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Sweet Potato

By,

SRI V. T. SUBBIAH MUDALIAR, L. Ag.
(Lecturer in Agriculture, Agricultural College, Coimbatore)

Origin: The sweet potato is essentially a crop of the tropics which is believed to have originated in South America. It is grown in the sub-tropics also. Though it is grown in a number of countries, the sweet potato regions are confined to Brazil, southern states of the United States of America, Malaya, East Indies, West Indies, China, India and parts of New Zealand and Australia.

Spaniards are said to have been responsible for spreading sweet potato from South America and Mexico to the other parts of the world. It does not appear to have been known to early Greeks, Romans, Arabs or Egyptians. Early Chinese books describe a number of varieties and some of the names of the sweet potato varieties found therein bear a close resemblance to certain names given to sweet potato varieties in America or New Zealand. Whatever may be the origin of the crop, it is cultivated widely in many countries of the world now and millions of people use it as an article of food. The wide distribution of the sweet potato indicates that it is a popular food crop; it is immensely liked everywhere and its high yield has its own appeal.

Sweet potato is a subsidiary food crop, capable of replacing cereals to a certain extent. It is satisfying to the palate and the stomach and meets nutritional requirements as well as cereals. It was used as a substantial part of the national diet during the war in America. It is an important human and livestock food crop in the southern states of the United States of America. Sweet potato produces larger amounts of carbohydrates from the land than cereals and is therefore a more efficient energy producer. The production of more carbohydrates is the pressing need of the present hungry world.

The accompanying statement furnishes the food values of rice, sweet potato and tapioca, based on the average yields obtained in South India and the food values furnished in Health bulletin No. 23 of 1941 of the Nutrition Research Laboratory, Coonoor.

		Rice	Sweet potato	Tapioca
1. Duration in months	...	5	5	7—10
2. Acreage in Madras State	...	10,774,620	35,000	41,600
3. Yield in lb. per acre	...	1,127 (clean rice)	7,628 (tubers)	9,432 (tubers)
4. Protein in lb. per acre	...	78	28	68
5. Carbohydrates in lb.	...	892	2,365	3,651
6. Calories per acre (in thousands)	...	1,776	4,562	6,794
7. Relative calorific value	...	100	257	382

Tapioca produce nearly 4 times and sweet potato over 2½ times as many calories as rice, from the same area. Tapioca and sweet potato are efficient calorie producers. It must however be said that strict comparisons are rather difficult, because of the wide variations in the requirements in soil, climate and water of the different crops and fundamental differences in the duration of the crops. Any comparison made is therefore artificial and has its limitations.

The following analysis gives the food and vitamin value of tapioca and sweet potato tubers both raw and dried, and rice:

		Tapioca tubers		Rice	Sweet potato tubers	
		Raw	Dried		Dried	Raw
Moisture	...	59·4	13·0	13·0	13·0	66·5
Protein	...	0·7	1·5	6·9	3.1	1·2
Fat	...	0·2	0·4	0·4	0·8	0·3
Mineral matter	...	1·0	2·1	0·5	2·6	1·0
Carbohydrates	...	38·7	82·9	79·2	80·5	31·0
Calcium	...	0·05	0·11	0·01	0 05	0·02
Phosphorus	...	0·04	0 09	0·15	0·13	0·05
Iron	...	0·9	1·9	1·0	2·08	0·8
Vitamin value per 100 grams.						
Vitamin A.	...	—	—	—	20	10
,, B.	...	15	32	20	—	—
,, D.	...	—	—	—	62	24
Calorific value per 100 grammes	...	159	341	348	342	132

The air-dry tubers are as rich as rice in carbohydrates and the value of the other nutrients is not much lower. The tubers are mainly a carbohydrate food, capable of making up the deficiency of rice, as a subsidiary item of food. It is in the national interest, to switch over suitable areas from cereals to sweet potato and include this valuable food in the national dietary, as a partial substitute for cereals.

Distribution: Sweet potato is being grown in large areas in America and China. In India, however, it was classified as a vegetable crop and the extent of cultivation of sweet potato was not being recorded separately. This has since been rectified and sweet potato acreage is being separately recorded now. Sweet potato is being grown in about 35,000 acres in the Madras State and it is 0·1 per cent of the total cultivated area.

In Madras, South Kanara leads in the extent of cultivation of sweet potato with 14,000 acres and Malabar, Visakhapatnam, Tiruchirapalli, Salem and Tirunelveli have small areas under cultivation. This shows that sweet potato on be successfully grown all over the State.

Description: The sweet potato is a plant of the family of *Convolvulaceae*, with a trailing habit. The stems are thin, pliable and vinous; the tender stems are light green and the mature stems are dark green, or pigmented in varying shades of purplish or reddish-brown. The leaves are variously shaped and placed alternately on the stem. Some varieties have leaves which are entire and heart-shaped and some are palmately lobed in different degrees with light indentations to deep fingering. The colour of the leaf stalk and the veins of the leaf are more or less of the same colour pattern as the stem. The flowering of the crop is said to be extremely sparse and not common, but the crop flowers freely under South Indian conditions. Seed-setting is not normal, due to incompatibility of pollen of the same variety, but pollen from other varieties are capable of fertilising the ovaries. Artificial crossing of varieties has been done successfully to produce new varieties and forms. The vines that trail on the ground send down roots from the nodes. The sweet potato roots develop into tubers that are variously shaped, rounded, elongated, bulged at the centre or at the ends and conical-shaped with the bulge at the base or the tip. The rind of the tubers is whitish, creamy, yellow or pinkish. The flesh is either 'dry and mealy' or 'moist and sugary' on cooking, depending upon the variety.

Sweet potato is propagated vegetatively by planting stem cuttings generally and in certain cases tubers. The number of varieties of sweet potato is therefore limited, when compared to other crops raised from seed. A number of varieties are said to be grown in America, East Indies, Hawaii and China. The local names given to varieties differ from place to place and the nomenclature is often confusing.

Climate, Water and Soil Requirements: Sweet potato thrives in a warm climate as in the tropics. It is also grown in the sub-tropical regions, but it does not stand frost and has to be grown during frost-free periods. In the sub-tropical regions, the crop requires a clear growing period of 4½ months, warm nights, abundant sunshine during the day and moderate rainfall. In the tropics, however, the growing period need not necessarily be so long; there are varieties which mature in about 100 days; there are also others that stand in the field for over 5½ months. The duration of the crop is more or less a varietal character. There is an indication that the crop exhibits photo or thermo-periodism. The best tuber formation is in the cooler months of the year. The summer crop trials at the Central Farm, Coimbatore were a failure, either due to the prevalence of high temperature or long hours of daylight. Since the crop matures in long day periods in the U.S.A. and also in the West-Coast districts of this State, the higher summer temperature may be a disturbing factor. Short-day light on the other hand favours the formation of flowers.

The sweet potato crop makes good growth and comes up well as a purely rain-fed crop, where the rainfall is plentiful and well-distributed as in Malabar and South Kanara districts. It is grown as an irrigated crop in the other parts of the State, where the rainfall is comparatively less. It is not able to withstand drought or stagnation of water. Excessive irrigation tends to promote rank vegetative growth at the expense of the tuber-formation.

Sweet potato comes up best in deep, loamy soils and sandy soils, which are friable. Soils that harden on drying, shallow soils, clayey soils and soils rich in organic matter are not suitable. The growth of the vines tends to be excessive in clayey soil and rich soils, with correspondingly reduced yield of tubers. The heavy soils do not permit the development of the tubers and clay adheres to the tubers at harvest and spoils their appearance. The physical texture of the soil affects the size, shape and texture of the tubers. Nitrogen-rich soils and soils manured heavily with nitrogen tend to develop the vines at the expense of the tubers. This is particularly so when the manure is not properly balanced and lacks potash. The advice given in foreign countries is to apply 1,000 to 1,500 lb. of a complete fertiliser containing 2—3% nitrogen, 8% phosphoric acid and 10% potash with at least 50 per cent of the nitrogen in organic combination.

Varieties: The varieties of sweet potato, under cultivation are limited when compared to the diversity and multiplicity of varieties noted in other crops. America, East Indies, Hawaii and China are said to have many varieties and the number of local names is confusing and complicates the study and classification of varieties. The cultivators recognise two varieties, or to be exact two types, only based on the colour of the rind of the tuber—"Red" or "White". The general concept is that the red variety is an early variety with a low yield, but with excellent table qualities and that the white variety is a late type which gives heavy yields of tubers of a slightly inferior quality. This is not a correct basis of classification, since a number of varieties with a common rind colour are grouped together as one variety.

The American classification is based on the shape and cooking quality of the tubers. Round types of tubers, having a central bulge, go by the name of "Sweet potato" and the elongated tuber types go by the name of "yams". Yam is the name given to tubers produced by the Dioscoreas, in the English-speaking countries and the use of the term "yam" for connoting a type of sweet potato is confusing.

The next classification of type is based on the cooking quality. Certain types are granular in texture and opaque on cooking and are dry for consumption. These are called "Dry and mealy" types. When the tubers cook to a waxy material that is translucent in appearance, the type is called "moist and sugary" or "moist-fleshed".

Classification of varieties is also done on leaf and petiole characters, pigmentation and so forth. Certain varieties have nearly rounded and entire leaves, while at the other end are some varieties with deeply lobed leaves.

Uses: The sweet potato tubers are mainly used as a vegetable in different ways, either raw, boiled, steamed, baked or roasted. They are also used for canning and dehydration. Dehydrated chips and flour keep well in storage. Starch, syrup, and alcohol are made out of the tubers on an industrial scale in America and sweet potato is coming into the lime-light, as a big commercial crop in place of corn and cotton.

The tubers not fit for human consumption and the sweet potato vines are used as feed for cattle, horses, sheep and pigs. The vines are also made into silage in a small way in America, but it is said to be slimy and inconvenient for handling. The vines could be cured into hay of medium to good quality. The green vines are fed to cattle in this country and what is not immediately consumed goes to the manure pit, a wasteful procedure. The green vines is a good feed for milch cattle, comparable with succulent leguminous fodder in value, but are apt to lossen the bowels when used as the sole roughage. 30—40 lbs. may be safely fed per head per day and supplemented by dry fodder. The surplus vines may be dried and made into hay. The vines contain about 17 per cent of proteins on an air-dry basis and properly made hay may be treated as a protein-rich feed.

The following analysis of sweet potato, compiled from various sources, gives an idea of the value of the different types of produce.

	Green vines	Vines (air-dry)	Silage	Tubers (range of)	Desiccated tubers
Moisture ...	86·42	10·00	54·87	78·26—58·85	10·46
Ash ...	2·98	19·75	1·85	0·76— 1·58	3·04
Crude protein ...	2·58	17·11	1·82	1·02— 2·91	4·50
Fat ...	0·32	2·12	0·66	0·55— 1·66	1·18
Crude fibre ...	3·05	20·22	1·48	1·11— 1·69	1·91
Carbohydrates* ...	4·65	30·80	39·41	15·38—34·42	78·91
	100·00	100·00	100·00		100·00
*Inclusive of					
Invert sugars ...				2·08— 5·74	18·55
Sucrose ...				0·58— 7·23	10·93
Total sugars ...				2·77—11·90	29·48
Starch ...					46·22

The sweet potato tuber is a good source of carbohydrates, present in a palatable form. The moisture content of the different varieties range from 58·85 to 78·26 per cent. To put it in another way, the dry matter content ranges from 21·74 to 41·15 per cent and the carbohydrate content from 15·38 to 34 42 per cent, and this is very significant to us.

The higher carbohydrate content is more than twice the lower carbohydrate content. The relative values of varieties depend therefore not only on the yields but also on the carbohydrate content of tubers. Since the carbohydrate content closely follows the dry matter, the relative values may be appraised by comparing the yield of air-dry matter content of the tubers. For practical purposes the yield of air-dry tuber provide a basis for valid comparison. The air-dry material has a moisture content of about 10 per cent and air-dry matter yield automatically includes the yield of green tubers and their dry matter content.

General Cultivation: Sweet potato is generally cultivated by planting cuttings of stems having 4—6 leaves and which are called "setts". The vines are taken from a previous crop or a special nursery raised by planting vines or small-sized tubers. The planting is done on ridges spaced 2—2½ feet apart, with a distance of 9 inches to one foot between the setts along the ridges, or in beds. The crop is usually irrigated in this State, though purely rainfed crops are raised with the South-West monsoon rains in Visakhapatnam, Malabar and South Kanara districts. It is generally grown as a rainfed crop in other countries. The vines produced have a tendency to strike roots at the nodes, which is attempted to be averted by occasionally turning the vines in certain cases. Depending upon the variety and season of planting, the crop matures in 100 to 165 days, when the vines are cut and the tubers dug and marketed straightaway.

Season: In Visakhapatnam, Malabar and South Kanara districts, the rainfed crop is planted in June, with the onset of the South-West monsoon. In Visakhapatnam district, a second planting season is September, just when the North-East monsoon commences. In the Nilgiris, the crop is planted in April—May with the help of the pre-monsoon showers.

The irrigated crops are all planted from September to November, almost throughout the state, though plantings may be done later in certain cases. These crops get the benefit of the North-East monsoon rains and are later irrigated when necessary. Ten to 20 irrigations are given to the crops on the whole. The crops planted in the other months of the year do not generally form tubers properly, which may be due to either photo-or thermo-periodism to which the crop is subject.

Tuber formation commences after the close of the North-East monsoon. This assures freedom from stagnation of water for the tubers during heavy rainfall periods. Stagnation of water during the growing period does not appear to be so harmful to the crop as during the tuber forming and maturing phases. The nights are particularly cool during the period of formation of tubers and this is helpful.

Preparatory Cultivation: Sweet potato is usually grown after a cereal crop. After the harvest of the previous crop, the land is ploughed 4 – 6 times, to bring about a fine, powdery condition of the soil. Since the sweet potato field is usually friable and loamy, proper tilth is easily secured. Just before the last ploughing, cattle manure is applied at 10 to 40 cart-loads (5 – 20) tons per acre. In the Circars region, cattle are penned in the fields during summer, instead of applying the cattle manure. A levelling board is sometimes worked over the land for breaking clods. Finally the land is thrown into ridges and furrows, 2 – 2½ feet apart or into beds 3 – 4 yards square, with irrigation channels in-between every two rows of beds. In the coastal sandy soils, however, beds 4 feet by 20 feet are formed for planting the setts, as at Bapatla and irrigation is done by splashing water from mud pots.

American experience indicates that the method of planting, whether on ridges or in beds on the level, does not materially affect the yields.

Manuring: Sweet potato is an exhausting crop and requires for its growth large quantities of nitrogen, phosphoric acid and potash. It has been computed that a 11,000 lb. crop removes from an acre of soil, the following manurial ingredients :—

		Nitrogen	Phosphoric acid	Potash
Tubers (11,000 lb.)	...	30	10	50
Vines dry weight—1 ton	...	40	11	33
Total	...	70	21	83

Sweet potatoes may be taken to yield 8 to 10 thousand pounds of tubers per acre in this country and an ordinary crop may be expected to remove ingredients of plant food from the soil, almost as much as shown above. The heavier the crop, the greater will be the removal of plant food ingredients. The large doses of cattle manure applied here may normally be expected to supply a sufficiency of plant food ingredients to the sweet potato crop. The soils are generally well furnished with potash, except the West-Coast districts, where however, wood ash is applied in addition to other manures.

The cultivators in the coastal areas apply 1 – 2 cwts. of ammonium sulphate per acre to the sandy soils. Fish guano, tobacco stems and wood ash are applied in Malabar and South Kanara districts, before ridging up the crop. Green leaves are also applied in addition, in the South Kanara district.

American workers have recorded that manuring the sweet potato crop with ammonium sulphate and other inorganic manures for the supply of nitrogen, tends to produce vines at the expense of the tubers and to

induce low keeping qualities in the tubers. While nitrogen promotes vegetative growth and builds up the plant body, phosphoric acid is required for the proper development of the roots. Tubers are after all roots enlarged by the deposition of starch and sugar and tuber formation and development are associated with the availability of phosphoric acid. Potash aids the elaboration of starch in the green leaves and its translocation to the tubers. The importance of an adequate supply of potash cannot be over-emphasised. Where potash is in short supply, the sweet potato leaves get thickened, there is derangement in the mechanism of translocation of starch to the tubers and the tubers do not develop properly. South Indian soils are said to be supplied with a sufficiency of potash, but poor soils would be benefited by potassic manuring. The application of wood-ashes as in Malabar and South Kanara are attempts to add potash to the soil. Even in other areas complete fertilisers may help to increase the yields.

Nurseries: The crop is propagated by planting stem cuttings. The tender as well as the over-mature stems are not used as planting material. The main crop harvest is from January to March and the harvested vines are used for planting the primary nurseries. The primary nurseries, about an eightieth of the area proposed for the crop of the next season, are prepared like the main field and should be located near wells, for facilitating irrigation during summer months. The setts are planted in beds with a spacing of 9 to 12 inches between the setts. The central part of the setts is pressed into the soil, leaving the two ends exposed. About 50% of the length of the sets is buried in the soil, with the top-end sticking out a little more than the bottom-end. The ends strike root at the nodes and sprout appear in 7 – 10 days. The nurseries are irrigated once in 4 – 7 days, during the early stages and later at longer intervals. The nursery areas make good growth and the land is covered by about June, when the vines are cut and planted in a second nursery, 8 — 10 times the primary nursery area. The secondary nurseries provide planting material from September onwards, for the main tuber crop. After the vines in the nurseries are cut, the nurseries may be irrigated for providing a second flush of vines for use as setts later in the season, if required.

When there is moisture in the main field, after the harvest of the tubers, the immature and undeveloped tubers in the soil sprout and vines produced are sometimes used as setts for planting the primary nurseries. This is a common practice in the sandy areas.

In America, the usual practice is to place sweet potato tubers side by side in sandy beds, 3 – 4 inches deep, overlying 8 – 12 inches of fresh horse manure trampled in, and cover the tubers for sprouting, 6 weeks before taking up the planting. The beds are watered after

bedding the tubers. 6 — 8 bushels (330 — 440 lb.) of tubers bedded in 16 square yards of beds give 10 to 15 thousand slips for planting an acre. The shoots called 'slips' are pulled with one hand, while the soil over the mother tuber is pressed with the other. The roots of the slips are dipped in a thick suspension of clay and cow-dung. The beds are watered immediately after pulling the slips, to settle the soil and promote the formation of further batches of slips. When 2 or 3 crops of slips from the same bed are used for planting, three to four bushels of tubers provide sufficient slips for planting an acre. Sometimes, the slips are allowed to run to vines and the vines are cut into setts for planting. The beds are then watered freely, with nitrate of soda dissolved at one ounce per gallon of water.

Planting the Crop: The setts are planted on the sides of ridges or in beds, after a soaking irrigation. The usual spacing is 2—2½ feet between the rows and 9 — 12 inches between the setts in the row. When planting is done in beds, the spacing given between the setts is 9 to 12 inches either way. 15 — 30 thousand setts are required for planting an acre, depending upon the method of planting and the spacing between the setts.

The vines being very succulent, get heated up and start rotting, when packed in gunnies for transport to other places. If the vines are to be sent long distances, they may be partially wilted, stripped of the leaves and the young tender portions, and packed in gunnies. Vines so treated keep in good condition for 10 — 12 days. One gunny bag of fresh green vines weigh about 60 lb. and give 2,000 setts. One bag of wilted vines, stripped of the leaves and tender shoots give an equal number of cuttings and weigh about 25 lb. Removal of the more succulent leaves and tender portions and wilting the vines save freight charges and prolong the keeping quality of the vines intended for setts.

The newly planted crop is irrigated on the fourth day after planting, if there are no rains and also on the 8th or 9th day to facilitate the rooting of the setts and the establishment of the crop.

Irrigation: Nearly 40 per cent of the sweet potato in this State is raised under rainfed conditions in Malabar, South Kanara and Visakhapatnam districts, during monsoon seasons, from June to December. The other areas are under irrigation, which is the most important operation during the period of growth of the crop.

The sweet potato is irrigated like most other crops, with about 3 inches depth of water each time, given periodically as and when required. The irrigations given at intervals of 3 — 5 days establish the crop. The North-East monsoon rains keep the crops growing

vigorously till about the middle of December. Even during this period, irrigations are given if rains withhold. After the monsoon ends, the crop is irrigated regularly once in 10 — 15 days, depending upon the type of soil and the depth of irrigations given. The crop receives 10 irrigations at least and at the most 20 irrigations. The final irrigation is carefully adjusted, so that the soil is lightly moist at the time of harvest. If the moisture is at the proper level, the soil does not stick to the tubers and they present a clean appearance.

The sweet potato is affected by drought, as well as by stagnation of water. The leaf surface of the crop is considerable, transpiration losses through the leaf surface are heavy and the leaves droop when the moisture in the soil gets low. If soil moisture is not then readily made-up, the growth is arrested, with a corresponding drop in the yield of tubers. The crop is particularly susceptible to stagnation of water after tubers commence forming; the tubers tend to rot and decay.

In the coastal sandy areas, temporary wells are dug and water is generally available at depths ranging from 3 — 6 feet from the surface. The water is carried in pots and splashed over the crop for providing moisture to the soil. Splash watering is done in such areas almost every-day during the first month and later every alternate day till about 10 days before harvest of the crop. The quantity of water used for splashing is much less than that used for crops under flow irrigation and the sweet potato is likely to require 60 — 70 splash or hand waterings.

After-cultivation: The sweet potato establishes within 10 days of planting and starts growing vigorously after three weeks, when it is given the first weeding. The second weeding is done a month after and later the vigorous vines tend to strike roots at the nodes contacting the soil. The growing vines are gently lifted to break and disconnect the roots. One view is that if rooting at the nodes is permitted, they would also develop into tubers, the large number of tubers that develop would necessarily be of small size and that the quantity of marketable tubers would be reduced. The American experience is that this supposition has no basis and that the rolling or lifting of the vines sometimes interferes with the metabolic activites of the plant. At best, the lifting of the vines may be inocuous.

With ridge planting, the ridges are earthed up, when the crop is about 2½ months old. The ridges get disintegrated by the heavy rains in Malabar and South Kanara and green leaves and wood-ash are applied to the rows at the time of earthing-up.

In America, the crop is planted both on ridges, as well as on level ground, with a spacing of ½ to 4 feet between the rows and 14 — 20 inches between the plants in the row. The vines spread all over and interfere with the cultivation of the inter-rows. The vines are rolled

over to alternate rows with the help of suitable rods or poles and the vacated rows are first cultivated. Later the vines are rolled over to the cultivated rows and the uncultivated rows are next taken up. The vines are generally moved with manual labour. Some implements are provided with leaf guards which lift the vines and clear the rows in advance.

Harvesting: When the tubers are fully developed and mature, the leaves turn pale and later lightly yellow. This is one of the usual signs of the maturity of the crop, but certain varieties do not exhibit this character. As the tubers develop, cracks develop about the base of the plants, though this may not be very apparent in irrigated lands and very loose soils. The mature tubers are comparatively brittle and the juice exuding from broken ends dry up quickly, without any discolouration, while the surface darkens or gets greenish when the juice dries up rather slowly in the case of immature tubers. The skin of the mature tubers is not easily bruised, nor does it peel off easily. Soil does not stick fast to the mature tubers.

The harvest of the crop is commenced a fortnight before the crop is fully mature and continued for a fortnight or so after full maturity. The harvest is done in stages so that the harvested tubers could be disposed off in the markets readily as they are dug in batches. The tubers are not usually kept in storage in this country for disposal later in a rising market. The harvest may, in extreme cases be postponed by a fortnight and the harvested tubers may remain with the cultivators for 7 — 10 days at the most, when there is no demand in the market. Since the tubers are not kept in storage, the area under the crop is limited to the demand in the market for fresh produce. If suitable methods of storing tubers are developed it may be possible to increase the area under the crop and supplement the country's food supply in a substantial manner.

The harvest of the tubers is best done at the correct stage of maturity to get the maximum yields and this point requires to be specially emphasised. If the tubers are harvested before they are mature, the yield and quality of the tubers are lowered. If the crop is kept on the land after maturity, the tubers tend to get damaged by the sweet potato weevil (*Cylas formicarius* F.) and the proportion of marketable tubers is reduced. The adult weevils as well as the grubs bore into the tubers and spoil them. The furrows get darkened and surrounding tissues are spoilt, giving an unpleasant smell and bitter taste. Fungal and bacterial damage follow in the wake of the weevil attack. The affected tubers have to be rejected; being unfit for table purposes. The extent of damage that the weevils effect has to be seen to be believed; 40 per cent of the tubers may be damaged in the course of a fortnight and 70 — 80 per cent in the course of a month. It is also noteworthy that immature tubers are seldom affected to the same extent by the weevil. It appears not unlikely that

the character of the latex in the tubers may be responsible for this differential behaviour of the weevils. The latex of the mature tuber dries up readily without any discoloration of the wound surface, while the latex of the immature tubers dries at a slower rate to a sticky material, which is discoloured. The weevil trouble is serious in certain localities and keeping continuous supply of planting material may be one of the causative factors. The presence of alternate host plants is another possibility. No effective remedial measures are known. Taking all these into consideration, it may be safe to advise that the harvest be done as soon as marketable tubers have formed in spite of the lower yield. Where however, the weevil damage is negligible, the harvest of the crop may be done at the correct stage of maturity or if necessary, even later.

The harvest is commenced by cutting the vines and clearing the land of the vines. The field is dug up with crow-bars and mammotties (spades) and the exposed tubers are collected, shaken free of soil and transported either in gunny bages or loosely in carts. 70—80 per cent of the tubers are marketable and the rest is made up of small-sized and immature tubers, diseased tubers and tubers cut while digging. The cut tubers are purchased by labourers at reduced rates and used in their households. The immature tubers are fed to cattle and other livestock. The diseased tubers are not useful and are rejected.

In America, sweet potato is harvested with potato digger ploughs designed for tuber-crop lifting. The mould-board of the plough is of a special design. There are slots running in the direction of the mould-board through which the cut furrow soil falls back in the furrow and the tubers are delivered in rows. The tubers lie partly buried in the soil and are picked by hand. There are sharp disc coulters attached to the beam of the plough, which cuts the vines in advance. The digging is done in the mornings, to permit the lifted crop being gathered before frost sets in, in the night. The tubers are transported to the store-houses.

The store-houses are insulated structures with facilities for the regulation of temperature and aeration. The tubers are spread out on racks and the temperature is maintained at 115° — 130°F, for 7 — 20 days. During this period the tubers lose their extra moisture, about 6% in the first week and another 6% in the next fortnight, and they are then able to stand storage, without sprouting. The temperature is then brought down and maintained at 55° — 60°F till required for the market. Surplus tubers that could not be accommodated in store houses, are put in conical heaps over a thick bedding of straw and covered over with straw and finally a thick layer of earth. Ventilation is provided for these clamps through a hole at the top. When tubers are required for the market, the tubers are cleaned, graded and packed in veneer barrels or baskets. They are never marketed in bulk or in bags as in India.

Changes take place in the composition of the sweet potato tubers, when kept in storage, after preliminary curing. There is a slight reduction in the moisture content. A part of the starch, upto 25%, gets transformed into dextrose and finally into sucrose. The dextrose content increases lightly, upto 0·77%, but the sucrose content increases up to 4·16%. There is a similar conversion of starch to sugars, during cooking, the sucrose content risings lightly upto 0·45% and the dextrose content. considerably, from 4 — 9%. The starch in the tubers is said to be dissolved by the diastatic enzymes present in the tubers, when the temperature is raised from 60° — 100°C. and maintained for in 1—1½ hours. The addition of sweet potato flour at 1·5% level to wheat flour is claimed to raise the loaf volume of the bread by about 10 per cent.

Successful storage of tubers in America is made possible by the observance of the following principles :—

1. Mature tubers are selected.
2. Diseased and bruised tubers are rejected.
3. The tubers are first cured partially, by subjecting them to sweating at high temperature for varying periods, depending upon the original moisture, and by
4. Regulating the storage temperature.

The natives of Africa are said to store sweet potato tubers in holes dug for the purpose. The tubers are spread out in shade for a few days, to reduce the moisture content. Later they are stored in pits, in layers alternately with wood-ash. The pits are finally sealed with a thick layer of earth. A large part of the tubers are said to keep well, without spoilage. Even when some tubers are spoiled, the spoilage does not spread to the neighbouring tubers, because of the ash in between. Experiments done in America show that any dry material will serve as a packing and that sand or road dust could replace the ash without any difference in storage efficiency.

Tubers wilted for 2 — 3 days, washed, cooked for an hour, split longitudinally into 3 or 4 pieces and dried in the sun till they are brick-hard are said to keep well in ordinary storage for over two years in East Africa. The slices are washed and cooked in the ordinary manner as and when required. It is claimed that such preserved tubers are even tastier than fresh tubers.

It has been noted that sweet potato tubers do not stand long storage under the conditions prevailing here. They have a tendency to sprout soon after they are put in storehouse here. Possibly the method of pitting followed in East Africa may be adapted to our

conditions, with suitable modifications. Preservation of slices that have been cooked and dried by the East African method may be suitable for localities, which are not very humid.

Yields: The yield of tubers is variable. The rainfed crop gives 5,000 — 7,000 lb. of tubers per acre and a variable quantity of vines. The yield of irrigated crops ranges from 4,000 — 24,000 lb. of tubers per acre, with an average of 8,000 lb. for the whole State.

The vine yield of the irrigated crop ranges from 10,000 lb. to 20,000 lb. per acre. Sweet potato planted in November – December, as a green fodder crop gives 3 – 4 cuttings of vines from March to May, aggregating 55 to 70 thousand pounds per acre. The growth of vines during the summer months is vigorous, when compared to the growth of other green fodder crops.

Tuber yield appears to be associated with the vigour of the vines but not necessarily with the growth of the vines. A certain extent of growth of the vines is necessary for the production of tubers, but excessive, rank growth of the vines is at the expense of the tubers. The proportion of vines to tubers may be a primary varietal character, but is greatly influenced by the richness of the soil, its content of organic matter, and the preponderance of nitrogen in the manures applied, without being balanced by sufficient quantities of potash.

Information on the performances of the local varieties of sweet potato under cultivation in this state, is lacking. Preliminary observation of six varieties of sweet potato introduced at the Agricultural Research Station, Koilpatti from Travancore in the 1948 – 1949 season, indicates that there are wide differences in the potential capacities of the different varieties. Whether the heavy croppers would behave consistently year after year and maintain their relative superiority remains to be seen. The yields obtained in the first year of the trial are however given below :—

No.	Name of variety	Yield in lb. per acre			Vine-tuber Ratio
		Tubers	Vines	Total	
1.	Seelanthi chuvalai ...	28,206	15,857	44,063	0·56
2.	Aruvan vellai ...	25,448	27,069	52,517	1·06
3.	Dindigul variety ...	15,220	19,189	34,409	1·26
4.	Bhadrakali ...	12,455	25,473	37,928	2·04
5.	Parenkima ...	10,241	33,291	43,540	3·24
6.	Kuduku Vellai ...	8,445	26,540	34,992	3·12

Variety No. 2 leads in the total production of succulent tubers and vines. No. 1 leads in the production of tubers. Where vines are fully utilised the preference may be for variety No. 2; otherwise preference may be for variety No. 1.

The choice of suitable varieties should help in increasing greatly the yield and profits obtained and consequently in popularising the crop and expanding the acreage under it.

The 'Pelicon Processor' one of the starchy varieties of sweet potato evolved in U. S. A. for use in industries is said to yield 20 to 30 thousand pounds of tubers per acre and the table variety 'Puerto Rico' an average yield of 16,500 pounds of tubers, with yields going up in some cases to 33,000 lb. per acre, in America.

Marketing: Sweet potato is grown in this State, principally as a vegetable crop and the area under the crop is regulated by the demand from the nearby consuming centres. It is perishable to an extent and is not moved over long distances, nor kept in storage or under preservation. Urban centres are the chief consuming areas and are catered to by suitable producing areas round about. Madras is a big consuming centre and collects the produce from the neigbouring districts of Nellore, Chingleput, North and South Arcot. Similarly, the various district headquarter towns draw their supplies from the surrounding taluks, through vegetable vendors and middlemen. The several weekly shandies are also collecting centres, where the cultivator himself disposes off his crop directly. The harvesting is adjusted to meet the demands of the consuming market. The people engaged in the vegetable trade are able to guide the cultivators in such a regulation of the harvests. The harvested tubers left unsold in the principal markets are attempted to be sold in the villages. The left-over tubers, when few, are sliced and made into chips by drying in the sun, to serve as a stand-by for the cultivator, but the total quantity so preserved is negligible.

If sweet potato is grown as a subsidiary food crop to supplement the food grains in short supply in the country, the tubers produced in excess of the current requirements may have to be kept in proper storage or preserved in suitable forms, by developing suitable methods. Sweet potato was used as a subsidiary food crop in the southern states of the United States of America during the war and if necessary, a similar and suitable adaptation of the food habits should not be impossible in this country. The prevailing high temperature would be an additional factor that may have to be taken into consideration, while storage and preservation problems are being tackled and solved.

Pests and Diseases: A number of insects and fungoid diseases are known to affect the crop and cause serious damage, in the various parts of the world. But fortunately none of them are of major importance in South India, excepting the "Sweet potato weevil"-*Cylas formicarius F.* The damage done by the weevil is very severe in certain localities. There are no known remedies against the weevil, but the observance of the following plant sanitation methods should help to minimise the damage :—

(1) The weevil burrows into the vines and later attacks the tubers. If the crop is grown in rows or on ridges and earthed up well, before the formation of the tubers, it would assist in reducing the incidence of the weevil.

(2) The fields selected for planting sweet potato should be far away from those cropped with it in the previous season and from nurseries. The distance from a possible source of infection is all-important, since the weevil is a slow-moving creature that is not able to traverse long distances.

(3) When vines are being cut for setts, 12—15 inches of the vine near the base of the plant should be rejected, as the weevil is mostly confined to the base of the plant.

(4) Keeping the prepared setts submerged in thin tobacco decoction or subjecting them to Gammexane smoke generated from pellets, for about 6 hours before planting, would reduce the weevils.

(5) The bunds and surroundings about sweet potato fields should be kept free of convolvulus weeds and plants, so that they may not act as alternate host plants for the weevils.

(6) The harvested fields should be cleaned and sweet potato residue of all kinds should be removed. The voluntary slips that develop in the harvested fields should be removed with the tubers and destroyed.

(7) Plant sanitation and segregation of the unaffected crop are the only rational methods of keeping the weevil population in check.

Cost of Cultivation and Returns: The cost of cultivation of sweet potato varies widely and a rough estimate is given below, assuming that all the items of labour, seed, and manure are paid for.

Cost of cultivation of sweet potato per acre

Particulars		Cattle pairs at Rs. 2—4—0 a day	Men at Re. 1 a day	Women at Re. 0—8—0 a day	Cost Rs.	A.	P.
Ploughing 4 times	...	8	8		26	0	0
Forming beds and channels	...		8		8	0	0
Carting and applying manure	...	3	4½	6	14	4	0
Cost of 20 cart-loads of cattle manure at Rs. 4 per cart	...				80	0	0
Planting setts	...		1	8	5	0	0
Cost of 15,000 setts at Re. 1 per thousand	...				15	0	0
Lift irrigation with mhote	...	37½	37½		121	0	0
Guiding water (15 irrigations)	...		15		15	0	0
Weeding twice	...			16	8	0	0
Harvesting and carting tubers	...	2	15	20	29	8	0
Lease of land	...				60	0	0
Total expenditure	...				381	12	0
Receipts.							
Value of 12,000 lb. of tubers at 20 lbs. per rupee				...	600	0	0
Value of 18,000 lb. of vines at Rs. 2/- per 1000 lb.				...	36	0	0
Total receipts per acre				...	636	0	0
Net profit per acre				...	254	4	0

If electrical energy were used instead of bullocks for lifting water for irrigation, 270 units of electricity would be used for 15 irrigations costing Rs. 16—14—0, instead of Rs. 121/- spent on mhoting. There would be a saving of Rs. 104—2—0 in expenditure and the net profit would increase correspondingly and be Rs. 358—6—0 per acre.

The quantity of manure and irrigation given is variable and determines the size of the crop harvested. The setts used for planting, the manure applied and bullocks worked with the mhote are with the cultivator and they are not paid for and these are the major items of cultivation. The cultivator and his family work in the field and the labour engaged for field work gets reduced thereby. The cultivation charges actually incurred by the cultivator are therefore much less than what has been figured, whereas the receipts shown are all real and tangible, so much so the real profit obtained is more than what has been worked out.

Further, 12,000 lb. has been shown as the average yield and this is low for the intensity of cultivation indicated, that is for the manure and irrigations given. The cultivator should get greater yields under such conditions and his profit should be more. Sweet potato cultivation is thus a very paying proposition and should appeal to the cultivators. It is a big commercial food crop, whose cultivation now at this time of shortage of food supply in the country is a real national service that combines the profit motive as well.

Cooking sweet potato and recipes: Sweet potato is a common vegetable which is well known and used by all classes of people. It is suitable for being made into almost all types of South Indian curries, just like the ordinary potato. It is commonly boiled with a little salt and water and sold in throughfares, and bazaars. It is taken as a light repast by children and labourers. It is tastier when it is cooked in steam with the jacket on. Baking in live coal is considered to be best form of cooking the tubers, which retains the full flavour of the tubers.

A few recipes are given below to help the house-wife in making a fuller use of the sweet potato and in indicating new methods of serving the tubers.

(1) *Bondas:* Boil and skin the sweet potato and mash it. Add salt, chilli powder, coconut scrapings and seasoning to taste. Seasoning consists of heating a little gingelly oil and roasting a mixture of black gram dholl and mustard, till the mustard sputters. Mix thoroughly and form small balls of about 1½ inches in diameter, dip in a thin batter made with Bengal-gram flour and fry in deep oil or ghee.

(2) *Chappathis:* Mix 4 cupful of mashed sweet potatoes with one cupful of American flour and a little salt and roll into a stiff dough, adding a little water, if necessary. Make chappathis with the mixed dough and serve.

(3) *Poli:* Prepare the dough as for chappathis given above using jaggery instead of salt. Form small balls 2 inches in diameter, roll rather thinly on a floured board and bake on a hot plate adding a little ghee while baking. Turn the poli on the plate after the under-side is done and bake to a light brown colour. Serve hot with a little ghee.

(4) *Chips:* Wash the tubers and slice into discs 1/8 of an inch thick and fry in coconut oil. Remove the chips when crisp and add salt and chilli powder to taste.

(5) *Porridge:* Mash boiled tubers, add sugar to taste and serve with hot milk. Dried sweet potato chips may also be cooked and used instead, similarly.

(6) *Bread:* Mashed sweet potato may be added to sifted flour, in the proportion of one of the mash to 2½ parts of flour and leavened bread made in the usual manner.

(7) *Biscuits:* Dried sweet potato flour may be added to sifted flour upto one-eighths and biscuits made in the usual manner.

(8) *Poori:* Mix dough as for chappathis, take small portions and roll thinly on a board fry in deep oil or ghee.

(9) *Salad:* Young leafy tops and stems are seasoned with salt, onions, lime juice and a little sweet oil, for use as salad.

Sweet potato is a profitable crop and produces from the same area more calories than cereals. It is necessary in the national interest to switch over larger areas for sweet potato cultivation. The cultivators are able to study the market and adjust their cropping to suit the market. Yet the area under the sweet potato crop is not increasing, because of certain risks associated with it. Sweet potato production is seasonal. The produce comes to the market from January to April mainly. Sometimes large areas come to maturity together and everybody sends his produce to the market, there is a glut and prices are depressed to uneconomic levels. The cultivator wants to avoid this and restricts the acreage under the crop. This is because the harvested produce cannot be kept in storage and held over for proper distribution. Here then is the bottle-neck and it is necessary to evolve methods of storage of sweet potato tubers to suit the prevailing climatic conditions.

Sweet potato is harvested in January to April and what can not be consumed in the fresh state, could be preserved by slicing, drying and storing as chips. The harvest is fortunately in the dry season and the drying could be done in the production village centres themselves, without resorting to artificial and costly methods. Methods of utilising

the dried chips to suit the taste and palate of the people, have to be evolved. The best way of drying also has to be worked out. Would raw tubers give the most acceptable type of chips or should the tubers be blanched or cooked partially or fully, before drying, are points that require to be settled. It is suggested that the chips could be easily milled into flour and used as a partial or entire substitute for making *dosais*, *iddalies*, oil-fried cakes and various other preparations. When the use of flour as acceptable types of food is popularised in the ordinary household, the cultivation of sweet potato will increase, and successfully combat the shortage of food supply in the country.

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"Classification of the Bananas"—A Resume*

By

Dr. K. S. VENKATARAMANI

Although there seems little reason to doubt that the banana was one of the first foods of man and that it was one of the first plants cultivated, its specific and varietal relations have never been well defined. For want of a proper approach to the problem of classification and nomenclature, the various attempts to study these plants have only resulted in chaos. Based on the extensive collection of the species of *Musa* at the Imperial College of Tropical Agriculture, Trinidad, Cheesman (1947, 1948, 1949) has recently discussed the subject in a series of articles under the caption "Classification of the bananas". His publications really deal with the genus *Musa* as a whole and not on the edible bananas as such. It is, therefore, necessary to point out that the word 'banana' has been used by him in these papers in a very wide sense and it covers both the fertile (wild and seeded) and the parthenocarpic (edible) forms.

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* I have freely drawn from Prof. E. E. Cheesman's publications. He has been of guidance to me in some of my work and I wish to take this opportunity to express my indebtedness to him.