Yam Facts & Figures

Yam is the common name for some plant species in the genus *Dioscorea* (family Dioscoreaceae) that form edible tubers.

Yellow yam - *dioscorea cayenensis*

These are perennial herbaceous vines cultivated for the consumption of their starchy tubers in Africa, Asia, Latin America, the Caribbean and Oceania. Yams are monocots, related to lilies and grasses.

Native to Africa and Asia, yam tubers vary in size from that of a small potato to over 1.5 meters in length and 70 kgin weight. There are over 600 varieties of yams and 95 percent of these crops are grown in Africa. Although some varieties of sweet potato (*Ipomoea batatas*) are also called *yam* in parts of the United States and Canada, sweet potato is not part of the family Dioscoreaceae but belongs in the unrelated morning glory family Convolvulaceae. Yams comprise both diploid and polyploid species.

Factor	Yam
Plant Family	Yam
Chromosomes	2n=20
Plant sex	Dioecious
Origin	West Africa, Asia
Edible part	Tuber
Appearance	Rough, scaly
Shape	Long, cylindrical, some with "toes"
Mouth feel	Dry
Taste	Starchy
Beta carotene	Usually very low
Propagation	Tuber pieces, vine cuttings

In West Africa yams are a major source of income, with a high cultural value. A festival is held annually to celebrate its harvest. Consumer demand for yam is generally very high in the sub-region and yam cultivation is very profitable despite high production costs.

Yams are grown by planting pieces of tuber, or small whole tubers ('seed yams') saved from the previous season. Small-scale farmers, the majority of producers, often intercrop yams with cereals and vegetables. The major pests that affect yams include insects such as leaf and tuber beetles, mealy bugs, and scales; parasitic nematodes; fungi causing anthracnose, leaf spot, leaf blight, and tuber rot; and viruses, especially the yam mosaic virus (YMV).

Major cultivated species

There are many cultivars of yam throughout the humid tropics. White Guinea yam, *Dioscorea rotundata*, is the most important species – especially in the dominant yam production zone in West and Central Africa. It is indigenous to West Africa, as is the yellow Guinea yam, *Dioscorea cayenensis*. Water yam, *Dioscorea alata*, the second most cultivated species, originated from Asia and is the most widely distributed species in the world.

Together, there are over 200 cultivated varieties of white and yellow yam. They are large plants; the vines can be as long as 10 to 12 meters (33 to 39 ft). The tubers most often weigh between 2.5 and 5 kilogrammes each, but can weigh as much as 25 kg (55 lb). The tubers are harvested after 7 to 12 months of growth.

The water yam, *Dioscorea alata*, also known as the 'winged yam' and 'purple yam', was first cultivated in Southeast Asia. Although not grown in the same quantities as the African yams, it has the largest distribution world-wide of any cultivated yam – being grown in Asia, the Pacific islands, Africa, and the West Indies. Even in Africa, the popularity of water yam is second only to white yam.

A Nigerian farmer displays her healthy yam tubers.

Dioscorea polystachya, 'Chinese yam', is native to China. It is somewhat smaller than the African yams, with the vines about 3 meters (10 feet) long, with a shorter growth period to havest (6 months). It is tolerant to frost and can be grown in much cooler conditions than other yams. It is now grown in China, Korea, and Japan. It was introduced to Europe in the 19th century when the potato crop there was falling victim to disease, and is still grown in France.

Dioscorea bulbifera, the 'air potato', is found in both Africa and Asia. It is a large vine, 6 meters (20 ft) or more in length. Though it produces tubers, the bulbils which grow at the base of its leaves are the more important food product. They are about the size of potatoes,hence the name 'air potato'), weighing from 0.5 to 2 kilogrammes. It is not grown much commercially since the flavour of other yams is preferred. However it is popular in home vegetable gardens because it produces a crop after only four months of growth and continues producing for the life of the vine, as long as two years.

Dioscorea esculenta, the lesser yam, was one of the first yam species cultivated. It is native to Southeast Asia and not much cultivated in other parts of the world. Its vines seldom reach more than 3 meters (10 feet) in length and the tubers are fairly small. Because of the small size of the tubers, mechanical cultivation is possible; which, along with its easy preparation and good flavour, could help the lesser yam to become more popular in the future.

Dioscorea dumetorum, the bitter yam, is popular as a vegetable in parts of West Africa. *Dioscorea trifida*, the cush-cush yam, is native to the Guyana region of South America and is the most important cultivated New World yam. Since they originated in tropical rain forest conditions their growth cycle is less related to seasonal changes than other yams. Because of their relative ease of cultivation and their good flavour they are considered to have a great potential for increased production.

Production

Yams are farmed on about 5 million hectares in about 47 countries in tropical and subtropical regions of the world (International Institute of Tropical Agriculture, 2010). More than 54 million tons of yams are produced in Sub-Saharan Africa annually on 4.6 M Ha. Over 95% of this production lies in a five-country "yam belt" that includes Nigeria, Benin, Togo, Ghana, and Côte d'Ivoire. Although yam production in Africa is 40% that of cassava, the value of yam production exceeds all other African staple crops and is equivalent to the combined value for the top three cereal crops – maize, rice and sorghum (Africa Yam Project, 2016).

Yam is the preferred staple food in West Africa but demand is constrained by inadequate production and losses in storage. The most important biotic constraints are nematodes, viruses and anthracnose. Yam cultivation also has high environmental impact because it is usually planted in recently cleared land and requires staking with branches/small trees, especially in the forest areas.

Yam crops face pressure from a range of insect pests, fungal and viral diseases, and soil-borne nematodes associated with intensive cropping systems. Productivity is also negatively impacted by declining soil fertility.

Genetic improvement can contribute significantly to addressing these challenges and seizing opportunities for expanding the markets for the commodity.
Whole seed tubers or tuber portions are planted into mounds or ridges, at the beginning of the rainy season. The crop yield depends on how and where the setts are planted, size of mounds, interplant spacing, provision of stakes for the resultant plants, yam species, and tuber sizes desired at harvest. Small-scale farmers in West and Central Africa often intercrop yams with cereals and vegetables. The seed yams are perishable and bulky to transport. Farmers do not generally buy new seed yams, usually setting aside up to 30 percent of their previous harvest for planting the next year.

Yam typically grows for six to ten months and is dormant for two to four months, depending on the species. The growth and dormant phases correspond respectively to the wet season and the dry season. For maximum yield the yam requires a humid tropical environment, with an annual rainfall of over 1500 millimeters distributed uniformly throughout the growing season. White, yellow and water yams typically produce a single large tuber per year, generally weighing 5 to 10 kg (Calverly, 1998; Storage and Processing of Roots and Tubers in the Tropics, Food and Agriculture Organisation of the United Nations). This means that only one crop cycle is possible per year, possibly restricting supply.

Yam production is very labour intensive. The crop also has low yield per hectare compared to other root crops such as cassava and sweet potato. It is not an efficient food staple given the relatively large amount of planting material that is required and its long growing season. Yam is also difficult to preserve and store over extended periods of time. The cost per 1,000 calories of yam is four times greater than that of other root and tuber crops (Oke, 1990; Roots, tubers, plantains and bananas in human nutrition, FAO. ISBN 92-5-102862-1). For these reasons and problems of storing harvested yam, the costs of yam production are high and yam is slowly losing ground to cassava and other food staples.

2012 Top 10 Yam Producers		
Rank	**Country**	**Production (m/tonnes)**
1	Nigeria	38,000,000
2	Ghana	6,638,867
3	Cote d'Ivoire	5,674,696
4	Benin	2,739,088
5	Togo	864,408
6	Cameroon	520,000
7	Central African Republic	460,000
8	Chad	420,000
9	Papua New Guinea	345,000
10	Colombia	361,034
Source: UN Food & Agriculture Organization		

However, despite these high costs and low nutrient density, when compared to other tubers and roots, low technology yam farming on average produces the highest amount of food calorie and protein annually per hectare per season. Given this nutritional value of yam and its high cultural significance in certain parts of Africa, there is an interest in developing knowledge that can improve yam agriculture.

The Top 5 Yam Producing Countries 2013			
Rank	**Country**	**Production (m/tonnes)**	**% of World Total**
1	Nigeria	40,500,000	64.2%
2	Ghana	7,074,574	11.2%
3	Cote d'Ivoire	5,731,719	9.09%
4	Benin	3,177,265	5.03%
5	Ethiopia	1,191,809	1.89%
Source: FAOSTAT data 2015			

The world average annual yield of yams was 10.2 tonnes per hectare in 2010. The most productive yam farms in the world were in Colombia, where nationwide average annual yield was 28.3 tonnes per hectare (Production crop data, Yams, 2010, Food and Agriculture Organization of the United Nations. 2011), with some farms reporting yields significantly above 30 tonnes per hectare for yellow yam and others reporting less than 1 tonne per hectare (Linus Opara, 2003; YAMS: Post-Harvest Operation).

Despite the intense labour requirements and production costs, consumer demand for yam is very high in West Africa, making yam cultivation quite profitable for farmers (Yam; International Institute of Tropical Agriculture, 2010). Yields may improve and costs of production made lower if mechanization were to be developed and adopted. However, current crop production practices and species used pose considerable hurdles to successful mechanization of yam production, particularly for small-scale rural farmers. Extensive changes in traditional cultivation practices, such as mixed cropping, may be required. Modification of current tuber harvesting equipment is necessary given yam tuber architecture and its different physical properties (Linus Opara, 2003; YAMS: Post-Harvest Operation).

Raw Yam - Nutritional value per 100 g (3.5 oz) Source: USDA Nutrient Database Units: µg = micrograms; mg = milligrams; g = grams; IU = International units	
Water	69.6g
Energy	494 kJ (118 kcal)
Carbohydrates	27.88 g
Sugars	0.5 g
Dietary fiber	4.1 g
Fat	0.17 g
Protein	1.53 g
Vitamins	
Vitamin A equiv.	(1%) 7 µg
Thiamine (B1)	0.112 mg (10%)
Riboflavin (B2)	0.032 mg (3%)
Niacin (B3)	0.552 mg (4%)
Pantothenic acid (B5)	0.314 mg (6%)
Vitamin B6	0.293 mg (23%)
Folate (B9)	23 µg (6%)
Vitamin C	17.1 mg (21%)
Vitamin E	0.35 mg (2%)
Vitamin K	2.3 µg (2%)
Minerals	
Calcium	17 mg (2%)
Iron	0.54 mg (4%)
Magnesium	21 mg (6%)
Manganese	0.397 mg (19%)
Phosphorus	55 mg (8%)
Potassium	816 mg (17%)
Zinc	0.24 mg (3%)
Lipids	
Fatty acids, total saturated	0.037 g
Fatty acids, total monounsaturated	0.006 g
Fatty acids, total polyunsaturated	0.076 g
Fatty acids, total trans	0.000 g
Cholesterol	0 mg

Unlike cassava, most varieties of edible, mature, cultivated yam do not contain toxic compounds. However, there are exceptions. Bitter compounds tend to accumulate in immature tuber tissues of white and yellow yams. These may be polyphenols or tannin-like compounds. Wild forms do contain some toxins that taste bitter, hence the name 'bitter yams'. The bitter compounds in these yams are water-soluble alkaloids which, on ingestion, produce severe and distressing symptoms. Severe cases of alkaloid intoxication may prove fatal. Bitter yams are not normally eaten except at times of desperation in poor countries and in times of local food scarcity. They are usually detoxified by soaking in a vessel of salt water, in cold or hot fresh water or in a stream.

'Aerial potato' yams also have toxins, including diosbulbin and possibly saponins. Extracts are sometimes used in fishing to immobilize the fish and thus facilitate capture, to bait and poison wildlife, and in the preparation of arrow poison (Oke, 1990; Roots, tubers, plantains and bananas in human nutrition - FAO. ISBN 92-5-102862-1)

Nutritional value

Yam is an important dietary element for many West African people. It contributes more than 200 calories per person per day for more than 150 million people in the region. It is rich in starch, and can be prepared in many ways. It is available all year round, unlike other seasonal crops. These characteristics make yam a preferred food and a culturally important food security crop (Izekor and Olumese, December 2010; *Determinants of yam production and profitability in Edo State, Nigeria – African Journal of General Agriculture **6** [4]*). Annual consumption in West Africa is 61 kilograms per capita - 15 million tonnes in total. Yams are boiled, roasted, baked or fried or mashed into a sticky paste or dough after boiling.

Yam tubers are rich in carbohydrates, Vitamin C and essential minerals while being low in saturated fat and sodium. The protein quality and content of roots and tubers is lower than in other food staples, but of all

roots and tubers, the protein content of yam and potato is the highest, being approximately 2 percent on a fresh weight basis. It is rich in phenylalanine and threonine but limiting in the sulphur amino-acids, cystine and methionine and in tryptophan. Nutritionists emphasize the need to supplement a yam-driven diet with more protein-rich foods. Yam generally has a lower glycaemic index compared to potato products, about 54% of glucose per 150 gram serving (*Glycemic index and glycemic load for 100+ foods, Harvard Health Publications, Harvard Medical School. 2008).*

The African yam (*Dioscorea sp*) also contains thiocyanate. It has been suggested that thiocyanate is potentially protective against sickle cell anaemia (Agbai, O. 1986; Anti-sickling effect of dietary thiocyanate in prophylactic control of sickle cell anaemia – *Journal of the National Medical Association* 78: 11).

Comparison to other staple foods

STAPLE:	RDA	Maize	Cassava	Sweet potato	Sorghum	Yam
Per 100g portion	Amount	Amount	Amount	Amount	Amount	Amount
Water (g)	3000	10	60	77	9	70
Energy (kJ)		1528	670	360	1419	494
Protein (g)	50	9.4	1.4	1.6	11.3	1.5
Fat (g)		4.74	0.28	0.05	3.3	0.17
Carbohydrates (g)	130	74	38	20	75	28
Fibre (g)	30	7.3	1.8	3	6.3	4.1
Sugar (g)		0.64	1.7	4.18	0	0.5
Calcium (mg)	1000	7	16	30	28	17
Iron (mg)	8	2.71	0.27	0.61	4.4	0.54
Magnesium (mg)	400	127	21	25	0	21
Phosphorus (mg)	700	210	27	47	287	55
Potassium (mg)	4700	287	271	337	350	816
Sodium (mg)	1500	35	14	55	6	9
Zinc (mg)	11	2.21	0.34	0.3	0	0.24
Copper (mg)	0.9	0.31	0.10	0.15	-	0.18
Manganese (mg)	2.3	0.49	0.38	0.26	-	0.40
Selenium (µg)	55	15.5	0.7	0.6	0	0.7
Vitamin C (mg)	90	0	20.6	2.4	0	17.1
Thiamine (B1)(mg)	1.2	0.39	0.09	0.08	0.24	0.11
Riboflavin (B2)(mg)	1.3	0.20	0.05	0.06	0.14	0.03
Niacin (B3) (mg)	16	3.63	0.85	0.56	2.93	0.55
Pantothenic acid (B5) (mg)	5	0.42	0.11	0.80	-	0.31
Vitamin B6 (mg)	1.3	0.62	0.09	0.21	-	0.29
Folate Total (B9) (µg)	400	19	27	11	0	23
Vitamin A (IU)	5000	214	13	14187	0	138
Vitamin E, alpha-tocopherol (mg)	15	0.49	0.19	0.26	0	0.39

STAPLE:	RDA	Maize	Cassava	Sweet potato	Sorghum	Yam
Vitamin K1 (µg)	120	0.3	1.9	1.8	0	2.6
Beta-carotene (µg)	10500	97	8	8509	0	83
Lutein + zeaxanthin(µg)		1355	0	0	0	0
Saturated fatty acids(g)		0.67	0.07	0.02	0.46	0.04
Monounsaturated fatty acids (g)		1.25	0.08	0.00	0.99	0.01
Polyunsaturated fatty acids (g)		2.16	0.05	0.01	1.37	0.08

Crop Improvement and breeding objectives for yam

Yam production is declining in some traditional producing areas in Africa due to declining soil fertility, increasing pest pressures and the high cost of labour. Smallholders therefore need access to innovations to improve productivity.

Yam vines twist up bamboo staking in a yam field

Breeding objectives include high and stable tuber yields, resistance to pests and diseases (nematodes, yam mosaic virus and other viruses, anthracnose, and scale insects), tuber quality, ease of harvest and long storage, suitability to cropping systems and markets, tolerance to abiotic stresses, and textural and nutritional attributes. Agronomic research on soil fertility is targeting the role of mycorrhizal fungi in yam mineral nutrition, while product development approaches are focussed on functional properties required for products for household and industrial purposes. At a macro level, research is targeting improvements in yam-based cropping systems. Ongoing research includes improving protocols for rapid field propagation using vine cuttings.However yam breeding is challenging, with limited capacity in the primary growing areas in West Africa.

The Africa Yam Project

A woman offers yam flour (*elubo isu*) for sale in Bodija market, Ibadan, Nigeria

The Africa Yam Project is an initiative led by the International Institute of Tropical Agriculture, focused on the genetic improvement of two major cultivated yam species: white yam (Dioscorea rotundata), which is native to West Africa, and water yam (Dioscorea alata) which originated from the Asia/Pacific region. The project partners are working towards increased yam productivity whilst reducing production costs and environmental impact by developing and deploying varieties with higher yield, greater resistance to pests and diseases and improved quality.

The project involves a network of research organizations in the four main producer countries of the West African yam belt: the National Root Crops Research Institute (NRCRI) and Ebonyi State University in Nigeria; the Crops Research Institute and the Savanna Agricultural Research Institute in Ghana; le Centre National de

Recherche Agronomique (CNRA) in Côte d'Ivoire; and l'Université d'Abomey-Calavi in Benin. Institutes from outside the region involved in the project include the Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), France; the Iwate Biotechnology Research Center (IBRC) and the Japan International Research Center for Agricultural Sciences (JIRCAS), Japan; the James Hutton Institute (JHI), UK; and the Boyce Thompson Institute for Plant Research (BTI), Cornell University, USA.

Sources and Related Links

1. International Institute of Tropical Agriculture
2. Africa Yam Project
3. CGIAR CRP on Roots, Tubers & Bananas
4. YamBase
5. Wikipedia Article on Yam