It Starts & Ends with Huli

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Maui Lehua, the main commercial Hawaiian taro variety.

Taro production is unique in many respects from other vegetable crops, but similar to other indigenous crop systems where the main propagule is a piece of the mother plant. Other examples include sweet potato, breadfruit, cassava, and banana.

It all starts with ***huli***, the centerpiece of the plant with all leaves removed and a thin piece of the corm retained for rooting. Taro can also be propagated by *oha* or side shoots, especially corms too small to be sold. Planted in furrows and lightly covered, this system will produce numerous huli that can be utilized at any time as compared to waiting for a field to mature before removing planting material.

The shortage of planting material is a major limiting factor for new farmers, and especially limits the expansion of taro in new production areas of the state. A system of crop production utilizing part of mother plant also runs the high risk of perpetuating diseases from previous crops, and also transferring insects and nematodes to new plantings.

Taro cultural management strategies start with clean huli, which can give plants a good start. Good soil health important for all crop systems, but is especially important for taro where a crop cycle can run from 8 to 18 months.

A soil sample gives you a partial report card of macronutrient status, especially pH or soil acidity. A proper pH of +/- 6 assures that soil Phosphorus is accessible to the plant, and that manganese and aluminum are not hyper-available or at toxic levels. Potassium, Calcium, and Magnesium are should also be available in adequate amounts.

Having a consistent supply of huli by creating a huli bank, planting small huli and oha in a furrow assures a constant supply of huli to plant at any time.

Crop rotation, fallow, and soil building are critical to the long-term productivity of your farm. The use of cover crops and green manures are important in breaking taro disease cycles, building organic matter.

The use of mulch and compost will also stimulate microbial growth, release nutrients and precious nitrogen, and can keep microbes in balance. Soil health improvement must be ongoing. With this said, we usually compromise in our farming system due to time or money or both, and this is when we create problems.

There's no doubt the ancient Hawaiians understood mulching in upland systems, probably the precursor to lo'i taro systems, and practiced nutrient recycling in polyculture systems integrating fish and taro or *loko i'a kalo*.

Banana production systems have evolved to the production of micro-propagated clones grown in-vitro or in sterile flasks with artificial nutrient-infused agar media and transferred to trays grown in greenhouses or shade houses before transplanting to the field.

This assures planting material is disease-free and gives clones a good start for a crop that's very susceptible to root-borne diseases and pests. A prime example is Cavendish banana production in Taiwan where it's grown in an annual crop, replanted each year utilizing disease-resistant micro-propagated planting material.

Taiwan Banana Research Institute. Cavendish banana clones are grown in sterile agar media then transplanted into the nursery before transferring to the field. Weed barriers are used in high density plantings. Banana is grown as an annual and replanted each year.

The shortage of huli is a major challenge for new farmers, and limits the expansion of taro in new production areas of the state.

The major market for Taiwan banana is Japan. The Japanese are very particular about quality, and are willing to pay top dollar for it. For example, a new disease-resistant banana cultivar was test-marketed but it was an inch shorter than the established banana cultivar, so it was rejected by Japanese markets.

Crop systems utilizing disease-free micro-stock assures that disease-free plants are entering the farm, and we'll probably see this same system evolving in many indigenous systems in Hawaii, including taro production, as diseases introduced on sexually propagated material increases. Breadfruit production has taken a similar trajectory since it's difficult to propagate large volumes from root cuttings.

In the meantime, taro disease control protocol for starts by collecting clean disease-free huli, lots of huli, and it's probably better if you collected them from your own farm and not from others. In a one-acre plot with huli planted 2 feet in rows and 4 feet between rows or 8 square feet per huli, 5445 huli are required per acre. If *huli* are removed from a diseased field, the chances are high that you may be transferring diseases into your new fields and possibly planting weakened *huli* as well.

Preventing diseases from entering your farming system is a better strategy than trying to control a disease once it gets into each field and is spreading like wildfire. Once upon a time, we used to call this aspect of cultural management ***sanitation***, but today we use some fancy words, like Biosecurity, to describe steps utilized in keeping invasive pests from entering your farm.

In most situations, it will be the farmer or someone you allow to bring a problem onto your farm, such as a cutting or seedling. Or it can even blow in from another farm or another part of the world, for that matter. Once on your farm, another strategy of intervention needs to be developed and employed to control your new pest.

Although there are probably less than 70 Hawaiian taro varieties today, at one time there were over 300 varieties probably created from a handful of varieties introduced by Polynesian voyagers.

Taro diseases can affect both wetland and upland systems, and although there's a big difference between planting

in water and planting in soil, many of the cultural management strategies are similar.

Mala or upland taro production systems are different from wetland or lo'i growing. Dependable irrigation systems delivering water to each plant on a regular basis is critical to the survival of the crop.

Taro production in Hawaii has evolved to the point where we're probably growing taro where it's never been grown before due to the movement of water systems developed for sugar and pineapple production.

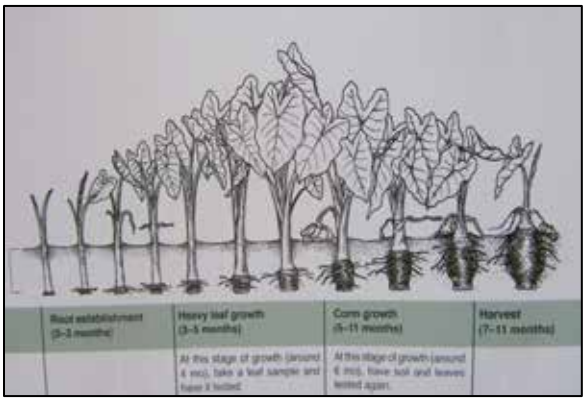
It's probably easier to control moisture in upland taro, especially when you're planting in an arid area employing drip irrigation than in a moist valley bottom with daily rains. In one instance, you have a hand on the trigger in determining how much water is applied to your field. If it starts raining and doesn't stop for a week, then all bets are off. We're in Hawaii and that's the nature of the beast, so learning to live with and adjusting to the elements so it works to your advantage is the key.

Many diseases prefer moist conditions leading to its spread, and the worse ones today are two strains of *Phytophthora* including leaf blight and pocket rot, and also other diseases favoring moist lowland conditions including Southern Blight or *Sclerotium rolfsii* and Corm Rot or *Pythium spp.*

Taking cues from an extension taro plant disease publication by Janice Uchida, James Silva, and Chris Kadooka entitled '*Improvements in Taro Culture and Reduction in Disease Levels'*, I've expanded on their recommended practices.

Their practices take advantage of the biology of the plant, the pathogen's growth requirements, and the natural ecosystem in the taro field that can be applied to both a *mala* or upland system and a *lo'i* or wetland system.

Diseased fields will produce more diseased *huli*, clear and simple. If disease enters fields early in the growth cycle of the plant, these will be the most problematic. Fields with low levels of leaf diseases at least a month or two before harvest will generally produce healthy huli that are ideal for planting.



An upland taro production cycle can run anywhere from 8 to 14 months, and a lot can go wrong in that period of time.

Some corm diseases are related to nutritional imbalances. One disease of unknown origin and possibly related to

nutrition, disease or both is a malady called ‘guava seed’ where small dots of hardened necrotic or blackened tissue is found enclosed in the corm. This malady showed up in a field that was low in a few macronutrients, including Calcium and Phosphorus.

In upland systems, root-knot nematodes Meloidegyne incognita and javanica are easily spread from hul into new fieldsi. Soaking prepared huli in a 10% Clorox solution for a few minutes is a practice used by some farmers.

When huli is in short supply, farmers will plant whatever they can get their hands on with no quality control system in place. Inspecting numerous huli for rots and diseases is a major chore and requires attention to detail.

If workers aren’t diligent when trimming huli, it’s easy to introduce diseases to a new planting. Refining your system of trimming huli helps to identify and cut out diseased areas or have the discipline to discard huli that’s not in good condition or with too much disease to trim.

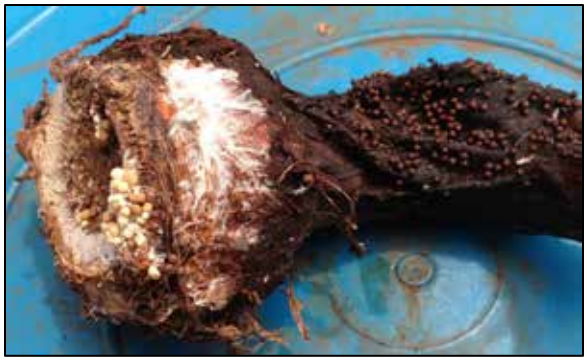
Sometimes diseases are not easy to detect and often form under the corm skin, so some farmers have modified their trimming techniques especially when huli are coming out of diseased fields.

The larger the huli, the more time is required to inspect each huli and determine if diseases are present. This vital step in the production system cannot be overemphasized, and farm workers must be trained and disciplined to select the best huli and remove diseased material.

After planting, fields should be irrigated sparingly until roots emerge. This is an important first step in establishing the plant root system. Planting a few extra huli so they can be removed and inspected to monitor root growth is important in determining when to increase water.

Over-irrigating early on can promote diseases such as Southern Blight and Pythium root rot, and are common especially when planting in rainy months when you don’t have a good handle over how much water is applied to the crop.

The Moi taros have a reputation as a resilient taro that does well in less than ideal growing conditions and is favored for growers on windward Oahu valleys and also on windward Maui, including Keanae, and can be stored in fields longer than most Hawaiian varieties.



Southern Blight Sclerotium rolfsii, including the many stages of the disease. White threads or hyphae will penetrate corm surface and feed on it. Sclerotia resemble mustard seed and are fruiting bodies in which the disease can perpetuate itself.

Tighter monitoring of irrigation frequency and duration can help to mitigate diseases and create conditions that are not conducive to these diseases.

Southern Blight appears to favor wet weather with poor air circulation, including hot, humid weather during rainy summers, and is especially a problem in warm lowland areas of the tropics. Southern Blight can be a problem near harvest and also while in storage and transport.

Southern Blight causes a pink rot with lots of thread-like growth called *hyphae* on the corm surface that can start as a bleaching or skin discoloring, and is also a post-harvest issue. Some taro varieties are more susceptible to Southern Blight than others. The fungus can also enter through wounds.

Under conditions ideal for the disease, all stages of the disease can be seen, including sclerotia, and spores resembling mustard seed. This disease perpetuates itself in disease pieces, and thousands of spores are left in the field to consume all taro material, so it's recommended to remove diseased materials, and also rest or rotate fields before planting taro in the same field.

High humidity is needed for infection so irrigation schedules near harvest must be fine-tuned by walking through the fields and determining moisture levels through soil-ball tests. The closer to harvest, the more diligence is required in monitoring moisture levels and field circulation.

An important strategy is to prepare a new field before harvesting to assure the huli will not be sitting around wasting away. Huli is valuable, and is not easily accessible unless you grow enough for yourself; it cannot be purchased in a store, and without huli you cannot plant taro. Storing huli for too long is not a recommended practice. Ideally, huli should be planted the day after they're harvested, just enough time for the cut surface to dry and callous a bit.

Planting huli in small furrows helps to focus drip irrigation and rain near the roots in dryland areas such as Hoolehua, Molokai.

Huli should be kept dry in a cool, dry area with no direct sunlight until the next day. Laundry baskets are good for

holding huli since they encourage air circulation. For smaller upland operations, huli can also be graded by size to facilitate planting different sizes in different rows, and harvesting over a longer period of time, harvesting the larger ones first when planting different sizes at the same time.

A close spacing of 2 feet in-row by 3 feet between-row will require 7260 huli per acre, and can create disease problems without good air circulation. Planting in the wind in Hoolehua.

Every day the huli remains unplanted, it uses up more of its stored food and water reserves to survive. After a week, the huli is very weak and will require a longer time to produce roots and a vigorous plant, and it may not produce roots for many weeks. This plant is starting its new life in the worst possible condition, will struggle, and be susceptible to all kinds of problems.

Some growers will place unused huli in water to store them until the field is ready. This allows huli to begin growing roots, but roots are usually damaged at planting especially in upland production systems, opening wounds for disease to enter. Ideally, this is not a recommended practice especially since it weakens huli and exposes them to diseases.

In the South Pacific where Pythium Corm Rot is a major problem, it was recommended that huli be held for a week before planting to discard huli showing corm rot symptoms. In Hawaii, corm rot can run as high as 100%, but this disease should be approached from a nutritional standpoint in addressing Calcium deficiency first, followed by sound cultural management practices.

Pythium Corm Rot is also implicated with Calcium deficiency. In 1919, a visit by an agriculturalist to Molokai commented that "Other experiments made by growers of taro in Halawa Valley Molokai gave strong indications that taro corm rot could be practically controlled by drying and plowing the patches and by applying either lime or coral sand some time before they are replanted to taro."

A runner-type hybrid with potential for leaf production in subsistence gardening systems. The purple leaf cast is an antioxidant called anthocyanin, a class of flavonoids.

Taro Leaf Blight Phytophthora colocasiae is the most destructive disease of taro and favors extended moist periods with poor air circulation.

Leaf blight is the most destructive disease affecting both yield and taro quality in both production systems. Originally classified as a fungus, it's more closely related to algae and will thrive and proliferate in wet conditions. The lack of circulation combined with cool wet conditions can promote the spread of this disease, and other foliar diseases, but none are as destructive as leaf blight.

Field layout, including plant spacing and orientation to prevailing winds can help to mitigate diseases by improving air circulation. In many upland systems, leaf blight has even been a problem even during summer months when extended periods of rain and cool conditions prevail. Poor circulation can also create a haven for insects and arthropods to thrive, including aphids, mites, and the taro leafhopper.

Nutritional status plays an important part in taro susceptibility to leaf blight. Taking a soil sample a few months before planting will allow for early adjustments in nutrition, including pH and proper proportions of key nutrients.

A proper Calcium-Nitrogen balance is critical in keeping leaves healthy and robust. Low Calcium will create thin cell walls and plants will be more susceptible to cell wall breakage or bursting, opening leaves to infection by organisms. This balance can be upset by applying too much nitrogen at once. Applying concentrated nitrogen fertilizer such as Urea or Ammoniun sulfate can result in rapid leaf growth resulting in thin cell walls that easily rupture, making leaves more susceptible to infection.

Recommended Nitrogen levels for upland taro production are around 300 pounds per acre, but nitrogen levels up to 600 pounds per acre can increase yields. However, higher nitrogen levels can predispose plants to more leaf blight.

Taro Leaf Blight can travel like wildfire under ideal conditions and devastate large fields.

Utilizing constant feed systems to deliver nitrogen or other nutrients or

microbes over an extended period of time or utilizing slow release or organic sources of nitrogen can minimize the problem.

Again, sound cultural practices to allow for adequate breakdown of crop residues after harvesting, developing a crop rotation strategy, adding cover crops and green manures as part of a crop rotation system, and continuously enhancing the production of organic matter encourages the proliferation of microbes and helps to add diversity to the soil and discourage one microbe from dominating the rest.

There are many other challenges in upland taro production that can be discussed such as insects, arthropods, more diseases, and nematodes, but the key is to grow a healthy plant starting with healthy huli so plants will have a good start in life.

Harvesting also involves selecting the best huli for the next crop. Again, strong disease-free huli produces healthy plants that will have a good start in life!

Reaching the harvest without a lot of major challenges requires diligence, including walking the fields to nip problems in the bud. Eleele makoko at harvest.

Growing high quality taro takes patience, diligence, and vigilance to maintain healthy plants. Pa'akala, a hybrid between Maui Lehua and Ngeruuch, a Palauan cultivar with high tolerance to Taro Leaf Blight.

Simple Innovations

It gets really hot and humidity in Taiwan, almost unbearable, and can create sunburn on ripening fruit. At a farm in Kaohsiung in Southern Taiwan known for very high quality pineapples, this farmer found an innovative solution. He bought reject caps from a cap manufacturer and placed them over the crown to prevent sunburn. Sweet stuff!

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Well, that's it for this quarter. Summer is upon us and we can only hope for more

rain and trade winds to keep us cool, but we're really living at the whim of our vast surroundings. Heat and clashes with cool air create big wind storms, a euphemism for hurricanes and is something we don't need this summer.

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