YAM: INTEGRATED MANAGEMENT OF A SUBSISTENCE CROP

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One of our allies in the Caribbean for a healthy life

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Yam, *Dioscorea* spp.

Yams play an important role in global nutrition. Fresh or processed, they supply healthy carbohydrates and energy, are used for animal feed, and serve as a raw material in pharmaceuticals **[1]**.

They produce underground or aerial tubers—known as gunda or bulbil—depending on the species **[2]**.

Their versatility and resilience make yams a valuable crop with room for commercial growth and benefits for Caribbean farmers **[1]**.

Raising production helps strengthen food security because yams are nutritious and functional.

Origin of the Yam

The genus *Dioscorea* originates in Burma, Asia **[3]**, and includes a wide variety of cultivated and wild species across tropical regions of Africa, Asia, and the Americas.

Yams, unlike other roots and tubers, show great genetic diversity and were derived from three different centers of origin **[4]**. From tropical America: *Dioscorea trifida*. From West Africa: *Dioscorea rotundata*, *Dioscorea cayenensis*, *D. bulbifera*, and *D. dumetorum*. From Southeast Asia: *D. alata*, *D. esculenta*, and *D. opposita*. They are thought to have evolved in distinct Asian and African lineages, with Old World species evolving separately from those in the New World.

In addition to being an important crop in tropical and subtropical regions, yam cultivation has spread worldwide. Indian and Malay sailors used it as food during long voyages **[3]**. *Dioscorea alata* spread from Asia to New Guinea and Polynesia, expanded westward, and, through the slave trade, spread from West Africa to the Americas.

Yam morphology

Yam plants are herbaceous or climbing shrubs that live for more than two years. They have aerial or well-developed tubers at the base, with stems that twine and climb any structure. Their leaves can be simple, alternate, or cordate, and some have lobes, as in *Dioscorea trifida* **[5]**.

Depending on the species, the stems may have spines. *D. rotundata* has rounded stems with thorns, while *D. alata* has winged stems without thorns **[5]**.

The flowers are small, clustered, and dioecious, meaning there are both male and female yam plants. Although males predominate, it is uncommon to see flowering in a commercial production field **[5]**.

How to differentiate yams?

Dioscorea cayenensis/rotundata have thorny, cylindrical stems and cordate leaves that may be opposite or alternate and are generally somewhat leathery and shiny on the upper surface **[5]**.

Dioscorea alata has angular stems with membranous, wavy wings that run the entire length of the stem. The leaves are opposite, with cordate to sagittate bases and small pseudostipules at the bases of the petioles. The leaves have a papery texture. Irregularly shaped aerial bulbils are sometimes produced in the leaf axils of this species, but these are used for seed and not harvested for human consumption.

Varieties of ***Dioscorea alata*** in the Caribbean have white flesh, although some purple-fleshed varieties popular in Asia, called Ube in the Philippines, may be of commercial interest.

D. cayenensis generally produces drier, more fibrous tubers, while those of ***D. alata*** tend to have less fiber and more mucilage when cut **[5]**.

Two subspecies of ***D. cayenensis*** exhibit variations in flesh color: ***D. cayenensis*** **subsp. *cayenensis*** generally has yellow-fleshed tubers, and ***D. cayenensis*** **subsp. *rotundata*** generally has white-fleshed tubers **[7]**.

How to differentiate the most common yams in Puerto Rico?

Dioscorea rotundata

"black guinea"
Round stems with thorns [6]

Dioscorea alata

"water yam"
Winged stems without thorns

Appearance of an edible commercial quality tuber

Common yam cultivars

In Puerto Rico, the most economically important and commercially produced species are *Dioscorea alata* and *Dioscorea rotundata* **[5]**.

The most consumed cultivars (cv.) of *D. alata*, known as water yams, are cv. Diamantes, cv. Florido, and cv. Binugas. These cultivars are the most susceptible to the fungus that causes anthracnose but are tolerant to seed rot caused by nematodes and the fungus *Penicillium* sp. **[7]**.

Within *D. rotundata*, known as white guinea yam, the most popular and commercially in-demand cultivars are cv. Black Guinea, cv. Habanero, and cv. Colombiano. In Puerto Rico, the Habanero and Colombiano cultivars are the most produced due to local demand **[7]**. Cv. Black Guinea is the only cultivar with a short dormancy period and can be planted at any time **[5, 7]**.

Why plant yams?

Advantages over other crops

Among Puerto Rico's roots and tubers, yams rank first in production and economic importance due to their profitability **[8]**.

Their underground tubers keep well for long periods after harvest and tolerate strong winds and hurricanes.

Within the Dioscorea genus, roughly 600 species are known; 12 are edible, and two—D. floribunda and D. composita—are used by the pharmaceutical industry for their high steroidal sapogenin content to make contraceptives, sex hormones, and cortisone **[2]**.

Here's why it stands out:

- Withstands sudden climate changes.
- Supports continuous food access and food security.
- Rich in nutritional and functional benefits.
- Low investment needed.
- A secure source of income.

Yam, a tropical crop

It originated in tropical rainforest regions with low radiation, so it adapted by climbing trees in search of sunlight **[2]**.

It is grown in warm climates with high relative humidity. It has adapted better than other crops to dry periods; however, to ensure good production, it must be irrigated at the beginning of its growth **[2]**.

IIn humid tropics such as Puerto Rico —where the growing season brings around 1,150 mm of rain and a two-to-four-month dry spell— yields can reach roughly 29–35 tons per hectare **[7]**.

The formation of underground tubers occurs when the days are shorter, which is why the harvest season is between November and January.

Nutritional value of yam g / 100 g dry weight

Nutrientes	Unidad	Valor/100g
Water	g	69.69
Calories	kcal	118
Proteins	g	1.53
Lipids	g	0.17
Carbohidrates	g	27.88
Fiber	g	4.1
Sugars	g	0.50
Calcium	mg	17
Iron	mg	0.54
Magnesium	mg	21
Phosphorus	mg	55
Potassium	mg	816
Sodium	mg	9
Zinc	mg	0.24
Vitamin C	mg	17.1
Thiamin	mg	0.112
Riboflavin	mg	0.032
Niacin	mg	0.552
Vitamin B-6	mg	0.293
Folate	mg	23
Vitamin A	IU	138
Vitamin E	mg	0.35

Source: Technological package for the production of yam 2024 **[7, 9, 10, 11, 12]**.

Nutritional value of yam

Nutrition Facts/Datos de Nutrición

1 servings per container / raciones por envase

Serving size / Tamaño por ración **1 cup/ taza (150g)**

Amount per serving / Cantidad por ración

Calories / Calorías **180**

	% Daily Value*/% Valor Diario*
Total Fat / Grasa Total 0g	**0%**
Saturated Fat / Grasa Saturada 0g	**0%**
Trans Fat / Grasa *Trans* 0g	
Cholesterol / Colesterol 0mg	**0%**
Sodium / Sodio 15mg	**1%**
Total Carbohydrate / Carbohidrato Total 42g	**15%**
Dietary Fiber / Fibra Dietética 6g	**21%**
Total Sugars / Azúcares Totales 1g	
Includes 0g Added Sugars / Incluye 0g Azúcares Añadidos	**0%**
Protein / Proteínas 2g	

Vitamin D / Vitamina D 0mcg 0%	• Calcium / Calcio 30mg 2%
Iron / Hierro 0.8mg 4%	• Potassium / Potasio 1220mg 25%

* The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

* El % de valor diario indica cuánto un nutriente en una porción de comida contribuye a una dieta diaria. 2,000 calorías al día se utiliza para el consejo general de la nutrición.

USDA. Department of Agricultural, Agricultural Research Service, Beltsville Human Nutrition Research Center. Food Data Central. https://fdc.nal.usda.gov/fdc-app.htm#/foof-details/169401/nutrient. Published 4/1/2019.

Functional and subsistence food

During the colonial era, yams were carried by Asian and African crews as ship provisions; their high vitamin C content also made them valuable against scurvy **[6]**. Yams suited fishing cultures that needed easy-to-get carbohydrates because they grow near coasts **[2]**. The tubers can also be stored for long periods.

Yams are a nutritious crop with high carbohydrate content, providing 100% of the energy and protein, 13% of the calcium, and 80% of the iron that an adult male needs each day **[9, 10, 11, 12]**.

Although often viewed as a subsistence crop, production has been rising and shows strong growth potential in Puerto Rico. Beyond its role as a staple food, there is opportunity in the pharmaceutical agroindustry for extracting derivatives used in the semisynthesis of steroid drugs **[12, 13]**.

It's easy to eat healthy

Enjoy yams for flavor and a smooth texture. They offer antimicrobial and diuretic support **[12]** and fiber that boosts energy and helps digestion **[12]**.

Their starch is a gluten-free energy source. Yams also bring antioxidants and allantoin, which promotes cell growth and has anticoagulant properties **[6, 12, 13]**.

Yams are rich in vitamins and minerals

In addition to protein, they contain vitamins C, E, and B vitamins, and minerals such as potassium, manganese, magnesium, copper, calcium, iron, and phosphorus.

The purple yam, known as "ube," is high in flavonoids, which have antimicrobial, anticancer, cardiotonic, and cholesterol- and sugar-lowering properties **[12]**.

Yam, a safe food source for diabetics

Yams have a low glycemic index because they provide complex carbohydrates and dietary fiber. The glycemic index measures how quickly foods affect blood sugar levels **[6, 12, 13]**. Their dietary fiber content benefits the digestive system, generating satiety **[13]**.

Yam cultivation

Yam reproduces asexually or vegetatively **[2, 7],** which means that the seed that comes out of a plant is genetically identical, or a clone of the original plant.

What we use for propagation is what we will harvest for consumption, so it is important to make a good propagation material selection.

Generally, pieces or cuttings of yam of 4 to 8 oz (113 to 227 g) that have a rind so it can sprout are used as seed. These cuts, when exposed, are more susceptible to attack by fungi, bacteria, and nematodes present in the soil **[7]**. For this reason, the ideal propagation material is a small, whole tuber without mechanical damage or disease, that comes from a healthy mother with high production.

A small, uncut tuber of 4 to 8 oz (113 to 227 g) resists drought better, and because it does not have wounds, it has a lower risk of getting sick **[7].**

Before planting

Soil needs to be deep, well-drained, and slightly acidic (pH 5.5–6.5) **[7]**. Use fallow land or follow beans, crotalaria, or cowpeas; skip fields that recently grew roots or tubers.

Form raised benches along the slope with loose soil, about knee-high, to guide straight tuber growth **[7]**.

Space benches around 4 feet apart and plants 1–1.5 feet apart. Train vines on guides or 5–6-foot poles so leaves stay off the soil and disease risk drops **[7]**.

Set up drip irrigation for dry periods **[7]**.

Start with healthy, high-yield propagation material and get a soil test before planting **[7]**.

For planting

The propagation material selected for planting should be uniform in weight, size, and of the same cultivar, for example, only black guinea or habanero to make the harvest more homogeneous.

Among all the roots and tubers, the yam is the only one that has a dormancy period. During this period, the harvested tuber that will be used as seed sleeps, waiting for the appropriate moment to germinate and grow. Before germinating or sprouting, the tuber enters this dormant period, which varies among species and cultivars and can last from 46 to 120 days **[7]**.

The Diamantes cultivar has the longest dormant period, approximately 124 days, and is planted from April to May. It is followed by the Colombiano cultivars, between 93 and 101 days, and the Habanero, at 84 days **[5, 7]**. These cultivars are generally planted from January to March. The Black Guinea cultivar, due to its shorter latency period of 46 to 50 days, can be planted all year round, so in order to avoid competition in the market with other cultivars, it is advisable to plant it between August and November **[5]**.

For planting

• Choose propagation material by size and cultivar, then disinfect it. Options include: a 1% sodium hypochlorite soak for 15 minutes; coating with agricultural or construction lime; or a registered product with both fungicidal and bactericidal action for yams **[7]**.

• If using yam cuttings, cut and disinfect them 1–2 days before planting. Use soil rich in organic matter and amend it to reduce plant-parasitic nematodes **[7]**.

• Plant disinfected cuttings or whole yams 1 to 1.5 feet apart and 4 to 6 inches deep. Place cuttings with the cut side up and the rind touching the soil.

• Prefer sprouted material so plants grow and mature more evenly **[7]**.

During the crop's lifecycle

First four months: the plant grows fast and strong. This is the time for careful weed control, even irrigation, and training vines around poles so leaves and branches don't touch the ground **[7]**.

Weed control can be manual or with herbicides registered for yam **[7]**. Apply with care to avoid damage. Hand weeding also helps loosen the soil.

Limiting diseases

Yam diseases can strike during growth and in storage.

Dioscorea rotundata types like Habanero, Colombian, and Black Guinea tend to suffer tuber damage from plant-parasitic nematodes and may develop leaf rust from *Goplana* spp **[7]**.

Dioscorea alata is more vulnerable in leaves and stems **[7]**.

Consistent, integrated management from propagation material selection to postharvest storage reduces risk and keeps plants healthy.

Leaf and stem diseases

The two most limiting diseases caused by fungi that affect leaves and stems are:

- **Candelilla or Anthracnose, caused by the fungus *Colletotrichum* spp.**, can occur at any stage of the crop and is more observed in *D. alata* cultivars than in *D. rotundata*. This disease presents as a severe burn on the leaves, which later affects the stems and eventually ends in complete defoliation of the plant **[5]**.

- **Rust, caused by the fungus *Goplana* spp.**, causes round yellow lesions on leaves and stems that become filled with an orange powder, which are the spores of the fungus. The spores are dispersed by wind, rain, irrigation, and the movement of people, animals and machinery. This fungus also causes defoliation and complete burning of the plant **[7]**.

Tuber diseases

The yam *Dioscorea rotundata* is the most produced in Puerto Rico due to its commercial value and strong growth **[5]**. The main limitation in commercial plantings is **Dry Rot caused by the nematodes *Pratylenchus coffeae* and *Scutellonema bradys*.**

Pratylechus coffeae predominates in Puerto Rico in the soil and in the yam tuber and is known as the root lesion nematode. In tubers, death of the skin and detachment of the bark can be observed, preventing their commercialization and consumption **[7].**

Integrated management practices to prevent the most limiting diseases [7]

- Do not use propagation material from farms with the disease.
- Do not plant or exchange infected propagation material.
- If you purchase propagation material or use it from affected farms, disinfect it with 1% sodium hypochlorite for 15 minutes.
- When dormancy breaks, the propagation material pieces should be treated with 1% sodium hypochlorite for 15 minutes.

Recipe to prepare 1% sodium hypochlorite (chlorine) solution: For 1 gallon of 1% solution add 0.19 gal (=719 ml = 24 ounces) of commercial 5.25% sodium hypochlorite (chlorine) in a bucket and add water until you have 1 gallon of solution.

Integrated management practices to prevent the most limiting diseases

- Disinfect the cutting instrument every time you cut the propagation material to avoid spreading diseases. Spores can remain in the soil and begin their infection process in the next crop.
- Store propagation material, disinfected in a 1% sodium hypochlorite solution for 15 minutes. Let it dry for 24 hours before storing **[7].**
- Seal stored broken material with lime to avoid fungal contamination **[7]**.
- Plant in well-drained soils where yams have not been planted previously to reduce the risk of disease.
- Use stakes or poles to promote crop aeration, reduce leaf wetness, and avoid contact with pathogens in the soil.
- Establish new crops away from crops with a high incidence of these diseases.
- Restrict access to infected crops **[7]**.
- Use tools exclusively for the farm to avoid spreading existing diseases or introducing diseases from other farms.
- Remove dead plants and dispose of them outside the planting area.

How to fertilize?

The results of the soil test will help us determine the amount and type of fertilizer to apply.
At planting, a complete fertilizer (12-24-12) should be applied two inches below the seed. Fertilizer should be applied two months later with a 15-5-10-3% EM (minor elements) formulation, and five months later with a 10-5-20-3% EM formulation **[7]**.
1.5 ounces per plant should be applied each time. Organic amendments can also be used, depending on the results of the soil test.

Harvest

Harvesting can begin as early as 8 months after planting **[7]**. Under optimal conditions, yields are about 28 to 34 tons per hectare. Harvesting is generally done by hand, but can also be done on flat land using an adapted potato harvester and excavator. Keep the soil moist during harvest to reduce skin loss and tuber breakage **[7]**.

Storage

After harvest, select tubers either for propagation or commercial sale. Handle carefully to prevent injury in the field and during transport.
Treat seed tubers in a 1% sodium hypochlorite bath for 15 minutes, then dry well before storage **[7]**.

If tubers are split or damaged, they should be treated with lime to prevent rot during storage **[7]**.

They can be stored for 2 to 3 months after harvest in a covered, ventilated area with low humidity. They can be hung in large hollow sacks in a warehouse or arranged on pallets under shade, preventing them from clumping and rotting. If they clump together, they should be checked frequently and moved to prevent moisture from rotting them. Direct contact with the soil should be avoided. **[7]**

Is it economically profitable to grow yams? You decide.

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Yam cultivation is a leading income source among root and tuber crops. Consumers prefer it, and at the market level it offers strong value for farmers. Local demand far outpaces supply—we meet only about 20%. Production has slipped in recent years due to pests, diseases, and weather shocks. Scientists at the College of Agricultural Sciences, University of Puerto Rico, are testing solutions from propagation material to harvest and providing farmer training to improve propagation quality and tuber size. According to the Department of Agriculture, 7,510 tons were produced in 2021—an increase of 2,934 tons from 2019—showing a solid rebound after Hurricane Maria. With training and good integrated management, farmers can raise yields and win back the local market.

Yam recipes

Yam Fritters

Milagros Santiago de Santana, ECFC, SEA

Servings per preparation: 16 fritters
Serving size: 1 fritter
Preparation time: 30-40 minutes

Ingredients:

- 1 lb of raw shredded yams
- 3 tsp. of wheat flour
- 1/2 tsp. of salt
- 1 tsp of anisette (anise liquor)
- Deep frying oil

Step by step instructions:

- Clean and disinfect food preparation surfaces. Wash your hands with soap and water, rubbing together for 20 seconds, then rinse and dry.
- Wash the yam and remove the skin with a clean peeler or knife. Rinse the peeled yam.
- Grate or grate the yam to create a paste.
- Add the other ingredients to the yam paste and mix well.

- Chill the mixture for an hour in the refrigerator to harden slightly.
- Using a metal spoon, pour the mixture into a sufficient amount of very hot oil (over high heat).
- Fry until golden brown.
- Drain excess oil before serving.
- Serve in syrup or sprinkle with powdered sugar.

Flowering yam spiders*


Picture by G. Soto-Torres, 2024

Servings per preparation: 17 spiders
Serving size: 1 unit
Preparation time: 40-60 minutes

Ingredients:

- 18 oz (500 g) of flowering yam
- 2 tbsp of fresh sofrito
- ½ tsp of ground turmeric
- A pinch of black pepper (to emphasize the turmeric)
- Salt to taste
- Deep frying oil

Step by step instructions:

- Clean and disinfect food preparation surfaces. Wash your hands with soap and water, rubbing together for 20 seconds, rinse, and dry.
- Wash the yam and remove the skin with a clean peeler or knife. Rinse the peeled yam.
- Grate or grate the yam using the finest part of a grater.
- Add the turmeric and pepper to the yam paste, mix well, then add the sofrito and salt to taste.
- Let the paste rest for at least 15 minutes in the refrigerator.
- In a deep fryer, set the oil temperature to 150°F (66°C) and adjust the heat to medium-low.
- Using a fork, cut into pieces approximately two inches long.
- Fry on both sides until evenly browned.
- Enjoy immediately, alone or with your favorite sauce, as a side dish for soups, or as a substitute for French fries.

***Giovannie Soto-Torres (2004) Flowering yam recipe revised by Prof. Fabiola Rodríguez, Agricultural Extension Service, College of Agricultural Sciences, UPR Mayagüez Campus.**

Purple yam or ube bars

www.kawalingpinoy.com

Servings per preparation: 50 bars
Serving size: 1 bar
Preparation time: 25 minutes

Ingredients:

- 1 lb purple yam (16 oz)
- 1 can of condensed milk
- 1 cup powdered milk
- Zest of 1 lemon

Step by step instructions:

- Clean and disinfect food preparation surfaces. Wash your hands with soap and water, rubbing together for 20 seconds, then rinse and dry.
- Wash the yam and remove the skin with a clean peeler or knife. Rinse the peeled yam.
- Cook until tender, piercing it with a fork until the fork can penetrate the paste.
- Mash the cooked yam and add the condensed milk, mixing well.
- Cook over medium-low heat for 8 to 10 minutes with the condensed milk and mix until thickened.
- Add the powdered milk and lemon zest and beat until a smooth ball of dough forms in the pot.
- Remove from heat and let cool.
- Use a spoon to break up the mixture and shape it into long, stick-like pieces about an inch long.
- Roll the stick in sugar or sprinkle with powdered sugar.

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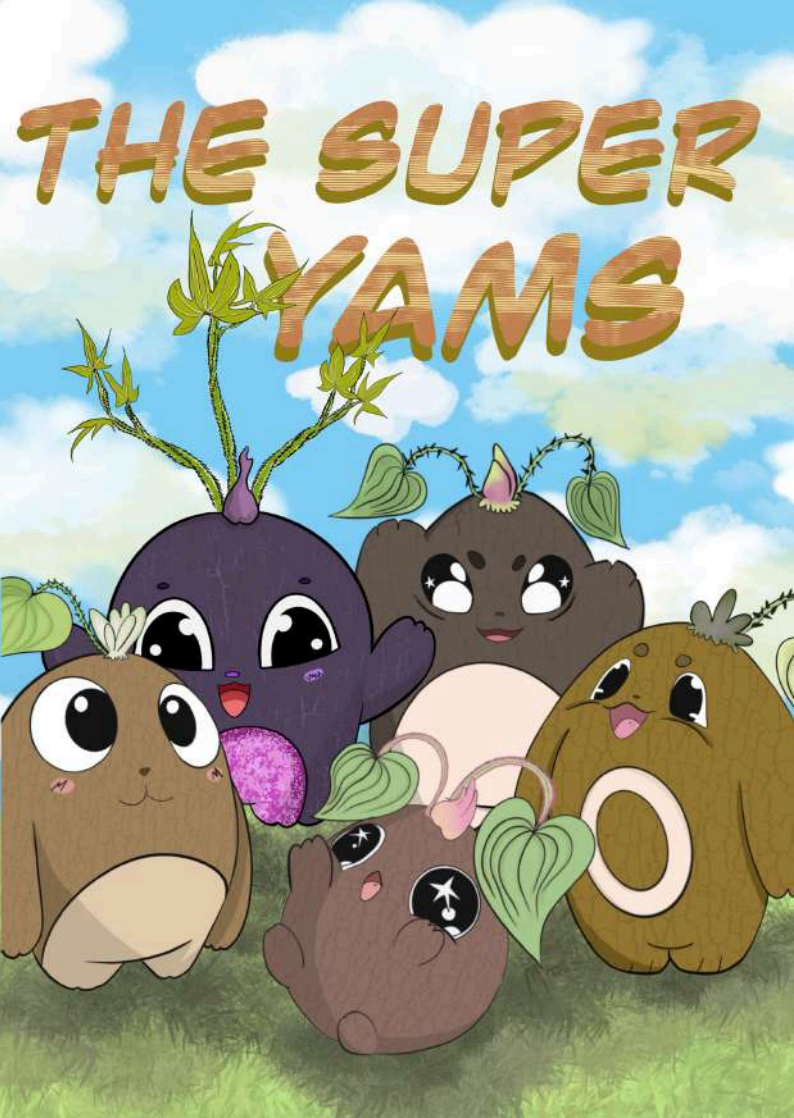
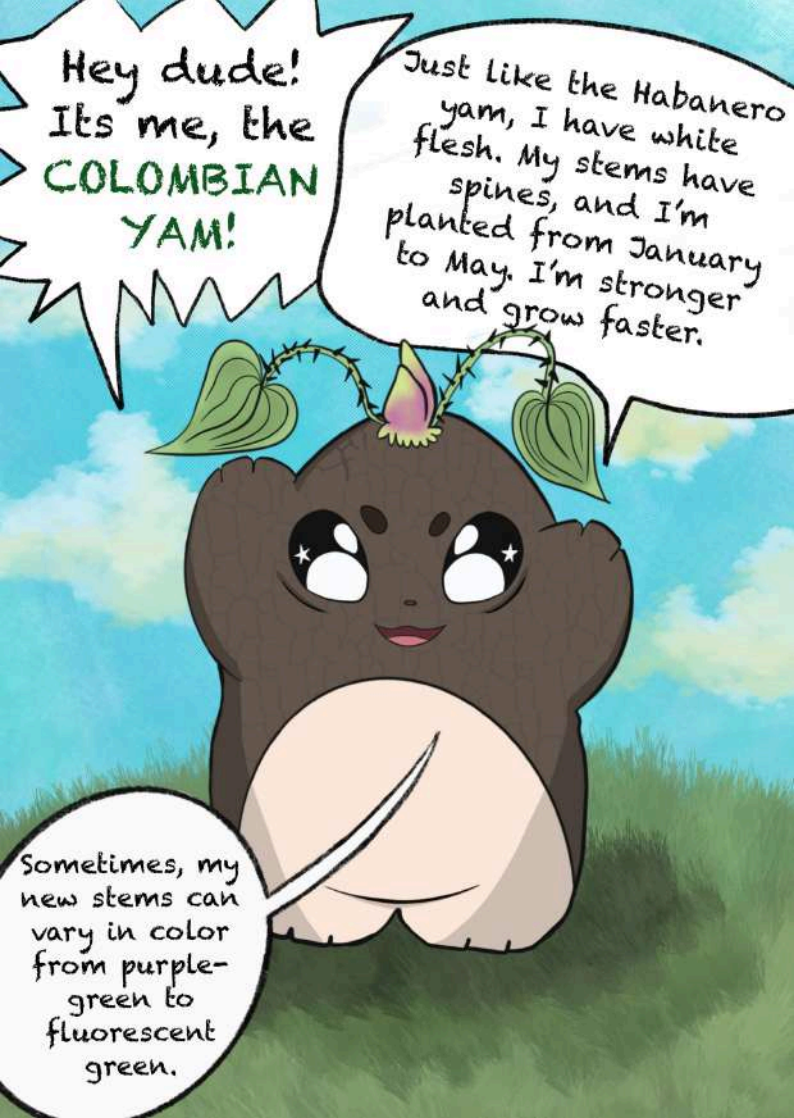

THE SUPER
YAMS

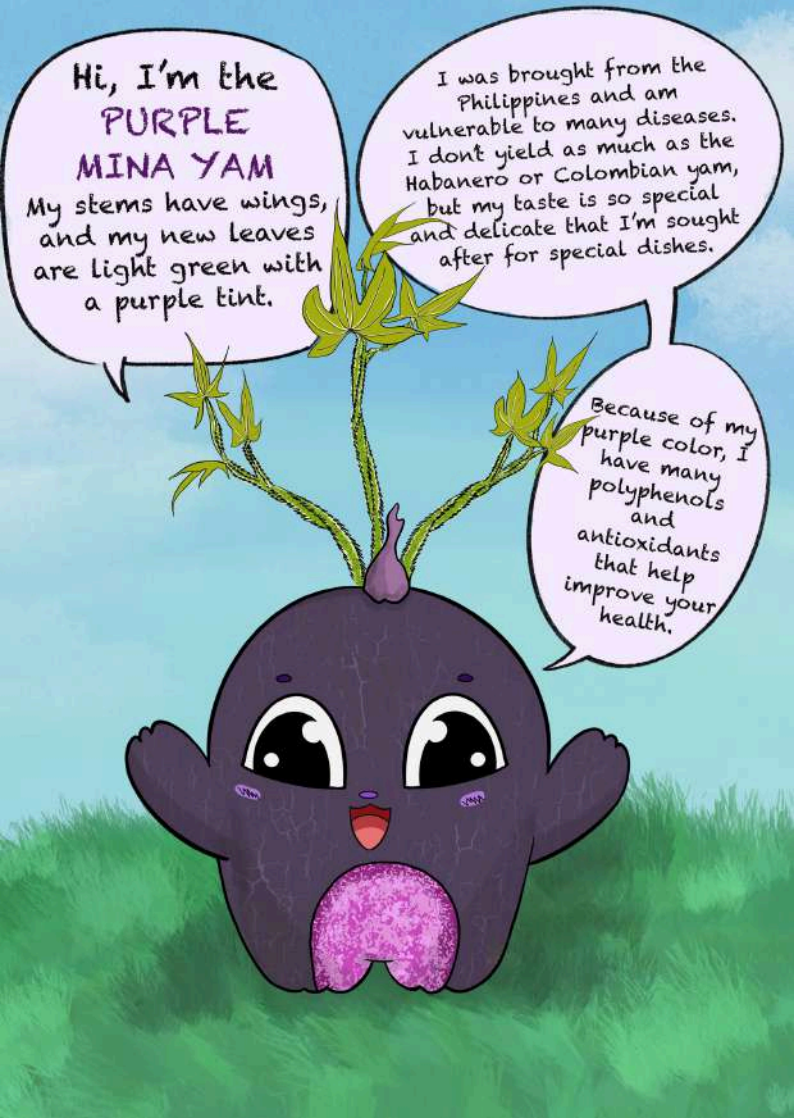

Welcome to my little paradise
MY YAM FARM!
Here I plant different varieties of yam.
Each yam crop is selected based on my clients preferences.
And each of my crops has its own superhero protector!.
Let me introduce you to... THE SUPER YAMS!

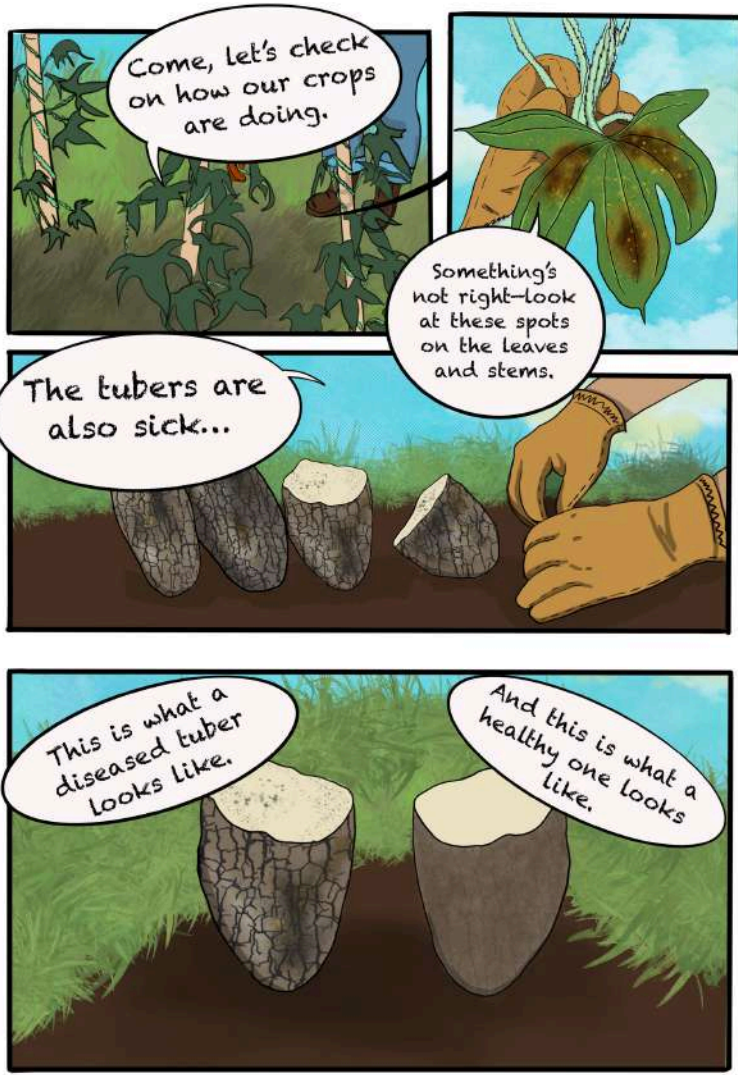

Hello, I'm the
BLACK GUINEA YAM!
You can plant me all year round. I'm white inside and have a great taste.
My stems are round with spines, and my new leaves are purple.
A fun fact about me is that I'm the only one that produces aerial tubers.


Hey dude! Its me, the COLOMBIAN YAM!
Just like the Habanero yam, I have white flesh. My stems have spines, and I'm planted from January to May. I'm stronger and grow faster.
Sometimes, my new stems can vary in color from purple-green to fluorescent green.


I'm the DIAMANTES YAM.
My stems have little wings, and I'm not spiny. My new leaves are light green and a bit fuzzy.
My underground tubers are white and round.


I'm the HABANERO YAM.
I have white flesh, and my underground tuber tends to be long and large.
My stems have spines, and I'm planted from January to May.


Hi, I'm the PURPLE MINA YAM
My stems have wings, and my new leaves are light green with a purple tint.
I was brought from the Philippines and am vulnerable to many diseases. I dont yield as much as the Habanero or Colombian yam, but my taste is so special and delicate that I'm sought after for special dishes.
Because of my purple color, I have many polyphenols and antioxidants that help improve your health.


Come, let's check on how our crops are doing.
Something's not right—look at these spots on the leaves and stems.
The tubers are also sick...
This is what a diseased tuber looks like.
And this is what a healthy one looks like.


I have no idea what's going on with my crops... Let's call Juana Veggie!
Hi Juana! We need help with my crop.
I'm here to help!
Plant Disease Diagnostic Clinic - UPRM
Send me samples and I'll investigate.


ONE DAY LATER...
Here we have some leaves, a bit of soil, and a microscope slide.
Cup with soil
Diseased leaf with fungus
Microscope slide
Let's see what's going on at the microscopic level.


I have the results.
!!
I looked at the orange powder on the leaves and found it was caused by a fungus known as rust.
I also found nematodes in the soil, which damaged the tubers.


Juana, thank you so much for your help!
Always here to serve you. It's very important that you follow the recommendations I sent by email.
Well friends... now what?


According to the recommendations, it's very important to maintain healthy soil, free of nematodes.
Also, it's essential to clean the seeds before planting.
I didn't know that!
From now on, I'll clean my seeds
and keep the soil healthy.


Let's start again! We choose seeds from healthy plants.
We pick the best by weight and size.
Then we clean them by soaking them in a 1% sodium hypochlorite solution. After 15 minutes, we rinse the seeds in water and let them dry.
And they're ready for planting!


In this plot I previously planted beans and crotalaria.
Those crops helped fertilize the soil.


This way we'll get rid of the nematodes.
Let's see how it goes with this good preparation and new seeds.


NOVEMBER
MARCH
From March to November...
Eight months later... let's check the results.
WOW!


We did it!
It was worth following the recommendations.


Painting
time

BLACK GUINEA YAM

HABANERO YAM

COLOMBIAN YAM

PURPLE MINA YAM

Stickers

Credits

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