cassava flour and prepared into dough. Sweetpotato flour's darkness and sweetness affecting its acceptance; but adding cassava flour dulls the sweetness and brightens the dough colour. In urban areas, sweetpotato is used as an ingredient for making meat pies.

Selecting sweetpotato varieties for food involves complex decision making including nutrients composition and density among genotypes. Processing qualities of tubers of 5 of 25 cultivars [TIS 1487, J.K. 70, Anoma, 2294 and 2291] were selected for high starch (18.5–31.3%), low moisture (61.2–73.2%), high protein (4.8–6.7%), and low fibre content (1.8–2.6%). Essential selection traits would include: dry tuber yield, acceptable sensory quality, tolerance to pest and disease in field and store, and high nutrient density per 100 g edible tubers.

Boiled tubers. In sweetpotato breeding, tubers are boiled and systematically assessed for *flesh colour*, *taste* (cortex sweetness or total free sugar content, and or its *ratio* to starch content) and *texture* (a function of density of dry matter, starch, and fibre content). Taste-texture appreciation favours staple consumed in large amounts with low sugar contents. Aikpokpodion (1998) identified 19 high yielding bland or non-sweet clones from 228 accessions (Table 19.20) and further breeding in West Africa should utilise them.

Flour. Sweetpotato flours stores longer than tubers. Utilising flour in composite flours is a desired trend for advancing processing. Diverse mixes of flours from sweetpotato, cassava, cowpea, maize, wheat, sesame, banana-plantain, groundnut paste to make juices, drinks, confectionaries or dough would raise nutrition density and better sustains dough supply.

Toasted granules. Reducing postharvest losses necessitates prompt processing of tubers into dry forms. Oduro et al. (2002) and Ellis et al. (2001) in Ghana, Sanni et al. (2001) and Meludu et al. (2003) in Nigeria processed sweetpotato tubers into toasted granules using similar steps for making *gari* from cassava. Some 152 consumers appreciated dry and water-soaked toasted granules of sweetpotato clones: Kayode, Shaba, Alphonso, GR3-25, TIS 80/004, and D.Wall (Meludu et al., 2003); it stored well in containers beyond 12 months and its vulgarisation would supplement cassava gari.

Forage and Chips. Sweetpotato shoots may be fed directly or fermented into silage; or forage and tubers for livestock may be cut, sliced, chipped, sun-dried, and bagged for addition to diets of chicken, goat, pigs, fish, and poultry. Once partially processed, their use in livestock feeding is enormous in West Africa (Tewe et al., 2003). As tuber losses to weevils have proved difficult to control cheaply; research for development should encourage prompt harvest, followed by efficient processing.

Table 19.20 Tuber characteristics of hard-textured non-sweet (bland) sweetpotato clones, Ibadan 1998

Clone	Skin/Flesh colour	Number of tubers/plant (1 × 0.5 m)	Weight (kg/) plant matter	Percent tuber dry flesh	Taste[+] of tuber boiled for 15 min
TIS 3030-op-1-18	purple/cream	2	1.23	29.6	–
TIS 3030-op-1-29	purple/cream	8	1.67	38.5	–
TIS 4400-2	white/cream	6	3.25	37.3	cassava
TIS 70357-op-1-18	purple/cream	3	2.52	36.0	–
TIS 70357-op-1-78/80	purple/white	15	6.85	41.1	–
TIS 70357-op-1-79/19	purple/white	3	0.85	34.8	–
TIS 80/0140	purple/white	4	2.18	36.1	yam
TIS 82/0070 × 2532-1-43/23	purple/white	6	3.96	37.2	–
TIS 8504-op-1-80	purple/white	8	3.62	28.3	–
TIS 87/0271	cream/white	4	2.25	36.2	–
TIS 87/0319	cream/cream	4	1.40	27.4	–
TIS XDB	purple/cream	5	3.03	34.4	–
TIS XDB-12(1)	purple/cream	5	2.18	42.7	yam
AOB-25	white/cream	7	3.45	31.3	bitter
De Virousky 16/0289	purple/white	4	2.55	21.2	–
GR-3-25	purple/cream	7	3.05	39.3	–
Lima 312 (2) [Hard flesh]	purple/white	5	0.78	36.9	yam
Mogosili	cream/cream	3	5.15	34.7	yam
Unknown SPH-15	cream/white	3	0.45	38.5	yam

[+] Taste may be similar to other staples
Source: Aikpokpodion (1998).

Root Storage Systems

Storage is fundamental to any sustained nutrition from sweetpotato tubers. Household storage of healthy tubers in pits (1–2 m deep) lined with dry grass is labour-intensive and impractical for large (3–7 ha) farms. Physico-chemical properties of sweetpotato flour can be altered to make them useful in food recipes by processing tubers within 7 days after harvest (Iwuoha and Nwakanma, 1999). Storage losses are low if initial tuber stock was clean and sane. Use of chemicals on tubers is not advised because of uncertain hazards of their residues to humans or livestock.

Orange-Fleshed Sweetpotato (OFSP)

The orange fleshed varieties provide a food-based approach for overcoming VAD in Africa. In Nigeria, during the 2006 flag-off of National Sensitization Workshop on Appropriate Distribution and Use of Vitamin A capsules, President Olusegun Obasanjo decried high yearly maternal mortality and 88,000 infant deaths from VAD, despite interventions by NAFDAC, UNICEF and partners (THISDAY, 2006); indicating VAD can be addressed by promoting OFSP.

Lesser use of OFSP in West Africa compared to East Africa is attributed to no promotion or use of palm oil in some areas or weak seed systems to satisfy vine supply. Some selected OFSP varieties are available for deployment to farmers. Where households cannot afford palm oil, growing OFSP is recommended.

In East and Southern Africa, sweetpotato research for development is well assisted by Centro Internacional de la Papa (CIP) offices in Africa; but less so in West Africa since 1988 when international mandate for sweetpotato passed to CIP from IITA Ibadan, Nigeria. Since 2005, CIP has collaborated more with Ghana and Nigeria through VITAA (Vitamin A for Africa) Project. Widespread cultivation of sweetpotato across West African indicates sweetpotato's great future, if well exploited for food, feed, and industry (including ethanol/bio-fuels).

A 2001–2003 food consumption and nutrition survey of Nigeria puts VAD level (based on serum retinol concentration) as 24.8% marginal [< 20 ug/dl], and 4.7% clinical [< 10 ug/dl] among children under 5 years and 13.1% deficient [<20 ug/dl] among mothers (Maziya-Dixon et al. (2004). VAD can be addressed through nationwide campaigns for local cultivation, processing and use of OFSP.

Sweetpotato for Livestock

Tiny sweetpotato tubers are converted in chips or feed. Feeding studies indicate varying optimal levels of dried flour in livestock rations (Table 19.21). Sun-dried samples infested by micro-organisms depress pigs and poultry growth. Less chips in pig and poultry feed was recommended due to increased diarrhoea incidence at higher contents of reducing sugar and the form of their presentation. Conversely, more non-sweet tubers in rations is recommended. Factors limiting usage of

Table 19.21 Recommended sweetpotato flour inclusion level in livestock rations for optimal performance by processing method

Species		Sun-dried (Percent)	Oven-dried
Broilers:	0–4 weeks old	0	12
	5–8 weeks old	0	18
Layers:	30–40 wks old	–	10
Pigs:	Weaner	–	17
	Grower	–	17
Sheep:	Growing/Fattening	–	40

Source: Tewe (1992)

sweetpotato in feed rations include: bulkiness and requirement for rapid dehydration to avoid microbial growth, contain less proteins and dustier rations compared to maize-based rations. Overcoming these limitations, require fabricating local dryers, solar drying, adding oil or pelletizing rations to reduce impurities, using shoots to augment low tuber protein contents; and distributing non-sweet clones.

Sweetpotato for Ethanol

Sweetpotato root starch and sugars convert to ethanol through enzyme fermentation yielding about 137 l of ethanol per tonne of tubers. Short growth and high yields gives sweetpotato a comparative advantage for bio-fuels. As a secondary food crop in West Africa, use for ethanol would not adversely disrupt community food balances. Such diversified use will favour local cottage industries; generate income, besides being food reserve. If processed into high grade flours it becomes usable in pharmaceutical industry in West Africa as in Japan.

Managing the share of *national food basket* sourced from sweetpotato is important. Japan (Komaki, 2006) now has a stable contribution of sweetpotato as a ratio in relation to other foodstuffs. Sweetpotato would occupy a fair share of the food basket as a diversified diet is more healthy and sustainable in supply. Adequate statistics is quintessential for managing sweetpotato production, storage, and transportation losses. Without understanding the dynamics of seasonal marketing and consumption in West Africa, quantification of trends and proper management of flows of materials will not be feasible.

Future of Sweetpotato

Advancing sweetpotato in West Africa (Tayo, 2000) will require better funding for weak national research institutes mandated to: 1) breed desirable traits into few varieties with high shoot and tuber yields for dual use as food and feed especially in savanna zones; 2) select varieties with low sugar contents, especially if poundable into good textured dough preferred among the elderly and diabetic; 3) better manage

Table 19.22 Land area (square kilometres) under different agro-ecological zones of West Africa

West Africa country	Semi-arid/ Arid	Derived savanna	Humid forest	Mid-altitude	North Guinea savanna	South Guinea savanna	Area with no data	Country total area
Benin	1.265	2.777	0.254	0.000	3.490	3.758	0.000	11.545
Burkina Faso	20.967	0.046	0.000	0.000	4.799	1.738	0.000	27.550
Cape Verde	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cote d'ivoire	0.340	9.527	13.669	0.013	0.123	8.150	0.170	31.994
Gambia	0.839	0.000	0.000	0.000	0.039	0.000	0.810	0.959
Ghana	0.454	6.036	9.209	0.000	3.662	3.120	1.259	23.740
Guinea	0.365	7.475	4.063	1.269	2.224	8.556	0.034	23.986
Guinea Bissau	0.000	0.000	0.000	0.000	2.193	0.216	0.034	2.442
Liberia	0.000	1.430	8.063	0.000	0.000	0.068	0.000	9.562
Mali	38.691	0.000	0.000	0.000	4.198	2.853	0.033	45.776
Niger	41.368	0.000	0.000	0.000	0.000	0.000	1.231	42.599
Nigeria	26.809	25.037	9.905	2.764	11.302	13.306	1.264	90.388
Senegal	13.426	0.000	0.000	0.000	4.100	0.002	0.038	17.566
Sierra Leone	0.000	4.255	2.401	0.000	0.000	0.000	0.000	6.656
Togo	0.036	3.954	0.440	0.000	0.795	0.464	0.000	5.688
Total area	144.560	60.536	48.005	4.046	36.925	42.233	4.145	340.450

Source: Aiabi (2008). Geo-Spatial Laboratory, IITA, Ibadan, Nigeria postharvest system for storing dry tuber products before spoilage (Okwuowulu and Asiegbu, 2002); 4) incorporate sweetpotato in intercropping systems to smother weeds and reduce costs; and 5) resolve policy issues that encourage neglect of research on arable staples; 6) strengthen seed systems to satisfy year-round demands.

Expanding sweetpotato hectares would be more in derived savanna and southern Guinea savanna emcompassing 10,000,000 ha in 11 countries (Table 19.22). Exploiting these zones forestalls risks posed to cereal production sensitive to unsteady rainfall in these areas. Future campaigns should focus on promoting greater cultivation and use of sweetpotato

Finally, better sweetpotato operations would involve producing efficiently, promptly processing tubers into dry storable forms for re-constitution into food-feed-based and industrial products; thus avoiding high (10–83%) post-harvest tuber losses (Nnodu, 1982). Low prices and profits discourage high investments on sweetpotato production or storage.

Acknowledgments I thank many collaborators who me sent national information; especially Dr Harrison Dapaah of Crops Research Institute Fumesua, Ghana. Mr Paul Obasi (for graphing tuber prices) and Mr Tunrayo Alabi (for agro-ecological mapping), both of IITA Ibadan Nigeria.

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