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WHY SAVING HAWAII'S TARO MEANS LOSING HAWAIIAN TARO

By

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Environmental and Natural Resource Journalism

Why Saving Hawaii's Taro Means Losing Hawaiian Taro

Chairperson: Jule Banville

Abstract Content:

This is a story about tradition versus science played out in the taro fields of Hawaii. The most culturally significant plant in Hawaii is at high risk for disease and potential ~~ly~~ extinction. Scientist Mike Melzer wants to make Hawaiian taro healthier by removing viruses from the plants in the hope that the virus-free taro will be able to withstand increasing virus invasions. Melzer's vision is to sow all Hawaii's taro fields with his "clean" plants. But to taro farmers like Chance Tom, Melzer's science is destroying the most important thing about taro: the plant's symbolic and physical connection to Hawaiian ancestors. Though Melzer hasn't changed the genetics to create virus-free plants, his vision asks farmers to get rid of their infected plants in favor of virus-free ones. But the infected plants are the very plants handed down to farmers for generations. Melzer is worried that a particular virus called Alomae-Bobone--which destroyed the Solomon Islands' taro industry in the 1990s—will arrive in Hawaii and kill all the Hawaiian taro. But Tom, and others like him, say the true tragedy wouldn't be the death of Hawaiian taro by some disease, but the systematic wiping out of their connection to this plant. In saving Hawaii's taro, something will always be lost.

Why Saving Hawaii's Taro Means Losing Hawaiian Taro By Breana Milldrum

Roughly 20 miles from the screeches of city buses and Honolulu's high rises, Chance Tom is surrounded by green — ti leaves, banana trees, coconut trees, breadfruit trees, grasses and meticulously manicured rows of wetland taro plants. On his taro farm, Tom sheds his shoes and walks around barefoot, the damp soil bubbling espresso-colored liquid between his toes. He crouches, cupping water diverted from the Waiahole stream to flood his taro patches, and splashes his face, takes a deep breath and does it again. The land smells wet and alive.

On the flood plain of Waiahole Valley on the northeast side of the Island of Oahu, Tom farms about six acres of taro on land he leases from the state. He lifts a 4-foot-square metal tray stacked with 50 chartreuse and deep purple stalks from the back of his Toyota pickup. These stalks are the growing material Tom will use to finish planting one of his nine flooded taro fields. He lifts each stalk from the tray, assessing its weight and rigidity.

“You see this one,” Tom says pointing to the base of a limp stalk. “I never cut enough, so it probably won't grow.” Taking a pocket knife and gently holding the stalk, he surgically removes the excess sliver of old root at the base, hoping he leaves the right amount so the plant can regrow. “Maybe it still has chance.”

Perhaps if this were another farmer farming another crop, the weakened plant material would be thrown away. But farming taro is unlike farming other crops because for taro farmers like Tom, throwing away stalks is like throwing away family, an ancestry, a lifeline to the past.

Tom has been growing the very same propagated taro plants, given to him by another longtime farmer, from the day he started farming in Waiahole nearly 10 years ago. Each stalk has been selected over hundreds of years for the quality of its corm—a potato-like bulb that grows in the fine, silty mud of the field—which farmers sell.

The genetic combination of any of Tom's plants could be hundreds of years old and because commercial taro is rarely allowed to go to seed, the gene pool of Hawaiian taro varieties is quite small. As is the case with most plant and animal species with limited genetic diversity, Hawaiian taro is especially susceptible to diseases. Leaf blight, corm rot and, though not seen in Hawaii yet, the very deadly Alomae-Bobone virus are all threats to a crop that has huge cultural significance here.

Growing taro is labor-intensive. It's a finicky crop. A farmer must have access to lots of clean, fresh, continuously flowing water. Too little water and the plant will dry out and too much will cause the corm to rot. Weeds are constantly infiltrating the field, as are apple snails that feast on the corm. Farmers have to hand-weed and hand-pluck the snails from the field, since the use of pesticides would contaminate the water.

So why do it? Poi, for one reason. The often purplish paste is a staple for many Hawaiian families and is a must-have item for tourists to try at a luau. But it's not just about poi. In fact, consumption of taro has declined by nearly 50 percent according to the Hawaii Agricultural Statistics Service. Still, farmers including Tom persist because growing taro isn't just about giving visitors something exotic to eat, it's a way to stay connected with a history, a culture and a way of life.

According to Hawaiian legend, the taro plant is considered the eldest brother of the Hawaiian people. Haloa, as he was called, was the son of Gods, born prematurely. He died shortly after birth and, in death, took the form of a taro plant. Haloa's younger brother was told by their father to always watch over and protect his older brother. In turn, Haloa would always nourish his brother and his descendants. The reverence to that direct link to ancestors persists, felt by both farmers and the Hawaii people.

Taro's not unique to Hawaii. It's cultivated in many parts of the world. But the first Hawaiians did breed and select for particular varieties that have since become utterly singular to Hawaii. There are about 70 varieties of Hawaiian taro cultivated and preserved through the saving of stalks, each a thread to the past, each stalk, Haloa.

According to the Hawaii Agricultural Statistics Service, as of last year farmers harvested 340 acres of taro across the state. That's a small percentage of Hawaii's agriculture compared to sugar cane which comes in at nearly 19,000 harvested acres and coffee at nearly 7,000 acres.

Hawaii is changing; cities are growing and farmland is shrinking. Water is either too scarce or too plentiful and new biological invasions—weeds, fungi, viruses—are arriving in the islands faster than ever before. Taro is a traditional crop, farmed the old fashioned way, and some believe it's precisely this dogmatic adherence to tradition that could put this fabled crop at risk of extinction.

Mike Melzer, a plant pathologist at the University of Hawaii has been working since 2014 to “clean” popular commercial varieties of taro in the hope of ridding the crop of economically and anatomically debilitating diseases.

“I think this research will provide valuable insight into taro. When you think about the importance of taro in Hawaii, it's a no-brainer,” Melzer says from his lab in Oahu.

Melzer, a member of the National Clean Plant Network, which operates under the U.S. Department of Agriculture, believes that by creating and distributing virus-free taro to farmers, his “clean taro” could slow the spread of taro's most damaging diseases. While work on genetic modification of Hawaiian taro is well-worn territory for scientists — and marginally abhorred — Melzer's stripped down approach is unlike any other research that's come before. Rather than compounding taro varieties through either cross-breeding or gene-insertion, Melzer is “purifying” the taro by removing all existing diseases.

It's important because Hawaiian taro is vegetatively propagated: Whatever viruses that stalk has will perpetuate as long as that stalk is planted. Given the nature of taro farming in Hawaii, that could mean infected stalks could not only persist for years and years, but could also be spread from farmer to farmer in the friendly practice of plant exchanges.

Melzer is growing hundreds of disease-free taro plants in tissue culture in his lab. Surrounded by glass beakers, syringes, plastic bottles and tubes, scales and wires, he begins the meticulous task of harvesting disease free taro cells. With an eye pressed to the microscope and a steady hand above a single-cell thick slice of taro, he plucks out the meristematic cells of the plant. Only these cells will do, as they not only retain the ability to develop into any and every type of cell needed to make up a taro plant, they are the only cells inherently free of diseases. That's because they're dividing so quickly that even if the rest of the plant has a disease, that disease cannot move fast enough to overtake all the new meristematic cells forming. It's at this point that these untainted cells, like the ungobbled marbles in a game of Hungry, Hungry Hippos, are plucked by Melzer's hand and spared from the reach of disease.

In a completely sterile environment, the cells are grown in petri dishes, registering as undifferentiated, bitty specks of color. When the plants grow taller, they're put in tubes. They look like mini versions of the adult plants, complete with dime-sized heart shaped leaves. On these little leaves, Melzer hangs his hopes for healthier Hawaiian taro, taro he hopes will be able to withstand whatever biological invasions may come.

But there's a big except: Infected taro plants have been harvested for hundreds of years and the plants have not shown dramatic die-off. So why worry now? Melzer says just because a devastating disease hasn't hit yet doesn't mean it couldn't happen. The Hawaiian taro is already carrying viruses and often, a plant can look completely healthy, showing no symptoms of infection. It's not far-fetched to predict the right combination of viruses interacting with one another wiping out Hawaiian taro.

And there's proof to back up his concern. In the 1990s the most damaging pathogen to hit taro occurred in the Solomon Islands. The Alomae-Bobone virus complex wiped out nearly 90 percent of the taro crop and the transmitter of this virus, the taro leaf hopper, already exists in Hawaii.

Alomae-Bobone virus complex, or ABVC, was first noted in the Solomon Islands in the 1950s, but it wasn't until the '80s and '90s, when the islands became more populated and plant material began to move more quickly and widely, that the absolute destruction become apparent.

Alomae stunts taro leaves, making them appear yellowish and crinkled, with each leaf becoming smaller than the last until the plant ultimately dies. Bobone twists and stunts the leaves and presents as bumps or depressions on the stalk. The combination of these two viruses, which is what ABVC is, turns out to be deadly. Several Hawaiian varieties

were taken to the Solomon Islands to assess their resistance to the disease. All Hawaiian varieties died.

“Even if it [Alomae-Bobone] did show up here in Hawaii, we wouldn’t even know what to test for because nobody has really said this is what causes this disease and this is how you can detect it. It’s kind of disturbing,” says Melzer.

Melzer wants to make sure there’s clean taro available to farmers every growing season should a taro Armageddon arise. It might be the only way, but in order for Melzer’s “clean” taro project to reach its potential, farmers would have to remove all their existing crops and replace them with all new huli. And each growing season, farmers would have to continuously replace their previous crop with new clean planting material. But for farmers like Tom, this process goes against the very essence of what taro is and what it means to farm this crop. The question hanging over this industry are big ones: What does it mean to save taro and what’s the best way to do it?

Jerry Konanui, or “Uncle Jerry” as many refer to him, pressed his palms deep into the wooden table at the local favorite, Kuhio Grille, in downtown Hilo on the Big Island of Hawaii. Konanui has been farming taro for more than 50 years. His chunky fists rise from the table in frustration as he talks about what he feels is science’s pointless endeavor to create what he calls “super taro.”

“They try to create that by putting in genes, genetic engineering, and it’ll work for a while, then you’re back into the trouble again. The super taro doesn’t exist,” Konanui says. “You know the plant. It moves, just like diseases.”

He comes to his opinions through the experience of his family, going back three generations farming on the Big Island. He’s a role model for many beginning taro farmers teaching young children and adults how to plant, harvest and even pound taro into poi. He leads discussions about best farming practices and is a primary authority on identifying Hawaiian varieties of taro leading school groups through his taro fields and regularly giving talks at growers conventions throughout the state.

Konanui accepts that in nature there is disease, but also believes there’s enough diversity and resilience in Hawaiian taro varieties to withstand threats. Plus, scientists just don’t get the larger connection to passed-down stalks and the role constant stewardship plays.

“There’s two big problems with modern science. One, is money, they always run out of money. The other is time, they never have enough time, so the end result is hana kapulu, the job is not done well. It is too shallow,” Konanui says.

For Konanui, Melzer’s work dismisses traditional practices. You don’t give up on diseased stalks by throwing them away for lack of cleanliness. Rather, you look at what’s causing the disease. Is it poor water quality, poor soil? The idea of throwing away stalks because it has viruses is not only a waste, but disrespectful, he says. Konanui doubts

farmers will get behind Melzer's work for the same reasons they stonewalled previous molecular projects on taro: Hawaiian taro is an ancestor and a tradition and a culture and intervention of modern science is the antithesis of Hawaiian taro survival.

But modern science, despite Konanui's criticisms, continues to take a serious interest in Hawaiian taro survival. One of the largest collections of Hawaiian taro is housed at Lyon Arboretum, located deep in the lush rainforest of Manoa valley on the island of Oahu. There, University of Hawaii researchers grow many of the Hawaiian varieties, starting them in tissue culture and then growing them into adult plants planted at the University's many fields on and off campus.

Carl Evensen is the Lyon Arboretum's director and an agronomist by trade. He has worked on several Hawaiian plants, including sweet potato and breadfruit, taro holds a special, if complicated, place in his heart. Evensen's grandfather was one of the pioneer researchers identifying Hawaiian varieties back in 1939. Evensen is also part Hawaiian and remembers growing up with taro as a part of his everyday life. Though trained as a scientist, Evensen cannot deny having some compassion for, or at least an understanding of, why some farmers and consumers do not want to genetically modify taro.

"I don't believe we are genetically related to taro but that misses the point," he says.

"The point is there is this strong reciprocal relationship which is like family and I would say, for most people, the idea of genetically modifying a family member would be repugnant and so that's how, in my mind, I've resolved this thing. And while some people may not understand this, once you understand the close connection between Hawaiians and taro, then you understand that this is beyond food. There is a spiritual, familial connection. It's hard to explain but it's very real."

Still, Evensen believes it's important to have some kind of backup and he takes a page out of Melzer's book, knowing that disease could very well wipe out all taro. The Arboretum's collection is like a living plant catalogue, one that is completely disease-free and kept in a sterile environment. If Alomae-Bobone strikes tomorrow and all the taro die, the seedlings at Lyon Arboretum would be the only plants left, the only ones with the DNA to make renewal possible.

Evensen maneuvers his tall body into the tissue culture propagation room. Under the sterile environment of germ-free hoods, botanical technician, Libby Dingeldein, deftly removes material from a taro seedling that she will place in petri dishes to create clones.

Once the seedlings grow a couple inches, they're transferred to test tubes where they will be cared for and monitored in a room that filters and recycles air to prevent any disease propagation. Dingeldein descends the steps into a basement with a door like a walk-in freezer. Inside are hundreds of baby taro plants, stuffed into generic tubes, each tube with a tag with its scientific name and its Hawaiian name. Niho pu'u is being inspected. The little shoots, roughly 3 inches long, are spearmint green and healthy.

Evensen smiles as he looks over the rows of tubes, each one unique, and points out his favorites.

“We keep these collections so we have the opportunity to eat them in the future and to appreciate them.”

Evensen grows about 25 varieties of taro at his home and his connection to his individual stalks are strong.

“I was holding these little huli (stalks) and I had an epiphany. Because these are clonal materials, that means it’s not just the same variety, it’s the same plant that’s been grown for over a thousand years,” Evensen said. “The taro is growing out constantly and I just got the tip that’s out on the end. It’s like ‘Wow! I’m holding a piece of history’ and it also occurred to me that many, many Hawaiians had held this plant in the same way”.

The varieties around today are only a fraction of what scientists believe was present during the times of the Native Hawaiians. With the great cultural significance of taro, it’s no wonder why Evensen and the Lyon Arboretum put so much effort into preserving those that remain. Melzer’s work with virus-free taro is an interesting assist to this mission and Evensen is for it.

“I personally think it’s a really great project,” he said. “From what Mike has told me, with other types of crops that have similarly become clean planting material, there is a significant yield-increase that is related to that”.

But Evensen also has his concerns. One of the side effects of having virus-free taro is that the physical traits that many growers use to differentiate varieties may actually be expressions of viruses. So, virus-free taro could look quite different, which begs the question: Are the viruses actually, in a cultural sense, a part of the taro?

Evensen knows the varieties will genetically remain the same even if they don’t look the same. But, he also knows from past history around scientific research and Hawaiian taro, some people will think of Melzer’s work as meddling engineering. Miyasaka knows too well how damaging public opinion, even if based on false information, can be.

“Frankly, there will probably be people who don’t understand what Mike is doing, equate it with genetic modification and they’ll be against it, I think that is a matter of not understanding what is going on,” Evensen said. “And the point is, if clean materials are produced, you can chose if you want to use them or not” he said, “the genetics don’t change.”

Evensen wonders, as do farmers like Chance Tom and Jerry Konanui, how effective Melzer’s virus-free plants will be. Many questions remain. Will the plants become quickly re-infected? And if so, is it worth—financially and labor-wise—getting new virus-free planting material every planting season? Will there be greater yields?

It's a week before Christmas and Chance Tom has a gift for his fellow taro farmer, neighbor and lease partner Hanale Bishop. One of the few remaining taro farming families in Waiahole, Hanale and his father are traditionalists. They farm only Hawaiian varieties and grow only what they need to feed their families and immediate community. When it comes to poi, father and son prefer to pound theirs by hand, using a pounding stone created for the purpose, pohaku ku'i ai, and a wooden board, papa ku'i ai.

Hanale strolls up to one of Tom's fields, his hands in his pockets, his shoulder-length hair tied up in a bun. Tom has been on a Latin American literature kick and hands his neighbor a copy of *The Book of Embraces* by Uruguayan author Eduardo Galeano. The year before, his gift was book of poems by Pablo Neruda. Hanale has a gift for Tom, too. As someone who spends as much time with a guitar as he does with taro, Hanale hands Tom a copy of his newest CD, *Rainwork*. It's a quiet and soulful album – self recorded – with lyrics and themes that praise simple living.

Chance calls Hanale his brother, though the two are not related. But close your eyes and listen to them talk, playfully poking fun at one another or backing each other up when one is being threatened, and it's clear Chance and Hanale are family. This bond extends to Hanale's father, Danny Bishop, who continues to share family huli and advise Chance on best farming practices. If it weren't for Danny, Chance probably wouldn't be farming taro here. But for some of his neighbors, Chance doesn't look Hawaiian enough to be in Waiahole, period.

The Bishops, though not pure Hawaiian, make the grade, however. This is in big part due to Danny Bishop's longtime Hawaiian activism and unwavering adherence to tradition.

In the taro community everyone knows Danny. He'll talk story with other farmers and find out their problems—lack of farm land, lack of water—and he's the guy who'll make sure his voice is heard. He doesn't scream or shout -- he's like his son, quiet, but he knows whose shoulder to tap, whether that be a journalist or former House of Representatives member Jessica Wooley.

Most recently Danny's been channeling his efforts into his position on the legislatively mandated Taro Security and Purity Taskforce. The taskforce was created by the state in 2008 because it was clear that taro production was in rapid decline. According to the Hawaii Agricultural Statistics Service taro production dropped nearly 50 percent over the past 20 years.

Danny and the taskforce pointed out the biggest problems facing taro and taro farmers and worked to offer up solutions to these problems. Setting aside wetlands for taro production and keeping them out of the hands of developers was one proposition. After

all, before Waikiki was all hotels and high-end shops, it was a wetland, used for taro and rice.

In a meeting in a Honolulu Community College classroom, Danny Bishop sits with researchers, teachers and other farmers, Hawaiians, Caucasians and Asians, his bare feet on the linoleum, stained with the silt from his loi. He leans back in his chair and crosses his feet. Yes, there's a crisis with taro, he says, but it's not disease, it's a lack of farmers and a lack of access to land. It's a lack of priorities – the first being traditional taro farming because it connects Hawaiians them to their ancestors.

But Danny doesn't mean only blood Hawaiians, he means the people who live in Hawaii, who feel a connection with this place. In that way, he means Chance Tom, even if others think Tom isn't truly Hawaiian.

A firefighter, co-owner of a successful tree-trimming business and a father of two, Tom probably works more and sleeps less than he should. At his home in the higher-elevation, upper-middle-class neighborhood of Manoa Valley, Tom's garage is filled with equipment. In his living room, there's a pool table piled with miscellaneous items: clothes, knives he bought online, electronics and gadgets, most still in original packaging.

"I grew up here and it was beautiful and I wanted to perpetuate those beauties," says Tom, and also admits he tries to find happiness in material things.

That's one reason he went back to farming - something he hadn't done since he was a teen - and found some of what he had been missing. "I love being with the plants," says Tom. "It's a normal thing already, a normal thing I need."

And he also needs the support of the Bishops, because the truth is farming taro is, in part, about race. Non-Hawaiian taro farmers are seen by some as imposters.

Tom, who grew up on Oahu and has farmed taro since he was 19, is still an outsider to others in his neighborhood. To them, he just doesn't look the part.

"Some of them even tried to come over here and threaten me and my son. That's why I always carry a machete when I come out here," he says. "They think I'm just a haole ('non-Hawaiian'), that I don't belong in Waiahole".

When he started farming in the Waiahole valley, a few local men came up to him and aggressively questioned why he was there and what he was doing. When he said he was leasing land and farming taro they said he was haole, and so he had no right. As voices grew louder, some of Tom's friends walked over, including Hanale Bishop, and confronted the men, backing Tom as the lease-holder. The men left, but Tom remains cautious, his ears perked for the sound of pickup trucks driving into his lot.

Tom's stories about his neighbors – some welcome him, some don't – are, like everything about taro farming, complicated. Nothing about this plant is ever just one way. Purity? It's up for debate.

There are those like Jerry Konanui who want to preserve Hawaiian taro varieties and all their physical traits, even when that expression includes a virus. Chance Tom is sort-of in that camp, but his concerns are more local, focused on individual plants: The way it's been done is the way it will get done for the next harvest, disease or no.

There are those less nuanced: Hawaiian taro should only be farmed by Hawaiians. There's Mike Melzer, whose notion of purity as a virus-free plant amounts to others as sacrilegious.

To further complicate things – or maybe to clear them up, depending -- there's also University of Hawaii taro researcher John Cho. He says that, biologically speaking, there is no "pure" Hawaiian taro. Stop the debate. It all came from Asia.

Cho has been working with taro in Hawaii and abroad since the mid-1990s. His main focus was to establish resistance to leaf blight by crossbreeding various plants from around the globe. Through his research and experiments, he traced taro's lineage to its start in Asia, where taro reproduces naturally in the wild, flowering occasionally and pollinated by insects.

Hawaii is one of the most geographically isolated places on the planet. Flora and fauna that are indigenous ("native") to these islands are a pretty select group: organisms that were able to somehow cross the earth's biggest ocean and make a go of it on a volcanic landscape. Taro was not among them.

Taro's trip across the Pacific came by way of canoes. The plants were selected from Samoa, Tonga and the Marquesas islands among other Polynesian islands by the first Hawaiians, who took stalks of their favorite varieties and planted them in the wetlands of Hanalei, Waipio and Waiahole to name a few.

And while those are the facts – that taro is, technically, a transplant -- it's a tough sell to those who still maintain the plant is the incarnation of Haloa, the brother of man.

"I try to educate some of them but they don't want to listen," says Cho, irritated.

Cho had less of a battle in Samoa, especially during the huge blight-caused loss in the mid-1990s. To farmers there, Cho's resistant hybrids were saviors in their taro fields, rescuing an important agricultural industry from collapse.

When he presented his hybrids to Hawaii, some farmers and anti-GMO activists painted Cho as a manipulative, money-hungry scientist out to modify Hawaii's sacred taro to make a buck by increasing crop yield.

Genetic modification? Sure, says Cho, he was pollinating different taros and crossbreeding them, technically "genetic modification". But his work, he said, was no different than what insects would do. Unlike Miyasaka, who had inserted non-taro genes into taro, Cho simply played with the combination.

Still some couldn't get past the buzz word: GMO.

"It's like religion, nobody's gonna convince Islamic extremists to convert to Christianity," says Cho. "Hawaiian taro is an emotional issue and I don't think it is ever going to change."

Tradition versus science which is better? Perhaps that's a question to ask the climate.

The first taro plants cultivated by Native Hawaiians had viruses and diseases. Through trial and error, early Hawaiians developed varieties to mitigate their prevalence. Taro resistant to rot were grown in wetland fields and taro that could better withstand drought were grown in higher, drier elevation.

Taro farming in Hawaii hasn't changed, though. Unfortunately for farmers, Hawaii's environment has.

This past year, 2015, was the hottest year on record for Hawaii, with average temperatures of 90 degrees in the summer and a staggering seven tropical storms and eight hurricanes reaching or coming close to the islands. The year brought heavy rains and strong winds to some areas and drought to others. Currently, the native Ohia tree is being ravaged by a fungus that was first detected on Hawaii Island in 2010 but is only now being seriously researched. Some scientists are calling this fungus the worst thing to happen to Hawaiian ecosystems since cattle were introduced and many are saying that the fungus is here to stay. Science is trying to play catch-up with no success.

Taro, like any other organism, becomes stressed when exposed to big environmental change. One of the consequences of this stress is decreased tolerance to disease. Genetic recombination gives it little chance of adapting to these changes.

Leaf blight, which has long been an issue with this crop, relies on rainy, wet weather to be successful. The forecast in Hawaii in recent years has cooperated. Hawaii researchers have been working on crossbreeding Hawaiian taro for leaf blight resistance since the mid-1990s, with premiere researcher Eduardo Trujillo developing a successful Hawaiian-Palauan taro cross fairly resistant to the disease.

Though farmers couldn't deny the higher yield return from growing hybrids, consumers didn't like the taste and, perhaps more important, they didn't like the thought of a hybrid Hawaiian taro. Ultimately and to this day, hybrids are linked to a "lesser" quality of poi, grown by some farmers and eschewed by others. The commercial promise of hybrids remains stunted because of its perceived impurity by both kinds of farmers and consumers.

So far, farmers have been able to financially survive the effects of leaf blight on their crops by committing to a lower yield for the sake of genetic purity and a "better tasting" product. They can also charge more for their adherence to "pure" taro.

Tom pulls stalk after stalk from a burlap sack and pushes each into the soft Waiahole soil; the stalks are lime green, plum, pink, and some are streaked with white, each one different, each one anywhere from 1 to 10 years old, some even older than that. Tom carefully spaces them in his field. Could Mike Melzer in his lab understand this? Tom doesn't think so.

"I don't think it's necessary, what he's doing," says Tom. His position is let the strong ones survive and the others die.

"Farming is its own canvas in a way, it gets screwed up sometimes and you're not necessarily in control and yeah, you try to maintain control," he says, lifting his feet lightly, trying not to disturb the soil, his back rounded under the noon sun. "I have leaf blight," he continues, pointing to some plants in the field, "but I let them go, I just hope for the best."

Susan Miyasaka, an agronomist at the University of Hawaii at Manoa, knows well this conflict between traditionalists and scientists. In the early 2000s, Miyasaka was genetically engineering Chinese taro for disease resistance by injecting rice, wheat and grape genes into taro. Though she was not genetically modifying Hawaiian taro, GMO activists and, later, the general public in Hawaii became concerned that Hawaiian taro would be next. Protests swelled and rallies spilled over to Oahu, Kauai, Maui and Hawaii islands with people chanting "A'ole (No) GMO Taro!"

Hundreds of farmers, consumers and lawmakers testified against GMO taro Hawaii County Councilmember Emily Naeole telling Hawaii News Now in March of 2008, "We really don't know what the true effects will be, so until something is guaranteed, we no like."

"There seem to be certain issues that are hot button issues and it seems like it doesn't matter what the facts are," says Miyasaka. "People get up in arms against them. One of them is vaccinations, another one is global climate change. These are scientific issues where there are some facts, but to the public, it may not matter what the facts are, they're just moved by emotion."

In 2006, the University of Hawaii placed an indefinite moratorium on genetically engineering Hawaiian varieties of taro. That made inserting non-taro genes into Hawaiian taro illegal. Though Miyasaka had been inserting non-taro genes into Chinese taro, she says the controversy itself halted her funding.

The ban has forced scientists to figure out other ways to battle taro diseases. Melzer's work sidesteps because it removes viruses, but leaves the genetics intact.

As for Miyasaka, she's still dealing with the perception that she was the scourge, the researcher who tried to genetically engineer Hawaiian taro. But she hasn't given up. She continues to work with taro, looking for ways to increase resistance to leaf blight, though now her primary means of manipulation happens through the much slower process of crossbreeding.

As she works on a more minor threat – leaf blight – she's also got Alomae-Bobone virus on her radar. She'd have to. Some Hawaiian varieties were tested in the South Pacific, where the Alomae-Bobone virus was located. None of the varieties were resistant, she says. Miyasaka believes that scientific inquiry could help save Hawaiian taro, but people's cultural and emotional beliefs continue to put it at risk.

“The perfect example is papaya. I remember when the ringspot virus first got here, the department of agriculture wanted to cut down trees and burn them, just get rid of them, and the farmers didn't want to because that was their money, that was their crop, so the department of agriculture, instead of saying, ‘Well we're going to do this anyway, we don't care about you, we'll figure out compensation later,’ they blinked and the papaya ringspot virus spread beyond their control.”

The papaya ringspot virus was first recognized on the island of Oahu in the 1940s. In little over a decade, as the virus spread with the aid of aphids and farming practices like pruning, Oahu papaya production plummeted and the industry was unable to recover. Papaya production was moved to Hawaii County in the hopes that the plants could be saved by isolation on another island. Less than 40 years later, the ringspot virus was found in Hawaii County papaya farms. By the 1990s, those farms were staring at the same dismal conclusion that Oahu faced.

Enter plant pathologist Dennis Gonsalves. He saw Hawaii was about to lose an important cash crop and started tinkering in his lab. He changed the genetics of the papaya and made it resistant to the virus. Gonsalves used a portion of a milder, mutated form of ringspot virus and injected it into some of the local varieties of papaya. The plants flourished; his most successful cultivar is called the Rainbow papaya.

Farmers couldn't put the GMO papaya plants in the ground fast enough. Within a couple years, the industry was booming again. Gonsalves was touted as a “hero” and, to this day, a majority of Hawaii papaya sold in stores and exported - with the exception of a few small organic farms – are GMO Rainbow. Without it, there would be no papaya industry

in Hawaii and it's worth about \$11,285,000 according to a 2014 tally from Hawaii Agricultural Statics Service.

But taro is different.

Miyasaka predicts the local attitude is so strongly opposed to genetic modification of Hawaiian taro that efforts to save it will come too late. "It would take Alomae-Bobone coming here and all the taro plants dying for them to think 'Oh, maybe we should do something about this.'"

In March of this year, Melzer and his team discovered a taro virus previously non-existent on Oahu island: Taro Vein Chlorosis virus, or TaVCCV. It creates clots in the veins of the taro leaves, making them shrivel.

A field planted just three months ago at the University of Hawaii's experimental station in Waimanalo is marred by stunted and sickly looking stalks. Researchers still don't know how it got to Oahu, though Melzer suspects an insect or, possibly, people transported it.

The good news is this virus likely won't wipe out Hawaiian taro, though it could significantly affect yields. There is nothing that can be done for the crop at Waimanalo and Melzer is currently scrambling to figure out a way to minimize loss for Oahu farms.

Taro Vein Chlorosis is living proof that taro viruses can show up quickly and without any warning. And they can spread faster than scientists can come up with genetic resistance.

This newly discovered virus is one more piece of evidence to support what Melzer and those in favor of using science to save plants have been saying: Let's not wait for a disaster -- Alomae-Bobone, for example -- to hit, before starting research to work in the fields. Because if Hawaii does nothing, if we continue to plant virus-riddled plants, the moment Alomae-Bobone hits our shores, all Hawaiian taro will die.

Although that's not exactly true. Some plants will likely survive. The little seedlings inside plastic tubes, lining shelf after shelf in a sterilized basement room at the Lyon Arboretum could be the last living Hawaiian taro on the planet. Will that be enough?