OHA
OFFICE OF HAWAIIAN AFFAIRS
Legislative Testimony

SB 709, SD 2, RELATING TO AGRICULTURE (GMO KALO PROHIBITION)

House Committee on Hawaiian Affairs

March 18, 2009 | 9 a.m. | Room: 329

The Office of Hawaiian Affairs (OHA) **SUPPORTS, with amendments,** S.B. 709, S.D. 2, which would prohibit any individual from developing, testing, propagating, releasing, importing, planting or growing genetically modified taro in Hawaiÿi. OHA supports this measure as an important recognition of a plant that has genealogical, spiritual and cultural links with Native Hawaiians and Hawai'i. Furthermore, kalo is integral to the identity of Native Hawaiians and, thus, the State of Hawai'i as a whole.

The traditional moÿolelo of Wäkea and Papahänaumoku explains that the first kalo plant, Häloanakalaukapalili, is the elder brother of Native Hawaiians. As the elder sibling, Häloa provides sustenance to Native Hawaiians, and in return, we, the younger sibling, care for him and ensure that he flourishes. The bond that connects Native Hawaiians to kalo remains a sacred one, and our kuleana dictates that we preserve that bond and protect Häloa. A living entity of this eminence cannot be modified or scientifically "improved." He must be honored and left alone.

OHA recognizes that Häloa is facing many challenges today, including diseases, invasive species and a dearth of water and farmable land. However, we believe that there are natural alternatives to genetic engineering - such as fallowing loÿi, restoring stream flows and improving the overall health of the environment - that have yet to be fully explored. We suggest scientists work with kalo farmers and the Native Hawaiian community to conduct a complete and comprehensive examination of these natural methods, which are neither intrusive nor offensive to Häloa or our culture.

OHA has questions about the amendment that reads: "This Act does not prevent the University of Hawaii from conducting field testing and commercial propagation of successful new varieties outside of the State." The ban proposed under the bill would not affect activities that occur outside of the state, and therefore this amendment would be unnecessary.

We also ask that Section 4 of S.B. 709, S.D. 2, be amended so that the bill takes effect on July 1, 2009.

OHA respectfully urges the committee to PASS S.B. 709, S.D. 2, taking our above-mentioned concerns in to consideration. We thank the committee for the opportunity to testify.

UNIVERSITY OF HAWAI'I SYSTEM
Legislative Testimony

Testimony Presented Before the
House Committee on Hawaiian Affairs
March 18, 2009 at 9:00am
by
James R Gaines
Vice President for Research, University of Hawai'i

SB 709, SD2 RELATING TO AGRICULTURE

The University of Hawaii (UH) is sensitive to and mindful of the spiritual and cultural significance of taro in Hawaii. By releasing its patents on disease resistant, traditionally cross-bred, hybrid taro into the public domain and entering into an agreement to consult with the Hawaiian community before conducting any research on genetically engineered Hawaiian taro, the University has demonstrated not only its respect for the cultural significance of Hawaiian taro, but also its desire to expand and enhance its interactions with Hawaiian taro farmers and the native Hawaiian community.

UH is working on many fronts to establish a working relationship with the taro farming community, including, among other efforts, its participation on the Taro Task Force. That Task Force, created by the Legislature as Act 211 in 2008, is currently meeting and driving positive dialogue to address the multitude of threats to Hawaiian taro. We believe it would be prudent for this Legislature to examine the outcomes of the Taro Task Force's efforts before supporting any further legislation regarding taro.

Testimony to this legislature from taro farmers, the Hawaiian community, and the Department of Agriculture indicate that the primary threats to taro in Hawaii come from invasive species and diseases associated with imported taro and issues related to agriculture in general such as access to land, reduced numbers of farmers, water quality, loi health, etc. Taro research is not the problem. The continued introduction of bills such as this does little to protect taro or assist in building collaborative relationships between UH and the taro farming community. Not only do bills of this nature continue to divide people who need to be working together to address real problems facing taro production in Hawaii, but they perpetuate ignorance of science and unfounded fears of new technologies that may, even indirectly, come to bear on solutions to the problems facing taro in Hawaii.

In closing, UH reiterates that it is not now, nor does it have plans to genetically engineer Hawaiian taro. UH has an agreement in place with the Hawaiian community regarding genetic engineering of taro and has every intention of upholding the terms of that agreement. UH will continue to participate in the Taro Task Force with the hope that the work we do as a world leader in tropical agricultural research will contribute to the preservation of the cultural and genetic integrity of kalo and support taro farmers in their efforts to meet current and new, value-added market demands.

The University of Hawaii opposes passage of SB 709SD2. Thank you for the opportunity to testify on this bill.

HI SciTech
HAWAII SCIENCE & TECHNOLOGY COUNCIL

SB709 SD2: Relating to Agriculture

DATE: March 18, 2009
TIME: 9:00am
PLACE: Conference Room 309

TO: House Committee on Hawaiian Affairs
Representative Mele Carroll, Chair,
Representative Maile S.L. Shimabakuro, Vice Chair

FROM: Lisa Gibson
President
Hawaii Science & Technology Council

RE: Testimony In Opposition to SB709 SD2

Aloha Chair, Vice Chair, and Members of the Committee,

Thank you for the opportunity to testify on this bill. The Hawaii Science & Technology Council (HISciTech) opposes SB 709 SD2. This bill prohibits the development, testing, propagation, release, importation, planting, and growing of genetically modified taro in the State of Hawaii (SD 709 SD 2). Rather we support HB 1663 HD2 as an improved "compromise" bill.

- We value and respect the spiritual and cultural significance of taro to native Hawaiians. However, this bill goes too far in calling for a ban on research of ALL varieties of taro (Hawaiian and non-Hawaiian).

- We have seen the decimation of taro in Samoa, Puerto Rico, the Dominican Republic and the Solomon Islands from diseases, pests, and global warming. These countries continue to seek out the expertise of Hawaii's researchers and see value in the tools of biotechnology to address the many agricultural challenges in their communities.

- **Amendments to the bill:** Research on non-Hawaiian varieties of taro must be allowed to continue to address real human needs.

T*he Hawaii Science & Technology Council* (HISciTech) is a 501(c)6 industry association with a 28-member board. HISciTech serves Hawaii companies engaged in ocean sciences, agricultural biotechnology, astronomy, defense aerospace, biotech/life sciences, information & communication technology, energy, environmental technologies, and creative media.

Sincerely,

Lisa H. Gibson
President
Hawaii Science & Technology Council
(808)536-4670

Association of Hawaiian Civic Clubs
P. O. Box 1135
Honolulu, Hawai`i 96807

TESTIMONY OF LEIMOMI KHAN, PRESIDENT
IN SUPPORT OF TARO FARMERS REGARDING

SB 709, SD2, RELATING TO TARO SECURITY

Committee on Hawaiian Affairs
Hearing date and time: Wednesday, March 18, 2009, 9:00 a.m., Room 329

Aloha Chairperson Carroll, Vice Chair Shimabukuro, and members of the Committee on Hawaiian Affairs. Thank you for this opportunity to testify on SB 709, SD2, which recognizes the importance of the kalo, or taro, in the heritage of the State and which prohibits the development, testing, propagation, release, importation, planting, or growing of genetically engineered taro in the State of Hawaii.

As with HB 1663, which has the same purpose as SB 709, SD2, the Association supports taro farmers in their efforts to protect and preserve Native Hawaiian traditional cultural practices as it relates to kalo.

This position is supported by several resolutions passed by delegates at annual conventions that express concerns relating to genetic modification of native natural resources.

On November 2, 2002, the Association passed a Resolution which urged the State of Hawai`i to place a moratorium on all bioprospecting expeditions currently being undertaken on public lands, submerged lands, and natural resources under the State's jurisdiction until such time as an appropriate legislation can be enacted.

On November 15, 2003, the Association passed three Resolutions. Resolution 2003-38, expressed concern that multinational corporations were misappropriating Hawaiian natural resources such as Hawaiian healing plants for commercial purposes with no compensation to the State of Hawai`i or to the Hawaiian people;

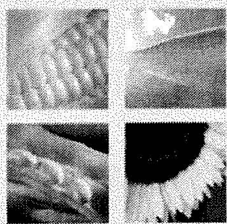
Resolution 2003-14, urged the University of Hawai`i to cease development of the Hawaiian Genome Project or other patenting or licensing of Native Hawaiian genetic material until such time as the Native Hawaiian people have been consulted and given their full, prior and informed consent to such project; and

Resolution 2003-13 urged the State legislature to enact legislation, in consultation with Native Hawaiians, that recognizes and protects the Native Hawaiian peoples' collective traditional knowledge, cultural expressions, art forms and intellectual property rights, including requiring that all cultural content that has been acquired under free prior informed consent; reserving the right to refuse to participate or authorize use of intellectual property rights; requiring that all cultural content has been reviewed for accuracy and appropriateness; retaining copyright authority over all indigenous knowledge that is shared with others for documentation purposes; insuring controlled access for sensitive cultural information that has not been explicitly authorized for general distribution, as determined by members of the local community; and arranging for benefit sharing agreements.

On October 5, 2005, the Association passed Resolution 2005-23, which resolved that the legislature of the State of Hawai`i and the University of Hawai`i be asked to impose policies to safeguard and protect Hawai`i's public trust resources from genetically engineered and bioprospecting threats, in consultation with Native Hawaiian organizations.

On November 30, 2007, the Association passed Resolution 2007-091, which urged the State of Hawai`i to require labeling of all products containing GMO substances.

Thank you for this opportunity to testify in support of taro farmers in their efforts to protect and preserve Native Hawaiian traditional cultural practices as it relates to kalo.



Hawaii Crop Improvement Association

Growing the Future of Worldwide Agriculture in Hawaii

Testimony By: Alicia Maluafiti
SB 709sd2, Relating to Agriculture
House HAW Committee
Wednesday, March 18, 2009
Room 329, 9:00 am

Position: Strong Opposition

Chair Carroll, and Members of the House HAW Committee:

My name is Alicia Maluafiti, Executive Director of the Hawaii Crop Improvement Association. The Hawaii Crop Improvement Association (HCIA) is a nonprofit trade association representing the agricultural seed industry in Hawaii. Now the state's largest agricultural commodity, the seed industry contributes to the economic health and diversity of the islands by providing high quality jobs in rural communities, keeping important agricultural lands in agricultural use, and serving as responsible stewards of Hawaii's natural resources.

As stated in previous years, HCIA member companies do not grow taro nor do we have an interest in taro as a commercial research and development crop. We consistently affirm and respect the cultural meaning of Hawaiian taro and firmly believe that the Hawaiian community must lead the discussion of the future of Hawaiian taro, and Hawaiian taro research and education programs.

HCIA does not support legislating a moratorium on taro or any other agricultural crop grown in Hawaii. Such policies send a chilling message that Hawaii is not in support of science and technology. It undermines future investments and growth potential for responsible use of agricultural biotechnology as a 21^{st} Century tool for farmers.

We stand firmly on the 1,000's of science-based and peer reviewed studies and 3,400 scientists around the world that attest to the safety of agricultural biotechnology. (The Safety of Agricultural Biotechnology study listing is available upon request) Plant research using this technology is not only safe but has the advantage of being more efficient. It requires significantly less time to produce new cultivars and is more precise than traditional plant breeding. As a result, varieties can be developed which are more productive and better adapted to local needs. It is an option or tool for plant breeding when other methods fail.

Thank you for the opportunity to present testimony.

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Orchid Growers Of Hawaii

P.O. Box 4153 Hilo Hawaii 96720
Website: www.ogoh.org

SB709sd2, Agriculture
Hse HAW, Weds, March 18, 2009
9:00 am – Room 329
Position: **Oppose, Prefer HB 1663hd1**

Chair Carroll and Members of the House HAW Committee:

My name is Thong-Teng Neo, President of the Orchid Growers of Hawaii, located on Hawaii Island. OGOH is an alliance of professional potted and cut flower orchid growers in the state of Hawaii. Its goals are to promote the development of this industry by supporting marketing, research and educational projects. As a non-profit service organization, it is dedicated to being an active, ethical member of the business and public sectors of Hawaii. OGOH is the combination of two former organizations, Hawaii Orchid Growers Association and Big Island Dendrobium Growers Association. It is also the new statewide orchid organization.

OGOH's mission is to help its members to enhance their position in the increasingly competitive global orchid trade. Working closely with UH CTAHR and local breeders to create and produce new orchid hybrids for member-growers and for consumer markets is the key to remain competitive in this global economy. Biotechnology not only provides a tool for us to create novelty orchids in a relatively short time but also help us to improve cultivation skills.

This bill calls for a ban of genetic engineering research and development on all taro. OGOH appreciates the cultural significance of taro to the Hawaiian community. However, this bill does not address only Hawaiian taro, and calls for a ban of all taro varieties in Hawaii. This research and development ban of all taro varieties goes too far. Other countries such as Dominican Republic, Samoa and the Solomon Islands are asking Hawaii researchers for their expertise in coping with the decimation of taro in their countries.

Instead, we ask for your support of HB 1663hd1, which prohibits genetic engineering research on Hawaiian taro varieties and allows laboratory testing only for non-Hawaiian taro varieties. HB 1663hd1 goes further and protects all other federally approved, permitted genetic engineering research and development.

Thank you for the opportunity to present testimony.

Yours sincerely,

Thong-Teng Neo
President
Orchid Growers Of Hawaii

TROPICAL
HAWAIIAN PRODUCTS

P.O. Box 210
Keaau, Hawaii 96749

Phone (808) 966-7435
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SB 709sd2
RELATING TO AGRICULTURE
Hse HAW Hearing – Room 329
Weds. March 19, 2009 – 9:00 am

Dear Chair Carroll and House HAW Members:

STRONGLY OPPOSE.

My name is Loren Mochida, General Manager of Tropical Hawaiian Products (THP) in Keaau, Hawaii. THP is a processor and exporter of Hawaiian Premium papayas to CONUS and Japan. THP represents over 60 papaya growers that provide the transgenic "Rainbow" papayas for processing.

We are strongly opposed to SB 709sd2 Relating to Agriculture.

We oppose SB 709sd2 because we need to focus on positive bills that will support the survival of Hawaii Agriculture, even more so in times of economic crisis. Sustainability is a buzzword these days. However, what does that mean in real life? As farmers, it seems that we need state/local policies and funding support that provide for affordable access to land and water. We need new ways to deal with pests and disease that love our tropical climate. We need crops and new varieties that can give better yields with less land and water. We need affordable solutions about how to get our products to market. Let us focus on these issues and solutions rather than a negative bill that does not fix anything.

The taro industry should learn from the papaya industry, that curtailing testing of their crops could be devastating to their industry. Should a foreign pest, disease or virus enter their crops that cannot be controlled by chemicals or integrated pest management (IPM), a new variety developed by biotechnology resistant to that specific pest could save their industry. Removing a tool that an industry can use is not a very good business decision.

People have several choices now of eating various varieties of papaya, from organic, conventional or biotech (Rainbow) papayas. Taro farmers should also have a choice of growing biotechnology crops if it means survival. Ask any papaya grower.

Thank you for this opportunity to testify on SB 709sd2.

KAHEA

THE HAWAIIAN-ENVIRONMENTAL ALLIANCE

PROTECTING

NATIVE HAWAIIAN

CUSTOMARY &

TRADITIONAL RIGHTS

AND OUR FRAGILE

ENVIRONMENT

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KAHEA: the Hawaiian-Environmental Alliance is a non-profit 501(c)3 working to protect the unique natural and cultural resources of the Hawaiian islands. KAHEA translates to english as "the call."

S.B. 709HD2- In Support
House of Representatives Committee on Hawaiian Affairs
March 18, 2009, 9:00 am, Rm. 329

Aloha mai kakou- Chair Carroll, Vice-Chair Shimabukuro and Committee Members,

We respectfully submit 8 volumes of testimony collected over the past month, from taro farmers and consumers across Hawaii nei, all in support of a ban on all GMO-taro. We also submit 9 published articles to substantiate the statements made below.

We ask you to please consider these important points:

Please do not amend the bill to only protect Hawaiian taros.

Taro is a very resilient plant that can grow, spread, flower, seed and get all mixed up in the taro patch, in the wild, and even in the lab. Even a tiny left over piece of root can grow into a full size plant. ALL GMO-taro in Hawaii would put farmers and consumers at risk of contamination as it would be inherently uncontrollable. Chinese taro, or Bun Long, is a very popularly consumed taro that is prized for lu'au leaf and taro chips, and is grown on most if not all taro farms in Hawaii. Cross-contamination of natural Bun Long by the look-alike GMO-taro of this highly consumed and farmed variety of taro, raises enormous liability concerns for farmers and producers of taro-products. It is easy to release an experiment, but impossible to control. There is no liability held, but everything is at stake.

The broader public's concerns about GMO-taro are in fact, real

Numerous scientific studies point to very serious health and allergy problems with GMOs, and lack of proper scientific protocols or tests of released GMOs. The biosafety dangers are real and present in this GMO experimentation and the cultural implications are already inflicting true pain in our community. There is simply no proof nor potential that such technology will be truly beneficial to consumers and to taro farming. Beyond just a business investment this issue is paramount to our community livelihood and environmental health, and for that we continue to advocate for democractic representation in the legislature, and notification and informed consent about these biosafety issues in our communities.

SEE ATTACHED:

- "Catholic Healthcare West GMO Press Release 1.09"
- "Health Risks of Genetically Modified Foods, KAMAKAU Testimony 2009"
- "GMO Cotton Effect on Soil Biological Activities 2009"

While a small number of commercial growers and poi companies oppose this ban, consumers overwhelmingly reject the idea of GMO-taro and poi.

Poi consumers take the safety and quality of poi very seriously! Poi consumers are also overwhelmingly local families with strong cultural ties to taro.

Allowing GMO-taro also severely threatens our ability to expand the value-added market for organic and uniquely hypo-allergenic taro products, as GMO-taro could never be guaranteed to be allergy-free and could cause allergic reactions. GMO-taro can never be certified organic. This is why GMO-taro contamination and related allergy concerns cause such great alarm to other taro businesses, as well as consumers.

SEE ATTACHED:
- "Soil Association- GMOs- American Consumer Report 10.08"

There are now well over 8,000 individuals and local organizations that have been supporting the intention of this legislation since 2007.

Community support for this initiative only continues to grow, uniting consumers and farmers.

SEE ATTACHED:
- 8 volumes of testimony collected over the past month, over a thousand letters in support of a ban on all GMO-taro.
- Public testimony of over 7,000 in support from 2008 can be found online at: http://www.capitol.hawaii.gov/session2008/lists/getstatus.asp?query=SB958&showtestimony=on&currpage=1

There are ways to engage in ethical science without genetically modifying a new organism.

The state recognized the importance of addressing these issues and projects by establishing the Taro Purity and Security Task Force in 2008.

Farmers and scientists must exercise due diligence in researching and developing all other options before resorting to such an extreme as creating a new organism. For example, eradication of the apple snail (another business venture gone wrong) would increase taro production by at least 25%. Assisting industrial farmers in transitioning to multi-cropping and organic fallowing techniques would also drastically increase yields. Establishing the scientific basis to explain the high yields of taro in Hawaii before industrialized farming, such as potential of kukui tree composting for fungus control.

A comparative analysis of existing taro farming techniques is needed before introducing new organisms to the Hawaiian ecosystem and new risks to the taro market.

SEE ATTACHED:
- "Comparison of GMO Cotton and Organic Farming 2.09"

There exist many safe methods of advancing taro farming- without GMOs.

Following the taro blight that wiped out Samoan taro production in the early 1990s, in-depth studies found that such blights can be prevented by multi-cropping of taro varieties and improved farming techniques such as fallowing, wider row spacing, more careful huli selection, etc. In addition, organic methods produce remarkable increases in yields and nutritional value per acre, reflecting a true abundance of efficiency, biodiversity and advancement of soil science-- especially compared to the declines often experienced in industrialized mono-cropped fields that are treated with chemicals and are not fallowed.

SEE ATTACHED:
- "Taro Industry Back on its Feet- Samoa Observer 12.08"
- "Bibliography of Taro Leaf Blight"
- "TaroGen Publications"

There are other technologically advanced ways to create new taro plants without putting public safety at risk.

For example, one cutting edge technology is called Marker Assisted Selection, which speeds up the plant breeding process- "*MAS makes it possible to select traits with greater accuracy and to develop a new variety quicker than in the past.*"

SEE ATTACHED ARTICLE: - "FAO study on Marker-Assisted Selection 7.07"

In this GMO debate it is certainly crucial to recognize that there do exist safer and more advanced emergency options for plant breeding. *However,* it is just as crucial to heed local taro industry concerns about introducing new varieties into Hawaii. Taro farmers across Hawaii do not now find this MAS technology necessary as there exists in Hawaii already a vast wealth of genetically diverse taro varieties. The introduction of new hybrids is not only unnecessary and costly but also a threat to the preservation and propagation of the existing native taro biodiversity. Additionally, due to taste and texture complaints recently introduced hybrid taros have already been rejected for poi production by local poi mills-- at great cost to the farmers who had been convinced by researchers to plant those new hybrids and who then had to replant their farms with the traditional Hawaiian taros.

The FAO article explains also that the MAS hybrid technology should only be used "*where there is a clear advantage over traditional selection techniques.*" In this case, the value of the technology is superficial and short term compared to the many unique and invaluable native heritage taros of Hawaii- the fortified and proven results of 1,200 years of traditional selection techniques- fine tuned to the many climates and conditions in Hawaii and to poi production. It with this native biodiversity and improved farming techniques that we can protect our farms from blights.

Please, Representatives, if you aren't absolutely and proof positive that GMO-taro is better for Hawaii than natural taro and safely advanced farming techniques then please don't allow this experimentation to continue, please support the intentions of SB709HD2 to protect all varieties of taro in Hawaii. If you have any substantial and scientific proof that GMO-taro will actually provide a safe and secure benefit to Hawaii please make such information publicly available for review and discussion.

Thank you for considering all this testimony, it comes from the heart and soul of Hawaii.

Me ka mahalo piha,

Bryna Rose Storch

Community Coordinator
KAHEA: The Hawaiian-Environmental Alliance

Catholic Healthcare West Presses Suppliers to Prohibit Animal Cloning and Genetically Engineered Foods

Marketwire News Releases
Published: 01/06/09 01:13 PM EST

Catholic Healthcare West

Leading Catholic Hospital System Takes Action for Sustainable Food Production

SAN FRANCISCO, CA -- (Marketwire) -- 01/06/09 -- Catholic Healthcare West (CHW) announced today that its food purchasing dollars will be focused on promoting sustainable food production practices, in part by seeking alternatives to foods produced with genetically engineered sugar, as well as meat and dairy produced with animal clones. The CHW position was developed in recognition of the serious health and environmental concerns these technologies raise and the threat they pose to healthier and more sustainable food production options. Among the concerns CHW is raising about genetically engineered and cloned foods are genetic contamination, increased pesticide use, animal cruelty, and the deep ethical and moral issues associated with these untested new technologies.

CHW recently asked eight of its largest food suppliers for their policies on genetically engineered sugar beets, which are being planted for commercial use for the first time this year. Results from the survey found that its suppliers would prefer non-genetically engineered sugar beets. Only Diamond Crystal indicated their intent to avoid buying genetically engineered sugar and that they will seek out suppliers that do not use genetically engineered foods through a validation process. CHW intends next to survey its meat and dairy suppliers on their potential use of animal cloning since the U.S. FDA recently decided to allow marketing of food from animal clones.

"We are working with our purchasing organization, Premier, and developing relationships with allied healthcare partners in looking for food companies that will provide us with meat and dairy products that are not from animal cloning, and foods that are made without genetically engineered sugar beets," stated Pat Burdullis, CHW's administrator of non-clinical supply chain contracts. "If these same food companies can provide foods that are natural and non-genetically engineered for their European customers, we believe they should provide us with the same level of service."

Genetic engineering and animal cloning are controversial in food production, since the technologies have not been subject to long-term safety testing and could create irreversible environmental damage. Genetically engineered crops can contaminate natural foods and have promoted the use of herbicides that may be harmful to human health and natural systems. Scientists say that animal clones are often abnormal and suffer from a host of often painful defects. A New England Journal of Medicine article stated that, "[It] may be exceedingly difficult, if not impossible, to generate healthy cloned animals."

"Genetic engineering and animal cloning are in direct conflict with our sustainable food service vision and corporate sustainability goals," stated Sr. Mary Ellen Leciejewski, CHW's ecology program coordinator. "We have numerous unanswered concerns about the imminent introduction of genetically engineered sugar beets and marketing of food from animal clones. Previous genetically engineered crops have increased pesticide use, and animal cloning is a cruel and unnecessary technology in meat and dairy production. Our aim is to promote alternative approaches that produce foods that are safer and healthier for our patients, staff, and visitors and that can sustain the farmers and food producers in our communities."

CHW has successfully advocated with its suppliers for safer, more environmentally friendly products, most recently with regard to its PVC/DEHP-free IV products now being provided by B.Braun.

With respect to food production, CHW is advocating for public policies that meet the following safeguards:

-- Before marketing, genetically engineered food or food from animal cloning must be fully evaluated through independent, peer-review for any effects on animal welfare, human health, and the environment.

-- Foods with genetically engineered ingredients and foods from animal cloning (including foods from the offspring of clones) must be labeled as such.

-- Genetically engineered seeds and plants are rigidly separated from other seeds and plants so that natural foods (those produced by non-genetically modified techniques) are protected from contamination; cloned animals and their offspring must be rigorously tracked throughout the food chain.

-- Genetic engineering patent holders are held legally liable for contamination of non-genetically engineered crops and growers are protected when their crops are contaminated by genetically engineered crops.

About Catholic Healthcare West

Catholic Healthcare West (CHW), headquartered in San Francisco, CA, is a system of 41 hospitals and medical centers in California, Arizona and Nevada. Founded in 1986, it is one of the nation's largest not-for-profit healthcare systems and the largest Catholic healthcare system based in the Western United States. CHW is committed to delivering compassionate, high-quality, affordable health care services with special attention to the poor and underserved. The CHW network of nearly 10,000 physicians and approximately 53,000 employees provides health care services to more than five million people annually. In 2008, CHW provided $967 million in charity care and unsponsored community benefit. For more information, please visit our website at www.chwHEALTH.org.

Contact:
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Ke Kula 'o Samuel M. Kamakau, LPCS

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E mālama 'ia ana ka mauli ola o kākou mai kēlā hanauna a i kēia hanauna.
Our spirit of being is nurtured from generation to generation.

Testimony in SUPPORT of HB1663, and in OPPOSITION TO HB1226

March 4, 2009

Aloha kakou elected lawmakers,

Ke Kula O Samuel Manaiakalani Kamakau is a Hawaiian immersion charter school located in Kane'ohe Hawai'i. Our school focuses on educating our future leaders and community members with an emphasis on some key principles and Hawaiian values including: Malama 'Aina, Stewardship of the Land. Malama Kino, Health and Wellness. 'Ai Pono, Healthy Diet.

We the 'Uo Mamo, or Board of Directors comprised of representatives consisting of school faculty including school director, teachers, support staff, parents, students and community members of Ke Kula O S.M. Kamakau firmly request that you, the lawmakers elected to represent us, **support legislation imposing a ban on Gentically Modified and Gentically Engineered taro of ALL varieties of taro (colocasia esculenta) in Hawaii, and oppose any legislation preempting genetic modification at any level in Hawai'i.**

Our request is validated on several levels.

1. Genetically engineered taro has not been proven safe for our environment and cross contamination will pose unnecessary risks to our 'aina as well as to our native varieties of taro.
2. Gentically modified and engineered products have not been proven safe for human consumption and also poses a threat to the well known hypoallergenic properties of taro (see reference attached).
3. Genetic engineering of kalo or taro is disrespectful to Hawaiian values and beliefs.

As an educational organization that utilizes taro farming, preparation and consumption as key components of our curriculum, our concerns are great regarding this issue. As an educational program that has hopes to restore one of the largest know lo'i or wetland taro patches in the area of Ha'iku, our recognition as taro farmers and exponential amounts of future taro farmers are undeniable. The purity and integrity of taro is extremely valuable if not vital to the future of many of our lessons to be taught.

We SUPPORT legislation as indicated in HB1663 banning genetic modification of ALL taro vaieties in Hawai'i, and OPPOSE legislation as indicated in HB1226 gmo preemption bill, for the same reasons listed above.

Mahalo Piha,
Ke Kula O Samuel Manaiakalani Kamakau
'Uo Mamo

SEE ATTACHED REFERENCE

Dona, A. and I.S. Arvanitoyannis. 2009. Health Risks of Genetically Modified Foods. Critical Reviews in Food Science and Nutrition. 49:2,164-175

<u>Health Risks of Genetically Modified Foods</u>
Dona, A. and I.S. Arvanitoyannis. 2009.
Critical Reviews in Food Science and Nutrition.
49:2,164-175

Overview
Need for testing
Effects on animal growth
Effect on gastrointenstinal tract
Effects on the liver
Effect on pancreas
Effect on the blood
Effects on the immune system
Effect on biochemical parameters
Mortality
Developmental effect on fetus, babies
Pleitropic and insertional effects (when genes influences multiple traits, thus one mutation such as from gmos can affect all traits)
Gmo growth hormone in milk, effect on host animal
Gmo growth hormone in milk, IGF effect on human health
Pigs expressing human growth hormone
GM pigs
On antinutrients
On potential transfer to the gut
Allergic responses
Bt expressed in many crops, farm workers exposed to

OVERVIEW

First, the authors challenge the concept of "substantial equivalence," which was used as a justification by the FDA to deregulate several key GM crops:"Substantial equivalence" may provide some theoretical points background in predicting toxicity, but in practice the only reliable way to evaluate the toxicity of a GM food is through toxicity tests on animals.

Furthermore, it has been argued that GM foods should be subjected to the same testing and approval procedures as medicines (i.e., clinical trials) since they must be adequate to ensure that any possibility of an adverse effect on human health from a GM food can be detected."On the premise that GM crops are safe because no evidence exists to the contrary this article indicates that:"In the absence of adequate safety studies, the lack of evidence that GM food is unsafe cannot be interpreted as proof that it is safe."

Also:"The results of most of the rather few studies conducted with GM foods indicate that they may cause hepatic, pancreatic, renal, and reproductive effects and may alter hematological, biochemical, and immunologic parameters the significance of which remains unknown. The above results indicate that many GM food have some common toxic effects. Therefore, further studies should be conducted in order to elucidate the mechanism dominating this action."

Also:"Small amounts of ingested DNA may not be broken down under digestive processes and there is a possibility that this DNA may either enter the bloodstream or be excreted, especially in individuals with abnormal digestion as a result of chronic gastrointestinal disease or with immunodeficiency"

Need for testing

"The toxicity tests should comply with the guidelines for toxicity testing of drugs. It should be emphasized that since these GM foods are going to be consumed by every human being they should be tested even more thoroughly than drugs and more experiments are required in order to study the possible toxicity and make any conclusions."

Also:"postmarketing surveillance should be part of the overall safety strategy for allergies, especially of high-risk groups such as infants and individuals in "atopic" families"

Effects on animal growth

Body weight might be significantly altered as it has been shown with the consumption of Mon863 corn (Seralini et al., 2007) and GM rice on rats (Li et al., 2004).

Effect on gastrointenstinal tract

Stomach erosion and necrosis were reported in rats fed with flavr-savr GM tomatoes, while GM potatoes expressing Galanthus nivalis (GNA) lectin induced proliferative growth in their stomach which is of particular importance if one takes into consideration that glomelular stomach erosions can lead to life-threatening hemorrhage, especially in the elderly and patients on nonsteroidal anti-inflammatory agents (Pusztai et al., 2003).

Intestines may also be affected by GM food consumption as it has already been shown with GM potatoes expressing Bt toxin which caused the disruption, multinucleation, swelling, and increased degradation of ileal surface cells in rats (Fares and El-Sayed, 1998), GM potatoes expressing gna which induced proliferative growth in the small-large intestines (Ewen and Pusztai, 1999a) and GM soybean type Roundup Ready_R which caused moderate inflammation in the distal intestine of salmons (Bakke-McKellep et al. 2007)."Also:"Binding to surface carbohydrates of the mouse jejunum was also revealed with Cry1Ac protoxin of the Cry genes, the most common terminators applied in currently approved crops (Vazquez-Padron et al., 2000).

According to Pusztai et al. (2003) since it is the genetic manipulation process itself which led to toxicity, similar hazards might be seen in animals or humans fed genetically-manipulated soya, canola, and corn over a long period of time (i.e., years or decades). The chronic inflammation and proliferative effect that may be caused by some GM plants on the gastrointestinal tract may lead after years to cancer.

Effects on the liver

As for the effects of GM food on liver there are only a few long-term studies. It has been found that GM soya can alter the cell structure and functioning of the liver in mice reversibly (Malatesta et al., 2002; 2003; 2005) and can cause changes in histomorphology (Ostaszewska et al., 2005) and the protein profile of the liver in rainbow trout (Martin et al., 2003).

Alterations have also been observed in hepatic enzymes after consumption of raw rice expressing GNA lectin (Poulsen et al., 2007), GM Bt with vegetative insecticidal protein gene (Peng et al., 2007) and in DuPont's subchronic feeding study in rats fed diets containing GM corn 1507 (MacKenzie et al., 2007). These alterations in hepatocyte cells and enzymes may be indicative of hepatocellular damage. Consumption of Mon863 corn in rats led to increase in trigycerides in females (Seralini et al., 2007).

Effect on pancreas

GM soybean has also an impact on pancreas, since changes occurred in pancreatic acinar cells of mice and a high synthetic rate of zymogen granules containing low amounts of _-amylase (Malatesta et al., 2003)."Effect on kidneys"Another target organ of some GM crops is the kidney. Smaller kidneys were developed in DuPont's study in rats fed diets containing GM corn 1507 (MacKenzie et al., 2007), whereas consumption of Mon863 corn in rats led to lower urine phosphorus and sodium excretion in male rats. There were also small increases in focal inflammation and tubular degenerative changes characteristic of a classic chronic progressive nephropathy (Seralini et al., 2007). Rats fed GNA rice had elevated creatinine plasma concentration either due to some kind of renal effect or the increased water consumption in order to excrete the excess iron in the GNA rice diet (Poulsen et al., 2007).

Salmons fed GM soybean had higher head kidney lysozyme and higher acid phosphatase activities (Bakke-McKellep et al., 2007).

Effect on the blood

Response variables were observed in animals fed with GM crops. DuPont's study in rats fed diets containing GM corn 1507 showed a decrease in red blood cell count and hematocrit of females (MacKenzie et al., 2007) while GM corn Mon863 affected the development of blood with fewer immature red blood cells (reticulocytes) and changes in blood chemistry in rats (Seralini et al., 2007). Bt with VIP insecticidal protein gene caused a decrease in platelets, monocytes ratio in female rats, and an increase in the granulocytes ratio in male rats (Peng et al., 2007).

Effects on the immune system

As for the effects of GM crops on the immune system an increase in the production of Cry9C-specific IgG and IgG1 in rats and mice fed with GM heat-treated corn CBH351 was observed (Teshima et al., 2002) because the Cry gene possesses immunogenic properties as it was shown by Vazquez-Padron et al. (1999). Serum IgG mediates the inhibition of serum-facilitated allergen presentation. The presence of enhanced IgG Abs activates the IgG response (van Neerven et al., 1999) thereby indicating the occurrence of an allergic reaction having occurred, although Germolec et al. (2003) suggest that antigen specific IgG does not correlate to clinical allergy. Moreover, GM corn Mon863 caused higher white blood cell levels in male rats (Seralini et al., 2007). DuPont's sub chronic feeding study in rats fed diets containing GM corn 1507 showed that eosinophils concentration in females was decreased (MacKenzie et al., 2007).

Rats given a diet based on GNA rice showed enlargement of the lymph nodes, and decreased weight of the mesenteric and of the female adrenal lymph nodes which may be indicative of an immune toxic response (Poulsen et al., 2007).

Effect on biochemical parameters

Subchronic feeding of GNA rice in rats resulted in decrease in glucose, while cholesterol, trigyceride, and HDLD concentration were higher (Poulsen et al., 2007).

Mortality

An increased mortality was observed in rats fed with GM tomatoes since seven out of forty rats died within two weeks without any explanation (Pusztai et al., 2003).

Developmental effect on fetus, babies

Food-ingested M13 DNA fed to pregnant mice, was detected in various organs of fetuses and newborn animals, suggesting a possible transfer through the transplacental route (Doerfler and Schubbert, 1998). Maternally ingested foreign DNA could be a potential mutagen for the developing fetus. Birthrates of piglets fed GM corn in Iowa country displayed an 80% fall due to high levels of Fusarium mold (Strieber, 2002), although it has been claimed that Bt corn expressing Cry proteins is less contaminated with mycotoxins (Weil, 2005). A Russian rat study reported very high death rates in the young of rats fed GM soya (56% died) in stunted growth in the surviving progeny (Ermakova, 2005). A study of GM rice expressing Xa21 on the development of rat embryos showed that there was an increase in the body weight gain of pregnant rats, the body weight, body length, and tail length of fetal rats (Li et al., 2004) whereas GM rice expressing cowpea trypsin inhibitor caused an increase in the male rats' body length and in the female rats' red blood cell number, hemoglobin, and monocyte number (Zhuo et al., 2004)."

Pleitropic and insertional effects (when genes influences multiple traits, thus one mutation such as from gmos can affect all traits):

"Concern has been expressed about the above potential effects which might cause the silencing of genes, changes in their level of expression or, potentially, the turning on of existing genes that were not previously being expressed (Conner and Jacobs, 1999). This interaction with the activity of the existing genes and biochemical pathways of plants, may lead to disruption of metabolism in unpredictable ways and to the development of new toxic compounds or an increase of the already existing ones as it happened with two genetically produced foods, tryptophan and g-linolenic acid (Hill et al., 1993; Sayanova et al., 1997).

Moreover, research into epigenetics has also revealed that genes account for only a part of the control of the biochemistry of organisms, and organisms have a level of control above genes that interact with genes explaining why genetic engineering is so unpredictable, with different results produced by each attempt and why the products are often unstable. The possibility that an unidentified compound may be present in the GM food makes crucial that each transgenic food as whole food and not as a single protein should be tested directly for toxicity in animals, although as Kuiper et al. (2004) state there are limitations in establishing dose-response relationships."

Gmo growth hormone in milk, effect on host animal

The use of rbGH in dairy cattle in order to increase milk yield has caused large controversy. Problems occurring such as an increase in mastitis may pose a risk to human health since the increased antibiotic use leads to antibiotic residues in milk (Epstein, 1996). Adverse effects in cows have been observed including lameness, mastitis, subclinical ketosis, an increase in embryonic loss and abortion, a decrease in final pregnancy rates, as well as a decrease in birth rate (Dohoo et al., 2003). It should be noted that lameness has also been reported in studies with transgenic pigs genetically engineered to carry human and bovine growth hormone genes (Pursel et al., 1989).

Gmo growth hormone in milk, IGF effect on human health

The consumption of milk from cows injected rbGH leads to an increase in IGF-I in humans, since IGF-1 survives digestion (Xian et al., 1995). The oral free IGF-1 feeding studies in rats sponsored by Monsanto and Elanco looked at by the Joint Expert Committee on Food Additives (JECFA) in 1992 had ambiguous results since neither used IGF-1 associated with its binding proteins, which are resistant to acidic conditions and may enable IGF-1 to survive digestion in the stomach. Moreover, IGF-1 is protected from digestion by the major milk protein casein (Hansen et al., 1997) and the milks buffering effect (Xian et al. 1995). Moreover, Monsanto's 90-day rat study which had previously shown that rbGH "is not orally active in rats" was re-examined and it was found that rbGH elicited a primary antigenic response meaning that rbGH was absorbed intact from the gut (Eppard et al., 1997). The full significance of human exposure to rbGH and IGF-1 is unknown, particularly in the neonate, the subpopulation at greatest risk (Morris, 1999). According to Chan (1998), at least some of the absorbed IGF-I can effectively stimulate the proliferation of cancer cells. The increased levels of IGF-I in humans predict increased rates in colon, breast, and prostate cancer, since they stimulate the indolent slowly growing tumor cells that appear in an aging individual resulting in clinical cancer necessarily old. On the other hand, FDA states that this potential does not exist since any increase of IGF-I in milk is much lower than the physiological amount produced in the organism. These concerns about the consumption of milk from cows injected rbGH may be carried also to other animals such as pigs expressing human GH, pigs injected recombinant porcine somatotropin (rpST), and GH transgenic salmon.

Pigs expressing human growth hormone

Transgenic pigs expressing human GH showed dramatic effects in growth rates, feed conversion, and body composition, but exhibited serious side effects that were attributable to the high level of GH expression (Pursel et al., 1989). Repeated injections of rpST can also produce altered lipid composition similar to that of the GH transgenic pigs (Solomon et al., 1997).Growth hormone on fish However, when the fish growth hormone (GM) gene is introduced in salmon may GH circulation may elevate by 40-fold, leading to enlarged skulls and impair feeding and respiration (Dunham and Devlin, 1999). Experiments should be conducted in animals being fed GH transgenic salmon and other fish in order to examine whether the consumption of GH transgenic fish expressing high levels of GH will increase the levels of IGFI and lead to the same health risks as rbGH milk. It should be emphasized that as in milk there is a possibility that the presence of other proteins in the fish tissue may protect IGF- 1 from digestion, which remains to be demonstrated in animal studies.

GM pigs

The experiment of Saeki et al. (2004) with pigs containing spinach desaturase gene which converts saturated fat into the unsaturated fat linoleic acid resulted in a high degree of mortality in founders and the F1 generation. Increased mortality might have been due to a random integration process where the transgene can insert in and damage any active gene locus (insertional mutagenesis) or to the significant alteration in the embryonic lipid profile caused by the transgene. The porcine embryo is unique in its high intracellular lipid content, which is associated with its sensitivity against freezing or in vitro production (Niemann and Rath, 2001). We strongly believe that the same toxicity could occur if the pregnant pigs were fed only the new source of glinolenic acid obtained from transgenic canola or of any future modified crop, since it alters the percentage of 18:2n–6 in liver (Palombo et al., 2000). We should be aware that any change in the lipidprofile of liver can also result in changes in metabolism with unexpected consequences.

On antinutrients

"The insertion of a new gene can sometimes lead to increase in existing levels of anti-nutrients, some of which cannot be reduced with heat treatment (Bakke-McKellep et al., 2007). One of the most widely available commercial GM products nowadays glyphosate-resistant Roundup Ready_R soybean may display an increase in anti-nutrients (Padgette et al., 1996). Heat-stable anti-nutrients such as phytoestrogens, glucinins, and phytic acid were also found to cause infertility problems in sheep and cattle (Liener, 1994), allergenic reactions and binding to phosphorus and zinc thereby making them unavailable to the animal respectively (Adams, 1995). An increase in the anti-nutrient level should not be accepted since a GM food may be consumed as raw material."

On potential transfer to the gut

"short DNA fragments of GM plants have been detected in white blood cells and in milk of cows and in chicken and mice tissues that had been fed GM corn and soybean, respectively (Beever and Kemp, 2000; Einspainer et al., 2001; Hohlweg and Doerfler, 2001; Phipps and Beever, 2001). Furthermore, fragments of recombinant cry1Ab gene were detected in the gastrointestinal tract of

Bacillus thuringiensis (Bt)11 corn-fed pigs but not in the blood (Chowdhury et al., 2003). Therefore, it seems plausible that small amounts of ingested DNA are not broken down under physiological digestive processes. The fact that fragments of transgenic genes may not be detected in blood but can be detected in tissues of animals by PCR, underlies that they are in quite low levels in circulation and more sensitive methods of detection are needed (Puztai 2001).

Moreover, Murray and his coworkers (2007) showed that not all PCR assays can detect DNA in extractions of shortly cooked corn, making the interpretation of the results from PCR even more difficult. These limitations in the detection of GM DNA should make us reconsider the view that gene transfer cannot occur, which falls in agreement with the findings of Netherwood et al. (2004) that transgene from GM soya survived passage through the small bowel in human ileostomists. According to Flachowsky (2005) the uptake of GM DNA into cells of the gastrointestinal tract will normally have no biological consequences because the DNA will be degraded in the cell. The question is whether it can be degraded in patients with severe gastrointestinal diseases. In the unlikely event that the DNA is recombined into a host chromosome, the probability that it will exert any biological effect on that cell remains unknown."

Allergic responses

"The introduction of novel proteins into foods such as a GM soybean variety expressing methionine from Brazil nut (Nordlee et al., 1996) and GE corn variety modified to produce a Bt endotoxin, Cry9C (Bernstein et al., 2003) may elicit potentially harmful immunological responses, including allergic hypersensitivity (Conner et al., 2003; Taylor and Hefle, 2002).

Moreover, according to Prescott et al. (2005) the introduction of a gene expressing nonallergenic protein such as GM field pea, expressing alpha-amylase inhibitor-1, may not always result in a product without allergenicity. This study underlines the need to evaluate new GM crops on a case-to-case basis and to improve the screening requirements for GM plants. Brassica juncea, another GM plant, expressing choline oxidase gene caused low IgE response in mice and a cross-reactive epitope search showed a stretch similar to Hev b 6 having some antigenic properties although according to Singh et al. (2006) it had no allergenicity. These findings should be more carefully interpreted and repeated in other animal series in order to elucidate whether IgE response may play a role in toxicity.

As for Bt expressed in many crops, farm workers exposed to

Bt pesticide may develop skin sensitization and IgG antibodies to the Bt spore extraction (Bernstein et al., 2003)."Effects on animal growthBody weight might be significantly altered as it has been shown with the consumption of Mon863 corn (Seralini et al., 2007) and GM rice on rats (Li et al., 2004).

Dona, A. and I.S. Arvanitoyannis. 2009. Health Risks of Genetically Modified Foods. Critical Reviews in Food Science and Nutrition. 49:2,164-175

PRESS RELEASE
Feb 24, 2009

Bt Cotton: weaving a web of infertility

A recent survey conducted by Navdanya reveals shocking statistics of dramatic decreases in microorganisms and beneficial soil enzymes in the soil of Bt Cotton fields. The study comes amid controversial government attempts to commercially introduce Bt Brinjal into India, despite consistent opposition and growing evidence of the negative impact genetically modified organisms have on society, human health and the environment. Numerous studies have linked farmer suicides in India to Bt Cotton due to increased costs of agricultural inputs and falling market prices, resulting in insurmountable debts and desperation. Various other studies have found high rates of infertility in rats that are fed GMO products, animal deaths after grazing on GMO fields and butterfly deaths after feeding on Bt corn pollen. This study now provides damning evidence of the environmental degradation caused by Bt crops, as the crop literally kills organisms in the soil that make available the nutrients plants need to grow, a frightening trend that can lead to large scale desertification . Irregardless of these warning signs and significant opposition, European governments as well are trying to push through a GMO corn variety, Mon810. We demand that an international moratorium be placed in commercialization of GMO crops until there has been more studies conducted to confirm its safety to human health as well as the environment.

Navdanya's study was conducted in Bt cotton growing areas of Vidharbha, comparing the microbial biomass in the soil of Bt cotton fields with that of fields that grew other crops or other types of cotton. The survey found statistically significant drops in 2 microbes and 3 beneficial enzymes. These results are significant as it provides scientific evidence that Bt Cotton is making the soil infertile by decreasing microbial activity, and thus essentially killing the very soil that the crop is grown in. Additionally this proves that industrial agriculture creates a relentless cycle of despair as industrial agricultural products deteriorate soil fertility that then necessitates intensified fertilizer and agricultural application, which ultimately results in increased farmer's costs and soaring debts. It is interesting to note that the study was conducted in a region which has shown an alarmingly high rate of farmer suicides, a shocking 20,000 in the past 5 years. Finally, the fact that Bt cotton crops decreases microbial activity in the soil portends a future of sterile soil that may result in massive desertification and loss of arable land in the future in a time where food security is evermore essential.

The microbes with most significant drops are as follows Actinomycetes(17% decrease), Bacteria(14.2%), Dehydrogenase(10.3%) Acid Phosphatase(26.6%) and Nitrogenase(22.6%).

Actinomycetes play an important role in decomposition of organic materials, and thus provide a vital part in organic matter turnover and carbon cycles that replenish the supply of nutrients in the soil and is an important part of humus formation.

Bacteria are vital in recycling nutrients, contributing to many important steps in nutrient cycles, such as the fixation of nitrogen from the atmosphere and putrefaction.

Dehydrogenase enzymes play a significant role in the biological oxidation of soil and increase beneficial microbial activity.

Acid phosphatase enzymes are used by soil microorganisms to access organically bound phosphate nutrients, which make phosphates available to plants.

Nitrogenase is the enzyme used by some organisms to fix atmospheric nitrogenous gas. It is the only known family of enzymes which accomplishes this process.

EFFECT ON SOIL BIOLOGICAL ACTIVITIES DUE TO CULTIVATION OF Bt. COTTON

by

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EFFECT ON SOIL BIOLOGICAL ACTIVITIES DUE TO CULTIVATION OF Bt COTTON

A survey was conducted under Bt cotton growing areas of Vidharbha. Twenty five fields were selected where Bt cotton is growing for the last three years, which was compared with the adjoining fields where either other varieties of cotton was growing or any other crops were growing during that period. The areas covered between Nagpur, Amravati, Wardha and adjoining areas. The sampling was done in 2[nd] week of December during the crop harvest. The effect on microbial population was recorded as Table 5.

Table 5. Effect on microbial population due to cultivation of Bt cotton

Microoganisms	Control soil (Non Bt Cotton plots)	Bt cotton plots	% increase (+) or decrease (-)	Level of significant
Actinomycetes ($\times 10^5 g^{-1}$)	52.5	43.6	- 17.0	**
Bacteria ($\times 10^6 g^{-1}$)	85.9	73.7	- 14.2	*
Fungi ($\times 10^4 g^{-1}$)	31.2	31.3	+ 0.3	NS
Nitrifiers ($\times 10^2 g^{-1}$)	19.7	18.9	- 4.1	NS

[a] Average of 25 plots; NS - Non significant; * significant at 5% level; ** significant at 1% level

The results clearly demonstrated significant decline in actinomycetes (17%) and bacterial (14.2%) population in Bt cotton plots. No change in fungi population was noticed and there was insignificant decline (- 4.1%) in nitrifiers population.

A significant decline in total microbial biomass (8.9%) was also noticed due to cultivation of Bt cotton (Fig. 6). The results pointed out that Bt cotton adversely affected on some group of microorganisms, which ultimately helps in reduction to microbial biomass.

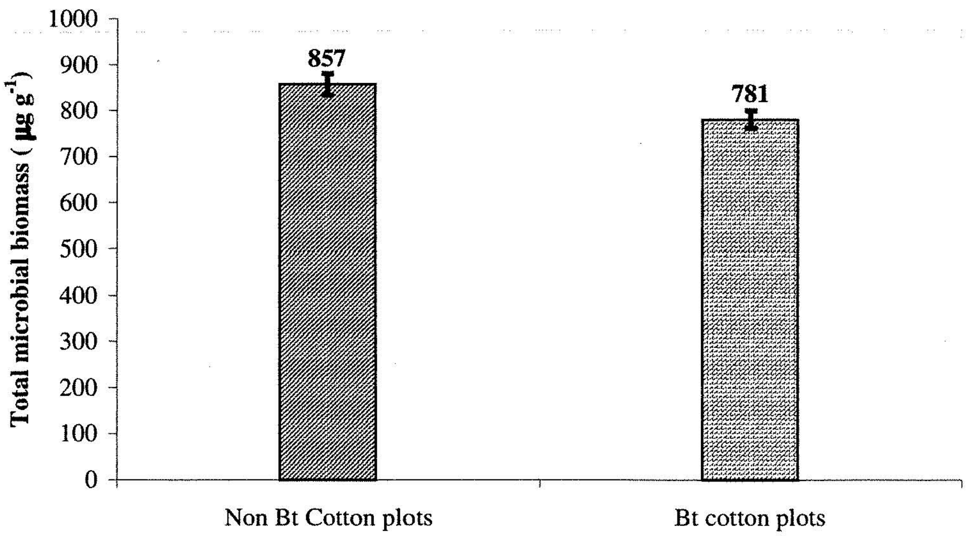


Fig. 6. Effect on microbial biomass due to cultivation of Bt cotton (Bar represent the standard errors of the mean)

The effect on different beneficial soil enzymes such as dehydrogenase, esterase, acid phosphatase, alkaline phosphatase and nitrogenase was studied under Bt cotton growing areas.

Table 6. Activities of soil beneficial enzymes[a] due to the cultivation of Bt cottons

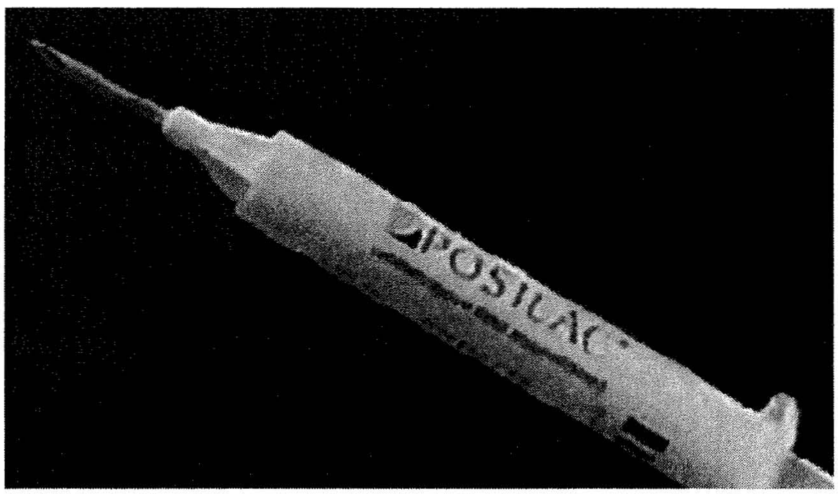
Types of enzymes	Control soil (Non Bt cotton plots)	Bt cotton plots	% increase or decrease	Level of significance
Dehydrogenase (p kat g^{-1})	6.52	5.85	- 10.3	*
Esterase (EU × 10^{-5})	45.23	41.79	- 7.6	NS
Acid phosphatase (EU × 10^{-5})	29.75	21.85	- 26.6	***
Alkaline phosphatase (EU × 10^{-5})	32.15	31.92	- 0.7	NS
Nitrogenase (n mol C_2H_4 h^{-1})	439	340	- 22.6	**

[a]Average of 25 plots; NS – Non significant; * significant at 5% level; ** significant at 1% level; *** significant at 0.1% level

The result showed (Table 6) significant reduction in acid phosphatase (26.6%), nitrogenase (22.6%) and dehydrogenase (10.3%) activities under Bt cotton growing fields. A slight reduction in esterase (7.6%) and alkaline phosphatase (0.7%) activity was observed but the results are not statistically significant. The present results clearly demonstrated that Bt cotton cultivation definitely affect soil biological health especially beneficial microorganisms (actinomycetes, bacteria) and enzymes (acid phosphatase, nitrogenase and dehydrogenase).

Land of the GM-Free?

How the American public are starting to turn against GM food



Soil Association

Land of the GM-Free?

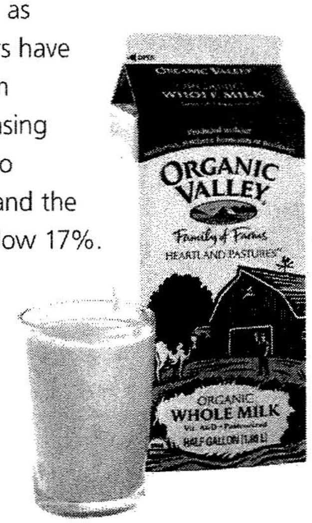
Executive summary

Despite the fact that 87 per cent of Americans believe that their food should carry a label telling them whether Genetically Modified (GM) products have been used in it or not, almost none do. As a result GM food has been sold widely and for many years in the USA – without consumers being aware of what they are buying. The powerful pro-GM lobby in the USA has used this as evidence that the public accept, or are at least neutral, on the issue of GM food. But given a choice, over 50 per cent of Americans say they would not eat GM.

The GM industry has managed to keep US consumers in the dark about the food they are eating for more than a decade, through lobbying the US Food and Drug Administration (FDA) and state governments to ensure that foods do not legally have to be labelled as GM. But some major new developments in the US market suggest that the tide may finally be turning against the GM lobby. This briefing is not intended to be comprehensive, but it highlights some significant developments that are being ignored in the current UK debate about GM.

In 1994 Monsanto produced a genetically engineered bovine growth hormone (rBGH) that is injected into dairy cows to increase the yield of milk. This GM hormone has faced criticism internationally since its launch on the grounds of both human health risks and animal welfare concerns. While the EU and Canada rejected it, it was deemed safe by the US Food and Drug Administration and the World Trade Organisation (WTO), and has been used widely in the US dairy industry, without any labelling of the milk as 'GM-produced'. Monsanto worked very hard to ensure that consumers have no way to make a choice – getting some US states to ban dairies from selling their milk with 'no artificial growth hormone' labels. But increasing consumer awareness of rBGH in the US has caused sales of the milk to plummet. Between 2002 and 2007 use of the hormone fell by 23% and the proportion of US cows being injected with rBGH fell from 25% to below 17%.

Understanding their customers wishes, many major retailers, processors and producers have recently moved to ban rBGH from their products, with Walmart, Safeway, Starbucks, Kraft and many more ensuring that their customers can buy GMO free dairy products for themselves and their families. Opposition to the use of this hormone has grown so much that Monsanto announced last



month that they would be selling off the failing product.

As well as this growing consumer rejection of GM food in America, GM companies have had to face opposition by US farmers and regulatory authorities to a series of new GM products. Both GM rice and GM wheat faced such strong opposition from farmers that they never made it out of field trials, and have never been grown commercially in the USA. Hardly any GM sweet corn[1] for human consumption is grown either (as opposed to maize grown for animal feed), for the simple reason that it tastes so bad that consumers won't buy it.

Attempts to launch GM alfalfa, America's fourth most widely grown crop, have also fallen flat. Farmers took legal action against the release of the crop and won. In 2007 the USDA was ordered to withdraw its approval of the GM alfalfa, a ban was placed on all planting of the crop and the sale of GM alfalfa seeds has now been prohibited throughout the USA. There is also evidence that US plant breeders are rejecting GM technology in favour of more reliable and effective methods such as marker assisted selection. Despite soya being one of the most widely grown GM crops, the newest high-yielding soya strains are non-GM.

For the first time in the USA, a major labelling initiative is underway that will finally provide consumers with the option of choosing a wide range of non-GM foods. The biggest companies in the natural and organic industry have united to develop a non-GMO label scheme that offers consumers the choice they clearly wish for, backed up by a robust verification system to ensure that it is a claim they can trust. This new 'Non-GMO Project' will be launched next year. It is led by a group of companies with combined annual sales of at least $12 billion – equivalent to almost 10% of the entire UK food and drink industry. Around four hundred companies across the US and Canada have pledged their support, and at the outset around 28,000 different products are likely to be covered by the scheme.

With US consumers, farmers and politicians losing their enthusiasm for GM crops, it is not surprising that the GM industry has scaled up its efforts to find a new market in the EU. But in Europe, over 175 regions and over 4,500 municipalities and local areas have declared themselves GMO-free. Major countries that once supported GM, like France and Germany, no longer do so, and the Republic of Ireland, Northern Ireland, Scotland and Wales are all committed to GM-free policies. It is just the strongly pro-GM English Government that looks increasingly out of touch with what consumers really want.

1 This report uses English terminology for crop names. We use 'maize' not 'corn' (for the crop used as animal feed), and 'sweet corn' for the maize people eat. 'Oilseed rape' is used instead of the North American 'canola'. Note that 'alfalfa' is also called 'lucerne' in the UK.

Monsanto's GM bovine growth hormone

What is it and what does it do?

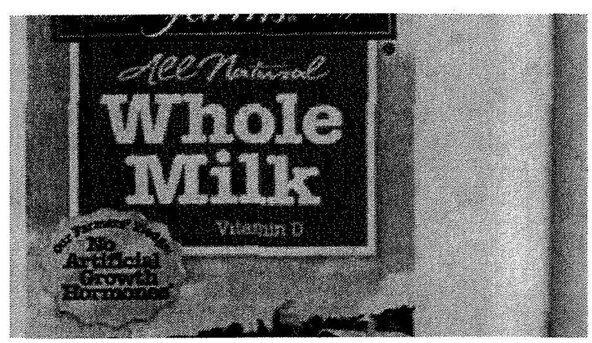
In 1994 Monsanto released a new GM product onto the market: recombinant Bovine Growth Hormone (rBGH), trade name Posilac (also known as rBST). It is an artificial, genetically modified version of bovine somatotropin, a hormone produced in the pituitary gland of cattle that stimulates growth in young cattle and lactation in adult cows. When the GM protein is injected into dairy cows (they have to be repeatedly injected every two weeks), it has the effect of increasing milk production by 7-15%.

Health

The use of rBGH has been controversial primarily due to its negative effects on animal health and concern has also been expressed by scientists over its potential effects on human health.

Meta-analyses of the scientific evidence published by the Canadian Veterinary Medical Association and the EU Scientific Committee for Animal Health and Animal Welfare have concluded that the use of rBGH causes 'substantially and very significantly poorer welfare in cows'. Their findings indicated that cattle receiving rBGH injections suffer from:

- 50% increased incidence of lameness
- 25% increased incidence of mastitis, a painful infection of the udder
- 18% increased incidence of infertility, an indicator of overall poor health
- infection at the site of injection, with lesions exacerbated by repeat injections
- substantial increase in multiple births which can lead to welfare problems



As well as these serious negative impacts on the welfare of cows, there are risks to human and animal health:

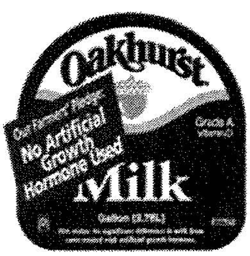
- the routine use of antibiotics to combat the elevated levels of disease in cows contributes to the development of resistant disease strains and thus reducing the available drugs for both human and animal use
- veterinary drugs found in milk
- elevated levels of pus in the milk from infected udders

Scientists have raised the possibility of several other human health risks resulting from consumption of milk produced with rBGH. While there does not appear to be a higher level of bovine growth hormone in milk from treated cows, levels of insulin-like growth factor 1 (IGF-1) are significantly elevated to at least 5 times the normal level. This substance is identical in both cattle and humans, and increased levels of IGF-1 in humans have been linked to cancer of the prostate, breast and colon. Indeed, an inquiry by the UK Veterinary Products Committee in 1999 stated that the likely increase of IFG-1 in the gut lumen following consumption of rBGH treated milk raised concerns about enhanced cell proliferation of the gut mucosa and therefore increased risk of cancer of the colon.

Regulation

The drug was approved for full distribution in the United States in 1993 by the US Food and Drug Administration (FDA), on the basis of one 90 day study on 30 rats that had been carried out by Monsanto.

Regulators in the EU and Canada were not convinced. Health Canada (the Canadian equivalent of the US FDA) stated that the results of Monsanto's rat trial showed cause for concern, and, following a detailed safety review, made the decision to ban the use of rBGH on the basis of unacceptable risks to animal health. EU regulators also refused approval for the drug, and launched an in-depth scientific study on the risks of using artificial hormones in farm animals. Their research led to a ban on rBGH use in the EU in 1989, made permanent in 2000, and the additional decision to ban imports of hormone-treated beef, which effectively blocked the majority of imports of beef from North America. In 1996 the USA complained to the World Trade Organisation, which eventually ruled in its favour, stating that the EU had not provided enough significant proof of danger. In contrast to its position on GM crops, the EU stated that it was the product's safety that should be conclusively proven, not its risks. The EU stood firm on its health concerns, and rather than allow synthetic hormones into the European food supply, it endured US trade sanctions amounting to 116.8 million USD per year on such items as Roquefort cheese and Dijon mustard. These sanctions are still in effect today.



FDA states: No significant difference in milk from cows treated with artificial growth hormone.

Currently, rBGH is not approved for use in Japan, New Zealand, Australia, Canada or the European Union.

Use in US – widespread and unlabelled but not without controversy

Despite the international controversy, Monsanto's GM hormone was launched in 1994 in the US, and by 2002, around a quarter of cows in the country were being treated with rBGH.

The FDA stated that since the recombinant, or genetically engineered form of BGH looks virtually identical to a cow's natural somatotropin, there is no significant difference between milk from treated and untreated cows. The FDA also concluded that it did not have the authority to require special labelling for milk and dairy products from rBGH-treated cows. While permitting dairies to label milk as 'from cows not treated with rBGH/artificial growth hormone', they stated that producers have no basis for claiming that milk from cows not treated with rBGH is safer than milk from rBGH-treated cows.

Despite these assurances, the American public were not as easily pacified as Monsanto might have hoped. Consumer groups were active in raising awareness of the risks of rBGH and while hormone-treated dairy products had become the norm in supermarkets and the food service sector, increasing numbers of smaller dairies chose to advertise their non-use of rBGH to their customers. Monsanto went on the offensive and sued a number of these dairies, alleging that they were illegally suggesting that non-rBGH milk was superior. In several cases, dairies were forced to add text to their labels echoing the FDA's statement of rBGH's safety.

This didn't fool the American public. The campaign against rBGH continued, scientists and doctors spoke out in the media about their concerns, and at their annual conference in June 2008 the American Nurses Association voted to work to "eliminate the use of rBGH in the US by appealing to those who make purchasing decisions within the institutions where we work".

Since Monsanto introduced rBGH to the dairy industry in 1994, demand for milk produced without synthetic hormones has increased by 500%. Many consumers switched to organic milk as, in the absence of reliable information, it was the only label they trust enough to give to their children. Between 2002 and 2007 use of the hormone fell by 23% and the proportion of US cows being injected with rBGH fell below 17%.

Desperate measures

Last year, Monsanto appealed to the FDA to block all labelling that refers to production without rBGH, and to the Federal Trade Commission to block any advertising of milk that mentioned non-use of the synthetic hormone. Both bodies dismissed Monsanto's complaint, stating that they would only intervene where fraudulent claims were made.

Since Monsanto failed to get federal support to impose a blanket ban on references to rBGH-free production, it started to campaign to restrict labelling information on a state-by-state basis. With the backing of a few of the most intensive dairy farming companies, Monsanto have been exerting pressure on state governments but have faced strong opposition from consumer groups and farmers.

In both Ohio and Utah laws are being considered that would ban 'rBGH-free' labels as 'misleading' on the basis that this couldn't be verified by a simple compositional test of the milk. Utah are proposing to ban all statements about production methods, while in Ohio any mention of rBGH on a label would have to be accompanied by the statement "FDA says no significant difference has been shown between milk derived from rBST-supplemented and non-rBST supplemented cows" in a specified font, size and package location. Both the International Dairy Foods Association and the Organic Trade Association are currently pursuing legal challenges against this.

Another attempt to limit consumer information was made in Pennsylvania last year. The Secretary of Agriculture proposed a law in October 2007 that banned non-rBGH labelling. Following an outcry by consumers and the dairy industry, this was overturned by the Governor in January 2008.

Monsanto have tried to push similar labelling restrictions through in Indiana, Missouri, Kansas, Vermont and New Jersey, but in each case the ban has so far failed to make it through the state legislature.

A further last ditch move to save the drug's image was the attempt to rebrand rBGH as environmentally friendly. Jumping on the green bandwagon, the company saw an opportunity to trivialise the drug's welfare issues by presenting them as a necessary sacrifice to be made in a time of climate change crisis, where global food shortages and carbon emissions could only be solved by the production efficiencies rBGH provided.

A study led by a former Monsanto-employed consultant and co-authored by the company's rBGH technical project manager proposed that rBGH use provides a way to reduce greenhouse gases, as the same quantity of milk can be produced by fewer cows. But as the journal Scientific American pointed out, the study hinged on the assumption that the cows injected with the GM hormone produced more milk for a given amount of feed – a claim specifically disallowed by the FDA when the drug was approved in 1993. In fact an rBGH herd would be consuming the same amount of feed – land, oil-based fertiliser and fuel for intensive cereal production – as a slightly larger non-rBGH herd producing the same amount of milk. The rBGH cows would need more veterinary drugs and produce lower quality milk. Both the US National Academy of Sciences and the US Environmental Protection agency have dismissed claims that rBGH could have any environment benefits.

Market defeat

2007 represented a turning point in consumer rejection of Monsanto's GM hormone. Demand for clean milk reached a critical mass, and major American brands paid attention. Knowing the importance of meeting their customers' demands, the country's biggest supermarket chains rushed to ban rBGH from their milk. By 2008 Costco, Kroger, Publix, Safeway and, most significantly, Wal-Mart have all removed rBGH from their own-brand milk. This has had a major impact all the way down the supply chain, ultimately pushing the nation's biggest dairy, Deans Foods, and their near-exclusive supplier Dairy Farmers of America, to phase out use of the drug. Starbucks announced in January 2008 that they had gone entirely rBGH-free, as did Chipotle, a national restaurant chain. Manufacturing giant Kraft is now producing an rBGH-free version of its cheese products. At the end of July this year, in what has been hailed as a major victory for consumers, Monsanto announced that it would be selling off the failing product.

First major GM labelling initiative in USA: the Non-GMO Project

In a recent poll, 53% of Americans said that they would not eat GM foods. This shows a significant disparity between what consumers in the US want from their food system and what that food system is actually delivering. It also demonstrates a lack of consumer knowledge about the proportion of food in America that contains GM. The majority of this 53% will already be unwittingly consuming GM food every day against their wishes, because GM food is currently not labelled in the US, despite the fact that 87% of Americans believe that it should be.

The US Government's opposition to telling American consumers that some of their food is GM stems from the greatest coup by the GM companies, which was to ensure no GM food had to be tested for safety. The concept of "substantial equivalence" means that if a GM crop looks like its non-GM equivalent and grows like it, then it is assumed to be the same, and no safety testing is needed before people eat it. GM maize may have added virus and antibiotic resistance genes, and a gene that makes it express an insecticide in every leaf, stem and root – but to the US government it looks and grows like maize, so it is safe to eat.

> *"I think that consumer rejection of GMOs is growing, and that giving the public here a choice will be a significant catalyst for continuing that trend"*
>
> Megan Thompson, Executive Director, the Non-GMO Project

This has meant that GM foods don't have to be labelled, and has resulted in widespread ignorance among consumers about the presence of GM in their food. Keeping consumers in the dark has prevented them from making real choices about the food they eat. Without labels the principles of supply and demand are no longer in effect as consumers can't send a message to farmers and manufacturers about what they do, and don't, want to eat.

Barriers to non-GM status for companies

Even though general consumer knowledge of GMOs is low in the US, there are still consumers who are well-informed and want to feed themselves and their families non-GM foods. North America has a thriving natural products industry and many organic and natural food companies. These companies have made a number of attempts to maintain non-GM status, however:

- companies can only control their own operating systems, with limited influence over others in the supply chain
- working in isolation companies do not have the market clout to secure clean supplies of ingredients, in some cases having to discontinue some product lines

as they could no longer secure guaranteed non-GM ingredients

- it is costly to devise and regulate a GMO traceability system, maintain a testing regime, market non-GM status, and educate and inform consumers
- the lack of one recognised label that guarantees non-GM status led to distrust of non-GM claims among consumers, exacerbated by a number of high profile incidents in which foods labelled GM-free were found to contain GMOs after all.

This has been a particular threat to organic businesses. In the US, the Government's organic standards say that certified foods should not be produced with GM ingredients, but a certain level of 'unavoidable' GM contamination is tolerated. This is seen by some as the thin end of the wedge, and as the GM crop acreage rises, organic companies have decided to take action to safeguard the future against the possibility of losing non-GM supplies of corn and soy in the next few years.

The Non-GMO Project

In 2005, two natural food retailers started the 'Non-GMO Project ', to develop a robust, industry-wide non-GMO verification system that would provide consumers with a trustworthy and recognisable non-GMO label to look for on products. The project would provide efficiencies of scale and would enable certification to be done in a simple low-cost way. The companies' united front could send a message to suppliers about non-GMO demand. They ensured the project would have robust scientific backing, and by 2007 the project expanded its board of directors to include representatives from all stakeholder groups in the natural products industry.

> *"By giving people here an informed choice, the Non-GMO Project is going to help align the food production in North America with what people here really want."*
>
> Megan Thompson, Executive Director, the Non-GMO Project

The project is now supported by the biggest companies in the North American natural and organic sector, an industry worth over $62 billion in the US alone. Well-known brands such as Whole Foods, Seeds of Change and Nature's Way are supporting the campaign, along with around 400 companies across the US and Canada, representing annual sales of around $12billion.

The Non-GMO verification scheme has just opened (summer 2008) for product registration. Already several hundred products have been enrolled and it is anticipated that several thousand will be registered in the coming months. The project has also set up an ingredient supplier database to help manufacturers find uncontaminated ingredients through access to a list of verified non-GM suppliers. As increasing numbers of processors and distributors get their products verified, the database of trusted sources is growing.

The Non-GMO seal will be launched on labels in October 2009 in conjunction with a major consumer awareness campaign. Several things indicate that the US market is ready for this sort of initiative. Greater interest in healthy food among consumers is reflected by the steady growth in sales of natural and organic food. In 2007, the US natural products industry was worth $62 billion and growing at 10%, while the organic sector was worth $20 billion and growing at 21%. With the uproar over rBGH dairy products finally making GM a prominent consumer issue, American consumers are beginning to ask more questions about where their food comes from.

The project is anticipating registration of around 28,000 unique products from the organic and natural industry in the verification scheme over the next few years, representing 70% of the sector. By implementing the non-GMO standard, the project aims to keep new GM crops from gaining dominance and build a resilient non-GM food sector within the United States.

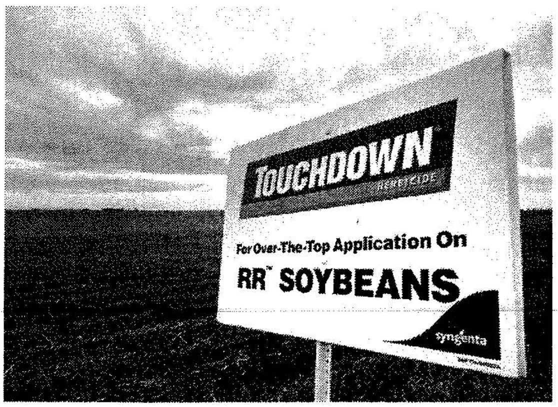
"The industry is fairly integrated as far as production facilities and ingredient supplies, and by gaining agreement about what "non-GMO" means we finally have the opportunity to really change things and take a united stand against unwanted GM contamination."

Megan Thompson, Executive Director, the Non-GMO Project

Above: the founding leaders of the Non-GMO Project

Rejection of new GM crops by farmers, regulators and plant breeders

On top of the growing consumer rejection of existing GM food in America, GM companies have faced rejection of a series of new products by US farmers and regulatory authorities. GM wheat, rice and alfalfa have all failed to get off the ground, as has GM sweet corn, which consumers simply refused to eat because it tastes so bad. In fact, after the first handful of GM crops were introduced in America in the late 1990s, US farmers and consumers have stopped any more commercialisation of GM crops. This suggests that the claim from the pro-GM lobby that GM crops have been welcomed by US farmers deserves scrutiny.



The US regulatory approval process is also increasingly questioned. Proposed field trials of several new GM crops, such as drug-producing maize and sugar cane and herbicide tolerant bentgrass, have been subject to federal court cases. In each case the court ruled that the United States Department of Agriculture (USDA) had broken the law in granting the trials approval without adequate safety data. In 2007 a federal district judge ruled that the USDA must halt approval of all new GM field trials until more rigorous environmental reviews are conducted.

GM Wheat

Following the widespread introduction of Monsanto's Roundup Ready GM maize, soybeans and oilseed rape (all engineered to be resistant to the weed-killer Roundup, which usually kills all plants), the company soon produced a Roundup Ready GM wheat variety. Monsanto expected their new wheat to get the same easy ride that greeted the first GM crops. However, several years experience of the first GM crops resulted in enormous opposition to GM wheat from the food and farming industries. American farmers had learned the hard way that their export markets did not want GM food, and the benefits for farmers that GM companies claim were obviously not enough to make the risk worth running. As GM varieties of maize, soybeans and oilseed rape gained in dominance, initially through deliberate plantings but accelerated by cross-contamination, US farmers had watched helplessly as huge international customers from Europe, Japan and other countries rejected their grain in preference to non-GM crops.

Studies predicted that GM wheat would fare no better. An economic report by Iowa State University produced in 2003, and updated in 2005, estimated that the commercial introduction of a GM variety of wheat could result in the loss of one third to one half of the US export market and that the price of spring wheat would plunge by a third. In part there was heightened opposition to GM wheat both within the US and internationally because, while existing GM crops are primarily grown for animal feed, wheat is used both for animal feed and for human food. The idea of GM daily bread was a step too far for consumers. The mainstream farming industry in the US lobbied against this new GM crop, saying that the introduction of GM wheat would be a serious threat to the economy, and the Canadian Wheat Board produced a damning report showing that, based on their country's experience of herbicide tolerant GM crops thus far, Monsanto's GM wheat should also be banned on environmental grounds.

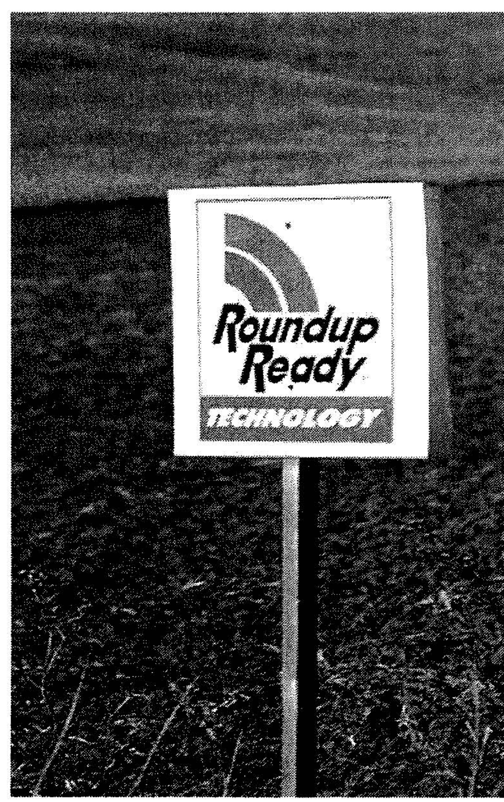
In the face of such categorical rejection, Monsanto abandoned its field trials of Roundup-Ready wheat in 2004, stating that it was more profitable for the company to concentrate its efforts on soya, maize and oilseed rape.

GM Alfalfa

Alfalfa, a grass used for animal feed, is the fourth most widely grown crop in the USA, behind corn, soybeans and wheat, and it is the third most economically valuable. More than 20 million acres of alfalfa are grown in the United States and it is the most important forage crop, providing feed for the nations beef and dairy cattle in particular.

In 2005, a GM strain of alfalfa was approved by United States Department of Agriculture (USDA). It had been developed by Monsanto in partnership with America's largest alfalfa seed company, Forage Genetics International. This alfalfa was engineered to withstand Monsanto's trademark glyphosate herbicide 'Roundup'. However, despite regulatory approval, a large number of American farmers also rejected the introduction of this new GM crop.

Alfalfa is an open-pollinated crop and pollen grains can travel long distances in the wind or via pollinating insects. This poses a serious contamination risk for conventional and organic growers, and cross-pollination could quickly reduce and even wipe out the US supply of non-GM alfalfa. Not only are those growing non-GM alfalfa unprotected from the economic damage that GM contamination causes, but they are also vulnerable to harassment and lawsuits from Monsanto if GM alfalfa is found on their land. Monsanto sues farmers with GM crops growing on their farms for patent violation, even if they have never actually planted any GM seeds themselves. In addition, many farmers currently produce normal alfalfa with minimal, if any, use of weed-killers. The introduction of a GM herbicide tolerant variety would not only encourage the use of far greater quantities of glyphosate, but also speed the growing development of glyphosate resistance in weeds, meaning that ever more toxic herbicides would need to be applied to all alfalfa crops to control them.



In February 2006, a coalition of alfalfa producers filed a lawsuit against the USDA claiming that GM alfalfa was a threat to both the environment and to farmers' livelihoods. The case was heard a year later, and in a landmark decision, the court ruled in their favour, declaring that the USDA had violated the law and had been "cavalier" in deciding that a full environmental impact statement was not necessary. The judge stated that "A federal action that eliminates a farmer's choice to grow non-genetically engineered crops, or a consumer's choice to eat non-genetically engineered food, is an undesirable consequence". The USDA was ordered to withdraw its approval of the GM alfalfa, a ban was placed on all planting of the crop and the sale of GM alfalfa seeds has now been prohibited throughout the USA. Despite an appeal by Monsanto, their GM alfalfa remains illegal until they can prove through a full environmental review that farmers and consumers will be protected, and non-GM crops will not be affected by their product.

GM Rice

Despite the development and USDA approval of several strains of GM rice, not one type is grown commercially in the United States. The US rice industry has consistently opposed the growing of GM rice, aware that there is no market for it. A number of key events have ensured that they are in no hurry to change their minds. In the last two years, catastrophic GM contamination incidents have put the entire US long-grain rice industry in crisis and cost the sector over $1 billion. In 2006 it was discovered that Bayer CropScience, a giant biotechnology firm, had accidentally contaminated over 30% of the entire US long-grain rice supply with three of their GM varieties, two of which had not been approved for cultivation or consumption anywhere in the world. None of the contaminant strains had ever been grown commercially, and the only possible source of contamination was traced to field trials carried out years earlier, between 1998 and 2002. It has not been established whether the contamination occurred through cross-pollination or through a post-harvest mix-up, but there should have been no route to the food supply for these experimental crops. The incident had powerful global consequences. The EU, Japan, Korea and the Philippines imposed strict testing requirements and effectively shut down rice trade with the US, halting shipments, cancelling orders and recalling rice from supermarket shelves. Several other countries imposed bans on US rice or demanded non-GM certification before purchase, and soon the major rice-importing countries had switched to suppliers such as Thailand or Vietnam, who quickly pledged to remain GM-free. Furious US rice farmers and traders filed multi-million dollar class action lawsuits against Bayer CropScience, but even compensation for their harvests will not undo the serious and continuing damage to the US rice industry.

A second serious contamination incident occurred just one year later, in early 2007. It was announced that 'Clearfield 131', one of the most popular non-GM long-grain rice seeds had become contaminated with an unapproved GM strain, again from Bayer CropScience. Sale of the seed was quickly banned by the USDA, and some farmers were forced to destroy crops already sown. Combined with the ban on rice seed that had been contaminated in the Bayer incident of 2006, this new discovery had the effect of seriously cutting the amount of available rice seed for farmers to plant, and led to reduced harvests with some farmers abandoning rice growing altogether. BASF, who produce Clearfield 131 lost up to $9 million dollars in the incident.

Bayer's clear inability to control contamination has led to rice producers calling for a ban on all experimental outdoor plantings of GM rice, and it seems that the commercialisation of any GM rice varieties is unlikely to happen in America in the foreseeable future.

Highest yielding soya strains are non-GM

With pressure to develop higher yielding varieties of food crops, US plant breeders are rejecting GM technology in favour of more reliable and effective methods. Soya farmers have been frustrated for years by the slow pace of increases in soya yields. This has been due in part to the dominance of Monsanto's Roundup Ready soya over the last decade. This GM soya has been shown to yield less than non-GM varieties. However, Pioneer, a branch of biotech giant DuPont, have finally had some success. Ignoring unreliable GM techniques that disrupt the plant's biology, Pioneer have instead used marker-assisted selection (MAS) breeding. MAS uses knowledge of the genome to speed up the selection process, but uses conventional cross-breeding that allows the plant to maintain its own safe-guards on gene expression. MAS is a technique long supported by environmentalists and organic farmers. Results of crop trials demonstrate a 5-10% yield advantage for this MAS soya over competitive varieties. This approach echoes the latest rice breeding research taking place in South East Asia, as scientists pursuing the ideal of flood and drought resistant varieties have left GM techniques behind and are concentrating on the more successful application of MAS methods to meet these goals.

Conclusion

Since the introduction of GM food, probably the biggest selling GM food product bought by consumers in the US has been GM hormone-treated milk. Dairy products produced with Monsanto's GM growth hormone achieved huge market penetration following their launch in 1994, but are now on their way out due to consumer resistance. This resistance to GM-produced milk started when consumers began to see non-GM labelled milk in their shops.

Labelling milk as 'GM hormone free' has been the only significant move to label any food as 'non-GM' until now. Just open for product registration, the Non-GMO Project is a major new market-led initiative in North America that will provide the sort of labelling that killed GM food in the EU, Japan and other countries. Every attempt to pass laws on GM labelling in the US has been fought fiercely by Monsanto and other GM companies, but there is now strong support from companies with combined sales of $12 billion to give consumers accurate information about GM in their food.

Even though US consumers are turning against GM, the GM industry has always claimed that US farmers love GM crops. But in fact farmers rejected genetically modified wheat, one of the largest commodity crops in the world, and no GM wheat is grown in North America. Farmers have also rejected GM alfalfa, the fourth most widely grown crop in the US. Following a court victory for farmers, the USDA was ordered to withdraw its approval of the GM alfalfa, a ban was placed on all planting of the crop and the sale of GM alfalfa seeds has now been prohibited throughout the USA. Despite the development of many commercial strains of GM rice, no GM rice is being grown commercially in the US, and even in the case of soya, one of the most widely grown GM crops, the newest high-yielding varieties being developed are non-GM rather than GM.

These developments, combined with the possibility of Democrat Presidential Candidate Barack Obama's pledge to support legislation to label GM food if he should get elected, suggest that GM companies are in for a difficult few years in the USA. The increasing focus on the climate change impacts of farming, to which GM crops offer no solution, and expensive oil driving up the cost of nitrogen fertiliser, on which GM crops are dependent, also suggest the environmental and economic pressures on GM will increase.

With consumers, farmers and politicians in America losing their enthusiasm for GM crops, it is not surprising that the GM industry has scaled up its efforts to find a new market in the EU. Major European farming countries, like the previously enthusiastically pro-GM French and German governments have gone cold. Other EU countries, like Greece, have always resolutely opposed GM crops, and among the newer EU member states, many, such as Poland, have already adopted non-GM policies. Over 175 regions and over 4,500 municipalities and local areas in Europe have declared themselves GMO-free.

The Irish Republic, Northern Ireland, Scotland and Wales are all committed to GM-free policies. This has left just the present English government ministers on an increasingly lonely and desperate pro-GM quest, as consumers in their main pro-GM ally, the United States, increasingly reject this uncertain, risky and unproductive technology.

Kathleen Hewlett and **Peter Melchett**

The Soil Association
October 2008

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Soil Association

The Soil Association is the UK's leading environmental charity campaigning for a global shift to sustainable, organic food and farming practices.

Founded in 1946 by a far-sighted group of farmers, doctors and concerned citizens, the organisation is dedicated to bringing about change by creating a growing body of public opinion that understands the direct link between farming practice and plant, animal, human and environmental health.

Today the Soil Association is an internationally respected authority on sustainable agriculture and recognised champion of healthy food, which uniquely represents and offers practical solutions to everyone involved in the food chain – farmers, food processors, retailers and consumers.

The Soil Association is reliant on the support of its members, donors and the public to carry out its work. You can help grow the organic movement, by joining the Soil Association you will be part of a dynamic organisation pressing to change the predominant food culture in this country. Single UK membership costs just £24 a year.

To join, visit www.soilassociation.org or call 0117 914 2447.

Influencing policy makers, food companies, farmers, consumers and citizens is an essential part of our work, to create the conditions for a major expansion of organic food and farming. Our other relevant policy reports include:

Seeds of doubt: North American farmers' experience of GM crops
Silent invasion: the hidden use of GM crops in livestock feed

For copies please call the Soil Association on 0117 314 5180
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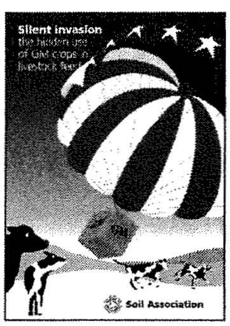

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Comparison of BT Cotton and Organic Farming in Vidharbha

K. Jalees

NAVDANYA
Steptember 2008,
New Delhi

1. Introduction:

Vidarbha in Maharashtra consists of the following 11 districts.

Sr. No.	Districts
1	Yavatmal
2	Amravati
3	Washim
4	Buldhana
5	Akola
6	Wardha
7	Nagpur
8	Bhandara
9	Chandrapur
10	Gadchiroli
11	Gondia

Whereas a large number of farmers in Punjab or Western Uttar Pradesh also have additional sources of livelihood other than agriculture. But farmers in Vidarbha entirely depend on agriculture and that too rainfed agriculture. Some of them have mulching animals but productivity is very low.

"I have no other method of earning a living. I only know to make a living from land" says Mr. Punjab Rao from Village Jamwadi inYavatmal District. He has 18 acres of land and grows Cotton, Jowar and Soyabean.

2. BT Cotton in Vidarbha

In Maharashtra, almost fifty percent cotton is grown in Vidarbha mainly in Yavatmal, Wardha, Amravati, Akola, Buldhana, Washim and Nagpur. In this region agriculture is largely rainfed. Cotton area in Vidarbha during 2002-03 and 2008-09 is given in Table 1. Because of massive publicity and the misleading propaganda by the seed companies, the cultivation of BT Cotton in Maharashtra has gone very rapidly, in last three years. Presently Vidarbha is growing nearly 20% BT Cotton of the country.

Table 1

Year	Area in Hectares (00)
2002-2003	14256
2003-2004	13885
2004-2005	130499
2005-2006	12805
2006-2007	13755
2007-2008	13722
2008-2009	12244

According to seed dealers, "Presently BT Cotton in Vidarbha covers 95-97 percent of cotton area. Though we also keep Non-BT seeds but there is no demand."

But BT Cotton failed to bring smiles on the faces of the farmers. According to Rajendra Shirbhate of Mangrul Village in Amravati, "Farmers never had good times but since the introduction of BT Cotton, situation has gone from bad to worse. Low cotton price also played havoc."

"Earlier cotton was known as a white gold because we could buy one *tola* of gold in one quintal of cotton. But now more than 5 quintal of cotton is needed to buy the same amount of gold i.e. one *tola* of gold." recalls a group of elderly farmers in Mangrool village.

As shown by Table 2, baring a few, almost all the farmers either incurred the loss or just recovered the cost of cultivation, resulting in debt trap which ultimately leads to suicide. According to Table 2, the average cost of cultivation is Rs. 8164 per acre, while the average Gross income is Rs. 8876 per acre and the net average income is just Rs. 714 per acre. For Farmers of Benora in Washim, the cultivation of BT Cotton has become like '*Matka*' (a kind of lottery), in which you never know the outcome. "During last 5 years the cost of cultivation oif cotton has escalated approximately three times, however the price of cotton has increased just by 20-25%", says Satish Ingolre of Vithole Village in Washim. According to Ingole, the price of cotton should be above Rs. 3000 per quintal.

But there are exceptions too, for instance Arun Sakhaskar of Satephal Village. He has 14 acres of land, out of which on 10 acres he grows BT Cotton. He has two children one son and one daughter with total family size of six. He seems to be happy with BT Cotton. His entire village is growing BT Cotton with inter cropping of tur. Like Arun, Pramod Kale of Bhidi on Wardha is growing BT Cotton on 8 acres of land. Though he is not satisfied with the yield but he does not complain. He has two sons, both of them are in Nagpur, doing Engineering courses. To meet the expenses of his sons, he has also undertaken some job. He says, "Not to talk of any government Job, even a peon in private company is 100 times better than a farmer, I do not want that my children should live a farmer's life."

3. Cultivation of Organic Cotton:

Farmers group in the suicide hit Vidarbha argue that the economies of cotton farming have been thrown out of gear. Cotton growing farmers in Vidarbha are living on negative returns. By bringing down cost of cultivation through scientific organic farming and by getting premium on the certified organic produce like cotton, cereals, and pulses, it is possible to come out of the present debt trap.

National Commission for Farmers had proposed that the government declare Vidarbha as an organic farming zone. Farmers with bigger lend holding can manage the costs and risks. For small and marginal farmers with rain fed cultivation, it makes economic sense to switch to organic.

Navdanya in collaboration with Vidarbha Organic Farmers Association (VOFA) is promoting organic crop across several villages. "By Organic Cultivation, we do not get much yield of cotton, however we do not have the risk of being indebted and ultimately committing suicides" says Abhay Thakre of Palasgaon in Wardha. Another farmer 'Moreshwar' of Madni in Yavatmal says, "organic cotton attacks less pests. When there is attack of sucking pest we spray the mixture of cowdung and urine. Besides, organic cotton needs less irrigation, only 2-3 times, where as BT Cotton needs 8-9 times irrigation". According to Rambhau, a farmer of Zapatkhed, "There is zero cost of pesticide and Fertilizer". He got inspiration from Shrikant, an associate of Navdanya.

While the average price for BT Cotton was Rs. 2000/- per quintal, organic cotton fetches much higher price, Rs. 3100 per quintal. According to Table 3 the average cost of cultivating of organic cotton is Rs. 3788, the average gross income per acre is Rs. 10075, and the net income per acre is Rs. 6287 per acre.

4. Cost Benefit Analysis of BT Cotton and Organic Cotton

According to Table 2 and Table 3, the Cost Benefit of BT Cotton and Organic Cotton in one acre in Vidarbha is given below:

	BT Cotton (Rs. / acre)	Organic Cotton (Rs. / acre)
A. Expenses; seeds; pesticides; fertilizer; irrigation; etc.	8164	3788
B. Output Value	8876	10075
C. Net Income (B–A)	714	6287

The above comparison clearly shows that value of input in BT Cotton is more than two times than organic. The income in BT Cotton is just Rs. 714 per acre where as it is Rs. 6287 in organic cotton which is about nine times higher.

5. Costs of Pesticides for BT Cotton:

As estimated by Table 2, the average cost of pesticide for BT Cotton is Rs. 1813 per acre or about Rs. 4605 per hectare (1813×2.54)

Table 4 gives the approximate value of pesticide spray on cotton in Vidarbha between 2006 and 2008.

Table 4

Pesticide costs of BT Cotton in Vidarbha

Year	Value of Pesticides (Rs. Crores)
2006	633.41
2007	631.89
2008	563.83

In 2007, the area of BT Cotton in Maharashtra and the country was about 2.88 and 6.2 million hectares respectively which shows that Maharashtra on BT Cotton consumed pesticides worth of Rs. 1326 crores, where as for the country the figure comes out to be Rs. 2855 crores.

6. Loss of Conventional Seeds:

During last one decade seed companies had evolved comprehensive strategy to promote their seeds by falsifying and dramatizing the yield of their seeds. This was repeatedly enforced by the representatives of the seed companies, farmers seminars and above all seeds dealers, which also acts as moneylenders. Farmers were guaranteed large returns.

Even after crop failure in the very first year, for the next year farmers were lured by assuring less spray of pesticides and higher yield. Thus, slowly and systematically farmers were trapped in the vicious circle of BT Cotton.

According to Mr. Sudhir of Lingi Village in Yavatmal, "Earlier entire village used to grow only *Desi / Conventional* cotton, but today there is hardly any farmer sowing *"Desi Seeds"*. Due to continuous neglect all *"Desi Seeds"* of cotton have vanished". Seed dealers do not store these seeds because nobody buy and moreover there is no profit. "Why should I sell such seeds when there is no buyer and the profit is minimal" says Nitin Sarode a seed dealer in Yavatmal.

"Previously Maharashtra Seed Corporation used to sell conventional seeds at the rate of Rs. 50 kg. Then government brought hybrid seed" says Mr. H.S. Dhinkar of Talni in Yavatmal. The following varities of conventional seeds were popular.

081

1007

468

and Laxmi

The yield of conventional cotton was about 2 quintal per acre. To increase the yield government brought Hybrid seeds of cotton. To promote hybrid cotton, government gave intensive to farmers. The common hybrid varieties were

AKH – 4

AKH – 3

AKH – 5

AKH – 8

"The AKH-4 was most common. But Hybrids seeds required a lot of spray to control pests. Then BT Cotton was introduced and these hybrids seeds were replaced by BT Cotton. Thus the government policy destroyed the conventional seeds" comments Mr. Dhinkar. But surprisingly government officials have no idea, how the conventional seeds were lost and they do not seem to be interested to revive these seeds.

7. Change in Cropping Pattern and Shift to Soyabean in Vidarbha:

During 2002 and 2008 Vidarbha has witnessed a significant change in cropping pattern. In Amravati division, the main agricultural area of Vidarbha and consisting of Yavatmal, Buldhana, Washim, Akola and Amravati Districts, the area of '*Jowar*' the main food crop declined from 504900 hectares in 2002 to 296000 hectares in 2008; a decline of about 42%. Similarly, during the same period the area of '*Moong*' also declined from 341300 hectares to 242000 hectares, a decline of 30%. The area of cotton almost remained constant between 2002 and 2007, though it was reduced in 2008 (Table 5).

According to Shankar Gulane and Laxman Shelkar of Mangrul Village in Amravati now only 10-12% land is used for *Jowar*, mainly as a fodder for cattle. "The yield of *Jowar* is very low, so no one seems to be interested in *Jowar*" says Purshottam of Singri Village.

As shown by Table 5, soyabean has recorded a major shift from just 434100 hectares in 2002 to 1097000 hectares in 2008 i.e. 2.5 times increase in just 6 years. This year alone there was shift of nearly 20%. This shift has come at the expense of *Jowar, Moong,* cotton and other crops.

"This is because soyabean costs much less to grow than cotton and needs less pesticide and fertilizer than cotton. Besides, it takes less time than cotton. It is sown in May-June and gets ready by November, which means you may grow wheat or other *'Rabi'* crop if you have irrigation. This is not the case with cotton" says Sanjay Garde of Village Girda in Washim.

According to K.B. Herde of Injhori, "Soyabean costs about Rs. 4000 per acre and the yield is 7-8 quintal. The usual market rate for soyabean is Rs. 1500 – 1800 per quintal. This gives you safe income of about 8000 per acre which is not the case with BT Cotton".

But this year there was a shortage of soyabean seeds and there was a demand for the subsidized cheaper seed. Some farmer's cites one reason for the shortages of seeds of soyabean. According to these farmers, "dealers backing cotton in a region where BT Cotton now reigns supreme feared that the ongoing shift to Soyabean would rob them of their huge profit which they earn by selling BT Cotton seeds and pesticides. There is no benefit for them in the shift to soyabean. Hence these dealers created the shortage of soyabean seeds".

Unfortunately an unprecedented pest attack caused irreparable damage to standing crops of soyabean in Vidarbha affecting over millions of farmers. It had been identified as leaf eating caterpillar known in local parlence as military worm or "*Lashkari Kira*".

8. False Propaganda by BT Seed Companies

To promote the sale of their seeds, companies resort to false and misleading propaganda. For instance, Chintamani a seed dealer in Kalamb displace two advertisements of Ankur BT. Both these advertisements exaggerates the yield of Ankur BT. Personal discussion with Ramesh Bhau Mahtre, the person whose name was given in the advertisement reveals that he has the demonstration plot for Ankur and the yield is lower than the claim in the advertisement (See Box).

1. Deepak Rao
   Village and P.O. Watkhed, Tehsil Ralegaon,
   Variety – Ankur Jai BT
   Area – 1 Acre
   Date of sowing – 15 June 2007
   Distance of sowing – 4×2

2. Ramesh Bhau Mehtre
Village and P.O. Kalamb,
Variety – Ankur Akka BT
Area – 1 Acre
Date of sowing – 22 June 2007
Distance of sowing – 3×3
Yield – 12 quintal / acre

9. BT Cotton Seed Companies, Brands & Rates

	Seed Companies	Brands
1	Nuzeveedu	Malika 207 Bunny
2	Ankur	Ankur 651 Akka Jai
3	Rasi	Rasi 2
4	Mahyco	Kanak Bombino Neena
5	Krishidhan	Maruti 9632 Super Maruti 441
6	Paras	Atal
7	Vikram	Vikram - 5 Vikram - 9

8	Tulsi	Tulsi - 4 Tulsi - 1 Tulsi - 101
9	Amreshvara	Chhatrapati Om - 3 Amar - 333
10	Vibha	Dyna Cash Grace
11	Palmur	Abhay Madhura
12	Ajit	Ajit - 155 Ajit - 11 Ajit - 33
13	Pravardhan	Pravardhan - 31 Rudra
14	JK	JK CH - 99 JK CH - 666 JK CH - 206
15	Kaveri	Encounter
16	Daftari	Daftari - 9
17	Nath	Vishvanath
18	Arya	

19 Shakti

20 Maharani

21 Gabbar

22 Krishna

23 Hanuman

24 Gayatri

25 Shivaji

26 Hero

27 Sigma

28 Rakhi

29 Mathura

30 Jambo

31 Amodh

Rates : Nuziveedu, Ankur, Paras, Krishidhan, Mahyco, Rasi, sale two types of BT Cotton Bollgard-I & Bollgard-II, their rates are Rs. 650 & Rs.750 respectively for a bag of 450 grams. The rates of other varieties are Rs. 650 for a bag of 450 grams.

10. Common Pests and Pesticide

BT Cotton is mainly attacted by following pest

Jassids
Aphids
Thrips
Boll Worm
Mealy Bug
Military worm

Following Pesticides are used to control above pests

Confidore	Thyrodron
Acetamiprid	Assitop
Monochrotophos	Syphermithane
Tracer	Metacid
Avant	Pride
Admire	Ecalux
Luseed	Endosulphan
Luphos	Novacron
	Tata Mida
	Roger

11. Farmers Suicides in Vidarbha

According to National Crime Records Bureau (NCRB) more than 1.5 lakh farmers committed suicide during 1997-2005. Maharashtra alone accounts for nearly 30,000 suicides, largely concentrated in Vidarbha region.

As many as 1211 distressed farmers committed suicide in 2007 in Vidarbha, the cotton belt of Maharashtra. Among the 11 districts in Vidharbha region, Yavatmal accounted for maximum suicides at (332) followed by Amravati (210). Other districts to cross the 100 marks were Washim (162), Buldhana (142), Akola (114) and Wardha (110). Most of the suicides occurred in the main districts growing BT Cotton.

The remaining five districts which were not included in the Prime Minister's package recorded lower number of deaths. Nagpur registered (42), Bhandara (32), Chandrapur (35), Gadchiroli (18) and Gondia (14).

Table 6

Sr. No.	Districts	Suicides
1	Yavatmal	332
2	Amravati	210
3	Washim	162
4	Buldhana	142
5	Akola	114
6	Wardha	110
7	Nagpur	42
8	Bhandara	32
9	Chandrapur	35
10	Gadchiroli	18
11	Gondia	14
	Total	**2011**

Finance Minister is his budget proposal 2008-2009 had announced a loan waiver of Rs. 60,000 crores which was subsequently increased to Rs. 71,000 crores. However, the farmers in Vidarbha failed to gain as the average land holding here is above the stipulated limit of 2 hectares. In districts like Yavatmal, which had recorded highest number of farmers suicides, almost 54 percent of farmers are not eligible for waiver.

Besides, the package money did not reach the local banks till mid of September. To distribute the loan during *"Kharif"* seasons co-operative banks and local banks had to borrow from NABARD and other sources. It is therefore, should not come as a surprise that even after the announcement of debt waiver farmers suicides continues unabated. Since then, a large number of farmers have committed suicide. Some of them are listed below.

Name	Village	District
Durgadas Desa Pawar	Bori Hazara	Yavatmal
Jyoti Tambke	Cheejgaon	Yavatmal
Kisan Rahate	Pimplakuti	Yavatmal
Ramesh Bhagwan	Nimkhed	Amravati
Vithal Namdeo Wankhede	Amala	Amravati
Hanumant	Jalgaon	Amravati
Sanjay Thakre	Sunderjapa	Amravati
Narendra Thataram	Khapthanda	Nagpur
Santosh Ramchandra Umble	Umrata	Nagpur
Kisan Udke	Kadki	Nagpur
Amar Singh Solanke	Donawada	Akola
Subhash Kisan Taside	Gajipur Takli	Akola
Naresh Gharpade	Chitanwadi	Akola
Ramesh Ambhore	Khanapur	Akola
Kolu Phunde	Bapevada	Bhandara
Datuji Choudhary	Nara	Wardha
Bhagwant Phuljule	Wani	Wardha
Keshav Shelke	Arvi	Wardha
Vasudev Bhangare	Giroli Heti	Gondia
Jagnath Satya	Kanhala	Gondia
Kashinath Wagmare	Mondala	Buldhana
Ramdas Maske	Pandaraeo	Buldhana

Due to repeated cotton failure and indebtedness, Vidarbha faces a new problem and this is a disturbing trend. Farmers are finding it difficult to get their children married off. Rambhau of Zapetkhed who has three daughters comments, "In a suicide ridden Vidarbha, girls avoid marriage with poor farmers for fear that they may commit suicide. They also do not want their fathers to take more loans". His views are shared by Shankar of Kolambi in Yavatmal. Incidentally Shankar has three sisters-in-law (sisters of wife).

12. Main Conclusions:

1. BT Cotton has replaced more than 95% conventional and hybrid cotton.

2. Average cost of BT Cotton cultivation is about Rs. 8164/- per acre and the profit is only Rs. 714 per acre.

3. The average cost of organic cotton cultivation is Rs. 3788/- per acre and the net profit is Rs. 6287 per acre.

4. In case of the organic cotton the cost of pesticides and fertilizer is cipher. For BT Cotton these two inputs costs about Rs. 3400 per acre.

5. Nearly 91% farmers growing BT Cotton are indebted whereas only 4% farmers cultivating organic cotton are indebted.

6. Due to government policies all the 'Desi/Conventional seeds are lost, and now no traders keep them'.

7. During last 7 years, Vidarbha has witnessed significant change in cropping pattern. In Amravati division, the main agricultural area of Vidarbha, the area of *Jowar,* the main food crop has declined from 504900 hectares in 2002 and 296000 in 2008. (a 42% decline). Similarly during the same period, the area of *'Moong'* declined from 341300 hectares to 24200 hectares (a decline of 30%). The area of cotton

remained constant between 2002-07. However, in 2008 it also registered a decline over previous year from 1150400 hectares to 1019500 hectare a 20% decline).

But soyabean recorded a spectacular growth from just 434100 hectares to 1097000 hectares during 2002 and 2008. It recorded nearly 20% increase over last year.

8. During last five years the cost of cultivation increased almost three times (300% increase) but the price of cotton did not increase proportionately. The price of cotton increased only23% from Rs. 1700/- to Rs. 2100/- per quintal

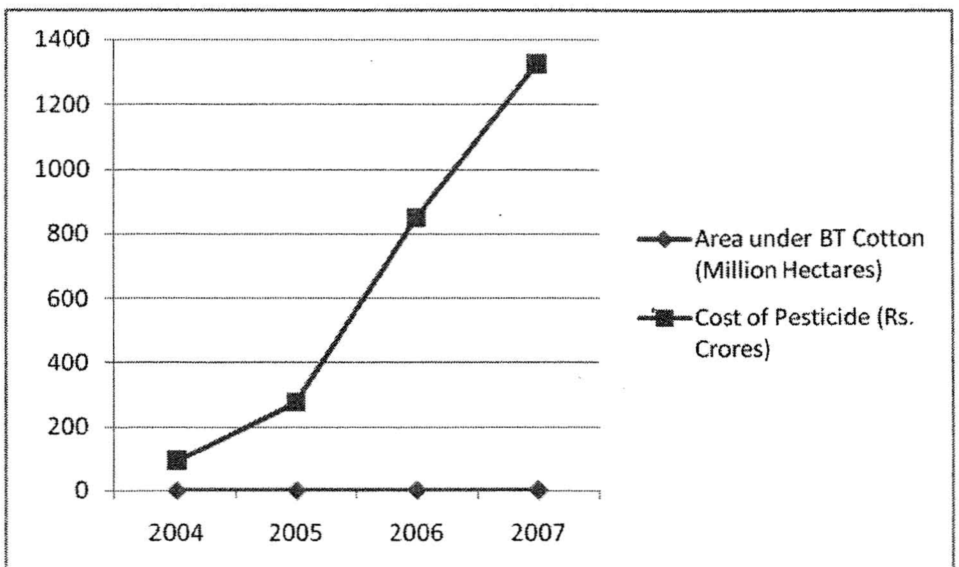
9. To control the larger segment of the BT Cotton seed market, companies have flooded the Vidarbha. The major companies have several brands, of BT seeds. Though there are more than 30 companies, however, Nuziveedu, Ankur and Rasi are commonly used by farmers. Surprisingly Mahyacol BT seeds are not preferred by the farmers, as it failed to give better results.

10. The relief package announced by the Finance Minister did not benefit the farmers as till mid of September, the package failed to reach local banks. To distribute the loan during *'Kharif'* season, cooperative banks and local banks had to borrow from NABARD and other sources.

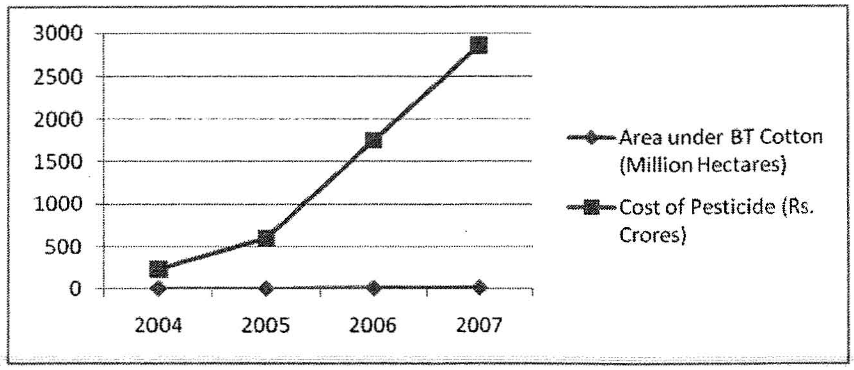
Appendix

Area under BT Cotton and cost of Pesticide in Maharashtra and India

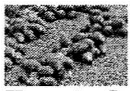
Year	Maharashtra		India	
	Area under BT Cotton (Million Hectares)	Cost of Pesticide (Rs. Crores)	Area under BT Cotton (Million Hectares)	Cost of Pesticide (Rs. Crores)
2004	0.200	92.10	0.500	230.25
2005	0.607	273.45	1.300	598.65
2006	1.840	847.32	3.800	1749.90
2007	2.880	1326.24	6.200	2855.1



Cost of Pesticide of BT Cotton in Maharashtra during 2004-2007



Cost of Pesticide of BT Cotton in India during 2004-2007



Taro is Samoa's main staple food as well as a lucrative cash crop. When taro leaf blight (TLB) hit the country in 1993, taro exports were worth $T20 million annually.

TLB wiped out the entire taro industry in a matter of months, it raised food security concerns and export revenues nose-dived thus upsetting the nation's comfortable level of foreign reserves.

Across the food sector, taro was soon replaced by less nutritious starchy staples in the form of instant noodles and rice.
Samoa's taro industry is now slowly getting back on its feet after the devastating outbreak of TLB caused by the fungus Phytophtora colocasiae.

New taro cultivars recently released have been assessed for their production qualities and closely studied in trial plots in various locations around the country.
This approach has allowed farmers to have direct input to the assessment of the cultivars, which passed the acid test for taro production in Samoa post-TLB.

Their assessments - good tasting, high yielding and, most importantly they're TLB-tolerant.
"They are very similar to the kind of taro we used to have where taste was the top priority," the CEO for the Ministry of Agriculture Asuao Kirifi Pouono said.
"These new varieties all have the taste we Samoans prefer," he reminisced about the so-called highly favoured taro Niue.

This was the main variety grown before 1993 but was highly susceptible to TLB.
"We call it mapo or firm to bite. They are also red, similar to the taro grown throughout Samoa pre-TLB."
In October, three new taro cultivars were launched by the Minister of Agriculture Taua Kitiona.

One of the varieties named Taua after him. The other two, taro So'o and taro Tonu, are named after researchers who worked on the breeding programme at Nuu Crop Development.
Asuao said more than 20 new varieties have so far been released to farmers since the breeding programme started.

The main push now is to bulk up these new cultivars to provide adequate planting material for farmers.
In response to the TLB outbreak in Samoa, and in recognition of the continuing loss of taro genetic diversity throughout the Pacific, the Australian government, through AusAID, funded a regional project entitled Taro Genetic Resources: Conservation and Utilisation (TaroGen).

One component of the project focused on breeding and was based at the Alafua Campus of the University of the South Pacific (USP). The Taro Improvement Programme was designed to work with national programmes run by MAFF and with farmers around the country to develop a national strategy for taro improvement.

The first stage of the project evaluated taro diversity in regional collections and in other cultivars sent to Samoa in response to a request for help. Initially, new TLB-tolerant varieties from the Federated States of Micronesia, Palau and the Philippines were introduced, both to maintain taro production and to assess their susceptibility to TLB in Samoa.

Taro Fili (from the Philippines) became the first TLB-tolerant variety that local consumers liked. When boiled, it had the right firmness and taste but developed too hard a texture when baked in the umu (Samoan earth oven).

A variety from Palau with good tolerance to TLB, good taste and reddish in colour was also well received. Polo voli, (so called because of its volley ball shape) became a winner with farmers and consumers.
The Taro Improvement Programme put a participatory breeding project in place to work with farmers to screen and select new clones, initially from the Pacific.

The active participation of taro growers has been the key to the success of the programme, which has continued work on breeding and selecting superior taro varieties since the TaroGen project concluded.
Funding and technical assistance is being maintained with support from the Secretariat of the Pacific Community (SPC) and USP.
The recent release of the new cultivars shows the importance of agencies working together to tackle a problem. It also highlights the benefits of a participatory approach to variety selection and breeding.

The need to take into account different growing conditions within a country, and changes in these conditions, becomes even more important with the increasing impact of climate change.
The programme has recently developed crosses (lines) between taro from the Pacific and from Asia, which are receiving excellent feedback from farmers in Samoa.

Donors are often concerned about the sustainability of a project once their funding support has ceased.
The fact that the Taro Improvement Programme is still active and is supported nationally and regionally is convincing evidence of the project's sustainability.

• For more information, please contact the helpdesk of SPC Land Resources Division: lrdhelpdesk@spc.int.

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AusAID/SPC TARO GENETIC RESOURCES:
CONSERVATION AND UTILISATION

A Bibliography of Taro Leaf Blight

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Contents

Introduction

This bibliography has been prepared by the Taro Genetic Resources: Conservation and Utilisation (TaroGen) project. TaroGen is an AusAID-funded regional project for taro improvement. It is implemented by the Secretariat of the Pacific Community (SPC) in collaboration with the University of the South Pacific (USP), the National Agricultural Research Institute (NARI), the International Plant Genetic Resources Institute (IPGRI), HortResearch, Queensland University of Technology (QUT) and the University of Queensland (UQ). Julia Brunt contributed to this project while working for the SPC Plant Protection Service, Suva, Fiji.

The purpose of this bibliography is to draw together publications on taro leaf blight in an effort to assist research. The bibliography updates an earlier edition (Taro leaf blight—a preliminary bibliography, by P. Walton) prepared in 1993. This edition now includes some 452 references to the literature, with abstracts where available.

Sources available to the compilers included:

AGRIS 1975—August 1995 (FAO)

CABPESTCD 1973—August 1998 (CAB International)

SPC library

IRETA library

Personal communications

Not all the papers included in this bibliography have been seen by the compilers, so there are a few incomplete references. We have also certainly missed others, especially from regions outside the Pacific and amongst the rapidly growing resources available on the World Wide Web.

We hope this bibliography will be widely used and any comments, corrections and additions are welcomed. In this way, the bibliography may be updated in future.

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Taro leaf blight
With special reference to the Pacific Islands

Introduction

Plant diseases pose a serious threat to food security and national economies worldwide. Recent examples are the southern corn leaf blight and coffee rust epidemics of the 1970s. In the Pacific region the impact of taro leaf blight, caused by the fungus *Phytophthora colocasiae,* and the threat it poses to countries not yet affected by the disease, illustrate this point clearly. The spread of the fungus to Samoa in 1993 demonstrated once again the devastating potential of the disease when, over a period of six months, the country lost an export industry worth US$10 million per year with a similar value for domestic supplies. Events of similar catastrophe occurred in Solomon Islands 50 years earlier and caused a loss of varieties and major changes to the cropping systems.

Taro leaf blight and the causal pathogen *P. colocasiae*

To date, taro leaf blight has been recorded in a number of countries in the Pacific region, most recently in Samoa in 1993. The disease is mainly a foliar pathogen although postharvest storage rots also occur. Initial symptoms of the disease are small brown water-soaked flecks on the leaf that enlarge to form dark brown lesions, often with a yellow margin. Secondary infections lead to rapid destruction of the leaf, which may occur in 10–20 days or less in very susceptible varieties. The normal longevity of a healthy leaf is about 40 days. The disease significantly reduces the number of functional leaves and can lead to yield reductions of the magnitude of 50% (Trujillo and Aragaki, 1964; Trujillo, 1967; Jackson, 1999). Inoculum in the form of spores is spread by wind-driven rain and dew to adjacent plants and nearby plantations. The disease can also be spread on taro planting material and the fungus has been reported as remaining alive on planting tops for about three weeks after harvest (Jackson, 1999). This is the most likely source of the pathogen in new countries and the means for its rapid spread within a country, once established. Therefore, strict quarantine measures are required as a first line of defense against the disease.

In addition to corm yield losses due to the reduced leaf area in diseased plants, there is also a corm rot caused by *P. colocasiae.* This is mainly a problem when taro corms are stored for more than seven days but not in subsistence economies where corms are harvested and consumed within days.

Fortunately, *P. colocasiae* does not have a wide host range. *Xanthosoma* taro is immune. Although *Alocasia* taro can be infected by the pathogen, there is little inoculum produced and therefore little likelihood of an epidemic on this host (personal observation).

Raciborski (1900), in Java, was the first person to study taro leaf blight disease and was the first to name the causal pathogen. There is limited information on the origin of *P. colocasiae* and the magnitude of the area of origin remains to be defined (Zhang *et al.,* 1994). Ko (1979) has indicated that Asia may be the centre of origin of *P. colocasiae* given that it is the world's centre of origin for many wild and cultivated varieties of taro. Prior to this, Trujillo (1967) had also speculated on a Southeast Asian origin for the pathogen. One of the indications of the centre of origin of a fungus such as *Phytophthora* is the existence of an A1/A2 mating type ratio of about 1:1 (Zentmyer, 1988). In order to determine if Taiwan was inside the centre of origin Ann *et al.* (1986) screened 799 isolates of *P. colocasiae*. All behaved as A2 mating types, indicating that the fungus is not indigenous to this area. Only A1 mating type has been found in India, indicating that it is not the centre of origin (Narula and Mehrotra, 1980). Evidence for an Asian origin of *P. colocasiae* has recently come from China (Zhang *et al.*, 1994), where previous reports had indicated that only the A2 mating type occurred (Ho *et al.*, 1983). Of 280 isolates of *P. colocasiae* obtained from Hainan Island, 136 were A1, 102 A2 and 42 A0 mating types. Such findings indicate that Hainan Island is inside the centre of origin of *P. colocasiae*. More recent work suggests that only mating type A2 occurs in Papua New Guinea (PNG), Hawai'i, Samoa and Guam (Fullerton *et al.*, 2000)

Based on a possible Southeast Asian origin for the pathogen, Trujillo (1967) postulated that the disease dispersed into the Pacific region by three different routes: 1. To Hawai'i via the Philippines; 2. From Taiwan to Micronesia via the Philippines; and 3. to Fiji via PNG and Solomon Islands. At that time taro leaf blight had been reported as present in Fiji but this was an obvious misidentification. The movement of taro leaf blight via PNG and Solomon Islands would appear to be a separate route and is supported by anecdotal evidence from inhabitants of these countries expressing that the disease only appeared after the Western Pacific Campaign of World War II (Oliver, 1973).

Ooka (1990) speculates that movement on the northern route went from Java to Taiwan, where Sawada reported the disease in 1911. From Taiwan it is believed to have moved to Japan and then to Hawai'i where it arrived in 1920 (Carpenter, 1920). The disease was first recorded in the Philippines in 1916 and movement to Micronesia probably occurred from there. The disease was recorded in Guam in 1918 (Weston, 1918).

History of taro leaf blight in the Pacific Islands

There has been little documentation of the impact of taro leaf blight as it has spread from country to country in the Pacific. What has been documented covers mainly Papua New Guinea. What is known is that wherever it has occurred in the region, many growers have been forced to abandon taro and rely on other root crops (Jackson, 1996).

The earliest records for the appearance of the disease in the Pacific Islands are for Guam (1918) and Hawai'i (1920), which precede the appearance of the disease in the more southern Solomon Islands and PNG by a couple of decades. Prior to the arrival of taro leaf blight in Hawai'i there were approximately 350 different varieties of taro in the country. Few have survived the disease and today the number of Hawaiian taros is less than 40 (Trujillo, 1996). In Guam, where the disease has been present for a longer period than Hawai'i, the disease is considered unimportant today (Wall, 1996). Recent interviews among farmers in Guam have highlighted that there may be as many as 23 varieties of taro on Guam but most are recent introductions with only six predating the arrival of taro leaf blight (Manner, 1991). The relatively few traditional taro varieties is believed to be a consequence of the disease (Wall, 1996).

In Micronesia the disease seems to have been brought in during the Japanese occupation of Chuuk and Pohnpei and taro cultivation appears to be declining rapidly. Taro leaf blight has contributed to significant changes in dietary patterns and cropping systems in Micronesia where earlier this century cassava became the staple instead of taro (Barrau, 1961; Jackson, 1996). On Pohnpei, the majority of the taro varieties that existed before the arrival of the Japanese are gone (Trujillo, 1996) and leaf blight has been responsible for the serious decline in taro as a crop plant (Santos, 1993; Raynor and Silbanus, 1993). On Pohnpei, taro now ranks behind yams, banana, imported rice and breadfruit as a staple crop (Primo, 1993; Raynor and Silbanus, 1993). Despite heavy rainfall and the long time presence of leaf blight in Pohnpei, farmers are still managing to produce taro. Wall (1996) reports that this is a result of the disease having selected more resistant taro varieties and the incorporation of sanitation and traditional mixed cropping systems for the management of the disease.

Taro leaf blight is believed to have contributed to the decline in taro production and its displacement in some areas by sweet potato in PNG. It is thought that the disease spread to PNG from Southeast Asia through Indonesia during the WWII (Kokoa, 1996). In Bougainville, *P. colocasiae* was first reported around the close of the war (Connell, 1978). It was the firm belief of the local population that the disease was not present before then. The impact of the disease in some areas was devastating and throughout lowland Bougainville taro was almost wiped out. It has been reported that the epidemic of taro leaf blight on Bougainville resulted in the deaths of about 3000 people (Putter, 1993) and in most areas sweet potato replaced taro as the main staple. The real impact of the blight is difficult to accurately assess. At the time of the appearance of the disease the Japanese were pillaging many of the local taro gardens. As a result, there was a serious lack of planting materials. Many people fled their villages and numerous cases of starvation and malnutrition occurred. It is difficult to distinguish the impact of the disease, if any, from these events. It is possible that the impact of the disease was delayed for a few years following the Japanese occupation. At the close of WWII people returned to village life. As the Japanese had taken most of the planting material people turned to many of the early maturing sweet potato varieties that existed in the now disbanded Japanese gardens to fill the interim. Later, when taro planting material did become available, it was wiped out again by the blight providing yet another setback for farmers. Unfortunately, the coincidence of the spread of taro leaf blight in Bougainville with WWII makes it difficult to attribute any given change solely to the effects of leaf blight (Packard, 1975).

The disease continues to spread in PNG and in 1976 a severe epidemic occurred on the island of Manus and in 1988 the disease occurred in Milne Bay for the first time, destroying the crop (Jackson, 1996).

In Solomon Islands it is also difficult to determine the impact that taro leaf blight had on taro production and cropping patterns in the country. Taro leaf blight first appeared in the Shortland Islands in 1946 (Liloqula *et al.*, 1996) and within the next few years had spread to most of the provinces as a result of the increased movement of people and produce in the post war years. What is known is that taro cultivation declined quite drastically in Solomon Islands at this time being replaced by sweet potato, which was a later arrival in the country. Whether the introduction of sweet potato alone or combined with the effects of taro leaf blight are the reasons for the decline in taro are difficult to ascertain.

The impact of taro leaf blight in Samoa

The most recent introduction of the disease was to the Samoan islands in 1993. Taro leaf blight was first detected in the Western District highlands of Tutuila Island, American Samoa on 15 June 1993. The disease has severely constrained taro production in the country (Gurr, 1996). Within a year of the introduction of the disease it had caused over 95% reduction in the supply of taro to the public market. In less than one month taro leaf blight was diagnosed and confirmed in Samoa. It was first observed on the the island of Upolu at Aufaga Aleipata and two days later from Saanapu and adjacent districts of Alafou, Samusu, Utufaalalafa, Malaela, and Lepa. The crop at this time was highly uniform and genetically vulnerable. The disease spread rapidly throughout the country severely affecting all local varieties, but was most severe on taro variety *Niue,* which was unfortunate as this was the variety of choice for commercial production because of its quality and taste.

It is believed that the rapid spread of the disease was encouraged by the movement of infected planting materials around the two main islands, Upolu and Savai'i. At this time there was a major replanting of taro underway in the aftermath of Cyclone Val and anything up to 10,000 plants could be planted by a single farmer in a one week period (Semisi, 1996). Various factors contributed to the rapid spread of the disease in Samoa. The area planted with taro *Niue* at the time was extremely large and effectively ensured a monocrop situation comprising a highly susceptible variety. There was a continuous and abundant source of taro for the disease because of the practice of many farmers to interplant on old plantations and stagger their cultivation. Combined with the movement of planting material and the ideal weather conditions that exist in Samoa for the disease, it is not surprising that the disease reached epidemic proportions.

Taro in Samoa is the traditionally favoured root crop and was considered an essential component of an everyday meal. Although this popularity is based on dietary and cultural factors, taro is also favoured for its considerable productivity in the fertile and high rainfall environment. Prior to the disease outbreak taro was the major export earner in the country and over 90% of households in Samoa were growing the crop (Ward and Ashcroft, 1998). In the twelve-month period prior to the outbreak of taro leaf blight 180,191 kg of taro were brought for sale at the local market. In the twelve-month period subsequent to the outbreak of the disease 59,212 kg were brought in for sale. Seventy-five per cent of this volume was brought in during the first three months of the twelve-month period when the impact of the disease was still to be realised (Chan, 1996). Paulson and Rogers (1997) report that supplies of taro on the local market in June 1994 were only 1% of the supplies that were available in June the previous year. The massive losses due to the disease had a similar impact on the export of taro. The first three months of 1994 saw only 60,000 kg of taro exported which was valued at about WS$56,000 (Chan, 1996). This represents about 0.5% of the 1993 export figure.

One of the initial responses of the Samoan Government to the disease was to encourage diversification of other crops, helping to explore alternative commercial agricultural enterprises (Semisi, 1996; Jackson, 1996). The government also provided assistance through the supply and distribution of planting material. Farmers quickly diversified into a range of other staple crops and bananas and *taamu* (*Alocasia macrorhiza*) replaced taro as the main staple.

Management of taro leaf blight

The recent outbreak of taro leaf blight in Samoa provides a good overview of the measures that have been used in an attempt to manage the disease.

Initial efforts to minimise the disease

Early efforts to contain taro leaf blight in Samoa included a spraying programme of infected plantings with the fungicides Ridomil MZ and Manzate. Staff from the Ministry of Agriculture, Forestry, Fisheries and Meteorology (MAFFM) carried out routine fungicide spraying of infected plantations. Later, fungicides were supplied free to farmers through village *pulenuu* (village mayors) and application equipment was made available at subsidised prices at the local Agricultural Store (Chan, 1996). At the completion of this initial spraying campaign over WST$600,000 had been spent.

In conjunction with fungicide spraying, quarantine efforts to minimise the movement of planting material, leaves and soil on the island of Upolu and between islands were enforced together with a public awareness campaign to inform farmers and the general public. This included information on disease symptoms, epidemiology and disease control. The campaign utilised radio, television, videos and print media including leaflets and newspaper.

These three actions had minimal effect on the spread of the disease. Unseasonal wet weather in the months following the introduction of the disease into Samoa and the fact that planting material was still being routinely moved meant the disease spread rapidly. By the end of 1993 the disease had spread to most of Savai'i and farmers were beginning to diversify with alternative crops.

Cultural control

Various cultural methods have been recommended for the control of taro leaf blight. Removal of infected leaves has been effective during the early stages of disease development in a number of countries. Wide spacing of plants has been reported to reduce disease severity but this appears to have a negligible effect when conditions favour disease development. Other cultural methods that have been recommended include delaying planting on the same land for a minimum of three weeks, avoiding plantings close to older infected ones and preventing the carryover of corms or suckers which can harbour the pathogen from one crop to the next (Jackson, 1999). Preliminary findings have indicated that fertilizer treatment may also help the plant cope with leaf blight (Tilialo *et al., 1996).* Trials in Samoa to investigate the effect of planting time, intercropping, the role of fertilisation on the incidence and severity of the disease and the effect of leaf removal have been inconclusive (Chan, 1997).

Chemical control

Jackson (1996) reports that the disease can be controlled by spraying copper fungicides. Copper oxychloride applied at a rate of 4.5 kg per 100 litres of water per hectare gave good control of the disease in Solomon Islands. Early trial work in Samoa concentrated on trials of Ridomil MZ, Manzate and phosphorous acid (Foschek). Pot experiments demonstrated the superiority of phosphorous acid over Ridomil MZ. Further experiments comparing phosphorous acid formulations (Foschek, Agri-Fos 400 and Foli-R-Fos) found no differences in terms of disease control (Chan, 1997). In Samoa, a recommendation for fungicide spraying was made for Foschek, alternated with Manzate to minimise resistance problems but the costs were prohibitive for the majority of farmers.

Resistant varieties

Most farmers who traditionally grow taro cannot afford the extra costs required for fungicides and labour involved in leaf removal and spraying. Alternative sustainable strategies for the management of the disease are needed. The use of resistant varieties is one such strategy. Given the susceptibility of local taro varieties to leaf blight in Samoa and the impact that the disease has had on varietal diversity, Samoa initiated a programme to screen and evaluate exotic taros. Of those varieties screened in the field *PSB-G2, Pwetepwet, Pastora* and *Toantal* were found to be more resistant to leaf blight. *Pwetepwet, Pastora* and *Toantal* originated from the Federated States of Micronesia (FSM) and were obtained from the Tissue Culture Unit at Alafua Campus, USP. *PSB-G2* was received from the Philippine Seed Board in 1994.

These four varieties were further multiplied and evaluated in trials at USP–Alafua during 1996–1998. A preliminary trial demonstrated that disease severity recorded for each variety was not significantly different. *Pastora* produced the largest corms followed by *PSB-G2, Pwetepwet* and *Toantal* (Hunter and Pouono, 1998). Samoans prefer dry, firm-textured taro and therefore, per cent dry weight is one measure of eating quality. Dry matter content of corms was highest for *PSB-G2* (37%) and taste tests at USP-Alafua demonstrated that both *Toantal* and *PSB-G2* were most preferred. MAFFM taste tests also rated *PSB-G2* highest followed by *Toantal* (Chan, 1997). Acceptibility of PSB-G2 (known locally as taro *Fili*) in Samoa has been high and a recent impact assessment carried out among farmers on the multiplication, performance and use of the variety confirms that it is performing well (Iosefa and Rogers, 1999). Additional varieties collected from Palau have shown good levels of resistance against taro leaf blight in Samoa. Indications are that farmers in Samoa are adopting a diversity of varieties from the FSM, Palau and the Philippines.

Taro Genetic Resources: Conservation and Utilisation (TaroGen) — a regional approach to taro improvement

The impact of taro leaf blight, the subsequent loss of taro genetic resources, and the continuing vulnerability of other Pacific Island countries to the disease was the major impetus behind the development of the Taro Genetic Resources: Conservation and Utilisation (TaroGen) regional project. In recognition of the urgency of the problem, three regional meetings to discuss disease control, loss of genetic resources and ways to prevent further spread of the disease were held in the region between 1993 and 1995. Outcomes from these meetings contributed to the formulation of the TaroGen project. The project is implemented by the Secretariat of the Pacific Community (SPC) and funded by the Australian Government. The project represents a collaboration with the International Plant Genetic Resources Institute, National Agricultural Research Institute and the University of the South Pacific and is working with national programmes to develop a regional strategy for taro genetic resource conservation and crop improvement. A unit has been established within SPC to provide the expertise required in conservation, plant breeding and project management. The project is designed to assist Pacific Island countries in the collection and conservation of taro germplasm and in the use of the genetic resources in plant improvement programmes with an overall goal of improving food security and rural incomes in Pacific Island countries.

One of the main components of TaroGen is to provide farmers in Pacific Island countries with taro varieties that have improved resistance to taro leaf blight. To achieve this the project supports breeding programmes in PNG and Samoa based on durable resistance. Breeding of more resistant varieties together with the introduction of resistant varieties is the most sustainable approach to managing the disease. Improved taro with good resistance to taro leaf blight and quality is now available in Samoa and PNG. In Samoa, the project partners, USP and MAFFM, have been very successful in developing a strong partnership between growers, researchers and extension staff. This partnership is ensuring that improved taro is readily available to farmers. Growers in Samoa have access to improved taro from both the USP and MAFFM programmes after only two years of the project. This approach has created considerable interest in PNG where a similar farmer participatory approach is now under consideration. TaroGen plans to make these improved lines, and other resistant varieties, available to farmers in other Pacific Island countries.

Conclusions

The recent introduction of taro leaf blight into Samoa illustrates clearly the devastation that taro leaf blight can cause and highlights the vulnerability of isolated taro populations that for years evolved in the absence of the disease. Unfortunately, other countries in the Pacific are in a similar position to that of Samoa before the blight. In Fiji production is dominated by *Niue,* which was the dominant cultivar in Samoa at the time of the blight's arrival. This represents a situation of severe genetic vulnerability and a rerun of the Samoan epidemic could happen anytime. Fortunately, those countries most at risk now have the opportunity to benefit from the outputs from the TaroGen breeding programme. Improved taro with good resistance to taro leaf blight can provide these countries with the opportunity to minimise the impact of the disease.

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When 8 antibiotics were tested against the pathogen, ledermycin proved the most inhibitive *in vivo* and *in vitro*, followed by terramycin [oxytetracycline], resteclin (tetracycline hydrochloride) and agrimycin-100.

40. Ashok Aggarwal, Gurinderjit Kaur, & Mehrotra, R. S. (1986). Effect of certain metabolic inhibitors on growth and respiration of *Phytophthora colocasiae* Racib. Indian Botanical Reporter **5**(2), 119–122.

In laboratory tests sodium azide, mercuric chloride, sodium fluoroacetate, sodium malonate, methylene blue and sodium fluoride inhibited respiration and mycelial growth of *P. colocasiae* on *Colocasia esculenta.*

41. Ashok Aggarwal, Kamlesh, & Mehrotra, R. S. (1993). Control of taro blight and corm rot caused by *Phytophthora colocasiae* homeopathic drugs. Plant Disease Research **8**(2), 94–101.

The effect of 4 homeopathic drugs (Kali iodide (potassium iodide), Arsenicum album (arsenic oxide), Blatta orientalis (an extract of cockroach) and extract of *Thuja occidentalis*) on the mycelial growth, sporangial production, pectolytic and cellulolytic enzyme production and control of *P. colocasiae* on taro (*Colocasia esculenta*) was investigated. All 4 drugs inhibited mycelial growth, but the percentage inhibition varied with different drug potencies. Max. inhibition (50–90%) was obtained by Kali iodide and Arsenicum album at all 3 potencies (3, 30 and 200) and by Blatta orientalis and *T. occidentalis* at potencies of 30 and 200. The effect on sporulation also varied with potency, with max. inhibition caused by each drug at a potency of 200, and by a potency of 30 for Arsenicum album. Kali iodide resulted in the greatest decrease in pectolytic and celluloytic activity, followed by Arsenicum, *Thuja* and Blatta. The occurrence of disease was reduced by 45–59% compared with an untreated control when taro leaves were treated with Kali iodide or Arsenicum album (both at 200 potencies) prior to inoculation with *P. colocasiae.*

42. Ashok Aggarwal, & Mehrotra, R. S. (1987). Control of *Phytophthora* leaf blight of taro (*Colocasia esculenta*) by fungicides and roguing. Phytoparasitica **15**(5), 299–305.

In *in vitro* tests Demosan 65W (chloroneb) was the most effective of 6 fungicides in inhibiting mycelial growth of *P. colocasiae*, followed by Difolatan 80W (captafol), Fytolan (copper oxychloride), Apron 35F (metalaxyl), Topsin-M 50W (thiophanate-methyl) and Dithane Z-78 75W (zineb). In field trials excellent control was obtained with chloroneb and captafol, good control with metalaxyl, fair control with copper oxychloride and poor control with thiophanate-methyl and zineb. Roguing of infected leaves did not eradicate the pathogen but may delay the start of epiphytotics.

43. Ashok Aggarwal, & Mehrotra, R. S. (1988). Effect of antibiotics on growth, enzyme activity and respiration of *Phytophthora colocasiae*. Plant Disease Research **3**(1), 37–42.

Details are given of the *in vitro* effects of 7 antibiotics on this pathogen of *Colocasia esculenta*. Ledermycin had the greatest effect on respiration and growth, while all the antibiotics had significant effects on the activities of transeliminases, hydrolases and cellulases.

44. Ashok Aggarwal, & Mehrotra, R. S. (1986). The effect of certain carbohydrates and amino acids on growth and respiration of *Phytophthora colocasiae*. Plant Disease Research **1**(1–2), 11–15.

The effects of 9 carbohydrates and 20 amino acids on respiration and mycelial growth of an isolate from *Colocasia esculenta* are tabulated and the results discussed.

45. Ashok Aggarwal, & Mehrotra, R. S. (1988). Effect of systemic and non-systemic fungicides on mycelial growth and respiration of *Phytophthora colocasiae*. Indian Phytopathology **41**(4), 590–593.

The effect of 11 fungicides (Ridomil-25 WP (metalaxyl), Apron 350 FW (metalaxyl), Topsin-M (thiophanate-methyl), Cuman L (ziram), Dithane-M 45 (mancozeb), Dithane-Z 78 (zineb), Difolatan-80-W (captafol), Blitox (copper oxychloride), Benlate (benomyl), Bavistin (carbendazim) and Fytolan (copper oxychloride)) at 5, 50 and 500 p.p.m. on *P. colocasiae* mycelial growth and respiration rate was investigated. All the fungicides inhibited the fungus. The results suggest a correlation between mycelial growth inhibition and respiration rate inhibition. All the fungicides which inhibited mycelial growth also significantly inhibited respiration rate. None of the fungicides tested stimulated respiration or mycelial growth.

46. Ashok Aggarwal, & Mehrotra, R. S. (1988). Effects of various fungicides on mycelial growth, sporangial production, enzyme activity and control of *Phytophthora* leaf blight of *Colocasia esculenta* L. Acta Phytopathologica Et Entomologica Hungarica **23**(3–4), 401–414.

Studies on the effects of 23 fungicides on *P. colocasiae* revealed that Apron 350 FW (metalaxyl), Blitox (copper oxychloride), Blimex, Cuman-L (ziram), Demosan 65W (chloroneb), Dexon (fenaminosulf), Difolatan 80 W (captafol), Fytolan, Hexaferb, Kitazin (S-benzyl O,O-diethyl phosphorothioate), Milton, Ridomil 25 WP (metalaxyl) and Syllit (dodine) all gave 100% inhibition at different concentrations. All fungicides had some effect on sporangial formation. The effects of 8 fungicides on pectolytic and cellulolytic enzyme activity were also observed. All inhibited the enzymes to some degree with metalaxyl (as Ridomil 25 WP followed by Apron 350 FW) being the most effective. It was also the most effective at 200 parts per million of 8 fungicides tested in field conditions.

47. Ashok Aggarwal, & Mehrotra, R. S. (1986). Pectolytic and cellulolytic enzymes produced by *Phytophthora colocasiae, P. parasitica* var. *piperina in vitro and in vivo*. Indian Journal of Plant Pathology **4**(1), 74–77.

P. colocasiae and *P. parasitica* var. *piperina* [*P. nicotianae* var. *parasitica*] produced pectolytic (PME, PG, PMTE and PMG) and cellulolytic (Cx) enzymes under conditions of different C sources in liquid medium and detached leaves of *Colocasia esculenta* and *Piper betle*. Pectin methylesterase (PME) activity was not detected in the isolates *in vivo*. Pectolytic enzymes produced by these fungi were of a constitutive rather than adaptive nature. These results indicate that PG, PMG and PMTE enzymes play a decisive role in the pathogenesis of *P. colocasiae* on *C. esculenta* and *P. nicotianae* var. *parasitica* on *Piper betle*.

48. Ashok Aggarwal, & Mehrotra, R. S. (1987). The role of phenolic substances in leaf blight of *Colocasia esculenta* caused by *Phytophthora colocasiae*. Journal of the Indian Botanical Society **66**(3–4), 272–274.

Alterations in phenolic compounds in *Colocasia* due to *P. colocasiae* infection are reported. Total phenols, orthodihydric phenols and flavonols markedly increased as a result of infection. Eleven phenols were detected in the infected plants as against 7 in healthy plants. Each stage of infection was characterized by an addition of a new phenol (4 in all, U1–U4). A close correlation existed between the phenolic acids produced by the pathogen *in vitro* and those in the infected plant. The implication of the occurrence of new phenols and further accumulation of the already existing phenols, as a result of infection, on disease development is discussed.

49. Ashok Aggarwal, & Mehrotra, R. S. (1988). Studies on transeliminases in *Phytophthora colocasiae*: inhibitory effects of plant growth regulators, phenolics and fungicides. Indian Journal of Plant Pathology **6**(2), 158–163.

All the growth regulators tested (IAA, IBA, GA, K, 2,3,4-T) and 10 and 100 p.p.m. checked the production of polygalacturonate transeliminase and pectin methyl transeliminase by this pathogen of *Colocasia esculenta*, but none could completely prevent it. Ferulic acid, m-hydroxybenzaldehyde, phloroglucinol and vanillin at 10, 50 and 100 p.p.m. were also inhibitory, as were all 6 fungicides tested, especially Apron 350 FW (metalaxyl), Ridomil 25 WP (metalaxyl) and Topsin M (thiophanate-methyl).

50. Ashok Aggarwal, Narula, K. L., Gurinderjit Kaur, & Mehrotra, R. S. (1990). *Phytophthora colocasiae* Racib.—its taxonomy, physiology, pathology and control. In S. K. Hasija, & K. S. Bilgrami (Editors), Perspectives in Mycological Research. Volume 2. (pp. 105–134). New Delhi, India.: Today & Tomorrow's Printers & Publishers. International Bioscience Series. Volume XV.

The taxonomy, physiology, pathology and control of *Phytophthora colocasiae* , the cause of leaf and corm blight of *Colocasia esculenta*, are reviewed.

51. Ashok Bhattacharyya, & Saikia, U. N. (1996). Fungicidal management of leaf blight of *Colocasia*. International Journal of Tropical Agriculture **14**(1–4), 231–233.

Field experiments conducted during 1990–91 at Jorhat, Assam, India, to study the effect of fungicides in controlling leaf blight caused by *Phytophthora colocasiae* in *Colocasia esculenta* revealed that 0.2% metalaxyl and mancozeb (as Ridomil MZ-72) was the most effective treatment, followed by 0.2% captafol (as Foltaf), Bordeaux mixture (1% copper sulfate and lime) and 0.25% mancozeb (as Foltaf). A significant increase in yield was recorded for all treatments over the untreated control. Bordeaux mixture gave the highest incremental cost-benefit ratio over the control (1:30.3).

52. Barrau, J. (1954). Decline in taro disease. South Pacific Commission Quarterly Bulletin **4**(2), 24.

53. Barrau, J. (1958). Subsistence agriculture in Melanesia. Bulletin, Bernie P. Bishop Museum, Hawaii (No. 219).

54. Barrau, J. (1961). Subsistence agriculture in Polynesia and Micronesia. Bulletin, Bernie P. Bishop Museum, Hawaii (No. 223).

55. Barrau, J. (1955). Taro disease in British Solomons. South Pacific Commission Quarterly Bulletin **5**(1).

56. Bergquist, R. R. (1973). Effect of fungicide rate, spray interval and timing of spray application in relation to control of *Phytophthora* leaf blight of taro. Phytophthora Newsletter (1), 6–7.

57. Bergquist, R. R. (1974). Effect of fungicide rate, spray interval, timing of spray application, and precipitation in relation to control of *Phytophthora* leaf blight of taro. Annals of Botany **38**(154), 213–221.

In trials at 2 sites on the windward side of Kauai, *Colocasia esculenta* was sprayed with mancozeb at 4.48, 2.24 or 1.12 kg/ha at intervals of 5, 7, 10 or 14 days. At the drier of the 2 sites rate of fungicide had no effect, while at the wetter site (0.25 cm/week more rainfall) the highest rate of fungicide was more effective than the lowest. Spraying every 5 days was significantly more effective than spraying every 14 days. Applications of fungicide at 7-day intervals when weekly accumulated rainfall exceeded 1 cm and/or when lesion counts exceeded 1/plant, gave substantial disease control. Yields at the wetter site were 8.66 and 11.19 kg primary corms/plant with no fungicide and with 1.12 kg mancozeb/ha, respectively, and significantly higher (14.26 and 16.71 kg/plant) at the 2 highest fungicide rates. Respective yields of secondary corms were 7.85, 7.08, 8.65 and 10.78 kg/plant.

58. Bergquist, R. R. (1972). Efficacy of fungicides for control of *Phytophthora* leaf blight of taro. Annals of Botany **36**(145), 281–287.

Results of laboratory, glasshouse and outdoor trials are reported, in which Polyram (metiram) and Dithane M-45 (mancozeb) gave very good control of *Phytophthora colocasiae* on *Colocasia esculenta* and were the least phytotoxic.

59. Bernardo, E. N. (1981). Pest resistance in plants with emphasis on root crops. In Southeast Asian and the Pacific Training Course on Root and Tuber Crops Germplasm Evaluation and Utilization (p. 251). Leyte, Philippines: College of Agriculture.

60. Bhatt, D. D. (1966). Preliminary list of plant diseases recorded in the Katmandu Valley. Journal of Science of the Tri-Chandra College Science Association **2**(1), 13–20.

61. Bourke, R. M. (1982). Agronomic field trials on food crops in Papua New Guinea 1928–1978. Technical Report DPI 82/3 . Department of Primary Industry, Papua New Guinea.

Included in this list of agronomic field trials carried out in Papua New Guinea are fungicide and cultivar trials on taro for blight control.

62. Bourke, R. M. (1982). Root crops in Papua New Guinea. In Proceedings of the Second Papua New Guinea Food Crops Conference. Port Moresby, Papua New Guinea, 14–18 July, 1980. (pp. 51–63). Port Morseby, Papua New Guinea: Department of Primary Industry.

The widespread occurrence of taro leaf blight in Papua New Guinea is noted.

63. Bourke, R. M. (1982). Root crops in Papua New Guinea. In 5th International Symposium on Tropical Root and Tuber Crops. Philippines, 17–21 September 1979. (pp. 121–133). Los Banos, Philippines: Philippine Council for Agriculture and Resources Research.

The widespread occurrence of taro leaf blight in the lowlands is noted. Agronomic work undertaken is tabulated.

64. Brooks, F. (2000). List of plant diseases in American Samoa, 35 pp. American Samoa: American Samoa Community College Land Grant Program. Land Grant Technical Report No. 31.

This publication includes a brief description of the taro leaf blight epidemic in American Samoa in 1993–94.

65. Brooks, F. (2000). Pests and diseases of American Samoa: taro in American Samoa, 2 pp. American Samoa: Agriculture, Human and Natural Resources, American Samoa Community College Land Grant Program. American Samoa Community College Land Grant Program Leaflet No. 2.

    The impact of taro leaf blight on the American Samoan economy is described along with an overview of taro pests and diseases.

66. Butler, E. J., & Bisby, G. R. (1931). The fungi of India, 237 pp. Imperial Council of Agricultural Research and Science Monograph No. 1.

67. Butler, E. J., Bisby, G. R., & Vasudeva, R. S. (1960). The fungi of India, 552 pp. India: Indian Council of Agricultural Research.

68. Butler, E. J., & Kulkarni, G. S. (1913). *Colocasia* blight caused by *Phytophthora colocasiae* Rac. Memoirs of the Department of Agriculture in India, Botanic Series **5**(4), 233–261.

69. CAB INTERNATIONAL. (2000). Crop Protection Compendium Global Module. Wallingford, UK: CAB INTERNATIONAL.

    This CD contains updated datasheets on taro and *Phytophthora colocasiae,* with information on biology, control and geographic distribution.

70. CAB INTERNATIONAL. (1998). Crop Protection Compendium Module 1. Wallingford, UK: CAB INTERNATIONAL.

    This CD contains datasheets on taro and *Phytophthora colocasiae,* with information on biology, control and geographic distribution.

71. CAB INTERNATIONAL. (1997). Distribution maps of plant diseases. (April–October), unnumbered.

    This set includes a map for *Phytophthora colocasiae* (Map no. 466). This is the 3rd edition of this map for this pathogen.

72. Cable, W. J. (1977). Report of a field study on taro research in the South Pacific. In Regional Meeting on the Production of Root Crops. Suva, Fiji, 24–29 October 1975. (pp. 94–99). Noumea, New Caledonia: South Pacific Commission. SPC Technical Document No. 174.

    In this review, taro leaf blight in the region is discussed. Control measures are outlined.

73. Carpenter, C. W. (1920). Report of the plant pathologist. Hawaii Agricultural Experiment Station Report 1919 (pp. 49–54). Hawaii, USA.

74. Castellani, E. (1939). Considerazioni fitopatologiche sull'Africa orientale italiana. [Phytopathological studies in Italian East Africa]. Agricoltura Colon , 486–492.

75. Chan, E. (1996). The impact of taro leaf blight on the Samoan economy and agricultural activity, 8 pp. Western Samoa Farming Systems Project, Ministry of Agriculture, Forestry, Fisheries and Meteorology, Unpublished report.

The outbreak of taro leaf blight in Samoa is discussed. The government reaction to the disease, the effect on the pattern of food production and consumption and the effect on Samoa's economy are considered.

76. Chan, E. (1997). A summary of trials carried out in the taro leaf blight control program 1996–1997, 33 pp. Western Samoa Farming Systems Project, Ministry of Agriculture, Forestry, Fisheries and Meteorology, Unpublished report.

77. Chan, E., Milne, M., & Fleming, E. (1998). The causes and consequences of taro leaf blight in Samoa and the implications for trade patterns in taro in the South Pacific region. Tropical Agriculture (Trinidad) **75**(1), 93–98.

The impact of taro leaf blight on taro production in Samoa after the outbreak of the disease in 1993 and steps taken by the Ministry of Agriculture, Fisheries, Forestry and Meteorology, including input subsidies, development of resistant varieties and food crop diversification are discussed. The implications of taro leaf blight for the Samoan economy and for taro trade and domestic prices in the Pacific region are also considered.

78. Chandra, S. (1984). Conclusions and recommendations for research and development in edible aroids. In S. Chandra (Editor), Edible Aroids (pp. 237–242). Oxford, UK: Clarendon Press.

The main areas of needed future research and development for edible aroids are identified as: agronomy and production systems; germplasm and breeding; diseases and pests; and storage, utilization and marketing. *Phytophthora colocasiae* is identified as an important disease and the importance of collecting resistant germplasm is stressed.

79. Chaudhary, R. G., & Mathura Rai. (1988). A note on the varietal screening of taro to *Phytophthora* blight. Haryana Journal of Horticultural Sciences **17**(3–4), 278–279.

In tests carried out in Arunachal Pradesh, India, 23 varieties of taro (*Colocasia esculenta*) were screened for resistance to *P. colocasiae*. Results showed that 5 varieties were immune and 1 was moderately resistant.

80. Cho, J. J., & Michelmore, R. W. (1996). Genetic analysis of *Phytophthora* leaf blight resistance in taro using molecular markers. In The Second Taro Symposium. Proceedings of an International Meeting. Faculty of Agriculture,

Cenderawasih University, Manokwari, Indonesia, 23–24 November 1994. (pp. 58–61).

Molecular techniques to accelerate the breeding of taro with resistance to blight are described. The technology can be used to tag genes associated with blight resistance. Breeding strategies using RAPD markers and PCR are described.

81. Chowdhury, S. (1944). Some fungi from Assam, I. Indian Journal of Agricultural Sciences , 230–233.

82. Cifferi, R. (1955). Preliminary list of noteworthy diseases of cultivated plants in continental eastern China. Plant Disease Reporter **39**(10), 785–792.

83. Clarke, W. C. (1973). A change of subsistence staple in prehistoric New Guinea. International Symposium on Tropical Root Crops. Ibadan, Nigeria, 1973.

84. Clarkson, D. (1981). Taro blight. Harvest (Papua New Guinea) 7(2), 87. Plant pathology note: no. 9.

85. Clarkson, D., & Moles, D. J. (1984). Effects of four fungicides on the growth of *Phytophthora colocasiae*. Papua New Guinea Journal of Agriculture, Forestry and Fisheries **33**(1–2), 51–53.

The efficiency of four fungicides in controlling *Phytophthora colocasiae* was investigated *in vitro* and *in vivo*. Du-ter and Ridomil were gave excellent control of fungal development but the phytotoxicity of Du-ter rendered it unsuitable for use on taro. Cuprox and Aliette were found to be less effective.

86. Cole, J. S. (1996). Isolation of *Phytophthora colocasiae* into pure culture. Taro Leaf Blight Seminar. Proceedings. Alafua, Western Samoa, 22–26 November, 1993. (pp. 83–85). Noumea, New Caledonia: South Pacific Commission. Unpublished.

The use of selective medium, selecting agents (Pimaricin, Penicillin-G and PCNB (Pentachloronitrobenzene)), isolation of the pathogen from plant material and baiting techniques for *Phytophthora colocasiae* are described.

87. Connell, J. (1978). The death of taro: local response to a change of subsistence crops in the Northern Solomon Islands. Mankind (No. 11), 445–452.

The outbreak of taro leaf blight on Bougainville after the 2nd World War, its spread in the Solomon Islands and the local response to the disease are discussed.

88. Coursey, D. G., & Booth, R. H. (1977). Contributions of post-harvest biotechnology to trade in tropical crops. In Regional Meeting on the Production of Root Crops. Suva, Fiji, 24–29 October 1975. (pp. 100–105). Noumea, New Caledonia: South Pacific Commission. SPC Technical Paper No. 174.

Although the storage of taro is minimal, the role of *Phytophthora colocasiae* in postharvest decay of taro is discussed.

89. Coursey, D. G., Jackson, G. V. H., & Pena, R. S. d. l. (1979). Working group report: handling and storage. In D. L. Plucknett (Editor), Small-scale Processing and Storage of Tropical Root Crops (pp. 15–25). Boulder, Colorado, USA: Westview Press. Westview Tropical Agriculture Series, No. 1.

In this chapter, preharvest (removal of infected leaves 2 weeks before harvest) and packaging and handling techniques to reduce damage caused by *Phytophthora colocasiae*, and other diseases are discussed.

90. Cox, P. G. (1986). Taro leaf blight, 15 pp. Lae, Papua New Guinea: Department of Agriculture and Livestock, Bubia Agricultural Research Centre. Seminar paper presented at Bubia Agricultural Research Centre, Lae, Papua New Guinea, 5 November 1986.

Research on taro leaf blight at DPI Crops Research is outlined. Experiments on chemical control using metalaxyl, the effect of taro leaf blight on leaf number, the effect of dose rate on the chemical control of taro leaf blight, the effect of application frequency on chemical control and the effect of leaf number on varietal reaction to taro leaf blight are described.

91. Cox, P. G., & Kasimani, C. (1988). Control of taro leaf blight using metalaxyl. Tropical Pest Management **34**(1), 81–84.

Metalaxyl with copper (as 0.3% Ridomil plus 72 w.p.) gives excellent control of taro (*Colocasia esculenta*) leaf blight (*Phytophthora colocasiae*) when applied at 2-week intervals using a knapsack sprayer. It is concluded that this is useful for taro research and suggests a way to control the disease in subsistence food gardens in Papua New Guinea, which may be preferable both to the development and introduction of elite cultivars and to attempts at cultural control.

92. Cox, P. G., & Kasimani, C. (1990). Control of taro leaf blight using metalaxyl: effect of dose rate and application frequency. Papua New Guinea Journal of Agriculture, Forestry and Fisheries **35**(1–4), 49–55.

Metalaxyl (as Ridomil plus 72 WP) was applied to taro (*Colocasia esculenta*) cultivar K264 using a knapsack sprayer to control leaf blight (*Phytophthora colocasiae*). The efficacy of 3 dose rates (0.1, 0.2 and 0.3%) applied at 2-week intervals (experiment 1) and 3 application frequencies (2, 5 and 7 times) using 0.3% metalaxyl (experiment 2) was investigated. In experiment 1, analysis of variance showed a significant increase in corm weight in all plots treated with metalaxyl ($P<0.001$) but no difference in yield between treatments. In the second experiment, treated plots again showed a significant increase in corm yield: 5 applications of metalaxyl at 3-week intervals resulted in an increase of almost 50%.

93. Cox, P. G., & Kasimani, C. (1987). Effect of blight on leaf area duration, leaf number and marginal unit leaf rate of taro, 15 pp. Kerevat, Papua New Guinea: Department of Agriculture and Livestock, Lowlands Agricultural Experiment Station.

Leaf blight substantially reduces both the leaf area duration and the marginal unit leaf rate of taro. Leaf number is the principal component of leaf area duration affected by blight. Use of effective leaf area does not correct for differences in the unit leaf rate. A model is presented which explains this in terms of the division of labour along the plant axis. The implications of variation in the rate of yield accumulation for the control of taro leaf blight in farmers' gardens are discussed. Two disease indices are proposed: (1) percentage loss of leaf number (for the comparison of different varieties); and (2) percentage of growing period affected by blight (for the comparison of different disease progress curves).

94. Cox, P. G., & Kasimani, C. (1990). Effect of taro leaf blight on leaf number. Papua New Guinea Journal of Agriculture, Forestry and Fisheries **35**(1–4), 43–48.

Setts of taro (*Colocasia esculenta*) cultivar K264 were planted in a randomized complete block design with 5 replicates of 4 treatments: plants inoculated with *Phytophthora colocasiae* at 78, 105 or 133 d after planting or uninoculated in control plots. The number of leaves declined following inoculation, reaching an equilibrium after 3–6 weeks. Leaf number was then similar in all inoculated plants. The number of older leaves was reduced by the blight, but the rate of leaf production was unaffected. Yield from all inoculated plants was significantly reduced ($P<0.01$) but there was no significant difference between inoculated plots.

95. Cox, P. G., & Kasimani, C. (1987). Effect on leaf number on varietal reaction to taro leaf blight, 12 pp. Lae, Papua New Guinea: Department of Agriculture and Livestock, Bubia Agricultural Research Centre.

Leaf blight reduces the cumulative leaf number of taro. A plant with more leaves suffers a greater proportional loss of leaf number in the presence of blight, and a correspondingly greater proportional loss in mean corm weight. It is concluded that this has implications for the design of improved taro cultivars.

96. Das, S. R. (1997). Field efficacy of fungicides for the control of leaf blight disease of taro. Journal of Mycology and Plant Pathology **27**(3), 337–338.

Field experiments were conducted at the Orissa University of Agriculture and Technology, Bhubaneswar, Orissa, India, for the 3 successive kharif seasons of 1991–93 to test the efficacy of copper oxychloride, mancozeb, metalaxyl, captafol, ziram and Bordeaux mixture against leaf blight disease (*Phytophthora colocasiae*) of taro (*Colocasia esculenta* var. *antiquorum*). The local variety, Telia, was used as a test crop. Fungicides were sprayed when disease symptoms first appeared and repeated twice at 14-day intervals.

Leaf blight severity and marketable corm yield were recorded for each treatment. All fungicides significantly reduced leaf blight intensity and increased corm yields in comparison with the untreated control. Metalaxyl + mancozeb gave significantly more effective disease control than the other fungicides followed by mancozeb and Bordeaux mixture. Mancozeb recorded the highest corm yield (95.6 q/ha). It is concluded that leaf blight of taro can be effectively managed by giving 3 sprays of metalaxyl + mancozeb or mancozeb alone starting at the onset of the disease and repeating at fortnightly intervals.

97. Dayrit, R., & Phillip, J. (1987). Comparative performance of eight dryland taro varieties on Pohnpei, Federated States of Micronesia, 4 pp. Kolonia, Federated States of Micronesia: AES/CTAS.

98. Delp, C., Hunter, D. G., & Pouono, K. (1999). USP Taro Breeders Club: an innovative and participatory approach to improving taro in Samoa. IRETA's South Pacific Agricultural News .

The Taro Breeders Club initiated at the University of the South Pacific in Samoa in 1999 is described.

99. Deshmukh, M. J., & Chhibber, K. N. (1960). Field resistance to blight *Phytophthora colocasiae* Rac. in *Colocasia esculenta* Schott. Current Science (Bangalore) **29**(8), 320–321.

The progress of taro leaf blight in the field resistant cultivar, Ahina, and susceptible Patna Local was compared. Fewer sporangia of the fungus were produced on the resistant cultivar and the disease progressed at a much slower rate. The reaction on the resistant cultivar was much more severe. It is concluded that the observed field resistance is a weak hypersensitive reaction.

100. Dey, T. K., Ali, M. S., Bhuiyan, M. K. R., & Siddique, A. M. (1993). Screening of *Colocasia esculenta* (L.) Schott lines to leaf blight. Journal of Root Crops **19**(1), 62–65.

A total of 38 *C. esculenta* lines were evaluated for susceptibility to leaf blight, caused by *Phytophthora colocasiae*.

101. Dey, T. K., Ali, M. S., Chowdhury, N., & Siddique, M. A. (1991). Vegetative growth and sporangial production in *Phytophthora colocasiae* Racib. Journal of Root Crops **17**(2), 142–146.

The influence of agar media, temperature and liquid substrates on vegetative growth and sporangial production of *P. colocasiae* was investigated. Oat meal agar with yeast extract and V-8 juice agar gave maximum vegetative growth and mycelial density. Highest vegetative growth and mycelial density was recorded at 25 +/- 1 C. Rain water was the best liquid substrate for sporangial production followed by charcoal water at 20 +/- 1 C.

102. Dingley, J. M., Fullerton, R. A., & McKenzie, E. H. C. (1981). Records of fungi, bacteria, algae and angiosperms pathogenic on plants in Cook Islands, Fiji, Kiribati, Niue, Tonga, Tuvalu, and Western Samoa. SPEC/UNDP/FAO Survey of Agricultural Pests and Diseases, Technical Report No. 2.

The distribution of *Phytophthora colocasiae* in the Pacific region is given as Solomon Islands, Papua New Guinea and Hawaii (page 136). Reports for Fiji and Western Samoa are cited, but it is concluded that these reports need confirmation.

103. Erari, D. K. (1994). Penggunaan beberapa mikroorganisme saprofit dan fungisida Metalaxyl untuk pengendalian penyakit hawar daun talas (*Phytophthora colocasiae*). [The use of several saprophytic microorganisms and metalaxyl fungicide to control taro leaf blight (*Phytophthora colocasiae*)]. Unpublished report of the Faculty of Postgraduate Studies, Bogor Agricultural Institute.

104. Erari, D. K. (1985). Penilaian ketahanan beberapa klon talas asal Manokwari terhadap serangan penyakit bercak daun talas (*Phytophthora colocasiae*). [The evaluation of several taro clones from Manokwari to taro leaf blight (*Phytophthora colocasiae*)]. Unpublished report of the Faculty of Agriculture UNCEN, Manokwarai.

105. Erwin, D. C. (1983). Variability within and among species of *Phytophthora.* D. C. Erwin, S. Bartnicki-Garcia, & P. H. Tsao (Editors), Phytophthora: its Biology, Taxonomy, Ecology, and Pathology (pp. 149–165). St Paul, Minnesota, USA: APS Press (American Phytopathological Society).

Phytophthora colocasiae is considered in this discussion on variability within and among species of *Phytophthora.*

106. Erwin, D. C., & Ribeiro, O. K. (1996). *Phytophthora colocasiae.* Phytophthora Diseases Worldwide (pp. 299–300). USA: APS Press (American Phytopathological Society).

The fungus is described and its taxonomy discussed.

107. Esgrerra, N. M. (1981). Status of integrated pest management on root crops in the Philippines. In Southeast Asian and the Pacific Training Course on Root and Tuber Crops Germplasm Evaluation and Utilization (pp. 264–312). Leyte, Philippines: Visayos State College of Agriculture.

108. Ezumah, H. C., & Plucknett, D. L. (1981). Cultural studies on taro, *Colocasia esculenta* (L.) Schott. Journal of Root Crops **7**, 41–52.

109. FAO. (1998). Global Plant and Pest Information System.

Also available via the Internet at http://pppis.fao.org. This CD is a snap shot of the database taken in July 1998. Data is updated regularly in the internet version and CDs pressed periodically. The database contains information on *Phytophthora colocasiae* and the text of a thesis on 'Phenology and epidemiology of *Phytophthora colocasiae* Racib. on taro in the East West Province, Papua New Guinea' by Putter, C. A. J.

110. FAO. (1963). Host list of fungi etc. recorded in the South East Asia and Pacific region. *Colocasia antiquorum*—taro; *Dioscorea* spp.—yam; *Manihot utilissima*—cassava. Technical Document FAO Plant Protection Commission .

111. FAO. (1963). Quarterly report for October–December 1962 of the Plant Protection Committee for the South East Asia and Pacific Region. Bangkok, Thailand: FAO.

112. Ferentinos, L. (1993). Proceedings of the Sustainable Taro Culture for the Pacific Conference. University of Hawaii, 24–25 September 1992. (140 pp.). Honolulu, Hawaii: Hawaii Institute of Tropical Agriculture and Human Resources. HITAHR Research and Extension Series No. 140.

     Several papers concern taro leaf blight and have been noticed separately in this bibliography.

113. Firman, I. D. (1975). *Phytophthora* and *Pythium* species and the diseases caused by them in the area of the South Pacific Commission. Fiji Agricultural Journal **37**, 1–8.

114. Firman, I. D. (1982). Review of major diseases of crops in the South Pacific. In Sub-Regional Training Course on Methods of Controlling Diseases, Insects and Pests of Plants in the South Pacific (pp. 39–46). Tonga: GTZ/USAID/CICP/MAFF.

115. Fonoti, P., Hunter, D. G., & Delp, C. (2001). Improving traditional farming systems through plant breeding. In Proceedings of the Regional Workshop on the Improvement and Development of Traditional Farming Systems for South Pacific Countries. IRETA, University of the South Pacific, Alafua Campus, Samoa, 18–22 October 1999.

116. Fonoti, P., Hunter, D. G., Singh, D., Okpul, T., Delp, C., Pouono, K., & Sivan, P. (1999). Breeding for resistance to taro leaf blight in the South Pacific. In Proceedings of the 12th Biennial Australasian Plant Pathology Society Conference. Canberra, Australia, 27–30 September 1999. (p. 248).

117. Fullerton, B., Hunter, D. G., & Jackson, G. (1998). Phytophthora colocasiae: the pathogen and its epidemiology. In Proceedings of the Taro Breeding Workshop. Suva, Fiji Islands, 26–28 August 1988. (pp. 8–9). Noumea, New Caledonia: AusAID/SPC Taro Genetic Resources: Conservation and Utilisation, Secretariat of the Pacific Community.

118. Fullerton, R. A. (1995). SPC/DAL/Unitech Taro Seminar II, Lae, Papua New Guinea. Report to the New Zealand Ministry of Foreign Affairs and Trade, 55 pp.

Auckland, New Zealand: HortResearch. HortResearch Client Report No. 95/239.

In this report the Taro Seminar II meeting held in Lae, 26–30 June 1995 is analysed. The major focus on taro leaf blight is noted and details of work in progress on chemical control and breeding for resistance are summarised. Recommendations included the need for a continuation of the breeding programme, sourcing resistant material, exposure of resistant lines to other strains of the pathogen and conservation of genetic resources. The paper 'Breeding for resistance to taro leaf blight—a pathologist's perspective' presented by R.A. Fullerton at the meeting is appended.

119. Fullerton, R. A., Tyson, J., Hunter, D. G., & Fonoti, P. (2000). Plant Pathology Progress Report. In Taro Genetic Resources Committee Meeting. Lae, Papua New Guinea, 18 April 2000.

The development of laboratory and field screening techniques for taro blight are described. Additional information is provided on determination of *P. colocasiae* mating type from different Pacific countries.

120. Galloway, L. D. (1936). Report of the Imperial Mycologist. Science Report of the Agricultural Research Institute, Pusa. (pp. 120–136).

121. Gendua, M. A., & Johnston, M. (1996). The performance of taro (*Colocasia esculenta*) seedlings grown to maturity. In The Second Taro Symposium. Proceedings of an International Meeting. Faculty of Agriculture, Cenderawasih University, Manokwari, Indonesia, 23–24 November 1994. (pp. 79–82).

Taro seedlings showed greater variation in their reaction to *Phytophthora colocasiae* than their parents. It is concluded that selection within seedling populations offers much potential.

122. Ghani, F. D. (1980). The status of Keladi China *Colocasia esculenta* (L.) Schott cultivation in Peninsula Malaysia. In International Symposium on Taro and Cocoyam. Visayas State College of Agriculture, Baybay, Leyte, Philippines, 24–25 September, 1979. (pp. 35–54). Stockholm, Sweden: International Foundation for Science. Provisional Report (International Foundation for Science) No. 5.

In this account of taro growing in Malaysia, taro leaf blight is reported as sometime occurring during wet weather. When it occurs, it is serious causing decay of the petioles and the corms.

123. Ghosh, S. K., & Das, N. (1996). Physiology of sporangial germination of *Phytophthora colocasiae* Racib. *in vitro*. Advances in Plant Sciences **9**(1), 107–110.

Sporangia of *P. colocasiae*, the cause of leaf blight and corm rot of taro (*Colocasia esculenta*), were harvested from 10 day old cultures grown in oat + yeast extract + thiamine medium. The mode of sporangial germination was investigated in both distilled and tap water at various temp. (10–30 C) and incubation durations. Both direct and indirect germination of sporangia took place. At 10ø, indirect germination began within 15 min and 100% germination took place after 2 h, while at 30ø it started after 30 min and only 18% of sporangia germinated indirectly after 2 h. Direct germination occurred up to 6.1% at 30ø after 3 h and even after 24 h but at 10ø no direct germination was observed.

124. Ghosh, S. K., & Sitansu Pan . (1989). A comprehensive account of the fungal diseases of *Colocasia esculenta* (L.) Schott. Indian Journal of Mycological Research **27**(2), 107–119.

This review covers the distribution, symptoms, epidemiology, aetiology, perennation, hosts, losses caused by and control measures for leaf blight (*Phytophthora colocasiae*), dry rot (*Fusarium* [*solani* var.] *coeruleum* and *F. solani*), and the root and corm rots caused by *Pythium* spp.

125. Ghosh, S. K., & Sitansu Pan. (1991). Control of leaf blight of taro (*Colocasia esculenta* (L.) Schott) caused by *Phytophthora colocasiae* Racib. through fungicides and selection of variety. Journal of Mycopathological Research **29**(2), 133–140.

Spraying with Ridomil MZ 72 WP [metalaxyl] at 3 kg/ha at intervals of 15 d was highly effective in controlling the disease under field conditions, and gave max. net financial return. This fungicide was equally effective against *P. colocasiae in vitro*. Of 11 cultivars screened under natural epiphytotics, Burdwan local was the best for commercial cultivation in this agroclimatic zone.

126. Ghosh, S. K., & Sitansu Pan. (1994). Pectolytic and cellulolytic enzyme activity by 3 isolates of *Phytophthora colocasiae* Racib. with graded virulence. Mysore Journal of Agricultural Sciences **28**(1), 47–51.

The involvement of cell wall degrading enzymes in the pathogenesis of *P. colocasiae* on *Colocasia esculenta* was investigated using 3 isolates of the pathogen with high, medium and low virulence. In *in vitro* experiments using culture filtrates, production of polygalacturonase (PG), pectin methyl esterase (PME) and polymethyltranseliminase (PMTE) was greatest for the isolate with high virulence; no polymethylgalacturonase (PMG) activity was determined. In further *in vivo* tests on detached leaves, PMTE, PMG and PG activity was highest for the most virulent isolate; no PME activity was determined.

127. Giri, D., Banerjee, K., Laha, S. K., & Khatua, D. C. (1989). Some diseases of horticultural and field crops. Environment and Ecology **7**(4), 821–825.

Amongst the diseases detected during surveys undertaken in the kharif and rabi seasons of 1981 in West Bengal, India, leaf blight (*Phytophthora colocasiae*) of *Colocasia nymphaeifolia* was recorded for the first time in India.

128. Gollifer, D. E. (1971). Preliminary observations on the performance of cultivars of taro (*Colocasia esculenta* L.) in the British Solomon Islands with notes on the incidence of taro leaf blight (*Phytophthora colocasiae* Rac.) and other diseases. In Tropical root and tuber crops tomorrow. Volume 2. Proceedings of the Second International Symposium on Tropical Root and Tuber Crops. Honolulu, Hawaii, 23–30 August 1970. (pp. 56–60). Honolulu, Hawaii, USA: University of Hawaii.

All cultivars surveyed were infected by *Phytophthora colocasiae*. The effect of the disease on yield has not been measured in the Solomons.

129. Gollifer, D. E. (1972). Taros *Colocasia esculenta* L. Annual Report 1971, British Solomon Islands Protectorate, Department of Agriculture, Dala Experimental Station (pp. 38–45). Honiara, Solomon Islands: Department of Agriculture.

Results of cultivar, fungicide and yield loss trials are reported.

130. Gollifer, D. E., & Brown, J. F. (1974). *Phytophthora* leaf blight of *Colocasia esculenta* in the British Solomon Islands. Papua New Guinea Agricultural Journal **25**(1–2), 6–11.

Leaf blight, caused by *P. colocasiae*, is the most widespread disease of this crop on the larger volcanic islands. None of the 181 local cultivars tested was immune or highly resistant to the fungus. A small proportion, however, did not show high levels of disease. Cu fungicides as foliar sprays, although giving poor control, resulted in yield increases of up to 25%.

131. Gollifer, D. E., Jackson, G. V. H., & Newhook, F. J. (1980). Survival of inoculum of the leaf blight fungus *Phytophthora colocasiae* infecting taro, *Colocasia esculenta* in the Solomon Islands. Annals of Applied Biology **94**(3), 379–390.

The fungus was isolated by baiting with detergent-treated taro leaf discs placed on water slurries of soil, on suspensions of macerated leaf lesions or on washings from petioles of harvested plants. Inoculum on detached leaf lesions or in soil remained viable for only a few days, and that on petiole bases (used for vegetative propagation) for 2 days if stored dry, but for 14 days if planted in the field immediately. Artificial augmentation of surface inoculum with naturally produced sporangia extended the period of inoculum detectability. Incubation of inoculated tops under high humidity led to active infection and sporulation on petioles, especially the cut ends. Of several aroids tested only *Alocasia macrorrhiza* proved susceptible but it has not been found naturally infected. Thus perennation between crops is effected by short-lived, surface propagules and possibly by mycelium within petiole

lesions. Reduction of the former and prevention of the latter might be achieved by dry storage of tops (used for propagation) for 2–3 weeks.

132. Gomez, E. T. (1925). Blight of gabi (*Phytophthora colocasiae* Rac.) in the Philippines. Philippine Agriculturist **14**, 429–440.

The importance, distribution, symptoms, causal organism, environmental factors affecting the disease and control measures of gabi (*Colocasia esculenta*) blight in the Philippines are discussed.

133. Gomez-Moreno, M. L. (1942). Araceas de Fernando Poo. [Araceae of Fernando Poo]. Ann Agic Terr Esp Golfo Guinea , 7–37.

134. Goswami, B. K., Zahid, M. I., & Haq, M. O. (1993). Screening of *Colocasia esculenta* germplasm to *Phytophthora* leaf blight. Bangladesh Journal of Plant Pathology **9**(1–2), 21–24.

Among 50 lines tested by inoculation in the field during 1987–89, 2 were highly resistant to *P. colocasiae*, 5 resistant, 12 moderately resistant and the rest moderately to highly susceptible.

135. Greenough, D. R. (1996). Taro leaf blight research programme for American Samoa. Taro Leaf Blight Seminar. Proceedings. Alafua, Western Samoa, 22–26 November, 1993. (pp. 87–88). Noumea, New Caledonia: South Pacific Commission. Unpublished.

Variable results have been achieved with Ridomil in the control of taro leaf blight in American Samoa. Research needs were identified as: chemical control studies with Ridomil, Ridomil/Aliette and calcium hypochlorite and integrated management studies including variety and fertility trials. Progress of this research is briefly described.

136. Greenough, D. R., & Trujillo, E. E. (1996). Effects of nitrogen, calcium, and/or potassium nutrition on the resistance and/or susceptibility of Polynesian taros, *Colocasia esculenta*, to the taro leaf blight, caused by the fungus *Phytophthora colocasiae*. In ADAP Project Report (pp. 19–25).

The objectives and progress and major accomplishments in the project are reported. Results of field trials in Hawaii, American Samoa and Guam are reported.

137. Greenough, D., Fa'aumu, S., & Tilialo, R. (1994). Effect of three concentrations of Ridomil 2E on the incidence of taro leaf blight (*Phytophthora colocasiae*) in American Samoa. Phytopathology **84**(10), 1115. Abstract of a paper presented at the APS Annual Meeting, Albuquerque, New Mexico, 6–10 August, 1994.

The epidemic of taro leaf blight in American Samoa starting in June 1993 is described. Chemical and cultural control measures were initiated. Ridomil 2E at 3, 5 and 7 fluid ounces/2 gallons water were applied as a soil drench, 2 and

4 months after planting. The highest concentration gave the best control, with only some phytotoxicity observed.

138. Gregory, P. H. (1983). Some major epidemics caused by *Phytophthora*. D. C. Erwin, S. Bartnicki-Garcia, & P. H. Tsao (Editors), *Phytophthora*: its Biology, Taxonomy, Ecology, and Pathology (pp. 271–278). St Paul, Minnesota, USA: APS Press (American Phytopathological Society).

Five examples are discussed including the epidemiology of *Phytophthora colocasiae* on taro.

139. Guarino, L., & Jackson, G. V. H. (1986). Describing and documenting root crops in the South Pacific, 141 pp. Suva, Fiji: FAO/SPC. RAS/83/001 Field Document No. 12.

The presence of *Phytophthora colocasiae* in the region and the breeding for resistance in Papua New Guinea and Solomon Islands is noted.

140. Gunua, T. G. (1997). Foliar diseases of taro in the wahgi valley of the Western highlands province of Papua New Guinea. Papua New Guinea Journal of Agriculture, Forestry and Fisheries **40**(1–2), 22–26.

Foliar diseases of taro (*Colocasia esculenta*) in 3 areas of the Wahgi Valley in the Western Highlands of Papua New Guinea were investigated. Taro leaf blight (*Phytophthora colocasiae*) was not found at any of the sites.

141. Gurr, P. (1996). The taro leaf blight situation in American Samoa. Taro Leaf Blight Seminar. Proceedings. Alafua, Western Samoa, 22–26 November, 1993. (pp. 35–38). Noumea, New Caledonia: South Pacific Commission. Unpublished.

The detection of the taro leaf blight epidemic in American Samoa in 1993, its spread and measures taken to control the disease are outlined. Successes and problems with chemical control using the copper based fungicide (Paranoias), Ridomil 2E and calcium hypochlorite are discussed.

142. Hicks, P. G. (1967). Resistance of *Colocasia esculenta* to leaf blight caused by *Phytophthora colocasiae*. Papua New Guinea Agricultural Journal **19**(1), 1–4.

Seven of the clones tested were weakly to moderately resistant.

143. Hill, D. S., & Waller, J. M. (1990). Taro. In Pests and Diseases of Tropical Crops Field Handbook .

144. Hill, V. (1995). In worlds of our own: different ways of seeing and the small-holder taro grower in Western Samoa. Unpublished doctoral dissertation, Victoria University, Wellington, New Zealand.

145. Ho, H. H. (1992). Keys to the species of *Phytophthora* in Taiwan. Plant Protection Bulletin (Taiwan) **1**(2), 104–109.

A dichotomous key and a synoptic key for the identification of the 23 *Phytophthora* species recognized in Taiwan are presented.

146. Ho, H. H. (1981). Synoptic keys to the species of *Phytophthora* in Taiwan. Mycologia **73**(4), 705–714.

Three synoptic keys are presented to facilitate identification of plant pathogenic *Phytophthora* species in culture.

147. Ho, H. H., & Chang, H. S. (1992). A re-evaluation of *Phytophthora* species described by K. Sawada in Taiwan. **43**, 297–316.

The taxonomic status of all 23 species of *Phytophthora* described by K. Sawada in Taiwan is reviewed, based on a study of available dried plant specimens, type/authentic cultures and the original publications. Sawada's findings of *P. colocasiae* on taro are confirmed.

148. Ho, H. H., Hu, Y. N., Zhuang, W. Y., & Liang, Z. R. (1983). Mating types of heterothallic species of *Phytophthora* in China. I. Acta Mycologica Sinica **2**(3), 187–191.

Each of 38 isolates of 7 heterothallic *Phytophthora* spp. was grown in dual culture with known A1 and A2 strains. There was no correlation between mating types and hosts or geographical distribution.

149. Ho, H. H., Liang, Z. Y., Zhuang, W. Y., & Yu, Y. N. (1984). *Phytophthora* spp. from rubber tree plantations in Yunnan Province in China. Mycopathologia **86**, 121–124.

150. Ho, P. K., & Ramsden, L. (1998). Mechanisms of taro resistance to leaf blight. Tropical Agriculture (Trinidad) **75**(1), 39–44.

Five cultivars of taro and 2 other related aroids were screened for the induction of pathogenesis-related (PR) proteins in response to infection by *Phytophthora colocasiae.* Extracellular fluid from infected leaves was tested for PR protein expression by SDS-PAGE analysis and activity gels were used to measure the activity of the known PR proteins, beta-1,3-glucanase, proteinase inhibitors and peroxidase). Infected plants showed increased levels of PR proteins but this did not correlate with resistance in the most susceptible cultivars. Despite high levels of some PR proteins, infection still occurred in these cultivars. Successful resistance in other plants was more closely linked to the pattern of expression of proteinase inhibitors which appear to be an important defence strategy in taro in related aroids.

151. Hohl, H. R. (1975). Level of nutritional complexity in *Phytophthora*: lipids, nitrogen sources and growth factors. Phytopathologische Zeitschrift **84**(1), 18–33.

In a medium (P-1L) that supported good vegetative growth of all 24 test strains, representing 16 *Phytophthora* spp., the single most effective additives were lecithin and linoleic acid, which were generally superior to sterols.

152. Hohl, H. R. (1975). Levels of nutritional complexity in *Phytophthora*: lipids, nitrogen sources and growth factors. Phytophthora Newsletter (No. 3), 12.

A medium containing lecithin and linoleic acid was devised which supported good vegetative growth of 24 strains representing 16 *Phytophthora* spp. These strains were divided into 4 levels of nutritional complexity on the basis of the results.

153. Hohl, H. R. (1983). Nutrition of *Phytophthora.* D. C. Erwin, S. Bartnicki-Garcia, & P. H. Tsao (Editors), *Phytophthora*: its Biology, Taxonomy, Ecology, and Pathology (pp. 41–54). St Paul, Minnesota, USA: APS Press (American Phytopathological Society).

The nutritional aspects of vegetative growth of *Phytophthora* species is reviewed, including several references to *P. colocasiae.*

154. Holliday, P. (1980). *Phytophthora colocasiae.* In Fungus diseases of tropical crops. (pp. 348–349). Cambridge, UK.: Cambridge University Press.

A description of the fungus is given and symptoms of the disease and its control are briefly discussed.

155. Houtondji, A., Palay, L., & Messiaen, C. M. Recherches sur l'activite eventuelle de quelques nematicides vis a vis de champignons phytopathogenes du sol (chou caraobe). [Investigations on the possible antifungal activity of some nematicides (tannia plant)]. In Congres sur la protection de la sante humaine et des cultures en milieu tropical: nouvelles strategies de protection integree des cultures et de lutte contre les vecteurs de maladies, regions tropicales et subtropicales. Marseille, France, 2–4 July 1986. (pp. 301–304). In French.

156. Hunter, D. G., & Delp, C. (1999). Breeders club helps save taro. The University of the South Pacific Bulletin **32**, 2.

157. Hunter, D. G., & Delp, C. (2000). Taro returning to Samoa. IRETA's South Pacific Agricultural News **17**, 4–5.

158. Hunter, D. G., Delp, C., Iosefa, T., & Fonoti, P. (2000). Improving taro production in Samoa through breeding and selection. In 12th Symposium of the International Society for Tropical Root Crops. Tsukuba, Japan, 10–16 September 2000.

159. Hunter, D. G., Delp, C., Iosefa, T., & Metai, A. (2000). Samoan taro growers are battling taro leaf blight, *Phytophthora colocasiae*. In 1st Asian Conference on Plant Pathology. Beijing, China, 25–28 August 2000. (p. 335).

This poster presented at the conference is available on page 335 of the 3rd circular/program.

160. Hunter, D. G., & Fonoti, P. (2000). Taro leaf blight—tackling the problem as partners. FOCUS (July), 18.

Two initiatives in Samoa, a taro breeders club and a taro improvement project, are described in this short article.

161. Hunter, D. G., Iosefa, T., Delp, C. J., & Fonoti, P. (2000). Beyond taro leaf blight: a participatory approach for plant breeding and selection for taro improvement in Samoa. In Proceedings of the International Symposium on Participatory Plant Breeding and Participatory Plant Genetic Resource Enhancement. Pokhara, Nepal, 1–5 May 2000. Cali, Colombia: CGIAR Systemwide Program on Participatory Research and Gender Analysis for Technoloy Development and Institutional Development, Centro Internacional de Agricultura Tropical.

This paper documents the arrival and impact of taro leaf blight on the Samoan economy and initial attempts to try and contain the spread of the disease. The article focuses on the need for breeding for resistance as the most sustainable approach for management of the disease and compares conventional and participatory methods.

162. Hunter, D., & Pouono, K. (1998). Evaluation of exotic taro cultivars for resistance to taro leaf blight, yield and quality in Samoa. Journal of South Pacific Agriculture **5**(2), 39–43.

Four taro cultivars (Pwetepwet, PSB-G2, Pastora and Toantal) were screened and evaluated in trials at the University of the South Pacific Alafua Campus, Samoa, for their resistance to taro leaf blight, and for their yield and eating quality. Disease severity levels were not significantly different for any of the cultivars studied. Corm yields were highest for Pastora, followed by PSB-G2, Pwetepwet and Toantal. Toantal and PSB-G2 rated highest for taste and dry weight.

163. Hunter, D., Pouono, K., & Semisi, S. (1998). The impact of taro leaf blight in the Pacific Islands with special reference to Samoa. Journal of South Pacific Agriculture **5**(2), 44–56.

An account of *Phytophthora colocasiae* on taro in the Pacific Islands, especially Samoa, is given and control methods discussed.

164. Hunter, D., Sivan, P., Pouono, K., & Amosa, F. (1998). Taro leaf blight and its management in Samoa. 7th International Congress on Plant Pathology. Edinburgh, UK, 10–14 August 1998.

An abstract of this paper is available electronically on the webpage at www.bspp.org.uk/icpp98/abstracts/4.7/8.html and also in the printed proceedings of the congress. The impact of taro leaf blight in Samoa, its cultural control, screening of exotic taro cultivars, breeding, chemical control and future work are discussed.

165. Hunter, J. E., & Kunimoto, R. K. (1974). Dispersal of *Phytophthora palmivora* sporangia by wind-blown rain. Phytopathology **64**(2), 202–206.

In this paper on the dispersal of spores of *P. palmivora*, reference is made to some unpublished work of the authors on *P. colocasiae*. In a pilot study with the taro pathogen, sporangia were not released into moving air under drying conditions, but were readily released by rain-splashing.

166. Iosefa, T., & Rogers, S. (1999). The multiplication, growth and use of introduced taro cultivars in Samoa. Report of an impact assessment carried out during August to November, 1998. Suva, Fiji Islands: Pacific Regional Agricultural Programme Project 1—Farming Systems in Low Lands.

Information on the performance of TLB-resistant cultivars in Samoa is given.

167. Irwin, S. V., Kaufusi, P., Banks, K., Pena, R. d. l., & Cho, J. J. (1998). Molecular characterization of taro (*Colocasia esculenta*) using RAPD markers. Euphytica **99**, 183–189.

168. Ivancic, A. (1996). Breeding for resistance to taro diseases in Solomon Islands. In Seminar on Pacific Plant Pathology in the 1990s. Suva, Fiji Islands, 5–7 September 1991. (pp. 17–18). Noumea, New Caledonia: South Pacific Community.

A brief overview of taro leaf blight in the Solomon Islands (as well as other pests) and breeding for resistance are given.

169. Ivancic, A., Kokoa, P., Gunua, T., & Darie, A. (1996). Breeding approach on testing for resistance to taro leaf blight. In The Second Taro Symposium. Proceedings of an International Meeting. Faculty of Agriculture, Cenderawasih University, Manokwari, Indonesia, 23–24 November 1994. (pp. 93–96).

Resistance to taro leaf blight was studied under screenhouse, nursery and field conditions, and in special 'water beds'. The density of plants, temperature and humidity appeared to be the most important factors influencing infection and spread of the fungus. Plants growing in extremely hot and humid plastic cages showed higher susceptibility than those growing under normal conditions. Of all the methods, only that using water beds allowed the detection of different levels of resistance and susceptibility to *P. colocasiae*.

170. Ivancic, A., Kokoa, P., Simin, A., & Gunua, T. (1996). Mendelian studies of resistance to taro leaf blight. In The Second Taro Symposium. Proceedings of an International Meeting. Faculty of Agriculture, Cenderawasih University, Manokwari, Indonesia, 23–24 November 1994. (pp. 97–100).

Self-pollination and crossing between taro varieties indicated that the majority of Papua New Guinea genotypes are heterozygous for resistance to taro leaf blight. The most frequent ratios in segregating populations resulting from crosses resistant X resistant and resistant X susceptible was 3:1, 9:7 and

7:9. It is concluded that it is likely that more than one gene controls resistance to taro leaf blight.

171. Ivancic, A., Kokoa, P., Simin, A., & Gunua, T. (1995). Resistance to *Phytophthora colocasiae* Racib. in taro *Colocasia esculenta* (L.) Schott: a genetic study of segregating populations. Journal of South Pacific Agriculture **2**(2), 17–21.

Populations analysed in this study were developed from three groups of crosses: (a) resistant X resistant; (b) resistant X susceptible; and (c) susceptible X susceptible. The most frequent segregation ratios (resistant:susceptible) were 3:1, 9:7, 7:9 and 13:3, suggesting that the number of genes controlling resistance to *P. colocasiae* in taro may be relatively low. The appearance of resistant genotypes in populations resulting from crosses between two (partially) susceptible genotypes indicates that minor genes associated with partial resistance may be involved.

172. Ivancic, A., & Okpul, T. (1996). A new mutation of taro (*Colocasia esculenta*) observed at Bubia Agricultural Research Centre. Papua New Guinea Journal of Agriculture, Forestry and Fisheries **39**(2), 6–9.

An unusual mutant of taro was discovered in the cycle-2 population of the recurrent selection programme at the Bubia Agricultural Research Centre, Papua New Guinea. The mutant plant developed a thin elongated stem (about 95 cm long). The stem had several nodes, each carrying 1 leaf. The leaf size decreased with distance from the corm top. The stem was filled with soft, aerated spongy tissue. Side stems were thin and relatively long, growing from lower nodes of the main stem and the corm top. Their structure was similar to that of the main stem. The plant had a normal corm. It was susceptible to *Phytophthora* leaf blight and did not flower. Authors' summary.

173. Ivancic, A., Simin, A., Ososo, E., & Okpul, T. (1995). Wild taro (*Colocasia esculenta* (L.) Schott.) populations in Papua New Guinea. Papua New Guinea Journal of Agriculture, Forestry and Fisheries **38**(1), 31–45.

Wild taro populations were evaluated for breeding purposes in several locations of Papua New Guinea. All evaluated populations were found to be susceptible to taro leaf blight (*Phytophthora colocasiae*) and the Alomae-Bobone virus complex. Absence of taro leaf symptoms was mainly due to isolation of the population (the pathogen did not reach the population). Flowering ability was relatively high. At least a few plants were found to be flowering in each population. The analysis of quantitative variation indicates that there was relatively high uniformity in leaf dimensions and number of lamina veins within populations. Relatively low variation of measured quantitative characteristics and uniformity in qualitative traits indicate that seed propagation may be extremely rare and that at least some PNG wild taro populations may consist of a single clone. It is concluded that in breeding, wild taro genotypes can be used as sources of genes for the improvement of flowering ability, environmental adaptability (for swampy or dry land conditions), growth vigour and earliness.

174. Jackson, G. V. H. (1996). Brief summary of situation in the region and comments on available assistance for long-term regional projects on taro leaf blight control. Taro Leaf Blight Seminar. Proceedings. Alafua, Western Samoa, 22–26 November, 1993. (pp. 71–74). Noumea, New Caledonia: South Pacific Commission. Unpublished.

The impact of taro leaf blight in the Pacific Islands is described. The need for government action, the role of donors and inter-governmental agencies, control of the disease in Western Samoa, assistance for the region, infrastructure support and breeding for taro leaf blight resistance are discussed.

175. Jackson, G. V. H. (1980). Diseases and pests of taro, 51 pp. Noumea, New Caledonia: South Pacific Commission.

This handbook contains a section on taro leaf blight and includes information on distribution, symptoms, spread, effect on yield and control of the disease.

176. Jackson, G. V. H. (1990). Pathogen-free Pacific taro. FAO Plant Protection Bulletin **38**(3), 145–150.

The availability of 59 varieties and 8 breeders' lines of taro, 3 varieties of giant taro and a single tannia as pathogen-tested tissue cultures, or as suckers from indexed plants grown in quarantine, is reported. Some varieties have resistance to *Phytophthora colocasiae*.

177. Jackson, G. V. H. (1986). Preliminary results from surveys of plant diseases in the Federated States of Micronesia and Palau. In UNDP/FAO/GTZ/IRETA Regional Crop Protection Workshop. Apia, Western Samoa, 8–12 September, 1986. (106–113 .). Suva, Fiji: UNDP.

Preliminary results of surveys for plant diseases in the Federated States of Micronesia and Palau are presented and pathogens of major quarantine importance (including *Phytophthora colocasiae* on taro) are identified.

178. Jackson, G. V. H. (1996). Strategies for taro leaf blight research in the region. Taro Leaf Blight Seminar. Proceedings. Alafua, Western Samoa, 22–26 November, 1993. (pp. 95–100). Noumea, New Caledonia: South Pacific Commission. Unpublished.

The research strategies of the countries and territories in the region are discussed based on their different needs. The varying needs of countries are identified as those where outbreaks are recent (American and Western Samoa), where outbreaks are long-established (Solomon Islands and Papua New Guinea) and those countries still free of taro leaf blight. Research needed in the first two categories is outlined and contingency plans, emergency response groups, quarantine surveillance and community awareness campaigns highlighted as necessary for the third. The need for a regional approach to the disease is also flagged to prevent further spread.

179. Jackson, G. V. H. (1977). Taro leaf blight. Advisory Leaflet, South Pacific Commission (No. 3), 4 pp.

The disease of *Colocasia esculenta* caused by *Phytophthora colocasiae* is described and recommendations are given for its control.

180. Jackson, G. V. H. (1999). Taro leaf blight. Pest Advisory Leaflet (No. 3), 2 pp. Published by the Plant Protection Service of the Secretariat of the Pacific Community.

In this 2nd edition of this leaflet the symptoms, effect of the disease, infection and spread, control and quarantine precautions for this disease are outlined.

181. Jackson, G. V. H. (1997). Taro leaf blight control strategies. (p. 20 pp.). Second consultancy mission for Western Samoa Farming Systems Project.

In this consultancy report commissioned by International Development Support Services on behalf of the Western Samoa Farming Systems Project, MAFFM (Ministry of Agriculture, Forestry, Fisheries and Meteorology), a review of the breeding and varietal selection work carried out at Nu'u Crops Development Centre and the University of the South Pacific since the last visit (1996) is presented. Demonstration of methods of evaluating seedlings for taro leaf blight resistance in the nursery and field and the formulation of a programme for multiplying introduced varieties for farmer evaluation are also reported. Recommendations for the programme are made.

182. Jackson, G. V. H. (1996). Taro leaf blight control strategies. First consultancy Mission Report. Western Samoa Farming Systems Project, 46 pp. Samoa: Ministry of Agriculture Fisheries, Forests and Meteorology Western Samoa.

In this consultancy report commissioned by International Development Support Services on behalf of the Western Samoa Farming Systems Project, MAFFM (Ministry of Agriculture, Forestry, Fisheries and Meteorology); strategies to overcome taro leaf blight since its first outbreak in 1993 in Samoa are considered. The existing taro leaf blight programme was evaluated and some recommendations made for future research. A protocol for varietal selection and breeding is proposed.

183. Jackson, G. V. H., & Breen, J. (1985). Collecting, describing and evaluating field crops. Suva, Fiji.: UNDP/FAO. RAS/83/001 Field Document No. 8.

Included in this publication are guidelines for assessing taro leaf blight in the field.

184. Jackson, G. V. H., & Firman, I. D. (1984). Guidelines for the movement of taro and other aroids within the Pacific. In S. Chandra (Editor), Edible Aroids (pp. 194–211). Oxford, UK: Clarendon Press.

Hazards (including taro leaf blight) in the movement of germplasm of taro and other edible aroids within the Pacific region are detailed and techniques for safe transfer discussed. It is concluded that direct importation of vegetative material should be avoided in favour of transfer through intermediate quarantine outside the region, or as tissue cultured plants derived from shoot tips.

185. Jackson, G. V. H., & Gollifer, D. E. (1975). Disease and pest problems of taro (*Colocasia esculenta* L. Schott) in the British Solomon Islands. PANS **21**(1), 45–53.

More than 200 local varieties were screened for resistance to *Phytophthora colocasiae.* Of these only Abumae has shown promise. However, the taste and texture of this variety are unacceptable.

186. Jackson, G. V. H., & Gollifer, D. E. (1975). Storage rots of taro (*Colocasia esculenta*) in the British Solomon Islands. Annals of Applied Biology **80** (2), 217–230.

Several fungicides chosen for their ability to control the pathogens previously isolated from stored cocoyam corms failed to prevent severe rotting. This result led to a reappraisal of the organisms involved in the initial stages of decay. Isolations made from stored corms during the first 5 days showed that *Phytophthora colocasiae* and *Pythium splendens* were the dominant fungi in the rots. Later *Botryodiplodia theobromae* rapidly colonized the corms to complete the decay. Attempts to reduce losses by leaving petiole bases, cormels and roots attached only succeeded in delaying infection by a few days. Corms placed in soil in well-drained pits stored relatively well up to 4 weeks without impaired taste. Fungal rots were completely eliminated in corms stored in the soil, but bacterial rots caused by *Erwinia chrysanthemi* were responsible for some decay.

187. Jackson, G. V. H., & Gollifer, D. E. (1977). Studies on the taro leaf blight fungus *Phytophthora colocasiae* in the Solomon Islands. In Regional Meeting on the Production of Root Crops. Suva, Fiji, 24–29 October 1975. (pp. 107–110). Noumea, New Caledonia: South Pacific Commission. SPC Technical Paper No. 174.

Phytophthora colocasiae has become a limiting factor on taro (*Colocasia esculenta*) production and has caused an increasing dependence upon sweet potato (*Ipomoea batatas*). The fungus attacks both leaves and corms. However, corm-rots caused by *P. colocasiae* do not develop in the field, but extensive infection occurs after harvest. Within 5 days corms are often completely decayed. Control measures, using fungicides and screening for resistant varieties, are discussed.

188. Jackson, G. V. H., Gollifer, D. E., & Newhook, F. J. (1980). Studies on the taro leaf blight fungus *Phytophthora colocasiae* in Solomon Islands: control by fungicides and spacing. Annals of Applied Biology **96**(1), 1–10.

In trials in 1972–4, mist blower application of 2.25 kg copper oxychloride/ha gave effective control of *P. colocasiae* and increased main plant and sucker plant corm yields to 10.74 and 2.79 t/ha respectively compared with 6.78 t and 1.88 t in untreated controls. Mancozeb did not control the disease or increase corm yields. Phytotoxicity from captafol nullified any potential gain in yield from disease control. Leaf removal from healthy plants to maintain 4 leaves/plant for 90 days to simulate roguing of leaves for disease control caused no yield loss. Regular roguing of diseased leaves over the same period in plots affected by a severe epiphytotic did not eradicate the pathogen. Disease increased rapidly after roguing ceased and corm yields were greatly decreased. Attempts to decrease the effect of *P. colocasiae* by wider than traditional spacing (76 X 76 cm) were unsuccessful. Plants free from competition normally had 6–7 leaves but this number was decreased by severe disease to 3–4, the same number as was borne by plants under the competitive conditions of closer than traditional spacing. Main corm yields increased with increasing plant density irrespective of the presence of *P. colocasiae*.

189. Jackson, G. V. H., Gollifer, D. E., Pinegar, J. A., & Newhook, F. J. (1979). The use of fungicides against post-harvest decay in stored taro in the Solomon Islands. In D. L. Plucknett (Editor), Small-scale processing and storage of tropical root crops. (pp. 130–150). Boulder, Colorado, USA: Westview Press. Westview Tropical Agriculture Series No. 1.

The control of postharvest decay of taro, including that caused by *Phytophthora colocasiae*, is discussed. At 5 days, rots caused by *P. colocasiae*, which were the first to develop in stored corms, were controlled by most of the fungicides tested. Best results were given by captan, copper oxychloride, captafol, mancozeb, Terrazole and sodium hypochlorite. Dipping in 1% sodium hypochlorite before storage in polythene bags gave good results and may be a suitable method for village storage or where corms are being taken long distances to market.

190. Jackson, G. V. H., Gollifer, D. E., & Regional Meeting on the Production of Root Crops. (1977). Studies on the taro leaf blight fungus (*Phytophthora colocasiae*) in the Solomon Islands. Regional Meeting on the Production of Root Crops; collected papers. Conference Regionale de la Production des Plantes a Racines Alimentaires; documents de travail. Suva, Fiji, 24 Oct 1975. (pp. 107–110). Noumea, New Caledonia: South Pacific Commission.

191. Jackson, G. V. H., & Macfarlane, R. (1996). Contingency plans for the eradication of *Phytophthora colocasiae* in Pacific Island countries and territories. Taro Leaf Blight Seminar. Proceedings. Alafua, Western Samoa, 22–26 November, 1993. (pp. 101–107). Noumea, New Caledonia: South Pacific Commission. Unpublished.

Possibilities for the eradication of taro leaf blight in the Pacific are outlined. The general principals, initial response sequence, preliminary action sequence and general response activities of contingeny action plans are itemised.

Specific strategies for the eradication of taro leaf blight are then considered. Duty statements for key personnel in an eradication campaign are given.

192. Jackson, G. V. H., & Macfarlane, R. (1992). Plant protection in atolls of the Pacific. In Workshop on Developing an Agricultural Research Programme for the Atolls. Pacific Harbour, Fiji, 19–23 November 1990. (pp. 131–145). Apia, Western Samoa: IRETA.

Phytophthora colocasiae is identified as an important disease, which has been accidently introduced to atolls in the Pacific region. General recommendations for improving plant protection in atolls are given.

193. Jackson, G. V. H., & Pelomo, P. M. (1979). Breeding for resistance to diseases of taro, *Colocasia esculenta*, in Solomon Islands, 8 pp. Honiara, Solomon Islands: Ministry of Agriculture and Lands, Dodo Creek Research Station.

194. Jackson, G. V. H., & Pelomo, P. M. (1980). Breeding for resistance to diseases of taro, *Colocasia esculenta*, in Solomon Islands. In International Symposium on Taro and Cocoyam. Visayas State College of Agriculture, Baybay, Leyte, Philippines, 24–25 September 1979. (pp. 287–298). Stockholm, Sweden: International Foundation for Science. Provisional Report (International Foundation for Science) No. 5.

Breeding in the Solomon Islands for resistance to taro leaf blight and taro viruses is reviewed.

195. Johnson, A. (1960). A preliminary plant disease survey in Hong Kong, 32 pp. Rome, Italy: FAO, Plant Production and Protection Division.

196. Johnston, A. (1969). A preliminary plant disease survey in the British Solomon Islands Protectorate. (p. 31 pp.). Honiara, Solomon Islands: Government Printing Office.

In this survey carried out in 1959, *Phytophthora colocasiae* is recorded on taro and its distribution (Choiseul, Ganongga, Malaita, Shortlands) in the Solomon Islands given.

197. Johnston, M., & Gendua, P. A. (1998). The growth performance of taro (*Colocasia esculenta*) grown from true seed. Tropical Agriculture **75**(1/2), 13–17.

Some variation in resistance to taro leaf blight was observed in seedlings and this was correlated with corm yield.

198. Kamlesh. (1989). Antifungal activity of some homoepathic drugs against *Phytophthora colocasiae.* Unpublished doctoral dissertation, Kurukshetra University, Kurukshetra, India.

199. Karanya, I. (1984). Rok bai mai (*Phytophthora colocasiae* Raciborski) khong phuak lae kan thotsop phit khong sankhemi. (*Phytophthora* leaf blight of taro (*Phytophthora colocasiae* Raciborski) and fungitoxicity test. Unpublished

doctoral dissertation, Kasetsart University, Graduate School., Bangkok, Thailand . In Thai.

In this MSc thesis, the fungus that caused taro leaf blight during the rainy season was identified as *Phytophthora colocasiae*. Studies on the physiological properties of *P. colocasiae* demonstrated that the optimum temperature and pH for maximum mycelial growth were 25–30 C and pH 4–8, respectively. This was found only when *P. colocasiae* was cultured on PDA with added taro extract and OMA media. *P. colocasiae* could successfully be mated with *P. palmivora* in the A1 group. *P. colocasiae* is categorized as belonging to the A2 mating group. It is concluded that *P. colocasiae* is a heterothallic fungus. Pathogenicity tests showed that *P. colocasiae* could successfully infect and colonize all parts of the taro, except the rhizome. *P. colocasiae* produced clear and specific symptoms of concentric zones of leaf blight lesions. Morphological observation of *P. colocasiae* showed that it was capable of producing either ellipsoid or elongated ellipsoid zoosporangium *in vivo*. Indirect germination of this structure was found on taro leaf that yielded a large number of zoospores and later formed and encysted zoospores. Several germ tubes could be formed before direct penetration into intercellular space of the host epidermal cells. Evaluation on the fungitoxicity of various fungicides showed that Ridomil and Galben inhibited mycelial growth. Application of Ridomil at 250 ppm on taro leaves could visibly control the growth of *P. colocasiae,* but at higher dosea (2000 ppm) phytotoxicity was apparent.

200. Karanya, I., & Thammasak, S. (1984). Kan suksa rok bai mai khong phuak (*Phytophthora colocasiae* Rac.) duai scanning electron microscope. (Scanning electron microscope studies of taro leaf blight disease (*Phytophthora colocasiae*) in Thailand.). Journal of Thai Phytopathological Society **4**(2), 69–76.

201. Karanya, I., & Thammasak, S. (1984). Kan thotsop phit khong san khemi kanchat ra kap chua *Phytophthora colocasiae* Rac. sahet rok bai mai khong phuak. (Evaluation on fungitoxicity against taro blight pathogen (*Phytophthora colocasiae* Rac.) in Thailand). Journal of Thai Phytopathological Society **4**(2), 60–68.

202. Karanya, I., & Thammasak, S. (1983). Rok bai mai ru rok ta-sua khong phuak (Taro (*Colocasia antiquorum* Schott.) blight disease (*Phytophthora colocasiae*) in Thailand. Journal of Thai Phytopathological Society **3**(1), 1–9. In Thai.

203. Kay, D. E. (1987). Taro. In Root Crops (pp. 233–251). London, UK: Tropical Development and Research Institute.

In this chapter on taro, *Phytophthora colocasiae* is identified as an important pre- and post-harvest disease.

204. Ko, W. H. (1979). Mating-type distribution of *Phytophthora colocasiae* on the island of Hawaii. Mycologia **71**(2), 434–437.

All 101 isolates from 16 *Colocasia esculenta* fields were of mating type A1; 8 from the island of Maui and 5 from Kauai were also of A1. Five isolates previously reported (3 from Asia) were all A2. It is suggested that the fungus originated in Asia.

205. Kohler, F., Pellegrin, F., Jackson, G. V. H., & MacKenzie, E. (1997). Taro. In Diseases of Cultivated Crops in Pacific Island Countries (pp. 52–53, 169). Noumea, New Caledonia: Secretariat of the Pacific Community.

Symptoms of the disease are briefly described and illustrated. Control measures are also outlined.

206. Kokoa, P. (1991). A checklist of plant diseases in the Highlands of Papua New Guinea 1985–1990, 22 pp. Papua New Guinea: Department of Agriculture and Livestock. Technical Report No. 91/2.

Phytophthora colocasiae is recorded on taro in Gulf Province and Western Highlands Province.

207. Kokoa, P. (1999). Genetic diversity of *Phytophthora colocasiae* in Papua New Guinea. In Annual Report for 1998 (p. 96). Taro Network for South-East Asia and Oceania (TANSAO).

Collections of *P. colocasiae* in Papua New Guinea are described. One batch of isolates has been sent to CIRAD, France for isoenzyme anaysis.

208. Kokoa, P. (1993). Taro leaf blight in Papua New Guinea: an overview. In Book of Abstracts. The First Taro Symposium. Lae, Papua New Guinea, 25 October 1993. (p. 15). Lae, Papua New Guinea: University of Technology.

The importance of the disease and methods of controlling it in Papua New Guinea were examined in this paper presented at this meeting. The importance of breeding for resistance is emphasised.

209. Kokoa, P. (1996). Taro leaf blight in Papua New Guinea: an overview. Taro Leaf Blight Seminar. Proceedings. Alafua, Western Samoa, 22–26 November, 1993. (pp. 45–49). Noumea, New Caledonia: South Pacific Commission. Unpublished.

In this report of taro leaf blight in Papua New Guinea, the importance of taro as a staple food crop, occurrence of the disease in the country and methods of control are described. Research on the disease carried out at Bubia Agricultural Research Centre is also highlighted, which includes work on screening for resistance, the epidemiology of taro leaf blight, disease and loss assessment and breeding for disease resistance.

210. Kokoa, P., & Darie, A. (1996). Field screening of taro varieties for resistance to taro leaf blight. In The Second Taro Symposium. Proceedings of an International Meeting. Faculty of Agriculture, Cenderawasih University, Manokwari, Indonesia, 23–24 November 1994. (p. 127).

In this abstract it is reported that taro varieties from the Papua New Guinea germplasm collection were screened under field conditions for resistance to taro blight. Of 433 varieties, 3 (K333, K345 and Ainaben) showed a high degree of resistance or immunity to the disease. Their use in a breeding programme at Bubia Agricultural Research Centre is noted.

211. Kokoa, P., & Darie, A. Screening of taro (*Colocasia esculenta*) for resistance to taro blight (*Phytophthora colocasiae*). In Annual Report 1992–1995, Bubia Agricultural Research Centre . Lae, Papua New Guinea: Department of Agriculture and Livestock.

212. Kokoa, P., Ivancic, A., & Ganua, T. (1996). Laboratory methods of testing taro varieties for resistance to taro leaf blight. In The Second Taro Symposium. Proceedings of an International Meeting. Faculty of Agriculture, Cenderawasih University, Manokwari, Indonesia, 23–24 November 1994. (p. 127).

In this abstract, it is reported that spore counts on leaf pieces inoculated with a pure culture of *Phytophthora colocasiae*, were a better measure of disease resistance testing than measurement of lesion diameter.

213. Kulkarni, S. N., & Sharma, O. P. (1975). Corm rot of *Colocasia antiquorum* Schoff, due to *Phytophthora colocasiae* Sacc. JNKVV Research Journal **9**(1–2), 70.

214. Lambert, M. (1979). Storage and processing of root crops in the Pacific. In D. L. Plucknett (Editor), Small-scale Processing and Storage of Tropical Root Crops (pp. 47–52). Boulder, Colorado, USA: Westview Press. Westview Tropical Agriculture Series, No. 1.

Included in this chapter is a brief discussion of postharvest problems of taro. It is emphasised that strict plant quarantine is necessary to protect Pacific islands currently free of taro leaf blight from the introduction of *Phytophthora colocasiae.*

215. Larsen, A. (1989). Notes on root crops in Vanuatu, 32 pp. Rome, Italy: FAO/SPC. RAS/83/001 Field Document.

Taro leaf blight was not found in Vanuatu, but the proximity of the disease in Papua New Guinea and Solomon Islands is noted.

216. Lebot, V. (1992). Genetic vulnerability of Oceania's traditional crops. Experimental Agriculture **28**(3), 309–323.

The genetic reasons for the deterioration of the agronomic performance of traditional crops of Oceania, using information mostly derived from surveys of genetic resources conducted in more than 50 Pacific islands, coupled with genetic investigations, are reviewed.

217. Leonian, L. H. (1930). Differential growth of *Phytophthora* under the action of malachite green. American Journal of Botany **17**, 671–677.

218. Liloqula, R. (1986). Crop protection services and problems in the Solomon Islands. In UNDP/FAO/GTZ/IRETA Regional Crop Protection Workshop. Apia, Western Samoa, 8–12 September 1986. (pp. 79–82). Suva, Fiji: UNDP.

In this description of crop protection services in the Solomon Islands, the control of taro leaf blight and the screening of local and foreign varieties for resistance are included in the list of priorities for the plant pathology section.

219. Liloqula, R. (1989). Taro breeding programmes. In Annual Report 1986. Solomon Islands Government. Research Department, Agriculture Division, Ministry of Agriculture & Lands. (pp. 35–36). Honiara, Solomon Islands.

Results of 2 trials to evaluate yielding ability of taro varieties resistant to taro leaf blight are reported.

220. Liloqula, R., & Saelea, J. (1996). Taro disease situation in Solomon Islands. Taro Leaf Blight Seminar. Proceedings. Alafua, Western Samoa, 22–26 November, 1993. (pp. 57–61). Noumea, New Caledonia: South Pacific Commission. Unpublished.

The importance of taro to agriculture in the Solomon Islands and diseases of the crop, including taro leaf blight, and their control are discussed.

221. Liloqula, R., Saelea, J., & Levela, H. (1996). The taro breeding programme in Solomon Islands. Taro Leaf Blight Seminar. Proceedings. Alafua, Western Samoa, 22–26 November, 1993. (pp. 143–147). Noumea, New Caledonia: South Pacific Commission. Unpublished.

The breeding programme for taro diseases in the Solomon Islands, with special reference to the taro leaf blight back-crossing breeding programme, is described. Breeding work on nematode and virus resistance is also discussed and the future work programme outlined.

222. Liloqula, R., Saelea, J., & Levela, H. (1993). Traditional taro cultivation in the Solomon Islands. In Proceedings of the Sustainable Taro Culture for the Pacific Conference. University of Hawaii, 24–25 September 1992. (125–131.). Honolulu, Hawaii: Hawaii Institute of Tropical Agriculture and Human Resources. HITAHR Research Extension Series No. 140.

In this discussion on the traditional cultivation of taro in the Solomon Islands, diseases, including *Phytophthora* blight, are considered.

223. Lin, C. K., & Liang, P. Y. (1965). Studies on nitrogen, calcium and organic acid requirements with reference to pH relations in the nutrition of some species of *Phytophthora*. Acta Microbiologica Sinica **11**, 470–479.

224. Liyanage, A. d. S., & Misipati, P. (1995). Taro leaf blight (*Phytophthora colocasiae*). In IRETA and SOA 1993 Annual Research Report (pp. 60–63). Samoa: IRETA Publications, University of the South Pacific, Alafua Campus.

The outbreak of taro leaf blight in Samoa in 1993 is discussed. Symptoms of the disease, the pathogen, its spread and the susceptibility of all indigenous cultivars is considered.

225. Lucas, J. A., Shattock, R. C., Shaw, D. S., & Cooke, L. R. (1991). *Phytophthora.* (p. 447 pp.). Cambridge, UK: Cambridge University Press.

226. Luthra, J. C. (1938). India: some new diseases observed in Punjab and mycological experiments in progress during the year 1937. International Bulletin of Plant Protection **8**(4), 73–74.

227. Macfarlane, R. (1996). Taro—a preliminary pest risk analysis. Taro Leaf Blight Seminar. Proceedings. Alafua, Western Samoa, 22–26 November, 1993. (pp. 113–115). Noumea, New Caledonia: South Pacific Commission. Unpublished.

A preliminary PRA for taro in the Pacific region is presented. The occurrence of diseases and pests in different countries is tabulated and recommendations for the movement of taro between any two countries or territories summarised.

228. Macfarlane, R. (1985). Taro beetle (*Papuana uninodis*). Annual report 1984, Research Department, Agriculture Division. (pp. 7–8). Honiara, Solomon Islands: Ministry of Agriculture and Lands.

Four plant spacings (5000–40 000 plants/ha) were tested in the Solomon Islands for their effects on damage by *Papuana uninodis* on taro. Total yields increased and mean corm weights increased with planting density, but no significant differences in beetle damage were found. However, increased plant density was accompanied by increasing damage to the leaves by *Phytophthora colocasiae*.

229. Maheshwari, S. K., Sahu, A. K., & Misra, R. S. (1999). Efficacy of fungicides against *Phytophthora colocasiae* under laboratory conditions. Annals of Plant Protection Sciences **7**(2), 228–229.

The efficacy of 9 fungicides against *P. colocasiae* under laboratory conditions was assessed. Of the fungicides tested Ridomil MZ (metalaxyl + mancozeb), Indofil M-45 (mancozeb), Blitox 50 (copper oxychloride) and Hill Copper (copper oxychloride) completely inhibited the growth of the pathogen. The remaining fungicides (Bavisitn (carbendazim), Borax, Kitazin (iprobenfos), streptocycline and Topsin-M (thiophanate-mtheryl)) inhibited the fungus to varying degrees.

230. Malaki, I., & Atkinson, W. (1998). Review of the taro trade and prospects in the South Pacific. Journal of South Pacific Agriculture **5**(2), 23–30.

Taro trade is discussed, with particular reference to the role played by Fiji and Samoa. The devastating effect of taro leaf blight on taro trade by Samoa in 1993 is considered.

231. Manner, H. (1991). Report of a visit to Ulithi Atol. In A. M. Vargo (Compiler), A Rapid Rural Appraisal of Taro Production Systems in Micronesia, Hawaii and American Samoa. (pp. 147–153). Hawaii, USA: University of Hawaii.

Phytophthora colocasiae is reported as one of the most common problems on taro on Ulithi.

232. Manner, H. (1991). Report of the rapid rural assessment of taro production systems in Guam. In A. M. Vargo (Compiler), A Rapid Rural Appraisal of Taro Production Systems in Micronesia, Hawaii and American Samoa. (pp. 39–55). Hawaii, USA: University of Hawaii.

A rapid rural appraisal of taro production on Guam is reported. *Phytophthora colocasiae* was identified on 15 farms but in general farmers did not perceive the disease to be a constraint to production.

233. Manrique, L. A. (1995). Taro production principles and practices, 215 pp. Honolulu, Hawaii: Manrigue International Agrotechnology.

234. Matanubun, H., & Paiki, F. A. (1996). Taro research in Irian Jaya: its present status and future. In The Second Taro Symposium. Proceedings of an International Meeting. Faculty of Agriculture, Cenderawasih University, Manokwari, Indonesia, 23–24 November 1994. (pp. 102–104).

Yield losses due to blight of up to 72% have been reported. None of the varieties in Irian Jaya were resistant and no control could be achieved by altering plant density or soil tillage practices. *Pseudomonas fluorescens, Bacillus subtilis* and *Gliocladium fimbriatum* controlled *Phytophthora colocasiae* both *in vitro* and *in vivo*. Metalaxyl was also more effective than Dithane M-45.

235. Mathur, P. N., & Paharia, K. D. (1964). Screening of *Colocasia* varieties for resistance to *Colocasia* blight (*Phytophthora colocasiae* Racib.). Science and Culture **30**(1), 44–46.

236. Matthews, P. J. (1998). Taro in Hawaii: present status and current research. Plant Genetic Resources Newsletter (No. 116), 26–29.

In this popular account, breeding work being carried out at Mauai Agricultural Research Centre, Hawaii, for blight resistance are briefly mentioned.

237. Mattos, J. K. d. A. (1994). Doencas da batata-doce, beterraba, cara, gengibre e inhame. [Diseases caused by fungi on sweet potato, beetroot, *Dioscorea* spp., ginger and yam.]. Informe Agropecuario Belo Horizonte **17**(182), 25–28. In Portuguese.

Fungal diseases affecting sweet potato, beetroot, *Dioscorea* spp., ginger and yam in Brazil are briefly reviewed, including symptoms, susceptible cultivars, importance and control measures. The main diseases included *Phytophthora colocasiae* on yam.

238. McKenzie, E. H. C. (1996). Life cycle of *Phytophthora colocasiae* Racib. Taro Leaf Blight Seminar. Proceedings. Alafua, Western Samoa, 22–26 November, 1993. (pp. 75–81). Noumea, New Caledonia: South Pacific Commission. Unpublished.

The taxonomy, host range, asexual life cycle and sexual reproduction in *Phytophthora colocasiae* is described. The origin of the pathogen and notes on how to distinguish *P. colocasiae* on taro and in culture are given. Finally a synoptic key to the 17 *Phytophthora* species recorded in the Pacific is provided.

239. McKenzie, E. H. C., & Jackson, G. V. H. (1986). The fungi, bacteria and pathogenic algae of Solomon Islands. RAS/83/001 (Field Document No. 11), 206–207.

A report produced as part of the FAO/SPC Strengthening Plant Protection and Root Crops Development in the South Pacific project. *Phytophthora colocasiae* is recorded as present in the Solomon Islands. The biology of the pathogen is briefly outlined.

240. McKenzie, E. H. C., & Jackson, G. V. H. (1990). The fungi, bacteria and pathogenic algae of the Republic of Palau. SPC Technical Paper (No. 198), 28–29.

Phytophthora colocasiae is recorded as present in Palau.

241. McRae, W. (1934). Foot-rot disease of Piper betle L. in Bengal. Indian Journal of Agricultural Science **4**(4), 585–617.

242. Mendiola, N., & Espino, R. B. (1916). Some Phycomycetous diseases of cultivated plants in the Philippines. Philippine Agriculture and Forestry **5**, 67–72.

Cited in Tucker, 1933.

243. Mirza, R., Kafi, A., & Huque, A. (1965). List of plant diseases recorded in Pakistan. Technical Document, FAO Plant Protection Commission in South East Asia **43**, 1–17.

244. Misra, R. S. (1995). Effect of dates of planting on *Phytophthora* blight severity and tuber yield in *Colocasia*. Journal of Root Crops **21**(2), 111–112.

A field trial was conducted over a 3 year period in Bhubaneswar, Orissa, India, to determine the effects of planting date of *C. esculenta* on disease severity caused by *P. colocasiae* and tuber yield. Five dates of planting starting from May 1, at intervals of 15 days were used as treatments. Planting on May 1 and May 15 resulted in higher yields compared with the other dates. However, the percentage of plants infected, the percentage leaf area damaged

and the percentage of disease intensity were also higher on crops planted on these dates. It is suggested that the early planted crops were mature at the time of infection whereas the later planted crops were still developing at the time of infection.

245. Misra, R. S. (1996). A note on zoosporogenesis in *Phytophthora colocasiae*. Indian Phytopathology **49**(1), 80–82.

A brief report on zoosporangial morphology and germination of *P. colocasiae* (the causal agent of leaf blight in *Colocasia esculenta* and *C. antiquorum*) is given.

246. Misra, R. S. (1994). In *Phytophthora* diseases of Horticultural Crops. Proceedings of the National Group Meeting on *Phytophthora* diseases of Horticultural Crops. Calicut, India, 22–23 September.

247. Misra, R. S. (1996). Prevalence and assessment of yield losses caused by *Phytophthora* leaf blight in *Colocasia* in Northern and Eastern parts of India. In G. T. Kurup, M. S. Palaniswami, V. P. Potty, G. Padmaja, S. Kabeerathumma, & S. V. Pillai (Editors), Tropical tuber crops: problems, prospects and future strategies. (pp. 380–387). Lebanon, New Hampshire, USA: Science Publishers, Inc.

An extensive survey of major *Colocasia* growing areas in the states of Orissa, West Bengal, Bihar and Uttar Pradesh in northern and eastern parts of India was undertaken during 1988 and 1989 to record the incidence of leaf blight, caused by *P. colocasiae.* Out of 128 representative fields of *Colocasia* visited during the 1988 monsoon season, 94% of fields were infected by leaf blight, and 78.38% fields had >80% incidence. During 1989, of 164 fields visited 92% showed blight infection and 81.75% of fields showed >80% incidence. A strong positive correlation existed between disease severity and yield loss (r=0.867 and 0.84 in farmers field and experimental farm, respectively). A corresponding negative correlation existed between disease severity and tuber yield (r=0.884 and -0.661 in the farmers' field and experimental farm, respectively). In the farmers' fields a mean yield loss of 33.64% was recorded due to leaf blight, whereas in the experimental farm 50.39 and 26.26% mean yield losses were recorded in susceptible and tolerant cultivars, respectively due to blight.

248. Misra, R. S. (1993). Prevalence and assessment of yield losses of *Phytophthora* blight of *Colocasia* in the Northern and Eastern parts of India. In Proceedings of the International Symposium on Tropical Tuber Crops. Trivandrum.

249. Misra, R. S. (1991). Prevalence of *Phytophthora* leaf blight of *Colocasia* in Northern and Eastern India. Phytophthora Newsletter (No. 17), 36.

In 1988 and 1989, 94% and 92%, respectively, of fields were found to be infected with blight, with 78% and 81%, respectively, showing more than

80% incidence. Yield losses of 50–60% are estimated. A high degree of resistance in a local variety 'Jankhri' is reported.

250. Misra, R. S. Studies of *Phytophthora* leaf blight of *Colocasia*. In Annual Report 1990–91 . Trivandrum, India: Central Tuber Crops Research Institute.

251. Misra, R. S. (1993). Yield losses in *Colocasia* caused by *Phytophthora* leaf blight. Phytophthora Newsletter **19**, 16–17.

Tuber yield losses due to *Phytophthora colocasiae* were assessed in Orissa, India. In farmers' fields a mean yield loss of 34% was recorded at the experimental farm, 50% and 26% in susceptible and tolerant varieties, respectively.

252. Misra, R. S., & Chowdhury, S. R. (1996). *Phytophthora* leaf blight of taro: effect on dry matter production. Journal of Root Crops **22**(1), 54–57.

Phytophthora leaf blight of taro (*Colocasia esculenta*) appeared early and progressed fast in susceptible cultivars compared with tolerant ones. The effect of leaf blight on dry matter production was more pronounced in susceptible cultivars, and fungicide sprays increased dry matter accumulation (measured as crop growth rate) in susceptible cultivars. Crop growth rate was least influenced by leaf blight in the tolerant cultivar Jankhri, in which fungicidal spraying did not increase dry matter accumulation. Use of the tolerant cultivar without using fungicides is advocated to minimise the yield losses caused by *Phytophthora*.

253. Misra, R. S., & Singh, D. P. (1991). Resistance in *Colocasia* against *Phytophthora* blight and progress of the disease in selected cultivars. Phytophthora Newsletter **17**, 36–37.

Of the 43 cultivars screened in Bhubaneswar, India, 4 (Muktakeshi, Mahasaru, Jankhri and Topi) showed a high level of resistance to taro leaf blight. All other cultivars were moderately to highly susceptible to the disease, with cultivars Telia and Barnandi the most susceptible.

254. Misra, R. S., & Singh, D. P. (1991). Varietal resistance in *Colocasia* against *Phytophthora* leaf blight and progress of the disease in selected cultivars. Phytophthora Newsletter (No. 17), 36–37.

Of 43 cultivars tested in 1988 and 1989, the following showed a high degree (<10% taro leaf blight) of resistance: Jankhri, Nahasaru, Muktakeshi and Topi.

255. Moles, D. J., Rangai, S. S., Bourke, R. M., & Kasamani, C. T. (1984). Fertilizer responses of taro in Papua New Guinea. In S. Chandra (Editor), Edible Aroids (pp. 64–71). Oxford, UK: Clarendon Press.

Shortage of land of suitable fertility and *Phytophthora colocasiae* are identified as reasons for the reduction of area under taro in Papua New Guinea.

256. Muthappa, B. N. (1987). Records of microorganisms in Papua New Guinea 1977–1986. Department of Agriculture and Livestock, Port Morseby, Research Bulletin (No. 43), 72 pp.

257. Narula, K. L., & Mehrotra, R. S. (1987). Biocontrol potential of *Phytophthora* leaf blight of *Colocasia* by phylloplane microflora. Indian Phytopathology **40**(3), 384–389.

Two bacteria, 3 actinomycetes and 4 fungi showed antagonistic potential against *P. colocasiae in vitro. In vivo*, the bacteria reduced disease incidence by 37–43%. *Streptomyces albidoflavus* reduced percentage infection by 90–93% and *S. diastaticus* by 76%. Among the fungi, *Botrytis cinerea* gave the best control (33% reduction).

258. Narula, K. L., & Mehrotra, R. S. (1984). The epidemiology of *Phytophthora* leaf blight of *Colocasia.* Proceedings, National Academy of Sciences, India, Section B—Biological Sciences **54**(3), 227–235.

259. Narula, K. L., & Mehrotra, R. S. (1980). Occurrence of A1 mating type of *Phytophthora colocasiae.* Indian Phytopathology **33**(4), 603–604.

The mating type was isolated from *Colocasia antiquorum* var. *esculenta* (*C. esculenta* var. *antiquorum)* from 3 North Indian states.

260. Narula, K. L., & Mehrotra, R. S. (1981). Phylloplane microflora of *Colocasia esculenta* (L.) Schott in relation to *Phytophthora colocasiae* Racib. Geobios **8**(4), 152–156.

Alternaria spp., the most abundant on young and mature leaves, were replaced on senescent ones by *Cladosporium cladosporioides, Penicillium rubrum, P. chrysogenum, Botrytis cinerea*, and *Myrothecium roridum.* Three *Streptomyces* spp. and 2 bacterial isolates were antagonistic to *P. colocasiae* in dual culture plates.

261. Narula, K. L., & Mehrotra, R. S. (1989). Phytophthora blight of Colocasia—control with antibiotics and selective fungicides. Indian Phytopathology **42**(2), 328.

An abstract of a paper presented at the Proceedings of 41st Annual Meeting of Indian Phytopathological Society, held in New Delhi 28 February, 1989 to 2 March, 1989.

262. Narula, K. L., & Mehrotra, R. S. (1984). Saprophytic survival of *Phytophthora colocasiae* in soils. Indian Phytopathology **37**(2), 256–261.

263. Naskar, S. R. (1989). Evaluation of taro varieties under rainfed conditions in Orissa. Journal of Root Crops **15**, 59–60.

264. Newton, K., & Jamieson, G. I. (1968). Cropping and soil fertility studies at Keravat, New Britain. Papua New Guinea Agricultural Journal **20**, 1–2.

265. Ngiralmau, M., & Bishop, R. (1991). A report on the rapid rural appraisal of *Colocasia* taro agriculture in Palau. In A. M. Vargo (Compiler), A Rapid Rural Appraisal of Taro Production Systems in Micronesia, Hawaii and American Samoa. (pp. 97–111). Hawaii, USA: University of Hawaii.

A rapid rural appraisal of taro production in Palau carried out in 1990 is reported. Taro leaf blight was prevalent but was not considered serious by farmers.

266. O'Connor, B. A. (1967). Exotic plants and diseases. Noumea, New Caledonia: South Pacific Commission.

Included in this book is a datasheet on the distribution, symptoms, spread and damage, and control of taro leaf blight (one page).

267. Okpul, T. (1999). Taro (*Colocasia esculenta*) breeding in Papua New Guinea. In Annual Report for 1998. (pp. 92–95). Taro Network for South-East Asia and Oceania (TANSAO).

Progress with taro breeding, including that for blight resistance, in Papua New Guinea is reported.

268. Okpul, T., Ivancic, A., & Simin, A. (1997). Evaluation of leaf blight resistant taro (*Colocasia esculenta*) varieties for Bubia, Morobe province, Papua New Guinea. Papua New Guinea Journal of Agriculture, Forestry and Fisheries **40**(1–2), 13–18.

Taro (*Colocasia esculenta*) varieties (35) resistant to taro leaf blight (TLB) (*Phytophthora colocasiae*) were evaluated at Bubia Agricultural Research Centre, Lae, Papua New Guinea, for yield components and eating quality in comparison with the locally preferred cultivar, Numkowec. The main factors affecting eating quality were presence of conspicuous corm fibre and acridity. Leaf blight resistant varieties AN 65, 17, 50, 32, 46, 21, 12 and AN 20 had acceptable eating quality. Their corm yield ranged from 300 g/plot (AN 50) to 570 g/plot (AN 21). However, their corm yield was not significantly different from that of Numkowec (430 g/plot). These resistant varieties are recommended to farmers in the Lae area based on their resistance to TLB and their similarities in corm yield and eating quality to Numkowec.

269. Oliver, D. (1973). Bougainville: a personal history. Melbourne, Australia: Melbourne University Press.

270. Onwueme, I. C. (1978). Harvesting, storage, diseases, and pests of cocoyams. In The tropical tuber crops. Yams, cassava, sweet potato, cocoyams. (pp. 215–219). UK: John Wiley & Sons.

In this chapter, diseases of taro, including blight, are briefly described.

271. Onwueme, I. C., & Charles, W. B. (1994). Tropical root and tuber crops: production, perspectives and future prospects. FAO Plant Production and Protection Papers (No. 126), 153–154.

In this chapter on harvesting, storage, diseases and pests of cocoyams, taro blight is described and control measures outlined.

272. Ooka, J. J. (1983). Taro diseases. In J. K. Wang (Editor), Taro. A review of *Colocasia esculenta* and its potentials. (pp. 236–257). Honolulu, Hawaii: University of Hawaii Press.

This chapter includes discussion of taro leaf blight and its control.

273. Ooka, J. J. (1990). Taro diseases. In Proceedings of taking taro into the 1990s: a taro conference. Komohana Agricultural Complex, Hilo, Hawaii, 17 August 1989. (pp. 51–59). Honolulu, Hawaii: University of Hawaii. Research Extension Series, Hawaii Institute of Tropical Agriculture and Human Resources No. 114.

Although taro [*Colocasia esculenta*] is susceptible to attack by at least 23 pathogens, only a few cause serious reduction in growth and production. *Phytophthora* blight (*P. colocasiae*) and *Pythium* root and corm rot are the most serious fungal diseases of *C. esculenta*. Dithane-M45 [mancozeb] is available for control of *Phytophthora* blight.

274. Ooka, J. J. (1994). Taro diseases. A guide for field identification. Honolulu, Hawaii, USA: University of Hawaii. HITAHR Research Extension Series No. 148.

275. Ooka, J. J., & Trujillo, E. E. (1984). Taro diseases and their control. In M. Lambert (Editor), Taro Cultivation in the South Pacific (pp. 52–66). Noumea, New Caledonia: South Pacific Commission. SPC Handbook No. 22.

This chapter includes a description of taro leaf blight, its symptoms and control.

276. Packard, J. C. 144 pp. Honolulu, Hawaii: University of Hawaii. Miscellaneous work papers (University of Hawaii, Pacific Islands Studies Program).

This is a reproduction of an MA thesis with minor revision.

277. Packard, J. C. (1974). The history of the Bougainville taro blight. Unpublished doctoral dissertation, University of Hawaii at Manoa, Honolulu, Hawaii. Thesis for Master of Arts in History, no. 1152.

278. Paharia, K. D., & Mathur, P. N. (1961). New host plant of *Colocasia* blight (*Phytophthora colocasiae* Rac.). Current Science (Bangalore) **30**(9), 354.

279. Paharia, K. D., & Mathur, P. N. (1964). Screening of *Colocasia* varieties to *Colocasia* blight (*Phytophthora colocasiae*). Current Science (Bangalore) **30**(1), 44–46.

Twenty cultivars were screened for resistance to taro leaf blight One was considered immune (Poonampat), one resistant (Sakin V), 7 moderately resistant and 11 susceptible. Results are tabulated.

280. Paiki, F. A. (1988). Identifikasi *Phytophthora* dan *Pythium* pada talas (*Colocasia esculenta*) dan pengaruh beberapa caru budidaya serta fungisida Metalaxyl terhadap perkembangan penyakit hawar daun danbusuk umbi. [Identification of *Phytophthora* and *Pythium* on taro (*Colocasia esculenta*) and the effect of cultivation techniques including metalaxyl fungicide towards the development of leaf blight and corm rot. Unpublished report of the Faculty of Postgraduate Studies, Bogor Agricultural Institute.

281. Paiki, F. A. (1993). Pathogenicity of *Phytophthora* and *Pythium* on taro (*Colocasia esculenta*) in Irian Jaya. Book of Abstracts. The First Taro Symposium. Lae, Papua New Guinea, 25 October 1993. (p. 13). Lae, Papua New Guinea: University of Technology.

Taro leaf blight in Irian Jaya is described. Metalaxyl gave good control of the disease.

282. Paiki, F. A. (1996). Symptoms of taro leaf blight disease (*Phytophthora colocasiae*) and relationship with yield components in Biak, Irian Jaya. Science in New Guinea **21**(3), 153–157.

P. colocasiae causes leaf blight and rot on taro flowers, petioles, stem bases and corms in Irian Jaya. Significant symptoms of leaf blight and corm decay were always found on the same plant. Disease intensity on monoculture cropping systems was higher than on mixed cropping systems. Leaf blight disease intensity showed a linear relationship with yield components. An increase in disease intensity was followed by a reduction of the corm weight/crop.

283. Paiki, F. A., & Erari, D. K. (1985). Ketahanan klon-klon talas terhadap panyakit bercak daun (*Phytophthora colocasiae*). [The resistance of taro clones to taro leaf blight (*Phytophthora colocasiae*). Unpublished report of the Faculty of Agriculture UNCEN, Manokwarai.

284. Paiki, F. A., & Ruimassa, R. (1996). Identification of fungi attacking taro leaves. In The Second Taro Symposium. Proceedings of an International Meeting. Faculty of Agriculture, Cenderawasih University, Manokwari, Indonesia, 23–24 November 1994. (p. 124).

In this poster, taro leaf blight was identified as one of the fungal diseases infecting taro in Irian Jaya. All varieties were affected and infection was evident when the plants were 8 months-old.

285. Palomar, M. K. (1981). Evaluation techniques for disease resistance in root crops. In Southeast Asian and the Pacific Training Course on Root and Tuber Crops

Germplasm Evaluation and Utilization (pp. 252–263). Leyte, Philippines: Visayos State College of Agriculture.

286. Pardales, J. R. (1999). Past, present and future research and development activities on taro in the Philippines. In Annual Report for 1998. (pp. 6–24). Taro Network for South-East Asia and Oceania (TANSAO).

It is reported that the variety VG-2 (Iniito) and two promising selections from the germplasm collections in the Philippines were sent to Western Samoa following the outbreak of taro leaf blight. Iniito is reported to be growing well in Samoa.

287. Pardales, J. R., & Villanueva, M. R. Cultural management for lowland taro under monoculture system in the Phillipines.

288. Pardales, J. R., Villanueva, M. R., & Cotejo, F. R. (1982). Performance of taro under lowland conditions as affected by genotype, nutritional status and population density. Annual Tropical Research , 156–167.

289. Parham, B. E. V. (1949). Country paper Fiji. In Annual Report of the Economic Botanist for the Year ending 1948. (pp. 24, 31–35). Journal of the Legislative Council, Fiji, Council Paper No. 24.

290. Parham, B. E. V. (1947). Ecomomic botany notes. 3. Disease of taro. Agriculture Journal (Fiji) **18**(3), 80.

A disease of taro is reported from the British Solomon Islands Protectorate in July 1946. Although the disease was originally thought to be caused by a virus, the causal organism was identified as *Phytophthora colocasiae.*

291. Park, M. (1939). Report on the work of the Division of Plant Pathology. In Administrative Report of the Director of Agriculture, Ceylon for 1937. (p. D42–D48). Ceylon.

Phytophthora colocasiae is reported for Ceylon [Sri Lanka] for the first time. The fungus was found on *Alocasia* sp.

292. Parris, G. K. (1941). Diseases of taro in Hawaii and their control. Circular (University of Hawaii, Hawaii Agricultural Experiment Station), (No. 18), 29 pp.

A description of taro leaf blight is included in this leaflet.

293. Patel, M. Z. (1984). Progress report on breeding work in Solomon Islands. FAO/SPC Root Crop Breeding and Germplasm Workshop. Suva, Fiji, 29 October–2 November 1984. (6 pp.). Unpublished meeting paper.

294. Patel, M. Z., & Liloqula, R. (1985). Leaf blight disease (*Phytophthora colocasiae*). Annual Report 1984 (Solomon Islands, Ministry of Agriculture and Lands,

Agriculture Division, Research Department) (pp. 8–12). Honiara, Solomon Islands.

Progress in breeding for taro leaf blight is reported.

295. Patel, M. Z., & Liloqula, R. (1985). Progress on breeding disease resistant taro in Solomon Islands. In Fifth Conference of the Australasian Plant Pathology Society. Auckland, New Zealand, 20–24 May 1985. (p. p. 53).

In this poster progress in the breeding programme initiated in 1979 is described. The programme reached the third backcross generation. Results of yield trials are presented. Resistance to taro leaf blight was found to be controlled by a single dominant gene, so additional sources of resistance have been sought from India and South East Asia. Possible approaches to combine resistance from various sources are discussed.

296. Patel, M. Z., & Liloqula, R. (1986). Progress on breeding disease resistant taro in the Solomon Islands. In UNDP/FAO/GTZ/IRETA Regional Crop Protection Workshop. Apia, Western Samoa, 8–12 September, 1986. (133–151.). Suva, Fiji: UNDP.

Progress in the breeding programme initiated in 1979 is described. The programme has reached the third backcross generation. Results of yield trials are presented. Resistance to taro leaf blight was found to be controlled by a single dominant gene, so additional sources of resistance have been sought from India and South East Asia. Possible approaches to combine resistance from various sources are discussed.

297. Patel, M. Z., & Liloqula, R. (1987). Taro breeding programme. Solomon Islands Government, Research Department, Agriculture Division, Ministry of Agriculture and Lands, Annual Report 1995 (pp. 10–11). Honiara, Solomon Islands: Dodo Creek Research Station.

The breeding programme for resistance to *Phytophthora colocasiae* and *Hirschmanniella miticausa* in the Solomon Islands is briefly described.

298. Patel, M. Z., Saelea, J., & Jackson, G. V. H. (1984). Breeding strategies for controlling diseases of taro in Solomon Islands. In Proceedings: sixth symposium of the International Society for Tropical Root Crops, Lima, Peru. Lima, Peru, 21–26 February, 1983. (pp. 143–149). Lima, Peru: International Potato Center.

Resistance to leaf blight caused by *Phytophthora colocasiae* was found in a wild taro (*Colocasia esculenta*) accession introduced from Thailand and designated Bangkok. F1 and BC1 data from crosses between Bangkok and local cultivars indicated that resistance is controlled by a single dominant gene.

299. Patiasina, J. W., Karafir, J. P., Killian, A. M., & Paiki, F. A. (1981). Preliminary study on the control of taro leaf blight in Irian Jaya. Manokwari, Indonesia: Faculty of Agriculture, Cenderawasih University.

300. Paulson, D. D., & Rogers, S. (1997). Maintaining subsistence security in Western Samoa. Geoforum (No. 28), 173–187.

In this discussion, the effect of taro leaf blight on food security in Samoa is considered.

301. Pena, R. S. d. l. (1989). Development of new taro varieties through breeding. In J. R. Hollyer, & D. M. Sato (Editors), Taking taro into the 1990s. (pp. 32–36). Honolulu, Hawaii: University of Hawaii.

Some of the advantages, problems and a general method of hybridizing taro are discussed. It is stressed that an organised crop improvement programme through breeding should be established and supported.

302. Pena, R. S. d. l. (1978). Upland taro. Home Garden Vegetable Series , Chap. No. 18,). Hawaii, USA: Hawaii Cooperative Extension Service, University of Hawaii.

303. Peregrie, W. T. H. (1971). Annual Report of the Plant Pathologist, Brunei, 1970.

304. Petch, T. (1918). Fungus diseases of food crops in Ceylon. Tropical Agriculture **50**, 159–163.

Cited in Tucker 1933.

305. Philemon, E. C. (1997). An overview of the pathology of genus *Colocasia*. Papua New Guinea Journal of Agriculture, Forestry and Fisheries. **37**(2), 53–61.

Information available from various sources, which relates to diseases of taro in Papua New Guinea, is reviewed.

306. Philemon, E. C., & Hyde, K. (1990). Plant diseases of Western Province in Papua New Guinea: a survey report, 107 pp.

307. Pillai, S. V., & Thankappan, M. (1991). Breeding for leaf blight resistance in taro: problems and prospects. Journal of Root Crops **17**, 57–61. (ISRC National Symposium Special).

308. Pillai, S. V., Thankappan, M., & Misra, R. S. (1996). Intervarietal hybridization for induction of resistance to leaf blight in taro. In G. T. Kurup, M. S. Palaniswami, V. P. Potty, G. Padmaja, S. Kabeerathumma, & S. V. Pillai (Editors), Tropical tuber crops: problems, prospects and future strategies. (pp. 164–168). Lebanon, New Hampshire, USA: Science Publishers, Inc.

Four *Phytophthora colocasiae* leaf blight tolerant taro (*Colocasia esculenta*) cultivars and their open pollinated progenies were selfed and intercrossed to isolate resistant recombinants from the segregating generations. The highest numbers of resistant genotypes were obtained from selfed tolerant lines, followed by open pollination of progenies of tolerant lines. A high proportion of second generation hybrids of tolerant cultivars also showed resistance. Selfed susceptible genotypes did not produce resistant lines, whereas crosses involving different susceptible lines gave a low percentage of resistant progeny. Genotypes with combined resistance, high yields and good cooking quality were identified. From a third cycle of segregating generations, 4 genotypes were identified with a high degree of resistance under field conditions and after artificial inoculation.

309. Pillai, S. V., Thankappan, M., & Misra, R. S. (1993). Leaf blight resistant hybrids of taro. Journal of Root Crops **19**(1), 66–68.

Of 270 *Colocasia esculenta* seedlings screened for natural resistance to leaf blight, caused by *Phytophthora colocasiae*, in the field at Trivandrum, India, 119 lines were resistant.

310. Po KiHo, & Ramsden, L. (1998). Mechanisms of taro resistance to leaf blight. Tropical Agriculture **75**(1/2), 39–44.

Five taro cultivars and 2 related aroids were screened for the induction of pathogenesis-related proteins in reponse to infection by *Phytophthora colocasiae.* Infected plants showed increased levels of PR proteins but this did not correlate with resistance in the most susceptible cultivars. Despite high levels of PR proteins, these cultivars were unable to prevent infection. Successful resistance in other plants was more closely linked to the pattern of expression of proteinase inhibitors, which appear to be an important defence strategy in taro and related aroids.

311. Pone, S. (1996). Taro leaf blight—a regional approach. In The Second Taro Symposium. Proceedings of an International meeting. Faculty of Agriculture, Cenderawasih University, Manokwari, Indonesia, 23–24 November 1994. (pp. 86–90).

A Taro Leaf Blight Network for the South Pacific is proposed. The Network will involve collaboration between scientists within Pacific island countries and international organizations and institutes outside the region. The aims of the Network are to assist in the development of alomae and bobone virus-testing techniques, identification of molecular markers for taro leaf blight resistance genes, breeding of taro leaf blight resistant varieties and the mass production and distribution of pathogen-indexed taro plantlets through tissue culture to member countries. Support will also be given to other taro leaf blight control measures. A meeting to formally launch the Network was planned for 8–12 May 1995. Names and addresses of contact people are given.

312. Pouono, K., & Hunter, D. G. (1988). Taro breeding and research in Samoa. In Proceedings of the Taro Breeding Workshop. Suva, Fiji Islands, 26–28

August 1998. (pp. 9–10). Noumea, New Caledonia: Secretariat of the Pacific Community. AusAID/SPC Taro Genetic Resources: Conservation and Utilisation.

313. Pouono, K., & Tuugasala, S. (1996). The incidence of taro leaf blight (*Phytophthora colocasia*) in relation to rainfall in Western Samoa: a progress report. In Mineral nutrient disorders of root crops in the Pacific: Proceedings of a workshop. Nuku'alofa, Kingdom of Tonga, 17–20 April 1995. (pp. 137–139). ACIAR Proceedings No. 65.

This paper presents preliminary findings on the interrelationships between rainfall, incidence of leaf blight [*Phytophthora colocasiae*], growth, yield and corm quality of taro on Upolu Island in Western Samoa. Disease incidence was positively related to rainfall and plant age.

314. Prana, M. S. (1999). Past, present and future R&D programmes on taro (*Colocasia esculenta*) in Indonesia. In Annual Report for 1998 (pp. 50–61). Taro Network for South-East Asia and Oceania (TANSAO).

Taro research in Indonesia is reported. Problems with isolating *Phytophthora colocasiae* from taro are outlined. However, it is reported that 4 successful isolations were made and these will be sent to France for molecular analysis.

315. Price, T. V. (1978). Pathosystem analysis of taro blight in Papua New Guinea. In Epidemiology and crop loss assessment. Proceedings of a workshop. Lincoln College, Canterbury, New Zealand., 29–31 August, 1997.

316. Primo, A. (1993). *Colocasia* taro on Pohnpei Island. In Proceedings of the Sustainable Taro Culture for the Pacific Conference. University of Hawaii, Honolulu, 24–25 September 1992. (pp. 6–8). Hawaii: Hawaii Institute of Tropical Agriculture and Human Resources. HITAHR Research Extension Series No. 140.

Research into the control of *Phytophthora* blight of taro is highlighted as a future research need for taro in Pohnpei.

317. Purwanti, H. (1986). Ketahanan talas terhadap hawar daun (*Phytophthora colocasiae*). Penelitian Pertanian **4**, 5–7.

318. Purwanti, H. (1986). Ketahanan varietas talas terhadap penyakit hawar daun (*Phytophthora colocasiae*). (Resistance of taro (*Colocasia esculenta*) varieties to leaf blight (*Phytophthora colocasiae*)). Penelitian Pertanian (Indonesia) **6**(1), 5–7.

319. Putter, C. A. J. Disease resistance in plants and its role in crop production strategy and tactics in Papua New Guinea. In Proceedings of the First Papua New Guinea Food Crops Conference. Port Morseby, Papua New Guinea.

320. Putter, C. A. J. (1980). The management of epidemic levels of epidemic diseases under tropical subsistence farming conditions. In J. Palti, & J. Kranz

(Editors), Comparative Epidemiology: a tool for better disease management (pp. 93–103). Wageningen, Netherlands: CTA.

The epidemic patterns of temperate and tropical plant pathogens are contrasted in a comparison of diseases caused by 2 species of *Phytophthora, P. infestans* and *P. colocasiae*. Disease and control strategies for the 2 epidemic patterns are compared. Epidemicity is proposed as a paradigm of tropical epidemiology and its implications for disease control are discussed. The socio-economic and ecological constraints imposed on pathosystem management in developing countries are evaluated and an attempt is made to formulate a control strategy for tropical diseases.

321. Putter, C. A. J. (1976). Phenology and epidemiology of *Phytophthora colocasiae* Racib. on taro in the East West Province, Papua New Guinea. Unpublished doctoral dissertation, University of Papua New Guinea, Faculty of Science.

In this thesis, the taro leaf blight pathosystem is described and analysed and management of the pathosystem considered.

322. Putter, C. A. J. (1993). Some epidemiological explanations to guide the design of taro blight resistance evalutation experiments, unnumbered. Rome, Italy: FAO. FAO unpublished report.

Techniques to be used for evaluating taro blight resistance in varieties are considered.

323. Putter, C. A. J. (1993). Some thoughts on taro improvement in the Pacific, 12 pp. FAO unpublished report.

The taro blight epidemic in Samoa is discussed and a general taro improvement programme is suggested that could be adopted and implemented as a crop improvement network approach in the Pacific.

324. Putter, C. A. J. (1993). Taro blight (*Phytophthora colocasiae*) in Western Samoa, 24 pp. FAO Mission Report TCP/SAM/2353.

In this report, details of a training workshop on the biology and epidemiology of taro blight held in 1993 are given and an assessment of the current situation and recommendations for an integrated disease management strategy made.

325. Quevedo, M. A., Sanico, R. T., & Baliad, M. E. (1991). The control of post-harvest diseases of taro corms. Tropical Science **31**(4), 359–364.

Results of trials of pre- and postharvest control measures for the control of postharvest decay of taro are reported. Benlate dips and packing taro corms delayed decay.

326. Quitugua, R. J., & Trujillo, E. E. (1998). Survival of *Phytophthora colocasiae* in field soil at various temperatures and water matric potentials. Plant Disease **82**(2), 203–207.

The survival of zoosporangia of *P. colocasiae*, isolated from *Colocasia esculenta* and produced on V8 agar, mixed with soil and stored at 3 soil water matric potentials and 4 temperatures was studied. A large number of the zoosporangia germinated by zoospore discharge and/or lysed in the soil during the first 5 days of incubation, decreasing the initial number of colony-forming units (c.f.u.) from 1X104 to 1X102 per g of soil in all treatments. Eighteen days after incorporation, the viable zoosporangia present in moist soils had thickened their cell walls and germinated only directly (i.e.,germinated by germ tube and hyphal production), often producing smaller zoosporangia. A few thick-walled chlamydospores were observed and they germinated only directly. Zoosporangia in soils at -1500 J/kg matric potential survived longer than 107 days and the amount of viable zoosporangia present at that time was approximately 0.1X102 c.f.u./g of soil. The majority of the thin-walled zoosporangia produced on V8 agar, when incorporated into moist soil, germinated indirectly (i.e., by zoospore release) in the first 5 days of incubation. Zoosporangia that did not germinate became resting zoosporangia by increasing their wall thickness or by producing chlamydospores. These enabled the pathogen to survive in soil at -1500 J/kg matric potential for more than 3 months. However, in the absence of the host, the pathogen is predicted to survive less than 1 year due to its lack of saprophytic ability to colonize non host tissues.

327. Quitugua, R. J., & Trujillo, E. E. (1997). Taro leaf blight evaluations of 30 different taro cultivars (*Colocasia esculenta*) produced in tissue culture. [Abstract]. Proceedings of the College of Arts and Science Conference. University of Guam.

328. Raciborski, M. (1900). Parasitic algae and fungi. Java Batavia Bulletin **19**, 189.

First report of the taro leaf blight pathogen in Java.

329. Ragus, L. (1991). Rapid rural appraisal of taro agriculture in the Commonwealth of the Northern Mariana Islands. In A. M. Vargo (Compiler), A Rapid Rural Appraisal of Taro Production Systems in Micronesia, Hawaii and American Samoa. (pp. 81–94). Hawaii, USA: University of Hawaii.

A rapid rural appraisal in the Northern Mariana Islands is reported. *Phytophthora colocasiae* was identified on Rota and Tinian.

330. Rajesh Kumar, & Dubey, S. C. (1996). Screening of *Colocasia* genotypes for resistance to *Phytophthora* leaf blight. In G. T. Kurup, M. S. Palaniswami, V. P. Potty, G. Padmaja, S. Kabeerathumma, & S. V. Pillai Tropical tuber crops: problems, prospects and future strategies. (pp. 388–390). Lebanon, New Hampshire, USA.: Science Publishers, Inc.

Fifteen genotypes of *C. esculenta* were screened for resistance to leaf blight caused by *Phytophthora colocasiae*. Genotype C189 had the highest infection rate (53.9%) as well as disease intensity (52.7%). Telia had the highest leaf infection (26.6%). Highly restricted disease symptoms were observed in Jhangdi and Topi. No symptoms or infections were observed in Kadma local, Muktakeshi or Nadia local. These genotypes showed immune reactions to blight.

331. Rangai, S. S. (1982). Preliminary results of a survey of taro (Colocasia esculenta) cultivation on the Gazelle Peninsula of New Britain. In Proceedings of the Second Papua New Guinea Food Crops Conference. Port Moresby, Papua New Guinea, 14–18 July, 1980. (pp. 123–133). Port Moresby, Papua New Guinea: Department of Primary Industy.

In a survey of growers, taro leaf blight was rated as a serious problem in taro production. A decline in the number of varieties grown is noted and it is suggested that this is due to the presence of blight.

332. Rangi, S. S. (1993). The vanishing status of taro. In Book of Abstracts. The First Taro Symposium. Lae, Papua New Guinea, 25 October 1993. (p. 21). Lae, Papua New Guinea: University of Technology.

The decline of taro production in Papua New Guinea, and the role of taro leaf blight in this decline, are discussed. Breeding for disease resistance is considered to be important in order to combat genetic erosion.

333. Rao, V. R. (1996). Taro genetic resources: conservation and use. In The Second Taro Symposium. Proceedings of an International Meeting. Faculty of Agriculture, Cenderawasih University, Manokwari, Indonesia, 23–24 November 1994. (pp. 19–28).

In this discussion the importance of considering taro leaf blight and taro viruses when conserving taro germplasm is outlined.

334. Rao, V. R. (1996). Taro genetic resources—International Board for Plant Genetic Resources (IBPGR). Taro Leaf Blight Seminar. Proceedings. Alafua, Western Samoa, 22–26 November, 1993. (pp. 139–142). Noumea, New Caledonia: South Pacific Commission. Unpublished.

Taro genetic resources with special reference to taro blight and taro viruses and the safe movement of germplasm are considered. IBPGR's interest in taro in Asia, the Pacific and Oceania is described.

335. Rasyid, A. (1988). Efikasi fungisida Ridomil 35 SD terhadap penyakit hawar daun (*Phytophthora colocasiae*) pada talas. [The efficacy of Ridomil 35 SD fungicide on controlling taro leaf blight (*Phytophthora colocasiae*) in taro.]. Unpublished report of the Faculty of Agriculture UNCEN, Manokwarai.

336. Raynor, B. (1991). Report on the rapid rural assessment of taro agriculture on Pohnpei Island, F.S.M. In A. M. Vargo (Compiler), A Rapid Rural Appraisal of Taro Production Systems in Micronesia, Hawaii and American Samoa. (pp. 117–144). Hawaii, USA: University of Hawaii.

A rapid rural appraisal of taro production on Pohnpei carried out in 1990 is reported. *Phytophthora* leaf blight was identified as the most important disease and was cited by growers as the major problem. Removal of infected leaves was the control measure used.

337. Raynor, B., & Silbanus, S. (1993). Ecology of *Colocasia* taro production on Pohnpei. In Proceedings of the Sustainable Taro Culture for the Pacific Conference. University of Hawaii, 24–25 September 1992. (20–24.). Honolulu, Hawaii: Hawaii Institute of Tropical Agriculture and Human Resources. HITAHR Research Extension Series No. 140.

In a survery of taro production on Pohnpei in which data were collected from December 1990 to July 1991, *Phytophthora* blight was identified as the most serious disease. Leaf blight was more serious on low-input farms than on high-input farms. Reasons for this are discussed and low-input strategies to improve disease control are recommended.

338. Reddy, D. B. (1970). A preliminary list of pests and diseases of plants in Western Samoa. Technical Document, FAO Plant Protection Commision in South East Asia **15**.

339. Reinking, O. (1919). Diseases of economic plants in China. Philippine Agriculturist **8**, 109–134.

340. Reinking, O. A. (1918). Philippine economic plant diseases. Philippine Journal of Science A **13** , 165–274.

341. Reinking, O. A. (1919). Philippine plant diseases. Phytopathology **9**, 114–149.

342. Ribeiro, O. K., Erwin, D. C., & Zentmyer, G. A. (1975). An improved synthetic medium for oospore production and germination of several *Phytophthora* species. Mycologia **67**(5), 1012–1019.

343. Robinson, R. A. (1996). Aroids. In Return to Resistance (pp. 237–238). Davis, California, USA: AgAccess.

344. Rogers, S., Iosefa, T., Hoponoa, T., Hazelman, S., & Hunter, D. (2000 July). Farmer inovation in the South Pacific. In ILEIA Newsletter, 2000 July, pp. 7–8.

This article describes how Samoan farmers have innovated to ensure rapid multiplication of leaf blight-resistant taro cultivars.

345. Rogers, S., & Schwanz, V. (1998). Coupling participatory research to technology transfer. In Diffusion and transfer of agricultural technology in the Pacific. Reports and papers from the third annual meeting of cooperators. Vava'u,

Kingdom of Tonga, 24–28 November 1997. (pp. 101–108). Suva, Fiji: Pacific Regional Agricultural Programme.

Included in this paper are the general recommendations for taro leaf blight control in Samoa.

346. Rwimassa, P. M. R. (1988). Permaduan beberapa dosis Dithane M-45 dan jenis klon talas dalam pengendalian penyakit hawar daun (*Phytophthora colocasiae*). [The impact of Dithane M-45 application rate and taro clones in controlling taro leaf blight (*Phytophthora colocasiae*).]. Unpublished report of the Faculty of Agriculture UNCEN, Manokwarai.

347. Saena, T. B. (1997). In-vitro multiplication of taro (*Colocasia esculenta* var. *esculenta* L. Schott.). Unpublished masters dissertation, University of the South Pacific.

This thesis contains general background information on taro leaf blight in Samoa and it's economic impact.

348. Sahu, M. P., & Singh, K. P. (1987). Fungicidal control of leaf blight disease of taro (*Colocasia esculenta* (L.) Schott). In Tropical tuber crops: production and utilization. Proceedings, National Symposium on Production and Utilization of Tropical Tuber Crops. Trivandrum, India, 27–29 November 1985. (pp. 183–185). Trivandrum, India: Indian Society for Root Crops.

349. Sahu, M. P., Singh, K. P., & Singh, J. R. P. (1989). Control of blight disease of taro. Indian Farming **39**(2), 22–23.

Four sprays of zineb at 15 d intervals starting from the end of Jul. to early Aug. reduced the incidence of *Phytophthora colocasiae* on *Colocasia esculenta* and increased the yield. Other measures including minimising the source of inoculum, maintenance of sanitary field conditions, crop rotation and the use of disease-free plant material, are also recommended.

350. Santos, G. H. (1993). *Colocasia* taro varieties on Pohnpei. In Proceedings of the Sustainable Taro Culture for the Pacific Conference. University of Hawaii, 24–25 September 1992. (8–14.). Honolulu, Hawaii: Hawaii Institute of Tropical Agriculture and Human Resources. HITAHR Research Extension Series No. 14.

The characteristics of the eight commonly grown taro varieties in Pohnpei are described, including their susceptibility/resistance to blight.

351. Sar, S. A., Wayi, B. M., & Ghodake, R. D. (1998). Review of research in Papua New Guinea for sustainable production of taro (*Colocasia esculenta*). Tropical Agriculture (Trinidad) **75**(1), 134–138.

Studies on taro leaf blight, including breeding, are reported.

352. Sarejanni, J. A. (1936). La pourriture du Collet des Solan'ees cultivees et la classification du genre *Phytophthora.* [Collar rot of cultivated Solanaceae and classification of the genus *Phytophthora*]. Annales De L'Institute Phytopathologique Benaki **2**, 35–52.

353. Sato, D. M. (1991). The rapid rural appraisal of taro agriculture on the Island of Hawaii. In A. M. Vargo (Compiler), A Rapid Rural Appraisal of Taro Production Systems in Micronesia, Hawaii and American Samoa. (pp. 59–77). Hawaii, USA: University of Hawaii.

A rapid rural appraisal of taro production on Hawaii conducted in 1989 is reported. *Phytophthora* leaf blight was identified in both lo'i and low input systems. In the former it affected leaf production but not corm production, and in the latter was not perceived as a constraint. No fungicides were used in either system to control the disease.

354. Savage, E. J., Clayton, C. W., Hunter, J. H., Brenneman, J. A., Laviola, C., & Gallegly, M. E. (1968). Homothallism, heterothallism, and interspecific hybridization in the genus *Phytophthora.* Phytopathology **58**, 1004–1021.

355. Sawada, K. (1931). Descriptive Catalogue of the Formosan Fungi, Part V. Formosa: Department of Agriculture, Research Institute.

356. Sawada, K. (1911). Infection of taro. In (Special Report of the Formosan Agricultural Experiment Station), (p. 11).

357. Sawada, K. (1911). *Phytophthora* disease of taro. In (Special Report of the Formosan Agricultural Experiment Station), (pp. 75–84).

358. Sawant, I. S., Sawant, S. D., & Nanaya, K. A. (1995). Biological control of *Phytophthora* root-rot of coorg mandarin (*Citrus reticulata*) by *Trichoderma* species grown on coffee waste. Indian Journal of Agricultural Sciences **65**(11), 842–846.

During 1989–92 the biological control of root-rot of mandarins caused by *P. nicotianae* var. *parasitica* and *P. colocasiae* was studied. *T. harzianum, T. viride* and *Gliocladium virens* were widely distributed in *Citrus* orchards in Kodagu, Karnataka, India, with populations of 200–2000 colony forming units/g soil. Seventeen isolates were highly antagonistic to both *Phytophthora* spp. *in vitro.* For large-scale fungal multiplication, local waste (coffee-cherry husk, fruit skin and berry mucilage, poultry manure and mushroom-grown waste) was a suitable substrate with 20–30 million colony forming units/g. Pot trials amended with coffee-cherry husk and poultry manure in a 1:2 ratio decreased feeder root-rot and increased seedling growth. Akomin 0.3%, metalaxyl + 0.25% mancozeb (as Ridomil MZ) spray and drenching 0.2% chlorothalonil were the best chemical treatments for disease control and increased seedling growth. Isolates E, T3, 3HR and D of *T. harzianum* and isolate B of *T. viride* grown on coffee-cherry husk decreased the feeder root-rot and increased plant growth when applied as 1% inoculum in soil.

359. Semisi, S. T. (1996). Taro leaf blight disease, *Phytophthora colocasiae,* in Western Samoa. Taro Leaf Blight Seminar. Proceedings. Alafua, Western Samoa, 22–26 November, 1993. (pp. 63–68). Noumea, New Caledonia: South Pacific Commission. Unpublished.

The importance of taro to the Samoan economy and as a staple food is highlighted. The occurrence, distribution, spread and control of taro leaf blight (which includes quarantine, training and public awareness campaign and a spraying campaign) are outlined. Research activities and collaboration with international/regional organisations are listed.

360. Semisi, S. T., Mauga, T., & Chan, E. (1998). Control of leaf blight disease, *Phytophthora colocasiae* Racib. in taro, *Colocasia esculenta* (L.) Schott, with phosphorous acid. Journal of South Pacific Agriculture **5**(1), 77–83.

Phosphorous acid applied at 14 ml/litre gave excellent control of taro (*Colocasia esculenta*) leaf blight disease caused by *P. colocasiae*. The duration of control varied, mainly due to prevailing climatic conditions. Under Western Samoa conditions, this appeared to be no more than 2–4 weeks. This compared poorly with control obtained for root and heart rot diseases in pineapple (one crop cycle) caused by *P. cinnamoni* with a single application of phosphorous acid. It is suggested that the high rainfall and rapid growth rates of taro may result in more rapid dilution of the fungicide. It is also suggested that it may be related to its indirect mode of action, i.e., that of stimulating host defence responses to the pathogen. Since there is an additive effect of phosphorous acid, and taro in the Pacific is believed to lack genetic resistance, the effect of the fungicide would not be as pronounced.

361. Semisi, S. T., Mauga, T., & Chan, E. (1995). Control of leaf blight disease, *Phytophthora colocasiae* Racib. in taro, *Colocasia esculenta* (L.) Schott, with phosphorous acid. In 10th Biennial Australasian Plant Pathology Society Conference. Christchurch, New Zealand.

A poster presented at this meeting.

362. Sen, H., & Das, P. K. (1991). Agronomical appraisal of some taro accessions in the Gangetic alluvium of West Bengal. Journal of Root Crops **17**(2), 154–155.

Nine taro selections were evaluated in West Bengal, India, during 1989–90, for production potential and susceptibility to leaf blight. Cormel yields were found to vary between season and cv. Kakakachu had the highest pooled mean yield (9.71 t/ha), which was closely followed by cv. Panchmukhi (9.03 t/ha) and cv. Kovvur local (8.72 t/ha). The incidence of leaf blight was widespread in both seasons, except on cultivars Panchmukhi and Nadia local in 1989. These cultivars were slightly affected in 1990, which might be due to the unusually heavy rainfall in that season.

363. Seth, L. N. (1939). Report of the Mycologist, Mandalay, Burma, for the year ended 31 March, 1939.

364. Shaw, D. E. (1984). Microorganisms in Papua New Guinea. Department of Primary Industry, Port Moresby, Research Bulletin (No. 33), 344 pp.

365. Shaw, D. E. (1963). Plant pathogens and other microorganisms in Papua New Guinea. Department of Agriculture, Stock and Fisheries, Port Morseby, Research Bulletin (No. 1), 1–78.

366. Simin, A., Ivancic, A., Ososo, E., & Okpul, T. (1996). Variation of wild taro (*Colocasia esculenta* (L.) Schott) in Papua New Guinea. In The Second Taro Symposium. Faculty of Agriculture, Cenderawasih University, Manokwari, Indonesia, 23–24 November 1994. (pp. 32–40).

Wild taro in Papua New Guinea showed little variation in susceptibility to taro leaf blight and taro viruses and in qualitative and quantitative characteristics. It is concluded that in Papua New Guinea, wild taro populations consist of a single clone.

367. Singh, D. (2000 March). Building up taro gene pool for better yield. In The National, Papua New Guinea ,2000 March, Agriculture Supplement, p. 14 pp.

368. Singh, D., Okpul, E., Iramu, E., Wagih, M., & Sivan, P. (2000). Breeding taro for securing PNG's traditional staple. In Proceedings Papua New Guinea Food and Nutrition Conference. Lae, Papua New Guinea.

369. Singh, D., & Okpul, T. (2000). Evaluation of 12 taro (*Colocasia esculenta* (L.) Schott) leaf blight-resistant colones for yield and eating quality in Papua New Guinea. SABRAO Journal of Genetics and Plant Breeding **32**(1), 39–45.

370. Singh, D., & Okpul, T. (1999). Genetic improvement of PNG's traditional staple. Post Courier , 33 pp. Dated 5 May 1999.

371. Singh, D., Okpul, T., & Guaf, J. (1999). Assessing genetically improved taro lines at NARI. Fresh Produce **144**, 6–7.

372. Singh, D., Okpul, T., Gunua, T., Iramu, E., Wagih, M., Hunter, D. G., Delp, C., Fonoti, P., Sivan, P., & Jackson, G. V. H. (2000). Breeding taro (*Colocasia esculenta*) for durable resistance to leaf blight (*Phytophthora colocasiae*) in the South Pacific. In Proceedings Durable Disease Resistance Symposium. Wageningen, The Netherlands, 28 November–1 December 2000. (p. 20). Abstract.

373. Singh, K. G. (1973). A check-list of host and disease in peninsular Malaysia, 189 pp. Kuala Lumpur, Malaysia: Ministry of Agriculture and Fisheries.

In this list *Phytophthora colocasiae* is recorded on *Colocasia esculenta* and *Piper betle* in Malaysia.

374. Singh, P. N., Sindhu, I. R., & Singhal, G. (1984). Microfungi associated with non-infected and infected leaves of *Colocasia*. Acta Botanica Indica **12** (1), 82–85.

Healthy *C. antiquorum* leaves and those infected by *Phytophthora colocasiae* harboured distinct phylloplane microflora. *Actinomucor repens, Aspergillus terreus, Curvularia tuberculata, Mucor racemosus* and white sterile hyphae were restricted to non-infected leaves, *Colletotrichum* sp., *Humicola brevis, Memnoniella echinata* and *Nigrospora sphaerica* to blighted ones. *Alternaria alternata, Aspergillus humicola, A. niger, Curvularia lunata* [*Cochliobolus lunatus*], *Curvularia pallescens, Fusarium* sp. and *Sclerotium* sp. occurred occasionally on healthy leaves but were frequent on blighted ones.

375. Sinha, A. R. P., & Salam, M. A. (1988). Pathogen fungi of Andamans-I. Advances in Plant Sciences **1**(2), 214–218.

Diseases caused by *Phytophthora* [*P. nicotianae* var.] *parasitica* on pineapples and *P. colocasiae* on *Bougainvillea speciabilis* and *Colocasia antiquorum*, in Andaman, India, are described.

376. Sitansu Pan, & Ghosh, S. K. (1997). Antagonistic potential of some soil fungi on *Phytophthora colocasiae* Racib. Journal of Mycopathological Research **35**(2), 153–157.

Soils from West Bengal, India, were screened to isolate potential antagonists of *P. colocasiae*. Of 58 microbial isolates (40 fungi, 8 bacteria and 10 actinomycetes), only 10 fungal isolates showed antagonistic potential in tests on dual culture plates. Of the 10, 5 were identified as *Trichoderma viride*, 3 as *T. harzianum,* 1 as *Gliocladium virens* and 1 was an unidentified sterile fungus. Mycoparasitic/hyperparasitic activities were observed as coiling of hyphae, formation of haustoria-like structures, disorganisation of host cell contents and penetration of host hyphae.

377. Sitansu Pan, & Ghosh, S. K. (1994). Effect of temperature, moisture and soil amendment on the survival ability of hyphae of *Phytophthora colocasiae* in soil. Journal of Mycopathological Research **32**(1), 59–65.

Hyphae generally survived longer in sterilized soil (30 d) than in natural soil (5 days). At >20°C and >55% soil moisture the hyphae disappeared within 5 days of burial in natural soil. Various soil amendments, including C and N compounds, had no apparent effect on survival in natural soil, though glucose, fructose and glucose + L-asparagine delayed lysis to some extent.

378. Sitansu Pan, & Ghosh, S. K. (1997). Functional relationship of environmental factors for prediction of *Phytophthora* leaf blight severities of taro (*C. esculenta*) under natural epiphytotics. Journal of Mycopathological Research **35**(1), 41–46.

In Bangladesh, the effect of environmental factors (Xi's, i=1–7) on *Phytophthora* leaf blight (*P. colocasiae*) severity (Y) in taro (*C. esculenta*) under natural epiphytotics were analysed for predictive purposes. Correlation analysis of the variables had established a prima facia case of functional relationship of *Phytophthora* leaf blight severity of taro over minimum air

temperature (X2), maximum relative humidity (X3), minimum relative humidity (X4), total rainfall (X5), number of rainy days (X6) and mean temperature-humidity index (x7). Finally, a multivariable linear prediction model Y=- 1534.1871 - 20.2920 X2 + 2.2079 X3 + 1.4724 X4 + 2.2095 X5 - 4.6821 X6 + 25.1241 X6 with R2=0.7859 was developed that showed maximum fitness with observed data.

379. Sivan, P. (2000). Taro germplasm collection, conservation and utilisation in the Pacific Islands. In 12th Symposium of the International Society for Tropical Root Crops. Tsukuba, Japan, 10–16 September 2000.

380. Sivan, P., & Misipati, P. (1997). Taro breeding for resistance to taro blight. In L. G. G. Yapa, & M. Umar (Editors), 1996 Annual Research Report. The Institute for Research, Extension and Training in Agriculture (IRETA) and the School of Agriculture (pp. 28–29). Apia, Samoa: University of the South Pacific, Alafua Campus.

Progress on this project on breeding taro resistant to blight in Samoa is reported.

381. Sivan, P., & Misipati, P. (1997). Taro breeding for resistance to taro leaf blight. IRETA's South Pacific Agricultural News **14**(9), 1,6.

Taro breeding for blight resistance in Samoa with the cultivars PSG-G2, Toantal, Pastora, Pwetepwet, Interpayer, Buntafortwe and Niue is described.

382. South Pacific Commission. (1997). Taro leaf blight seminar. Proceedings. Alafua, Western Samoa, 22–26 November 1993. Noumea, New Caledonia: South Pacific Commission.

Details of the proceedings of the taro leaf blight (caused by *Phytophthora colocasiae*) seminar held at Alafua, Western Samoa are provided. Summaries of the reports of working groups on cultural control, awareness campaign materials, taro (*Colocasia esculenta*) germplasm collection, selection and breeding and fungicide biology are presented. The recommendations of the working groups are provided. A list of the papers presented at the meeting is given. These have not been formally published, but are noted in this bibliography individually, and copies may be obtained from either IRETA or SPC.

383. South Pacific Commission. (1996). Taro Seminar II. Lae, Papua New Guinea, 26–30 June 1995. (35 pp.). Noumea, New Caledonia: South Pacific Commission.

A summary of the proceedings of this meeting is provided. Taro leaf blight was considered at several sessions including the country reports, other reports, taro pathology, breeding and the plant pathology working groups. Recommendations of the meeting are given.

384. Stamps, D. J., Waterhouse, G. M., Newhook, F. J., & Hall, G. S. (1990). Revised tabular key to the species of *Phytophthora*. (p. 28 pp.). UK: CAB International.

385. Stewart, R. B., & Yirgou, D. (1967). Index of plant diseases in Ethiopia. Bulletin of the Experimental Station, College of Agriculture Haile Selassie University , 30 .

386. Sumich, F. N. (1996). Chemicals active on *Phytophthora colocasiae*. Taro Leaf Blight Seminar. Proceedings. Alafua, Western Samoa, 22–26 November, 1993. (pp. 149–152). Noumea, New Caledonia: South Pacific Commission. Unpublished.

Details are given of three products active against *Phytophthora colocasiae*, Ridomil MZ, Manzate 200 DF and copper oxychloride. Factors to consider when using chemical sprays to control taro leaf blight are discussed.

387. Tamori, M. (1974). Studies on the genus *Phytophthora* and pineapple heart rot disease found in Okinawa. Science Bulletin of the College of Agriculture, University of the Ryukyus, Okinawa. (No.21), 1–72.

Results are presented of a study of the host range of *Phytophthora* species in Okinawa, a comparison of their morphological characters, oospore formation and pathogenicity of isolates from different hosts. Among species newly recorded was *P. colocasiae* on *Colocasia*.

388. Tan, T., & Wicaksono, B. W. D. (1996). A preliminary study of ten taro clones under Prafi conditions. In The Second Taro Symposium. Proceedings of an International Meeting. Faculty of Agriculture, Cenderawasih University, Manokwari, Indonesia, 23–24 November 1994. (pp. 74–78).

Phytophthora colocasiae infected all 10 of the taro clones tested at Prafi, Indonesia, and decreased yields.

389. Taylor, M. B., & Palupe, A. (1996). Taro tissue culture. Taro Leaf Blight Seminar. Proceedings. Alafua, Western Samoa, 22–26 November, 1993. (pp. 89–94). Noumea, New Caledonia: South Pacific Commission. Unpublished.

The use of tissue culture to assist in the problem of taro leaf blight is discussed. Its use in the importation of taro germplasm and rapid multiplication techniques are described in some detail.

390. Tedder, M. M. (1973). Staple diets in the BSIP. South Pacific Bulletin (Third quarter).

391. Teng, S. C. (1932). Some fungi from Canton. Contribution of the Biological Laboratory, Scientific Society of China, Botanical Series **8**(2), 121–128.

An annotated list of 41 fungi collected in Canton, China, and including *Phytophthora colocasiae* on Colocasia esculenta, is presented.

392. Tethool, Y. (1983). Pengaruh intensitas serangan penyakit becak daun (*Phytophthora colocasiae*) terhadap produksi talas di daerah biak.[The effect of taro leaf blight intensity (*Phytophthora colocasiae*)on taro production in Biak.]. Unpublished report of the Faculty of Agriculture UNCEN, Manokwarai.

393. Thaman, R. R. (1984). Intensification of edible aroid cultivation in the Pacific Islands. In S. Chandra (Editor), Edible Aroids (pp. 103–122). Oxford, UK: Clarendon Press.

In this account of taro cultivation in the Pacific, it is noted that it is almost impossible to grow *Colocasia* taro in the lowland areas of Bougainville due to taro leaf blight.

394. Thankappan, M. (1986). Investigation on the disease of aroids. Annual report 1985, Central Tuber Crops Research Institute, Trivandrum, India. (pp. 93–95). Trivandrum, India: Indian Council of Agricultural Research.

Outbreaks of *Phytophthora colocasiae* were very mild on 29 clones of *Colocasia* in 2 field trials, owing to unfavourable climatic conditions.

395. Thankappan, M. (1985). Leaf blight of taro—a review. Journal of Root Crops **11**(1–2), 1–8.

Leaf blight (caused by *Phytophthora colocasiae*) of taro, *Colocasia esculenta,* is discussed under the following headings: distribution, extent of damage, symptoms, predisposing factors, the pathogen, perennation, collateral hosts, other *Phytophthora* sp. on *C. esculenta* and control.

396. Thankappan, M., & Malathi, V. G. (1984). Diseases of aroids. Indian Farming **33**, 47.

397. Thomas, K. M., & Ramakrishnan, T. S. (1948). Studies on the genus *Phytophthora* II. Proceedings of the Indian Academy of Science, Section B **27**(3), 55–73.

398. Thompson, A. (1939). Notes on plant diseases in 1937–38. Malaysian Agricultural Journal **27**, 86–98.

399. Thompson, A. (1940). Notes on plant diseases in 1939. Malaysian Agricultural Journal **28**, 400–407.

400. Thongjiem, M., & Poolperm, N. (1999). Advances in taro (*Colocasia esculenta*) research in Thailand. In Annual Report for 1998. (pp. 97–102). Taro Network for South-East Asia and Oceania (TANSAO).

Phytophthora colocasiae is reported as a major disease.

401. Tilialo, R., Greenough, D., & Trujillo, E. E. (1996). The relationship between balanced nutrition and disease susceptibility in Polynesian taro. In Mineral nutrient disorders of root crops in the Pacific. Proceedings of a workshop. Nuku'alofa, Kingdom of Tonga, 17–20 April 1995. (pp. 105–109). ACIAR Proceedings No. 65.

The effects of N, P, K and Ca nutrition on the susceptibility of *Colocasia esculenta* to *Phytophthora colocasiae* are reported from field experiments in American Samoa. The importance of balanced plant nutrition in a sustainable, integrated management strategy to reduce the incidence of the disease is discussed.

402. Tomlinson, D. L. (1987). A bacterial leaf disease of taro (*Colocasia esculenta*) caused by *Xanthomonas campestris* in Papua New Guinea. Tropical Pest Management **33**(4), 353–355.

403. Trujillo, E. E. (1967). Diseases of the genus *Colocasia* in the Pacific area and their control. In Proceedings of the International Symposium on Tropical Root Crops. Volume 2. University of the West Indies, St Augustine, Trinidad, 2–8 April 1967. (IV 13-IV 19.). St Augustine, Trinidad: University of the West Indies.

The history and characteristics of taro leaf blight are described. Chemical control is possible but costly, and the author advocates the development of resistant varieties to manage this disease in the Pacific. Taro rots and other minor diseases are also described.

404. Trujillo, E. E. (1965). The effects of humidity and temperature on *Phytophthora* blight of taro. Phytopathology **55**(2), 183–188.

Sporulation of P. colocasiae on detached taro leaves was affected by temperature and relative humidity, with optima at 21 C and 100%. No sporulation occurred at RH lower than 90%. On washed lesions, 2–3 hours were required for sporulation to be initiated. Zoosporangia at RH lower than 90% lost viability rapidly and the percentage of indirect germination dropped significantly. This was attributed to rapid dehydration of the protoplasm. Indirect germination of zoosporangia occurred in water in less than 2 hours at the optimum temperature of 20–21 C, and zoospores germinated in less than a half hour after release. Direct germination occurred in 5–6 hour at 20–28 C. The percentage of direct germination was less than 5 at all temperatures. Epidemics of the disease occurred in the field when night temperatures and relative humidity were optimum for 6–8 hours for 3–4 consecutive days and light rains or dews prevailed in the morning. During these periods, 50% of the zoosporangia collected in the morning germinated indirectly. Zoosporangia collected at 2 pm were not viable; the phytoplasm appeared to be totally dehydrated.

405. Trujillo, E. E. (1965). The effects of humidity and temperature on *Phytophthora* blight of taro. Phytopathology **55**, 183–188.

406. Trujillo, E. E. (1965). Effects of humidity and temperature on zoosporangia production and germination of *Phytophthora colocasiae*. Phytopathology **55** (2), 126. Abstract of paper presented at the 1964 Annual Meeting of the Caribbean División of the American Phytopathological Society, Mexico City, 26–30 July 1964.

The effect of temperature and relative humidity on sporulation of *P. colocasiae* was demonstrated, with optima of 21 C and 100%, respectively. With RH less than 90%, no sporulation occurred. At RH less than 90%, zoospores rapidly lost their viability.

407. Trujillo, E. E. (1971). A list of diseases of economic plants in the Trust Territory of the Pacific Islands, 23 pp. Saipan, Trust Territory of the Pacific Islands: Department of Resources and Development, Division of Agriculture.

408. Trujillo, E. E. (1993). Status of *Phytophthora* leaf blight of taro in Western Samoa and recommendations for its control. Washington DC, USA.: USDA/OICD/DRD/AAE.

409. Trujillo, E. E. (1996). Taro leaf blight in Micronesia and Hawaii. Taro Leaf Blight Seminar. Proceedings. Alafua, Western Samoa, 22–26 November, 1993. (pp. 41–43). Noumea, New Caledonia: South Pacific Commission. Unpublished.

In this transcript of a presentation to the meeting, the spread of taro leaf blight into the region, with special reference to the situation in Hawaii and Micronesia, is described. Environmental factors affecting the disease and chemical control measures taken in Hawaii are outlined. Difolatan is considered to be the best fungicide. Ridomil was also effective, but copper fungicides give little control. Adequate fertilization of the crop is also considered necessary in the control strategy. In Micronesia taro varieties are disappearing. The crop is of less importance here, but taro leaf blight still limits taro production.

410. Trujillo, E. E. (1996). Taro leaf blight research in the American Pacific. ADAP Bulletin **1**, 1–3.

The spread of taro leaf blight in the Pacific and the effect of the disease's introduction on taro production in American Samoa and Samoa in 1993/94 is discussed. The ADAP Taro Leaf Blight Project, started in 1994 is described. Micronesian taro varieties were collected and evaluated for resistance and some were multiplied by tissue culture. Field testing of promising Palauan varieties is described. Other objectives of the project were to determine the viability of zoosporangia in soil at different moisture and temperature regimes and to determine the effect of balanced nitrogen, phosphorus, potassium and calcium nutrition on taro leaf blight incidence. Spore survival in the soil of >3 months in moist soils and <20 C is reported. Balanced fertilizer applications led to an increase in yield of taro but the effect on taro leaf blight was not significant.

411. Trujillo, E. E. (1971). Taro leaf spot. (Plant Disease, Agricultural Extension Leaflet No. 31. 1 p. Saipan, Mariana Islands: Department of Resources and Development, Division of Agriculture.

412. Trujillo, E. E., & Aragaki, M. (1964). Taro blight and its control. Hawaii Farm Science **13**, 11–13.

The disease is described and control experiments in Hawaii described. Results showed that basic copper sulphate at 2 and 4 lb/100 gal gave good control of blight, while maneb at 2 lb/gal was no better than the controls. Recommendations for spraying are given.

413. Trujillo, E. E., & Menezes, T. (1995). Field resistance of Micronesian taros to *Phytophthora* blight. Phytopathology **85**(12), 1564. Abstract of a paper presented at the APS Caribbean Division Meeting, 1–5 October 1995, Guadeloupe.

Taro cultivars from Guam, Palau and Rota were evaluated for resistance to taro leaf blight in the field at Hakalaua, Hawaii. High levels of resistance were found among the Palaun cultivars. All the cultivars tested were significantly more resistant to taro leaf blight than Niue, the principal cultivar grown in American Samoa. Disease resistance in the majority of the Palaun cultivars appeared to be related to the highly water-repellent nature of the foliage and to a hypersensitive reaction that caused infected leaves to drop off. It is concluded that the Palaun cultivars are promising for cultivation in American Samoa.

414. Trujillo, E. E., Wall, G., Greenough, D., & Tilialo, R. Effects of nitrogen, calcium, and/or potassium nutrition on the resistance and/or susceptibility of Polynesian taros, *Colocasia esculenta*, to the taro leaf blight, caused by the fungus *Phytophthora colocasiae*. ADAP Taro Leaf Blight Project Report.

415. Tsatsia, H. (1995). Taro breeding programme for disease resistance. In Annual Report 1994, Solomon Islands Government, Agriculture Division, Ministry of Agriculture & Lands, Research Department (pp. 30–32). Honiara, Solomon Islands: Dodo Creek Research Station.

Results of some field varietal trials are briefly reported, together with taste tests of some promising varieties.

416. Tucker, C. M. (1933). Description of the genus *Phytophthora*. University of Montana Agricultural Experiment Station Research Bulletin, 184, 80 pp.

The work of Mendiola in the Philippines and Petch in Ceylon (Sri Lanka) are described.

417. Tucker, C. M. (1931). Taxonomy of the genus *Phytophthora* de Bary. University of Montana Agricultural Experiment Station Research Bulletin **153**.

418. Umbala, K. G., & Ramarao, P. (1972). Leaf blight of *Colocasia* caused by *Phytophthora palmivora*. Indian Journal of Mycology and Plant Pathology **2**(2), 187–188.

The fungus was recorded on *C. esculenta*. Symptoms and the pathogen are described.

419. Unnikrishnan, M., Nayar, G. G., Pillai, P. K. T., Vasudevan, J. S., Jos, J. S., Venkateswarlu, M., Thankappan, M., & Lakshmi, K. R. (1987). Sree Rashmi and Sree Pallavi: two promising varieties of *Colocasia*. Journal of Root Crops **13**(2), 111–116.

Of the two promising varieties, Sree Pallavi (C-266) showed high field tolerance to leaf blight.

420. Vargo, A. M. (1991). The rapid rural appraisal of taro agriculture in American Samoa. In A. Vargo (Compiler), A Rapid Rural Appraisal of Taro Production Systems in Micronesia, Hawaii and American Samoa. (pp. 7–30). Hawaii, USA: University of Hawaii.

A rapid rural appraisal carried out in American Samoa in 1989 is reported. *Phytophthora colocasiae* was identified as an important disease during this appraisal.

421. Vargo, A. M. (1991). The rapid rural appraisal of taro production in Chu'uk. In A. M. Vargo A Rapid Rural Appraisal of Taro Production Systems in Micronesia, Hawaii and American Samoa. (pp. 33–34). Hawaii, USA: University of Hawaii.

In a survey carried out in 1990, *Phytophthora colocasiae* was identified as a major problem in taro cultivation on Moen and Uman.

422. Vasquez, E. A. (1989). Screening taro varieties for resistance to insect pests and diseases. R and D Philippines (No. 6–7), 28–29.

423. Vasquez, E. A. (1990). Yield loss in taro due to *Phytophthora* leaf blight. Journal of Root Crops **16**(1), 48–50.

Four taro (*Colocasia esculenta*) accessions (PRG-686, PRG-688, PRG-538 and PRG-179) with varying resistance to *P. colocasiae* were inoculated with the pathogen 2 or 4 months after planting (MAP). In general, plants inoculated at 4 MAP had a higher disease rating and lower yield than those inoculated earlier, except accession PRG-688 (resistant). Yield reductions were low in resistant accessions (2.9–4.7%) but higher in moderately resistant and susceptible accessions (24.4–36.5%). No significant differences were observed between yield reductions of susceptible and moderately resistant accessions.

424. Villanueva, M. R., & Tupas, G. L. (1980). Taro production in the Philippines—its prospects and problems. In International Symposium on Taro and Cocoyam. Visayas State College of Agriculture, Baybay, Leyte, Philippines, 24–25 September 1979. (pp. 99–111). Stockholm, Sweden: International Foundation for Science.

In this paper, taro leaf blight is identified as the most important disease of taro in the Philippines, causing more damage than insects.

425. Wagih, M. E. (1996). Disease-free baby corms of taro regenerated from axillary bud cultures coupled with thermotherapy. In The Second Taro Symposium. Proceedings of an International Meeting. Faculty of Agriculture, Cenderawasih University, Manokwari, Indonesia, 23–24 November 1994. (p. 124).

In this poster at the conference it is reported that axillary buds from taro severely infected by blight and viruses were excised, surface sterilised, treated at 55 C for 3 minutes and cultured. Shoots remained without symptoms for 6 months and were assumed to be disease-free. By 4–5 months small cormels had formed, providing an ideal way to transfer taro germplasm.

426. Wagih, M. E., Taufa, L., & Okpul, T. (1993). The use of seed-rescue culture technique in the production of pathogen-free taro for germplasm preservation and breeding for leaf blight resistance. In Book of Abstracts. The First Taro Symposium. Lae, Papua New Guinea, 25 October 1993. (p. 9). Lae, Papua New Guinea: University of Technology.

In this abstract, the use of seed rescue culture to produce pathogen-free taro plants in Papua New Guinea is reported. Three resistant varieties were identified.

427. Wahi, C. P. (1969). Vitamin requirements of *Phytophthora colocasiae* Racib. and *Helminthosporium euphorbiae.* Hans. Journal of Applied Science, India **1**(2), 71–76.

428. Wall, G. C. (1996). Life after blight. The current taro leaf blight status on Guam. Taro Leaf Blight Seminar. Proceedings. Alafua, Western Samoa, 22–26 November, 1993. (pp. 39–40). Noumea, New Caledonia: South Pacific Commission. Unpublished.

Taro leaf blight is endemic in Guam but is of little economic importance. The reasons for this are briefly discussed. The use of disease resistant varieties and cultural practices are highlighted as important control measures.

429. Wall, G. C., & Wiecko, A. T. (1998). Screening of 29 taro cultivars (*Colocasia esculenta*) propagated *in vitro*, for resistance to taro leaf blight (*Phytophthora colocasiae*). Journal of South Pacific Agriculture **5**(2), 9–12.

Twenty-nine taro varieties from Guam, American Samoa, Yap, Pohnpei and Thailand have been propagated *in vitro* and screened at the University of Guam for susceptibility to taro leaf blight. The most resistant varieties were: Gilin, Kugfel, Oglang, Pwetepwet, Thailand, Sushi, Ol and Pasdora.

430. Wall, G. C., Wiecko, A. T., & Trujillo, E. E. (1998). Evaluation of resistance to taro leaf blight in 29 *Colocasia esculenta* cultivars. Phytopathology **88**(9 (Supplement)), S123.

Twenty nine taro cultivars were collected from Pohnpei, Yap and Guam. After *in vitro* propagation, plants were transferred to a screenhouse until they reached a mature size. Three plants per test for each cultivar, and each was tested 3 or 4 times. Plants (1 leaf) were spray-inoculated with 100–200 zoospores per ml. They were then covered with black plastic overnight. The evaluation was based on percentage leaf area damaged by the pathogen in 6–8 days. Tests included resistant and susceptible controls. Six cultivars out of 29 showed a good degree of resistance.

431. Walton, P. (1996). Taro leaf blight bibliography. Taro Leaf Blight Seminar. Proceedings. Alafua, Western Samoa, 22–26 November, 1993. (pp. 161–168). Noumea, New Caledonia: South Pacific Commission. Unpublished.

In this preliminary bibliography, references to almost 100 publications on taro leaf blight are included. Most of the references have abstracts.

432. Ward, R. G., & Ashcroft, P. (1998). Samoa: mapping the diversity.

Background information on the taro leaf blight problem in Samoa is given.

433. Waterhouse, G. M. (1970). The genus *Phytophthora* De Bary, 104 pp. UK: Commonwealth Agricultural Bureaux. Mycological Paper No. 122.

This volume contains the text of the original description of *Phytophthora colocasiae* in both German and English.

434. Waterhouse, G. M. (1963). Key to the species of *Phytophthora* de Bary. (p. 22 pp.). UK: Commonwealth Agricultural Bureaux. Mycological Papers. No. 92.

435. Waterhouse, G. M. (1931). The production of conidia in the genus *Phytophthora*. Transactions of the British Mycological Society **15**, 311–321.

436. Waterhouse, G. M., Newhook, F. J., & Stamps, D. J. (1983). Present criteria for classification of *Phytophthora*. In D. C. Erwin, S. Bartnicki-Garcia, & P. H. Tsao (Editors), *Phytophthora*: its Biology, Taxonomy, Ecology and Pathology (pp. 139–147). St Paul, Minnesota, USA: APS Press (American Phytopathological Society).

The classification of *Phytophthora* species is discussed.

437. Wei, C. T., & Hwang, H. S. (1942). A checklist of fungi deposited in the mycological herbarium of the University of Nanking, I (1924–1937). Nanking Journal **9**(1–2), 329–372.

438. Weston, W. H. Jr. (1918). Report on plant diseases in Guam. Guam Agricultural Experiment Station Report 1917, 45–62.

439. Wiecko, A. T., Wall, G. C., & Trujillo, E. E. Taro leaf blight evaluations of 30 different taro cultivars (*Colocasia esculenta*) produced in tissue culture.

[Abstract]. In Proceedings of the College of Arts and Science Conference. University of Guam, Guam.

440. Worapan, K., & Thammasak, S. (1993). Rok bai mai ru rok ta-sua khong phuak. (Taro [*Colocasia antiquorum* Schott] blight disease [*Phytophthora colocasiae* in Thailand). Journal of Thai Phytopathological Society **3**(1), 1–9.

441. Xu, X. L., Ko, W. H., Xu, X. L., & Ko, W. H. (1998). A quantitative confined inocultation method for studies of pathogenicity of fungi on plants. Botanical Bulletin of Academia Sinica **39**(3), 187–190.

A technique for inoculation with precise numbers of fungal spores on leaves and stems of plants was developed. The technique consisted of placing 1-µl drops with a fixed number of spores on the surface of leaves and stems, and covering each inoculum drop with a 10-µl drop of low-temperature gelling SeaPlaque agarose to fix the inoculum on the target site. With this technique single zoospores of *Phytophthora capsici* were able to cause local lesions on leaves and stems of peppers (*Capsicum annuum* cv. California Wonder), and the size of the lesions directly correlated with the number of spores in the inoculum drops. Similar results were obtained when the technique was used to inoculate taro (*Colocasia esculenta*) leaves with zoospores of *Phytophthora colocasiae* and black mustard (*Brassica nigra*) leaves with *Alternaria brassicae*. This method has the advantages of being accurate and precise, and it is also easy to handle the inoculated plants. It may also be applicable to other pathogens.

442. Yap, T. C. (1999). Taro cultivation and research in Malaysia. In Annual Report for 1998. (pp. 27–32). Taro Network for South-East Asia and Oceania (TANSAO).

In a disease survey, no *Phytophthora colocasiae* was found in Malaysia.

443. Yokoyama, K. M., Hollyer, J. R., Nakamoto, S. T., & Wanitprapha, K. (1989). Taro. Hawaii, USA: Department of Agriculture and Resource Economics, College of Tropical Agriculture and Human Resources, University of Hawaii. Economic Fact Sheet No. 1.

444. Yu, J. Y., & Chang, H. S. (1980). Chemical regulation of sexual reproduction in *Phytophthora colocasiae*. Botanical Buletin of Academia Sinica **21**(2), 155–158.

Both A1 and A2 isolates produced substance(s) which initiated the formation of oospores in isolates of *P.* [*nicotianae* var.] *parasitica, P. palmivora* and *P. cinnamomi*, but were relatively insensitive in response to hormone(s) produced by opposite mating types.

445. Yu, J. Y., Chang, H. S., & Ko, W. H. (1981). Factors affecting the induction of sexual reproduction in *Phytophthora parasitica* by *P. colocasiae*. Journal of General Microbiology **123**(2), 249–252.

When *P. colocasiae* (A2) was used as a hormone producer and *P.* [*nicotianae* var.] *parasitica* (A1) as a hormone receptor, no sex organs of the latter were observed in matings lasting for 7 h, but the amount of hormone produced was sufficient to stimulate the production of 341 oospores/cm2 6 days later. Max. induction of sex organs was reached in matings lasting 48 h. Hormone production was inhibited by light, but the effect of light on oospore development was small. Temperatures of 10 and 15 deg C inhibited growth of, and hormone production by, *P. colocasiae*, and prevented *P. nicotianae* var. *parasitica* from forming new sex organs after stimulation by hormone. The effect of temperature on hormone and oospore formation differed. Hormone formation was poor at 30 deg , but oospore development was good.

446. Yusuf, R. (1987). The influence of *Phytophthora colocasiae* on distribution of *Colocasiae esculenta* varieties in Jawa Island, Indonesia. Berita Biologia. (Indonesia) (Supplement 3), 17–19.

447. Zentmyer, G. A. (1988). Origin and distribution of four species of *Phytophthora*. Transactions of the British Mycological Society **91**(3), 367–378.

Information is presented on possible origins, and on the distribution of *P. infestans, P. cinnamomi, P. palmivora* and *P. colocasiae*. Little information is available on the origin of *P. colocasiae*, but there are indications of an Asiatic origin. The fungus has been distributed by means of vegetatively propagated material, and also probably by soil.

448. Zentmyer, G. A. (1990). Origin, distribution and significance of species of *Phytophthora* in the Tropics. In Proceedings 3rd International Conference on Plant Protection in the Tropics: volume IV. Genting Highlands, Pahang, Malaysia, 20–23 March 1990. (pp. 210–214). Kuala Lumpur, Malaysia: Malaysian Plant Protection Society .

The controversy of the centres of origins of tropical species of *Phytophthora* are discussed. Information is presented on the possible origin of *P. palmivora, P. cinnamomi, P. infestans,* and *P. colocasiae*.

449. Zentmyer, G. A. (1983). The world of *Phytophthora*. In D. C. Erwin, S. Bartnicki-Garcia, & P. H. Tsao (Editors), *Phytophthora*: its Biology, Taxonomy, Ecology, and Pathology (pp. 1–7). St Paul, Minnesota, USA: APS Press (American Phytopathological Society).

Although most of this introductory chapter relates to work on *Phytophthora cinnamomi* and *P. palmivora*, it does contain a note stating the first description of *P. colocasiae* Raciborski was in1900.

450. Zettler, F. W., Jackson, G. V. H., & Frison, E. A. (1989). Taro leaf blight. In FAO/IBPGR Technical Guidelines for the Safe Movement of Edible Aroid Germplasm. (pp. 16–17). Rome, Italy: FAO/IBPGR.

The symptoms, distribution, biology, alternative hosts and quarantine measures for this disease are outlined.

451. Zhang, K. M., Zheng, F. C., Li, Y. D., Ann, P. J., & Ko, W. H. (1994). Isolates of *Phytophthora colocasiae* from Hainan Island in China: evidence suggesting an Asian origin of this species. Mycologia **86**(1), 108–112.

Of 280 isolates of *P. colocasiae* obtained from Hainan Island, China, 136 were mating type A1, 102 were type A2 and 42 were A0. The 3 mating types were all pathogenic to taro (*Colocasia esculenta*) leaves and had similar electrophoretic patterns of soluble proteins. The representative isolates tested showed considerable variation in growth response to temperature, in ability to produce sporangia and in morphology of sporangia. It is suggested that Hainan Island in inside the centre of origin of *P. colocasiae*.

452. Zheng, F. C., & Ward, E. (1998). Variation within and between *Phytophthora* species from rubber and citrus trees in China, determined by polymerase chain reaction using RAPDs. Journal of Phytopathology **146**(2–3), 103–109.

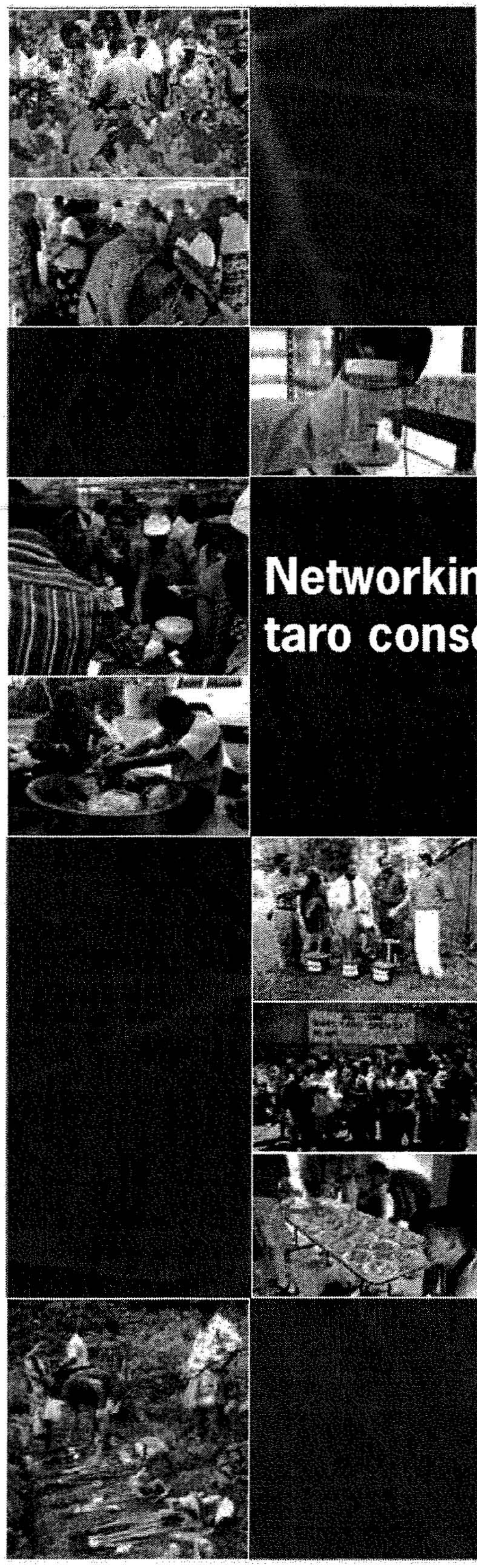
Variation among 39 isolates of *Phytophthora* of 6 morphological species (*P. citrophthora, P.* [*nicotianae* var.] *parasitica, P. capsici, P. palmivora* and *P. meadii*, from rubber and citrus trees, and *P. colocasiae* from taro) was studied using random amplified polymorphic DNA (RAPD) analysis. Ten randomly-chosen 10-mer primers were used. Generally, the banding patterns were similar within species and different between species, but no one primer was able to distinguish all 6 species from one another. Cluster analysis on pooled data from all the primers gave 6 groups of isolates corresponding to the 6 morphological species. The group corresponding to *P. citrophthora* was divided further into subgroups that were related to host species and geographical location. This work confirmed the existing morphological classification of *Phytophthora* isolates from rubber and citrus trees in tropical China and showed the validity of using RAPDs to study the taxonomy of *Phytophthora*.

Author Index

Subject Index

TaroGen

Taro Genetic Resources: Conservation and Utilisation



Networking and learning together for taro conservation and improvement

A list of publications from Tarogen and partners

University of Technology

Australian Government AusAID

ACIAR

NARI

Queensland University of Technology Brisbane Australia

nzaid

Bioversity International

The University of Queensland

HortResearch

Farm Support Association (FSA)

Planting Materials Network (PMN)

Compiled by D. Hunter & M. Taylor, 2007

Impact of the TaroGen project

The TaroGen project, which ran for five years from 1998, was a unique initiative for the Pacific region highlighting the benefits of networking and collaboration to tackle the problem of taro conservation and improvement in light of the leaf blight outbreak in Samoa in 1993. Although implemented by SPC, the project was a significant partnership between regional and international organisations to assist and support Pacific Island countries. This partnership involved organisations (Biodiversity International (formerly IPGRI), SPC, National Agricultural Research Institute-PNG and HortResearch), universities (University of the South Pacific, University of Technology-PNG, Queensland University of Technology and University of Queensland) and non-governmental organisations (Planting Materials Network and Farm Support Association). Funding for this collaboration was provided by AusAID, ACIAR and NZAID.

The main impacts of the project included:

- Development of a regional strategy to collect and describe taro which resulted in a database of over 2,000 taro accessions;
- Technical assistance from UQ and IPGRI scientists in analysis of morphological and molecular data which allowed the identification of 220 taro accessions as a core collection, representative of the broad diversity of taro in the region;
- Assistance provided to SPC to establish the Regional Germplasm Centre as a centre of excellence for research on conservation methods and germplasm distribution;
- Regional NGOs, PMN and FSA, providing important information on the in situ conservation of taro which illustrated that on-farm conservation of taro is a feasible method for some countries;
- Advances in taro virus characterisation and diagnostics by scientists at QUT which now allow the safe international transfer of taro germplasm;
- Crop improvement programmes established at NARI and USP-Alafua which have resulted in the production and distribution of leaf blight resistant taro varieties to farmers;
- Enhanced skills and capacity of many Pacific Island scientists through on-going mentoring with scientists of international repute. This included the completion of 10 postgraduate programmes; and
- Finally, through its many diverse activities and collaborations the Project has significantly added to the body of knowledge that exists on taro conservation and improvement as evident from the list of publications included in this document.

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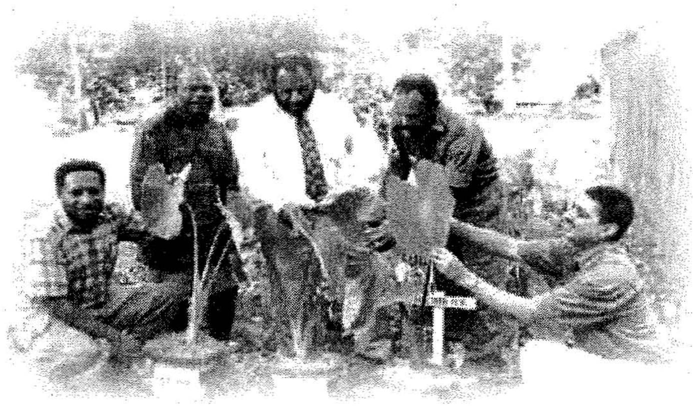

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Further information

Project website

The TaroGen website includes a vast array of information related to the project and its components: taro conservation and improvement. Some of the above publications are available to download at this site.

Go to: http://www.spc.int/tarogen/

Project-related website

Third Taro Symposium
In 2003, the collaborating partners involved in TaroGen organised the Third Taro Symposium at Nadi, Fiji, which brought together scientists from all over the world to review progress in taro research and development and explore options for future directions.

Go to: http://www.spc.int/cis/tarosym

Regional Germplasm Centre
The website of the SPC Regional Germplasm Centre contains information on conservation methods and current research. Data sheets also exist on some of the TaroGen breeding lines as well as accessions held in the taro core collection.

Go to: http://spc.int/rgc/

The Pacific Agricultural Plant Genetic Resources Network (PAPGREN)
Website contains much information related to taro and TaroGen.

Go to: http://spc.int/pgr/

Genetic Resources Thematic Group
This is one of the thematic groups within Land Resources Division of SPC dealing specifically with agricultural genetic resources.

Go to: http://www.spc.int/lrd/genetic_resources.htm

Contacts

Many of the scientists who collaborated on TaroGen continue to work in their respective areas of expertise and will be happy to discuss technical aspects of the project with those interested. They can also provide updates on project-related activities and copies of the publications listed above.

For relevant information contact:

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Benefits and limits of an important biotech tool
FAO publishes study on marker-assisted selection

http://www.fao.org/newsroom/en/news/2007/1000630/index.html

24 July 2007, Rome -*The biotechnology tool of marker-assisted selection (MAS) has raised high expectations for increasing genetic progress through breeding. Some experts have even argued that the application of MAS could "revolutionize" the way varieties and breeding stock are developed.*

In a new comprehensive assessment (Marker-Assisted Selection, Rome 2007), FAO emphasizes that MAS has enormous potential but notes that the technology has not yet delivered its expected benefits to farmers in developing countries. Shivaji Pandey, Chairperson of the FAO Working Group on Biotechnology, gives his view on MAS.

What is marker-assisted selection (MAS)?

MAS is a biotechnology tool that could greatly accelerate conventional breeding of crops, livestock, farmed fish and trees. Scientists are using MAS to genetically improve certain characteristics or traits (productivity, disease resistance, quality etc.) that are important for farmers. MAS makes it possible to select traits with greater accuracy and to develop a new variety quicker than in the past.

What is the difference between MAS and genetically modified organisms (GMOs)?

MAS and genetic modification are different biotechnologies. MAS allows desirable genes to be "marked" or tagged so they can be selected within the breeding population, while GMOs are the result of the transfer of a desirable gene or genes from one species to another.

New plant varieties or improved animal breeds resulting from MAS do not require a specific legislative framework. The complicated approval process required for GMOs does not apply for MAS - its costs of release are therefore lower.

In addition, the technology is not controversial so there is no problem with public acceptance. Indeed, one of the drawbacks of the intense debate that has taken place in recent years over the benefits and risks of GMOs is that it has overshadowed the potential role that other, non-GMO, biotechnologies, such as MAS, may play for food and agriculture.

What is the potential of MAS?

Since MAS first became a practical reality about 20 years ago, it has now gone past the research and development stage and is being applied in the field. For example, it is currently being used in dairy cattle breeding programmes in France and Germany, and rice varieties with improved bacterial blight resistance have being developed using MAS approaches and released in India and Indonesia.

However, initial enthusiasm and optimism have been tempered by the realization that it is more difficult and takes longer than originally thought before genetic improvement of traits using MAS can be realized. The considerable resources invested in this technology have been mainly concentrated in the industrialized world, and MAS has not yet delivered its expected benefits to farmers in developing countries.

What are the costs associated with MAS?

MAS requires quite a sophisticated infrastructure and considerable investments: including specialized equipment, electricity, laboratory design and management, data handling and statistics, and Internet connectivity. Efficient and effective application of MAS also requires well-qualified staff and good funding. It should therefore be used where there is a clear advantage over traditional selection techniques.

What are the constraints countries are facing applying MAS?

Apart from the investments required, a serious constraint that most countries face in applying MAS is the lack of a national policy on science and technology and on biotechnology. This is essential to provide guidance on the strategic planning, monitoring and evaluation of biotechnologies, including MAS, for food and agriculture. In addition, MAS should only be applied when well-structured breeding programmes are already in place, which is often not the case in many developing countries.

How could the application of MAS contribute to hunger and poverty reduction?

Most of the around 820 million hungry people in developing countries live in rural areas where people's livelihoods depend on agriculture. This means that investing in agriculture, and more broadly in rural development, must be at the heart of any strategy for hunger and poverty reduction. While the measures needed certainly go well beyond the issue of producing more food and agricultural products, achieving greater yields and higher value products from the same plot of land or enterprise, through, for example, appropriate application of technologies such as MAS, must be a key ingredient for the great majority of developing countries.

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Testimony transmitted by email 16 March 2009 from:

Penny Levin
224 Ainahou Place
Wailuku, Maui 96793

TO: Committee on Hawaiian Affairs
Rm 329, March 28th, 9:00am

RE: Testimony for SB709 SD2 *Relating to Agriculture*

Aloha Honorable Committee members;

Regarding SB709 SD2 *Relating to Agriculture,* I strongly support the proposed legislation to protect taro in the State of Hawaii from genetic engineering with one amendment as follows:

Page 5 Line 3-6 Remove the sentence "*This Act does not prevent the University of Hawaii from conducting field testing and commercial propagation of successful new varieties outside of the State.*"

The State of Hawai'i has no jurisdiction over the actions of the University of Hawai'i, or other research and commercial entities outside the borders of the State and therefore this statement is unnecessary as a matter of law. It is the right of the hosting countries/states and its citizens that may invite the University to conduct its work within its jurisdiction to determine whether or not genetic engineering of taro, or any other organism, may be appropriate.

In regards to importance of SB709, I submit the following, as well as the attached matrix of issues related to the potential impacts that a release of genetically engineered taro might have on taro farmers in the state:

Taro farmers have been coming out of the lo'i and traveling to the legislature for three years to lay this threat to their crop, their food, their livelihood and their culture to rest. Last year, over 7,000 people testified in support of similar legislation including taro farmers, Hawaiians, three County Councils, consumers, organic farmers, scientists, health practitioners and specialists, and other supporters from across the state. In November 2008, the County of Hawai'i passed an ordinance banning the genetic engineering of taro.

As a taro farmer with a background in science and biodiversity conservation, I have weighed the benefits and risks of genetically engineered taro carefully and found it to be too great a risk to the integrity of the plant as a traditional food crop, the environment, taro biodiversity, fragile taro markets, and consumer health. It is also inappropriate in the context of the significance of taro in Hawaiian culture.

For every proposed benefit, there are serious questions that remain in the highest standards of the science regarding the safety of transgenic crops for human consumption and the natural environment, as well as its true productivity and economic impact. The National Academy of

Science, the highest regarded scientific organization in the US, along with the International Assessment of Agricultural Science and Technology for Development [IAASTD] project, the UN/Food and Agriculture Organization (FAO) and World Health Organization (WHO) support this conclusion. In 2008, IAASTD produced a rigorous 2,500 page report after a four year study involving more than 400 scientists worldwide which concluded that organic agriculture, greater biodiversity within smaller contiguous fields, and improving access to markets would have a far greater impact than GE crops towards shifting world hunger and reducing crop disease. The study was supported by more than 30 governments and 30 global funders, including the US, England, other European nations, the World Bank, UN/FAO, WHO and the biotech industry, who recently pulled out of the project because they did not agree with the recommendations of the report.

The State of California, recognizing the uncontrollable persistence and irreversibility of gmo plants that hybridize non-gmo crops or escape into adjacent fields (whether they hybridize or not), passed into law this year landmark legislation (AB541) protecting farmers from crippling lawsuits by the biotech industry over cross-contamination. The companies do not compensate farmers for contaminating their fields even when organic certification is destroyed; rather, they consider cross-pollination or escape into other farmers' fields which can occur by wind, birds or insects to be theft of property rights. This says a great deal about who these companies really are and where their concerns lay.

But more important for taro in Hawai'i are three clear facts;

<u>First</u>, there are many problems that face taro that cannot be resolved by genetically modifying the plant. I have spent the last six years documenting the impacts and researching solutions with taro farmers to control the invasive apple snail, which is responsible for the highest percentage of crop and huli loss annually (Levin for DLNR-DAR, 2006; Hawaii Agricultural Statistics Service, multiple years). The apple snail is a major vector for other diseases that attack the taro; its razor sharp mouth creates a wound through which fungi and parasites can enter the corm, setting the stage for many forms of root rot. We know from experience and observation that solving the apple snail problem; improving soil organics, fallow durations and cultivar diversity; and restoring water to lo'i kalo will significantly reduce pests and disease occurrence and increase crop productivity. Removing the apple snails alone will eliminate an 18-25% crop loss and increase the available time a farmer has to care for his farm and his family by 50%. Proposed yield increases and disease resistance for GMO taro are hypothetical and untested; the apple snail will eat it anyway. There is no need or demand to grow GMO taro from local taro farmers or consumers. Indeed, even those few farmers who support continued gmo taro research, will not plant it in their fields. Better and safer options exist.

The genetically engineered taro has been developed using a variety called Bunlong, also known as Chinese, along with portions of wheat, rice and grapevine DNA. This variety has been used by taro farmers for more than 150 years in Hawaii – as a *leaf* crop and dryland table taro. It lacks the qualities of a good poi taro. It is used today mostly for the chip industry where tissue culture for clean planting material, good site selection, mulching and spacing practices significantly reduce disease. Poi millers use primarily Lehua and Moi, both Hawaiian varieties. A genetically engineered Bunlong taro does *nothing* to improve disease resistance or production for poi taro farmers. Millers will not buy it and consumers will not eat it (UH CTAHR survey 2008).

Second, taro will survive without genetic engineering long into the future if we attend to the sources of the problem. Taro is one of the oldest human-managed food crops in the world; its use dates back more than 50,000 years by some accounts, but it's regular cultivation can be documented to 7,000 -10,000 years ago in South and Southeast Asia. For an estimated 1,200 years, taro in Hawai'i has survived volcanic fallout, floods, droughts, pests and disease. The presence of the word, *kakane* (a leaf blight on plants) in the Hawaiian language illustrates that taro leaf blight has been around a very long time. Agricultural records show that several taro disease events occurred from the mid-1800s to the mid-1900s; but, this was *not* the primary reason for the decline of taro in Hawai'i as some would suggest. Only since the apple snail reached critical destructive mass (1990s), has the confluence of lack of cold water and poor soil quality created a corresponding persistence in disease occurrence in taro. A close look at data presented by HASS (2001) and UH CTAHR Cooperative Extension Services (Feb 2007) actually supports this understanding.

By the 1900s, many Hawaiians had lost access to both land and water. Many others died from disease, taking with them the knowledge of best growing practices and the taro varieties. In the 1930s, Chinese and Japanese farmers dominated commercial cultivation of taro, changing planting, mulching and fallow practices and cycles. Part of the decline in taro production can be attributed to changes in the market and in society. The demand for poi during the war declined significantly. A new era after WWII saw farming families urging their children to become doctors, lawyers and teachers rather than farmers; by the 1950s many people, including Hawaiians, preferred rice to poi. At the same time, farmers shifted away from organic mulching methods to chemical fertilizer applications initiating a long, slow decline in soil quality that persists today. The number of natural disasters during that same period severely impacted the productivity of taro-growing lands. Of the 50 tsunamis reported in Hawaii since the 1800s, seven inflicted major damage. The tsunamis of 1868, 1946, 1960 and 1975 and the hurricanes of 1940, 1957, 1959, 1982, 1986 and 1992 wiped out significant portions of low-lying taro lands, including those of Waipio and Pololu, Hawai'i; Halawa, Molokai; Keanae and Wailuanui, Maui; and Hanalei, Kauai (USGS and SOEST records). Major flooding events also took their toll, including in 1956, 1970, 1974-75, 1978-79, 1980-1983, 1987-88,1991-92, 1999-2000, 2004 and the rains of Feb-March, 2006 that devastated Kauai growers fields (USGS; greater than 10,000ft^3/sec). It takes an average two years to recover from such events; sometimes longer.

Archival records dating back to the early 1800s indicate it was attention to the soil and the water that kept the taro robust. Queen Emma herself grew taro whose corms averaged 22in. long and 22in. around and documented the careful management of the soil and plants by which she achieved this standard; something very few taro farmers still practice. She writes; "*the size of the roots depend upon the depth of loose soil, and the care bestowed on its cultivation. I have produced kalo which averaged twenty-two inches in length and the same in circumference when it was cultivated under my own eye, but far less in the same locality* *when the cultivation was somewhat neglected by my konohiki*" (HEN Vol. Arch. Collection, pp 76-83; undated manuscript, Bishop Museum; Queen Emma collection 71, nd, pg8).

Third, protecting the biodiversity of taro is critical to future survival, food and economic security. Hawai'i retains many of the ancient Hawaiian taro varieties, some of which are extremely rare, along with extensive ex-situ collections of taro from throughout the Pacific, and Asia. A ban on genetically engineered taro in Hawai'i provides a buffer of protection not just from cross-pollination but more importantly from simply the inability to visually distinguish between a gmo taro and a non-gmo taro in the field. The ban would protect not just the Hawaiian varieties, but all taro cultivars found in the state, an important resource for continuing to build leaf blight resistance using conventional hand-pollination techniques - or restoring traditional varieties back to their original islands throughout the region.

What we are asking for is a return to ethics in agriculture in Hawai'i - one where the researchers, institutions, agencies and industries who *say* they wish to help farmers are actually engaged in what farmers really need and ask for, rather than the pursuit of patents; where researchers also understand and take responsibility for the risks and burdens they place on us and our markets when they follow a path of their own making.

The State of Hawai'i made a commitment to taro by designating it as the State Plant and by establishing the Taro Security and Purity Task Force to address non-gmo issues for farmers in 2008. I urge the members of the Committee on Hawaiian Affairs to further this commitment by passing in full support SB709 SD2 with one amendment.

Mahalo nui loa.
Respectfully,

Penny Levin
Taro Farmer and conservation planner, Maui

Penny Levin - Testimony SB 709 SD2

MYTH	FACT	Evidence
1. Taro decline is due to disease, especially since the 1940s.	Taro decline is directly linked to loss of water resources and acreage (from over 1,200 to 380ac in 70 years); tsunami, hurricane and flood damage; changes in soil management practices; a decline in the number of acres and farmers (from over 1200ac in 1946 to 380ac in 2008; from many hundreds of farmers in the early 1900s to 110 in 2008); a decline in the number of Hawaiians practicing taro cultivation or with access to watered land; and the presence and increase in apple snail populations since 1983/84 to the present. Disease events play a minor role and are often a secondary result of these other causes because of weakened plants from lack of good water and soil or snail damage.	Graphs (2); UH CTAHR, Bishop Museum records, apple snail damage on taro corms which create open wounds (vectors for disease); long term observation in the field by taro farmers.
2. Taro flowers rarely, if ever, flower and therefore cross-contamination is not a threat.	All taro cultivars in Hawaii flower at least once a year and often simultaneously. They produce viable seed. Taro farmers observe this in their fields regularly. The Bishop Musuem records concur. IRETA (UNDP/FAO) promotes traditional hand-pollination in its taro breeding programs in the Pacific.	Taro flowers presented to HAW (2/18/09); Bishop Museum records; IRETA (J. Wilson 3/89)
3. Genetic engineering is the best technique for solving disease problems for taro in Hawaii.	GE taro researchers failed to evaluate less controversial, longer lasting solutions to taro problems, including improving soil conditions, increasing cultivar diversity, fallow time, and water availability. In fact, they have not done a single comparison. The EPA is currently investigating charges that the seed crop industry has prevented researchers from fully investigating both GE crop impacts and comparisons with non-GE plants. A 2,500 page report by the UN supports these findings and challenges the industry on economics, productivity, chemical use, speed, nutrition, health, disease and drought resistance.	February 20, 2009 NY TIMES Crop Scientists Say Biotechnology Seed Companies Are Thwarting Research; National Acadmeny of Sciences, UN/FAO
4. Taro farmers must have the GE taro in Hawaii as a back up, "just in case".	The GE Bunlong (Chinese) taro created in Hawaii will not help existing commercial wetland poi taro growers. Bunlong is *not* a poi taro. Internationally recognized germplasm facilities dedicated to the preservation of biodiversity conduct research using conventional breeding methods or GE, have higher research standards and adhere to the Cartegena Protocol (the precautionary principle). UH, HARC and PBARC do not. Even if research was allowed, response and federal permit time lags would be too late (see below)	WHO, FAO, UN, IINBR, Leuven University, Belgium in cooperation with Biodiversity International; Fiji University with FAO
5. Taro farmers who want GE taro as a backup, will plant it and be able to sell it to millers or consumers.	No taro farmer has said they will plant it in their fields, even those who want the research to continue. No miller will buy it and consumers will not buy it. Consumers in Hawaii demand GE foods be labeled so that they can choose.	Taro farmer, poi miller testimony; consumer survey UH CTAHR 2008

MYTH	FACT	Evidence
6. Recombinant DNA technology is merely an extension of traditional breeding and is necessary to analyse and genetically map Hawaiian taro cultivar varieties.	Recombinant DNA is a new technology that is "a form of synthetic DNA combining DNA sequences that would not normally occur together" While genetic mapping uses high tech equipment and processes found in the biotech industry; the techniques, the science, the practices nor the equipment are exclusive to the industry and are available as part of the science of microbiology and microecology where the protocols are also more rigorous and researcher ethics more clear.	J. Berg, J. Tymockzo,L Stryer. *Biochemistry*. San Francisco, W.H. Freeman ISBN 0-7167-8724-5
7. GMO DNA does not impact our foods or our health.	A recent study published by the National Academy of Sciences states that dietary DNA can find its way into the blood, opening up the possibility of GMO DNA transforming somatic cells. Bt toxin may also cause perforation of blood cells. [Gutierrez, D. 4/10/07]. Monsanto's GM corn MON863 approved for human consumption shows kidney, liver toxicity in animal studies as well as hormonal changes in rats in a study performed by researchers from the independent CIRGE (France). The science of the FDA, the agency responsible for protecting our health, has been serverly compromised by its own admittance. If ge research were safe, then universities wouldn't need to have strict IBC protocols to govern research in this field. Biotech research in Hawaii has been fined by EPA for careless and unpermitted field trials on several occassions in the last ten years.	NAS 2008, ICAR (P. M. Barghava; father of biotech in India); Com. for Independent Research and Genetic Engineering (France); FDA: Science and Mission at Risk, Nov 2007
8. Genetically engineered crops take less time to develop than conventional hybrids and produce more.	Conventional hybrids take few years to develop, as in the case of Samoan taro hybrids to counter leaf blight epidemics in the 1990s. They do not need permits from the FDA or EPA to move from the lab to the nursery, to field tests, to farms and tables. Exhaustive evidence and the industry's own admittance shows GE crop development lags far behind in speed. The physiology of plants is now reaching the limits of the productivity that could be achieved.	IAASTD; UK Dept for Environment, Food and Rural Affairs 2008; USDA; Lester Brown, Earth Policy Institute; S. Evans-Freke, Cibus chairman (BASF); Royal Society of Canada

MYTH	FACT	Evidence
9. GE "debris" does not spread to the surrounding environment	A 2007 study provides evidence that toxins from Bt corn travel long distances in streams and may harm stream insects that serve as food for fish. These results compound concerns about the ecological impacts of Bt corn raised by previous studies showing that corn-grown toxins harm beneficial insects living in the soil. This may have serious consequences for nearshore reefs in Hawaii. If crops are able to breed with wild relatives, the new genes will be spread to those wild plants. For example, sorghum can breed with the common weeds johnson grass and shattercane, and canola can breed with wild mustard plants. If the plant is Roundup-ready the weed will end up Roundup-ready.	NAS, NSF 2007 (J. Tank et al); Dr. P. Goldsbrough, Purdue University
10. GMO crops reduce chemcial use	Chemical use has declined on some crops but there is little or no change on others. Insect resistance to Bt toxin has already been demonstrated in the lab and observed in the field. Farmers must take other measures to slow down the development of resistance in insects, but it will eventually happen. Those who plant crops that are genetically engineered to resist the herbicide Roundup are now applying more of it to their fields. A study of over 8,000 university-based field trials suggested that farmers who plant Monsanto's engineered soy use 2.5 times more herbicide than non-GMO farmers who use integrated weed-control methods. Roundup Ready" (RR) seed and RoundUp, a chemical weed killer, is Monsanto's biggest money-maker and is sold together with the RR seed.	IAASTD; C. Benbrook, Pesticide Outlook (2001); Dr. P. Goldsbrough, Purdue University
11. GMO crops provide better economics for small farmers	IAASTD, FAO and WHO concluded it was unequal distribution of resources and environmental degradation, not crop productivity that are the most important factors in the current global food crisis, and concludes "small-scale farmers and ecological methods provide the way forward to avert the current food crisis and meet the needs of communities."	IAASTD; People, Land Management and Ecosystem Conservation program, UNEP (M. Pinedo-Vasquez 2009)

GMO TARO—A TARO FARMER'S PERSPECTIVE

Aloha, my name is Jim Cain, my family and I farm taro in Waipi'o Valley, island of Hawai'i. We also own and operate a family-run poi shop, King Laulau Brand Poi, where we process the taro we grow on our 6 acre farm, as well as taro we obtain from other farmers, providing poi for our Big Island community. I stand united with all the farmers of Waipi'o and strongly oppose the genetic modification of taro. My opposition to genetic engineering of taro is based on cultural, economic, and nutritional concerns.

The cultural concerns relating to the genetic manipulation of kalo cannot be overstated. Kalo's position as a high ranking family member in Hawaiian cosmology reflect deep rooted cultural values. These values, reinforced by kalo's role as a kinolau of Kane, show reverent respect for the natural world and kalo's ability to sustain and nourish people. These sacred family relationships can be traced back centuries to the very beginnings of Hawaiian culture, and every week when I deliver poi to my loyal customers, I am reminded of the importance of this ancestral food and its ability to nourish physically as well as spiritually. Genetic manipulation of Haloa shows utter disrespect for Hawaiian culture. In addition, recent attempts to patent and own taro hybrids derived from Hawaiian cultivars of taro are a cultural violation of these precious gifts that have been handed down to us generation to generation and are a direct link to our past.

Economically, genetic modification poses several risks to taro farmers and the poi industry. In recent years, there have been efforts to hybridize new varieties of taro in an attempt to produce disease resistance and increased yields. Cultivars of taro have been brought to Hawai'i from many places in the taro growing world to hybridize with Hawaiian varieties. After showing some initial promise, extensive testing by poi processors has shown that these hybrids produce inferior quality poi. Also, foreign cultivars of taro such as Palauan have been introduced into lo'i all around the state. While high-yielding, these varieties produce a low quality poi. Farmers have been left with no market for their crop, which takes over a year to produce, as poi millers universally reject these inferior taros. Subsequently, the availability of huli of the preferred Hawaiian varieties has been reduced. This has created both short-term and long-term economic hardships for taro farmers and poi processors and has contributed to the recent shortage of poi.

Of primary concern is the very real danger of contamination. A genetically engineered taro huli will look identical to the original Hawaiian variety from which it is derived. Once released into the lo'i, either controlled or by accident, recall will be impossible. Should problems arise, the effects of this contamination would be devastating to our industry. A history of contamination of other food crops world-wide by GE varieties has proven that containment, despite the reassurances of the bio-tech industry, is impossible.

Another economic concern of taro farmers is the issue of patenting of taro varieties. The traditional system of sharing huli between farmers is a proven way of ensuring the availability of planting material. The introduction of GE taro would seriously disrupt the ability of farmers to share huli and reduce the availability of suitable planting material.

Recent attempts by the University of Hawai'i to patent and sell huli to farmers is seen as an unacceptable precedent to make money off those who can least afford it. The bio-tech industry is not here for community service, but is predicated on the goal of controlling the incredibly profitable seed supply.

Nutritionally, poi has a world-wide reputation as a pure and healthy complex carbohydrate. There are no known allergies to poi, it is a food that can be assimilated by anyone. As a poi maker, I am honored to provide this nutritious food to babies whose parents use our poi as the first food to nourish their children, to elders who have been eating poi all their life, and to a wide range of people in between. Also, poi plays such an important role in celebrating families' life events such as baby lu'aus, graduations, weddings and funerals. A lu'au is not complete without poi on the table. Genetic engineering of taro consists of imposing genes from other plants such as rice and wheat into taro's DNA. The resulting changes could have untold effects on the hypo-allergenic qualities of taro and poi. When researchers are asked if they can guarantee the safety of their work, they honestly answer no. The dangers posed to the nutritional quality of this ancestral staff of life are completely unacceptable.

From my perspective as a Waipi'o taro farmer and poi processor, the disagreement over this issue is really a clash of values. University researchers value and are concerned about their perceived right to academic freedom. The bio-tech industry values and is concerned about their perceived right to unregulated free-market economics. Waipi'o, where I come from, is a very traditional Hawaiian valley. The still intact protocols and values that have been handed down are based on the value of Kuleana—rights that are based in the concept of responsibility. While moving forward, it is important to remember our connection to the past. That is why, in Waipi'o, the titles that garner the most respect are not Dr. or Professor, but begin with Auntie or Uncle or Tutu. It is important to note that the UH researcher responsible for the GE research on taro has never even been to Waipi'o Valley. Technology is seen as a tool not as a guiding principle. Science can be a wonderful tool for advancement, but science without a conscience, without the guidance of the precautionary principle, can wreak havoc. There must be a balance. In other words, Go easy. Be respectful.

In these troubled times of global warming, resource depletion, and world-wide unrest, the buzz word in Hawai'i has become sustainability. Reducing our dependence on off-island petro-chemical control, and becoming self-sufficient in food production are of huge concern. The proven methods of producing taro and poi can be seen as a model for the future of sustainable agriculture in Hawai'i. Producing taro with little or no outside resources, and providing food for our local population is a practice that has a track record that is centuries old in Hawai'i and stretches back many thousands of years in the history of mankind. It is vitally important that we support farmers who are feeding our local population.

The decline of taro production can be seen as a mirror duplicating the problems of self-sufficient food production in Hawai'i. The problems are rooted in availability of land and water and re-elevating the job of farmer to a viable occupation and way of life. Claims made by the bio-tech industry of impending devastating diseases are seen as scare tactics. Any good farmer knows that the key to crop health is soil fertility and it is in this direction we should be focusing our policies and research efforts. These are not new concepts, but lessons handed down to us from our kupuna. We just need to listen.

There is nothing wrong with our Hawaiian taros. They were developed over centuries by some of the most respected farmers the world has ever known. The sad decline in the number of varieties of taro that was grown by our ancestors has nothing to do with disease, but lies in the fact that, over the last century, people have moved off the land and instead of growing their food, are now buying all their food. In the interest of Hawai'i's long term security we need to reverse this practice.

Support for the passage of HB 1663 and SB709 that calls for a ban on the genetic engineering of taro in Hawai'i has swelled as people have become educated about this issue. The Hawaiian community, the taro farming community, and the poi eating community will continue to be passionately vocal in their efforts to protect Haloa. This will not go away because this is ohana. Precedence for the careful regulation of biotechnology has been established at every level of government world-wide, and it is important that the decision makers in Hawai'i educate themselves about the risks associated with this potentially dangerous technology.

In conclusion, I advise people that the best way to identify a taro farmer is to look at their feet. No can help, us taro farmers have ugly feet, it's an occupational hazard. So when someone claims to be speaking in the interest of the taro farmers, look at their feet. Look at who they represent. Please support our local farmers. Please malama Haloa.

Jim Cain, Waipi'o Valley
775-9001
kinglaulau@hotmail.com

Senate Bill: **SB 709 SD1** 2009 Regular Session
Title: Genetically Engineered Organisms; Taro
Committee on Hawaiian Affairs
Wednesday March 19, 9AM

Position: **Oppose**
Submitted By: Robert Paull
Honolulu, HI 96821

Testimony:

I have been a Professor at the University of Hawaii at Manoa for nearly thirty years in the area of crop production and plant sciences. This testimony is submitted as a private citizen and voter, and not as a representative of the University.

I have been involved in plant sciences and plant breeding for forty years and published in journals on the use of this technology.

In the last five years, the legislature has considered a number of Bills on genetic engineered crops. All these bills are designed to place restrictions on this technology and limit freedom of choice. The Bills are not science or risk-based but based upon the misuse and abuse of science, and belief that there must be a possible unknown risk. All the Bills heard by the Legislature refuse to compare risks amongst all plant breeding methods, this Bill is no exception.

There is a claim in this Bill that diseases can be controlled by using cold water and adjusting growing regime. If this is the case then why have not the diseases been controlled and therefore no longer a problem. This control method probably does not work for a new viral disease. Banning the use of genetic engineering limits the approaches available to solve present and potential future problems.

In addition, this Bill in the definitions excludes non-directed mutagenesis. Non-directed mutagenesis is done with high levels of irradiation and very toxic chemicals. The exclusion is not justified on scientific grounds as the National Research Council has concluded that this technology has a greater potential for unwanted changes than genetic engineering. It is not obvious how this exclusion requirement help human health or the environment or in this Bill the "cultural integrity of kalo".

The definitions in this Bill are so overly broad with no definition of "traditional methods of breeding, hybridization, or non-directed mutagenesis." Later in the Bill it talks about "controlled hand-pollination" suggesting this is the only method allowed. This means that all breeding methods including tissue culture developed in the last 100 years are banned to improve taro in Hawaii.

It is unclear which 'Bun-Long' (Chinese) taro is referred to in this Bills. In China, the general term "Bun-Long" is used to refer to a number of very distinct varieties of taro depending upon where it is being grown. Since different "Bun-Long" taro varieties have been brought to Hawaii in the last fifty years from South-East Asia, Taiwan and China are they covered by this ban.

This Bill goes to far beyond the spiritual and cultural significance of Taro to Hawaiians but aims to be a blanket research ban on ALL taro even varieties that are not traditional Hawaiian and any other varieties not yet in Hawaii. Research on non-Hawaiian Taro must be allowed to continue to meet potential future needs. The amended House Bill is preferred to this draconian Bill.

Testimony for HAW 3/18/09 9:00AM SB709SD2

Conference Room: 329
Testifier Position: Oppose
Testifier will be present: Yes
Submitted by: Rodney Haraguchi, President
Organization: Kaua`i Taro Growers Association (KTGA)
Address: P. O. Box 427, Hanalei, Hawaii 96714
Phone: (808)826-6202
E-mail: hvtaro@hawaiiantel.net
Submitted on: 3/17/09

Chair Mele Carroll, Vice Chair Maile Shimabukuro and committee members:

Mahalo for the opportunity to present our testimony to oppose this bill in its present form and request that it be amended to reflect HB1663HD1. We have been receiving calls from Hawai`i, Maui, Oahu and the mainland threatening to boycott our taro farm and two other millers, unless we support the SB 709. Even though we feel it's an invasion of our privacy and hurts the taro industry and ultimately the taro farmers, we feel even more strongly, that the 42 taro farms representing 396 acres oppose a ban on research of non-Hawaiian varieties of taro, must be heard.

The taro industry has been on a steady decline from 1948 when there was 14,000,000 pounds of taro, to 6,800,000 in 2000 and now 4,300,000 pounds that correlates with the decline in taro farms. This decline is the result of many facets and just remedying a few problems is not the answer. Taro farmers look at all avenues which includes continuing research on the non Hawaiian varieties.

Both organic and conventional taro farms suffer from a mild form of leaf blight that organic practices have not cured. And this leaf blight exists on dry land taro where cold water is not the issue. So how will taro survive when the severe form of leaf blight like the ones in Samoa and the Soloman Islands arrives in Hawai`i? Farmers in Hanalei are already working with CTAHR and HARC to eradicate the apple snails with nontoxic natural extracts which proved successful. They are also experimenting with compost, green manure, cover crops and organic fertilizers to transition to sustainable methods. And research is another option that should be available to find remedies and sometimes unexpected remedies. Taro farming is affected by many facets and farmers need to be open to the options available.

Kauai taro farmers provide 78% of the state supply of 4,300,000 pounds. Kauai farmers also have the highest yield per acre at 13,600 lb/acre and Oahu/Maui at 10,533 lb/acre and Big Island at 4,222 lb/acre. The following calculation is the amount of servings per week that the Kauai taro farmers supply the state.

4,300,000 X 78% = 3,354,000 lbs from Kauai
3,354,000 lb X 4 (servings per lb) = 13,416,000 servings
13,416,000 servings / 52 weeks = 258,000 servings per week

comprised of 50 farmers and increasing. There are considerations for the government to assist in funding for mechanization to increase production for the farmers. They also hold conferences and are looking at research to deal with the Samoan leaf blight and other diseases that may affect their industry. There's also taro from China that is supplying McDonald's taro pie and they probably would prefer to have Hawaiian taro for better marketing and public relations. .

In my perspective, every farmer, whether big or small, full time or part time, works hard and I respect them for continuing this way of life. In doing so, this is the farmers' satisfaction, having the consumers enjoy our product. **Statistics show the declining trend for taro farming in Hawaii and the taro farmers need help and are asking for help so that you will not say to us, "Why didn't you tell us?" And what will be the answer when the poi consumers ask, "Where's our poi, So let's support our Hawaii taro farmers so that there will be Hawaiian taro and poi in the future and not taro from Australia, China, Malaysia, Costa Rica, Puerto Rico and the largest exporter of taro at this time – Africa.**

Thomas T Shirai Jr
P O Box 601
Waialua, HI 96791
Emai: *Kawaihapai@hawaii.rr.com*

Hearing Notice
Wednesday, March 18, 2009 / State Capitol Conference Room 329

House Committee on Hawaiian Affairs (HAW)
Rep Mele Carroll, Chair/ Rep Maile Shimabukuro, Vice Chair

RE: Testimony of Strong Support for SB 709 SD2 (Relating to Agriculture)

Aloha Chair Carroll, Vice Chair Shimabukuro & Committee Members,

As a lifetime resident of *Mokule'ia,* I strongly support SB 709 SD2 because our *Po'e Kahiho* had propagation without chemical enhancement that didn't have an adverse effect on an *ahupua'a.*

My *Grandfather* and his *Kupuna* were *mahi'ai (farmers)* which included *Taro* cultivation and productivity:

The Hawaiian Planter – E S Craighill Handy (1940):
Kawaihapai. "..These terraces have evidently been lying fallow for some time, though several were being plowed for rice or taro in the summer of 1935. At the foot of the cliffs, watered by a stream the name of which was not learned, are several small terraces in which taro is grown by David Keaau (sic: David Keao)."

It's only within the last 3-5 years that *GMO (Genectically Modified Organism)* wetland *Taro (Kalo)* was being grown in *lo'i* encompassing about 1-2 acres here in *Mokule'ia.* The residue from the *lo'i* goes to the ocean. Additionally, there is a large *aquafier* beneath *Mokule'ia:*

Archeology of Oahu – Bulletin 104 by G McAllister (1933)
Site 196 . "In the valley near the mountain side of the Greenfield House was once evidently a large Hawaiian settlement... Water freshets have also obliterated many remains.."

The Hawaiian Planter – E S Craighill Handy (1940)
Mokule'ia. "There are two extensive old terrace areas in Mokuleia on the flatland near the sea. One is just below the Dillingham Ranch, watered by an underground flow.."

The Hawaiian Planter – E S Craighill Handy (1940)
Mokule'ia. "Kamakau, speaks of the "abundance of food grown in Makaleha, of the kihi and lapa varieties of taro, of sweet potatoes, awa, bananas…"

Verse 2 of *Kalena Kai* composed by *King Liholiho* during his 1820 visit to *Mokule'ia* was not intended to be interpreted as *GMO* crops productivity but genuine agricultural sustainability which included *Taro (Kalo)* productivity:

Kalena Kai – Chant composed by King Liholiho
'O ka ehu, ehu o ke kai – The sea spray
Ka moena pawehe o Mokule'ia – Geometric designs of the plains of Mokule'ia

If there is any amendments needs to be done regarding SB 709 HD2 then it should prohibit using *Hawaiian* varieties only even though it should be applicable to all *Taro* varieties here in *Hawaii.* *Mahalo* for the opportunity to provide testimony strongly supporting SB 709 SD2. *Malama Haloa.*

Thomas T Shirai Jr
Mokule'ia, Waialua

Rep. Maile Shimabukuro

From: Ming-Li Wang [mlwdjr@yahoo.com]
Sent: Tuesday, March 17, 2009 8:57 AM
To: HAWtestimony
Subject: oppose HB1663 HD2

Dear Senators,

I support research on genetic engineering of taro and oppose HB1663 HD2. If we don't continue to improve taro cultivars, we are setting the taro industry to be wiped out when new diseases come to Hawaii.

Ming-Li Wang
66-029 Mahaulul Lane
Haleiwa, HI 96712

Kawaihapai Ohana
c/o Thomas T Shirai Jr
P O Box 601
Waialua, HI 96791
Email: Kawaihapai@hawaii.rr.com

Senate Committee on Water, Land, Agriculture & Hawaiian Affairs (WTL)
Rep Mele Carroll (Chair) /Rep Maile Shimabukuro (Vice Chair)

Notice of Hearing
Wednesday, February 18, 2009
9:00AM / State Capitol Conference Room 229

RE: Testimony of Support for SB 709 SD2 (Relating to Agriculture)

Aloha Chair Caroll, Vice Chair Shimabukuro & Committee Members,

The *Kawaihapai Ohana* is a Recognized *Native Hawaiian Organization (NHO)* by the *Department of Interior (http://www.doi.gov)* and it's *kuleana* includes cultural and historical preservation applicable to *Kawaihapai Ahupua'a.* Some of the *Kupuna of Kawaihapai* were *Taro (Kalo) mahiai (farmers)* and were *Cultural Informants* for Bishop Museum who provided information about *Waialua Moku:*

The Hawaiian Planter by E. S. Craighill Handy (1940) – Page 85
"Kaaimoku Kekulu (sic: Kaaemoku Kakulu), native of the district says that the name of spring and the terrace section noted above is Kaaiea."
Kawaihapai. "There is a sizable area of terraces in the lowlands (now surrounded by sugar cane), watered by Kawaihapai Stream. These terraces have evidently been lying fallow for some time, though several were being plowed for rice or taro in the summer of 1935. At the foot of the cliffs, watered by a stream the name of which was not learned, are several small terraces in which taro is grown by David Keaau (sic: David Keao)."

The *Kawaihapai Ohana* supports SB 709 SD2 because our ancestors had a more traditional, effective and respectful way regarding this matter for many generations. Growing *GMO Taro,* has a direct affect upon an entire *Ahupua'a System* when the water from the *lo'I* goes in the *kahawai (stream), muliwai (head water)* and *kahakai (ocean)* affecting our seafood subsistence including all marine life. This has quietly and potentially affected *Mokule'ia* and the *Northwest Coastine* of *Waialua Moku.*

Verse 2 of the chant entitled *Kalena Kai (http://huapala.org/KAL/Kalena_Kai.html)* composed by *King Liholiho* in 1820 which describes the agricultural productivity of *Mokule'ia* was not meant to be interpreted as *Genetically Modified Crops:*

Kalena Kai by King Liholiho (1820) – Verse 2
'O ka ehu' ehu o ke kai – The sea spray
Ka moena pawehe o Mokule'ia – Geometric designs of the plains of Mokule'ia

Thank you for the opportunity to provide testimony supporting SB 709 SD2. *Malama Haloa.*
Thomas T Shirai Jr
Kawaihapai Ohana – Po'o

Rep. Maile Shimabukuro

From: mailinglist@capitol.hawaii.gov
Sent: Saturday, March 14, 2009 4:48 AM
To: HAWtestimony
Cc: happyjumpingfrog@hotmail.com
Subject: Testimony for SB709 on 3/18/2009 9:00:00 AM

Testimony for HAW 3/18/2009 9:00:00 AM SB709

Conference room: 329
Testifier position: support
Testifier will be present: No
Submitted by: Rose Zeitler
Organization: Individual
Address: 883 Buena Vista Drive   Watsonville
Phone: 8312954352
E-mail: happyjumpingfrog@hotmail.com
Submitted on: 3/14/2009

Comments:
I support the ban on genetically engineered taro, and also support ALL other genetically engineered products. Genetically engineered taro is not neccessary, is not safe or regulated as intensely as it should be. GE crops can cross pollinate with local plants and destroy the biodiversity of local flora and fauna. GE crops are not regulated and monitored as closely as they should be and I do not support their existence on Maui. I support the GE Ban. -Rose Zeitler, born and raised on Maui, currently away at College in CA

Nicole Holler
March 15, 2009
Organization: individual
Stand: In support
To: The committee on Hawaiian affairs

My name is Nicole Holler. I am a student at the University of Hawaii in the school of social work. I am testifying in support of bill SB 709.

I feel that we should prohibit the development, testing, propagation, release, importation, planting, or growing of genetically engineered taro in the State of Hawaii. We shouldn't mess with nature. It will also hurt our local farmers who are growing organic taro that is better for human consumption.

I urge you to please support this bill. Thank you for allowing me to testify on this bill.

Rep. Maile Shimabukuro

From: mailinglist@capitol.hawaii.gov
Sent: Tuesday, March 17, 2009 11:26 AM
To: HAWtestimony
Cc: lesyeehoy@yahoo.com
Subject: Testimony for SB709 on 3/18/2009 9:00:00 AM

Testimony for HAW 3/18/2009 9:00:00 AM SB709

Conference room: 329
Testifier position: support
Testifier will be present: Yes
Submitted by: Leslie A. Yee Hoy
Organization: Individual
Address:
Phone:
E-mail: lesyeehoy@yahoo.com
Submitted on: 3/17/2009

Comments:
Aloha
My name is Les Yee Hoy and I farm taro in Halawa Valley, Molokai. I'm testifying in strong support of SB709 not only as a taro farmer but as a farmer and also a concerned citizen.
How can anyone be so naive not to see the true motives of these biotech giants? What makes people think that they're going to stop after genetically engineering taro. The excuses they give to GE taro applies to everthing else that we eat. They will own the entire food supply.
You patent it, you own it.
Farmers unite. It's only a matter of time before you'll be here testifying to prevent these companies from genetically engineering(and owning) some crop that won't be yours after their done.
Respectfully
L. Yee Hoy

Rep. Maile Shimabukuro

From: DILL JR, GERALD M [AG/2111] [gerald.m.dill.jr@monsanto.com]
Sent: Tuesday, March 17, 2009 10:36 AM
To: HAWtestimony
Subject: Opposition to SB 709 SD 2 and support of HB 1663 HD 2

Representative Carroll,

I would like to voice my opposition to SD709SD 2. Banning research on any crop is a bad decision indeed. I respect the place that Taro holds to Hawaiian people and its culture and support the grower's free choice to select and grow organic varieties of all crops. However, legislation that stops research will stop development of tools and solutions to future problems that may arise from disease and pest pressure. Biotechnology is responsible for some of the most impactful plant diagnostic tools ever developed. The adoption of the tools and advances developed in this industry should be used to help improve genetics and crop performance in all crops. President Obama has raised the restrictions on stem cell research to advance science in the medical field that will impact the availability of cures for important diseases. Similarly, genetic research in Taro will impact that industry in the future in the tools and knowledge accumulated in the laboratory and greenhouse.

I ask that the Committee on Hawaiian Affairs oppose SB 709SD 2 and support the constructive alternative HB 1663 HD 2 this Wednesday, March 17, 2009.

Sincerely,

Gerry Dill
Kapolei, HI

Testimony
In Support of Ban on GMO-Taro

Aloha mai kakou

I join communities across Hawaii in rejecting the genetic modification of -ALL- taro varieties, by supporting a ban on all GMO-taro. I am deeply concerned about the unknown health risks, irreversible threats to native ecosystems, cultural disrespect, patenting and bioprospecting of Hawaii's natural resources and potential harms to our local farming economy that are associated with GMO-taro.

-Taro Deserves the Best Available Science-
GMO-taro is claimed to potentially reduce one type of taro disease in one variety of taro by creating irreversible, unnatural genetic mutations whose safety to consumers and the environment is not scientifically proven. GMO-taro has no proven benefits to taro farmers or consumers and is not the best available science needed to safely perpetuate taro farming and protect consumers in Hawaii. Better and safer options exist. Long-term scientific studies and farming practices throughout the Pacific have resulted in proven scientific techniques to expand the local taro industry, protect unique Hawaiian taro varieties, farmlands and watersheds-- without GMOs. These community-accepted practices include: organically improving soil health, establishing appropriate water-flow standards to prevent disease and pests, stopping imports of diseased taro and pests into Hawaii, and growing many traditional varieties of natural taro with different natural disease resistance. Being that safer science exists, there is no need or demand for experimental GMO-taro from local taro farmers or consumers.

-Health and Environmental Safety Concerns about GMO-Taro-
Taro is a nutritious food crop, especially cherished as a baby food and staple dish in Hawaii for centuries; and around the world as an important medicinal food for diabetes, cancer, autism and serious food allergies. Taro is the worlds only hypo-allergenic, or allergy-free, carbohydrate. GMO-taro, on the other hand, is not the same as natural taro. GMO-taro has never been in the human food supply before, and has NOT been scientifically tested on humans to prove that it is safe to eat. Moreover, the unnatural genetic mutations of GMO-taro can never be guaranteed to be hypo-allergenic, thus threatening consumers of this uniquely important medicinal food source. In fact, numerous scientific studies on laboratory animals show that GMOs can cause toxic, allergic, and even deadly reactions. Unnatural gene mutations introduced through GMO-taro may harm insects, birds, fish, and soil health. Risks and damages to Hawaii's people and lands could be irreversible.

-Community and Ethical Concerns about GMO-Taro-
Cultivated throughout centuries to be abundantly grown on Hawaii's diverse agricultural lands, taro is the sacred foundation of our unique local agriculture, society, traditions and family structure. Genetic modification of taro is an affront to the sacred Hawaiian tradition that respects the taro plant as a family member, an older brother to humanity. This family tradition is rooted in honoring the relationship of mankind with the very plants we depend on for healthy nourishment, and establishes an unique genealogical connection between taro and the Hawaiian people. The wisdom of such healthy community values must be encouraged, not disrespected or desecrated. Despite the unique

and utmost importance of this plant to our community, GMO-taro has been developed without any informed community consent, raising serious ethical science concerns. Businesses and researchers in Hawaii should encourage informed community consent and review, not avoid oversight and involvement from the very communities most effected by their activities.

-Economic and Bioprospecting Concerns about GMO-Taro-
The right to grow taro naturally and traditionally belongs to the public, and should never be owned by a corporation or university. Private patents and control of our public food resources would cripple our food security, taro economy and violate our inherent public rights. GMO-taro experiments and patents cannot help taro farmers with the real problems that they face and will only endanger the valuable traditional biodiversity of taro in Hawaii.

-Legal and Governance Concerns about Preemption Legislation-
In "exchange" for a ban on GMO-taro, the biotech/GMO industry may attempt to turn our community's intentions to protect taro into unfair "preemption" legislation which would prohibit state or county oversight, and public notice of all other GMOs and biotech activities in Hawaii. We do not support any such attempts to preempt legitimate local government regulations to protect public health. Preempting local efforts to protect public health raises serious legal, ethical, and scientific concerns-- our public and environmental safety, as well as our local-governance authority, must be prioritized over private investment concerns and high-risk experiments.

-Help Taro, Don't Hurt Taro!-
Agricultural science has proven that the taro will be as healthy as the land in which it is grown and the care with which it is shown. There is no actual need to permanently change the taro plant's natural genetic structure nor patent the plant for private profit in order to protect the local taro industry. Rather, farmers, scientists and decision makers must work to solve the broad resource management problems that face taro farming. Lack of meaningful support to address the drastically increasing challenges from invasive diseases, pests, excessive and illegal diversions of water, and operating costs, has led to a decrease in taro farming and a taro shortage in Hawaii. With appropriate political, scientific and community support, taro will once again be a primary resource for Hawaii's food security, contributing significantly to a healthy local diet and economy. GMO-taro and patents, however, could destroy the safety and sanctity of natural taro as an important allergy-free food, cultural resource and local agricultural industry in Hawaii.

As a strong supporter of taro farming in Hawaii, I ask you to protect the security of the health of natural taro and the local taro industry by establishing a ban on GMO-taro.

Malama Aina,

Barbara Best
280 Hauoli
Wailuku, HI 96793

Testimony
In Support of Ban on GMO-Taro

Aloha mai kakou

I join communities across Hawaii in rejecting the genetic modification of -ALL- taro varieties, by supporting a ban on all GMO-taro. I am deeply concerned about the unknown health risks, irreversible threats to native ecosystems, cultural disrespect, patenting and bioprospecting of Hawaii's natural resources and potential harms to our local farming economy that are associated with GMO-taro.

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As a strong supporter of taro farming in Hawaii, I ask you to protect the security of the health of natural taro and the local taro industry by establishing a ban on GMO-taro.

Malama Aina,

Will Ware
65 Cadillac Sqr.
Detroit, MI 48226

Testimony
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As a strong supporter of taro farming in Hawaii, I ask you to protect the security of the health of natural taro and the local taro industry by establishing a ban on GMO-taro.

Malama Aina,

Janelle Williams
179 Liko Lehua St.
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Personal Testimony Presented Before the

Senate Committee on Hawaiian Affairs

March 18, 2009 at 9:00 a.m.

by

Andrew G. Hashimoto

SB 709, SD 2 - RELATING TO AGRICULTURE

Chairperson Carroll, Vice Chair Shimabukuro, and Members of the Committee:

My name is Andrew Hashimoto, and I serve as Dean and Director of the College of Tropical Agriculture and Human Resources (CTAHR) at the University of Hawaii at Manoa. I am pleased to provide personal testimony on SB 709, SD 2. This testimony does not represent the position of the University of Hawaii or CTAHR.

The purpose of Senate Bill 709, SD2 is to establish a ban on developing, testing, propagating, releasing, importing, planting, or growing genetically modified taro in the State of Hawaii.

I am strongly opposed to SB 709, SD2. As written, the measure is too restrictive. It proposes a broad-scale ban not only Hawaiian taro but now includes a ban on <u>all</u> transgentic taro research in the State.

Out of respect for the cultural significance of Hawaiian taro, CTAHR agreed not to conduct any transgenic research on Hawaiian taro. We have honored that agreement and will continue to do so.

There are other places in the Pacific Basin, however, that are concerned with the effects disease and other threats on taro. We would like to continue to provide aid and research on these non-Hawaiian taro varieties. To be prevented from conducting any research on taro would be a great disserve to our clients and to our obligations as a land grant university, and may eventually affect the future availability of taro.

I recommend that the bill be replaced in its entirety with House 1663, SD2 which allows non-Hawaiian taro research to be conducted within the state, but bans field testing of non-Hawaiian taro in Hawaii, as an alternative to a prohibition of all activities involving genetically engineered taro, which SB 709, SD2 proposes.

Thank you for the opportunity to testify on this bill.

Rep. Maile Shimabukuro

From: mailinglist@capitol.hawaii.gov
Sent: Tuesday, March 17, 2009 9:19 AM
To: HAWtestimony
Cc: chicoine@hawaiian.net
Subject: Testimony for SB709 on 3/18/2009 9:00:00 AM

Testimony for HAW 3/18/2009 9:00:00 AM SB709

Conference room: 329
Testifier position: oppose
Testifier will be present: No
Submitted by: Kenny Chicoine
Organization: Individual
Address: PO Box 804 9670 Gay Rd Waimea, HI
Phone: 808-338-1833
E-mail: chicoine@hawaiian.net
Submitted on: 3/17/2009

Comments:
Overwhelming scientific data exists that proves over and over that biotechnology is highly benificial to the farmer, increases yield, reduces input cost, and is starting to be shown to increase food safety.

The Taro industry in HI has been on a steady decline for decades and current trends show no reason why this will change. Growing Taro is very difficult and disease and insect problems are likely to cause it decline further or become insignificant. New genetic modifications hold the most promise for the industry to survive and prosper.

Current Taro growers command a very high price and aren't likely to welcome improved varieties and the price competition it will bring to their business. The local consumer however, has much to gain in regards to consistant and affordable supply of this local staple

From: CLEGG, DAN [AG/2563] [dan.clegg@monsanto.com]
Sent: Tuesday, March 17, 2009 7:23 AM
To: HAWtestimony
Subject: SB709SD1

COMMITTEE ON HAWAIIAN AFFAIRS

Rep. Mele Carroll, Chair
Rep. Maile Shimabukuro, Vice Chair

Date: Wednesday, March 18
Time: 9 a.m.
Room: 329

SB 709 SD 1

Please oppose this bill and approve the modified bill that would allow NON-Hawaiian Taro work.

Thanks.

Dan Clegg

Monsanto Hawaii

Land and Resources Manager

PO Box 629

Kihei, Hi 96753

808-283-4028 cell

Supporters of SB709SD2
Hearing before House Committee on Hawaiian Affairs, March. 18, 2009, 9:00am Rm 329

First Name	Last Name	Town	State	Zipcode
Ephrosine	Daniggelis	Honolulu	HI	96839
Ann	Egleston	Honolulu	HI	96839
Markus	Faigle	Honolulu	HI	96839
Graceson	Ghen	Honolulu	HI	96839
Kapa	Oliveira	Honolulu	HI	96839
Rosemary	Cuccia	Honolulu	HI	96830
Mark Alapaki	Luke	Honolulu	HI	96828
Michele	McKay	Honolulu	HI	96828
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Noel	Barrett-Tau	Honolulu	HI	96826
Scott	Bullock	Honolulu	HI	96826
Saw	Ching	Honolulu	HI	96826
Garid	Faria	Honolulu	HI	96826
suzanne	garrett	honolulu	HI	96826
elizabeth	kane	honolulu	HI	96826
Kealii	Makekau	Honolulu	HI	96826
Carol	Murry	Honolulu	HI	96826
Naoko	Nelson	Honolulu	HI	96826
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Gordon	walker	honolulu	HI	96826
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Vickie	Innis	Honolulu	HI	96825
Dwynn	Kamai	Honolulu	HI	96825
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Carol	Viquelia	Honolulu	HI	96825
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Dayle	Bethel	Honolulu	HI	96822
Diana	Bethel	Honolulu	HI	96822
Alana	Bryant	Honolulu	HI	96822
carla	buscaglia	Honolulu	HI	96822
Lisa	Cripe	Honolulu	HI	96822
Simone	Derow-Ostapowicz	Honolulu	HI	96822
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Alison	Hartle	Honolulu	HI	96822
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David	Strauch	Honolulu	HI	96822
Christine	Walters	Honolulu	HI	96822
Liza	Williams	Honolulu	HI	96822
mary	Manley	honolulu	HI	96821
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Aida	San Miguel	Honolulu	HI	96819
Teri	Skillman-Kashyap	HONOLULU	HI	96819
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Haunani	Francisco	Honolulu	HI	96818
Kuuleilani	Reyes	Honolulu	HI	96818
shanelle	Solomon	Honolulu	HI	96818
Kimo	?	honolulu	HI	96817
Cathie	alana	honiolulu	HI	96817
Cristian	Ellauri	honolulu	HI	96817
Heidi	Ho	Honolulu	HI	96817
Kamaka	Jingao	Honolulu	HI	96817
kehaulani	kea	honolulu	HI	96817
Brenda	Kwon	Honolulu	ID	96817
miwa	tamanaha	999	HI	96817
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Zahava	Czara	Honolulu	HI	96816
Chris	Derauf	Honolulu	HI	96816
joel	fischer	honolulu	HI	96816
Barb	Forsyth	Honolulu	HI	96816
vanesa	furnari	honolulu	HI	96816
Rino	Geremen	honolulu	HI	96816
Moses	Goods	Honolulu	HI	96816
Kalani	Kalima	Honolulu	HI	96816
Johnette	Kaluna	Honolulu	HI	96816
Pualani	Kauila	Honolulu	HI	96816
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Sharlynn	Paet	Honolulu	HI	96816
Benton KealiÃ«i	Pang	Honolulu	HI	96816
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Cha	Smith	Honolulu	HI	96816
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Ruth	Uemura	Honolulu	HI	96816
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Marie	Brown	Honolulu	HI	96815
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pablo	yurkievich	honolulu	HI	96814
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Malia	Acohido	Honolulu	HI	96813
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Jaime	Ferreira	honolulu	HI	96813
Juanita	Kawamoto	Honolulu	HI	96813
Edward	Kenney	Honolulu	HI	96813
nainoa	Kuna	Honolulu	HI	96813
Clayton	Lee	Honolulu	HI	96813
Joan	Matsukawa	Honolulu	HI	96813
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Laura	Quintal	Honolulu	HI	96813
Danae	Souza	Honolulu	HI	96813
Diane	Texidor	Honolulu	HI	96813
Monica	Waiau	Honolulu	HI	96813
Brett	Waipa	Honolulu	HI	96813
PALANI	VAUGHAN	HONOLULU	HI	96806
Shawn	White	Honolulu	HI	96804
Janelle	Akiona	Waipahu	HI	96797
Karen	Awong	Waipahu	HI	96797
Leilani	Benson	Waipahu	HI	96797

Mimi	Forsyth	Waipahu	HI	96797
Felicia	Waialae	Waipahu	HI	96797
clayton	falvey	waimea	HI	96796
Lisette	Langlois	Waimea	HI	96796
Kane	Turalde	Waimea	HI	96796
Meghan	Au	Waimanalo	HI	96795
Mary	Baker	Waimanalo	HI	96795
Anela	Gueco	Waimanalo	HI	96795
Karen	Holman	Waimanalo	HI	96795
Dorothea	Kahiapo	Waimanalo	HI	96795
Laurie	Kahiapo	Waimanalo	HI	96795
CHRISTINE	Kauahikaua	WAIMANALO	HI	96795
Jackie	Remington	Waimanalo	HI	96795
Curt	Sumida	Waimanalo	HI	96795
Virginia	Walden	Waimanalo	HI	96795
Alyson	Barrows,	Wailuku	HI	96793
Barbara	Best	Wailuku	HI	96793
marti	buckner	wailuku	HI	96793
Christina	Chang	Wailuku	HI	96793
Kyle	Elizares	Wailuku	HI	96793
Michelle	Hillen	Wailuku	HI	96793
Sunnie	Hueu	Wailuku	HI	96793
Rebecca	Kiili	Wailuku	HI	96793
vincent	mina	Wailuku Maui	HI	96793
Victor	Pellegrino	Waikapu	HI	96793
Maureen	Reggie	Wailuku	HI	96793
Daphne O.	Sing	Wailuku	HI	96793
paul	strauss	Wailuku	HI	96793
Daniel	Tanaka	Wailuku	HI	96793
Chris	Taylor	Wailuku	HI	96793
Faith	Tengan	Wailuku	HI	96793
Gary	Wiseman	Wailuku	HI	96793
Bill	Akiona	Waianae	HI	96792
Lidia	Alfapada	Waianae	HI	96792
Sheldon	Brown	Wailuku	HI	96792
James	Clarke	Waianae	HI	96792
Chantel	Clarke	Waianae	HI	96792
Eva Kapelaonaalii	Collins	Wai?anae	HI	96792
Vince	Dodge	Wai`anae	HI	96792
Britany	Edwards	Wai'anae	HI	96792
Florence	Eli-Adam	Waianae	HI	96792
arlen	guieb	waianae	HI	96792
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Samuel	Kapoi	Waianae	HI	96792
Kapua	Keliikoa-Kamai	Waianae	HI	96792
P	Ling	Waianae	HI	96792
P	Ling	Waianae	HI	96792
TammyLeigh	Mahuka	Waianae	HI	96792
Joseph	Peters-Holokahi	waianae	HI	96792
Ileana (Haunani)	Ruelas	Waianae	HI	96792
chaunnel	salmon	Waianae	HI	96792

Shane	Silva	Waianae	HI	96792
kimo	stowell	Honolulu	HI	96792
Natashja	Tong	Waianae	HI	96792
Alexander	Uesugi	waianae	HI	96792
ANN	Walenta	WAIANAE	HI	96792
Scott	Foster	Waialua	HI	96791
Nina	Puhipau	Waialua	HI	96791
Barbara	Bogorad	Kula	HI	96790
Anastasia	Gilliam	Kula	HI	96790
Hilary	Harts	Kula	HI	96790
Bentley	Kalaway	Kula	HI	96790
Lisa	Raymond	Kula	HI	96790
Faith	Rose	Kula	HI	96790
julie	signore	kula	HI	96790
stephen	skogman	kula	HI	96790
Annjulie	Vai	Kula	HI	96790
melody	Zeitler	kula	HI	96790
Chana	Dudoit	Mililani	HI	96789
silva	ricky	mililani	HI	96789
Christine	Putzulu	Wahiawa	HI	96786
Mahealani	Carvalho	Volcano	HI	96785
Robert	Frutos	Volcano	HI	96785
Cynthia	Gillette-Wenner	Volcano	HI	96785
bill	lewis	Volcano	HI	96785
katharine	madjid	volcano	HI	96785
kamuela	Moraes	volcano	HI	96785
Dita	Ramler	Volcano	HI	96785
David	Johnston	Puuhene	HI	96784
Raphiell	Nolin	Puunene	HI	96784
Renate	Schaff	Pu'unene	HI	96784
Haley Ann	Bufil	Pepeekeo	HI	96783
Camillia	Elayyan	Pepeekeo	HI	96783
Anika	Borden	Pearl City	HI	96782
Summer	Faria	Pearl City	HI	96782
pono	kealoha	Pearlcity	HI	96782
Pono	Kealoha	Pearlcity	HI	96782
john	maple	Papaikou	HI	96781
kctherine	Ross	Papaikou	HI	96781
Harvest	Edmonds	Papa'aloa	HI	96780
hannah	bernard	paia	HI	96779
Miranda	Camp	Paia	HI	96779
Tia	Christensen	Paia	HI	96779
June	Davis	Paia	HI	96779
gabriel	donihi	paia	HI	96779
Eliza	Goodhue	Paia	HI	96779
Marie-Eve	Hobeika	paia	HI	96779
Arnold	Kotler	Paia	HI	96779
Bobbi	Lempert	Paia	HI	96779
Airielle	Pearson	Paia	HI	96779
JASON	SCHWARTZ	PAIA	HI	96779
Kim	Young	Paia	HI	96779

I	AM	Pahoa	HI	96778
aaron	ANDERSON	pahoa hi,	HI	96778
Satya	Anubhuti	Pahoa	HI	96778
Theodore	Banta	Pahoa	HI	96778
John	Begg	Pahoa	HI	96778
Clive	Cheetham	Pahoa	HI	96778
Janet	Codispoti	Pahoa	HI	96778
Chris	Costa	Pahoa	HI	96778
Luella	Crutcher	Pahoa	HI	96778
DALE	DAY	PAHOA	HI	96778
normand	dufresne	pahoa	HI	96778
Donna	Fischer	Pahoa	HI	96778
Paulette	Grube	Pahoa	HI	96778
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Ann	Kobsa	Pahoa	HI	96778
Diane	Koerner	Pahoa	HI	96778
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Justin	Wagner	Pahoa	HI	96778
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Jason	Winnett	Kalapana	HI	96778
liza	franzoni	paauilo	HI	96776
barton	susan	O'okala	HI	96774
james	patitucci	naalehu	HI	96772
Richard	Powers	Naalehu	HI	96772
Leilani	Resureccion	Naalehu	HI	96772
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darlene	toth	maunaloa	HI	96770
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Barnaby	Benton	Makawao	HI	96768
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Chasity	Cadaoas	Pukalani	HI	96768
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Teri	Holter	Makawao	HI	96768
Momi	Kaikala	Pukalani	HI	96768
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randy	keller	Makawao	HI	96768
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patricia	westbrook	Makawao	HI	96768
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Nameaaea	Hoshino	Lahaina	HI	96767
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elaine	durban	puhi	HI	96766
danitza	galvan	lihue	HI	96766
Donald	Heacock	Lihue	HI	96766
Miki	kaipaka	Lihue	HI	96766
Walter	Maza	Puhi	HI	96766
Richard	Miller	Lihue	HI	96766
Dick	Miller	Lihue	HI	96766
Michaella	Mintcheff	Lihue	HI	96766
Nina	Monasevitch	Lihue	HI	96766
U'ilani	Nakagawa	lihue	HI	96766
Lei ?Ilima	Rapozo	L?hu`e	HI	96766
Healani	Trembath	Lihue, Kauai	HI	96766
Lynlie	Waiamau	Lihue	HI	96766
Jonah	Jensen	Lawai	HI	96765
Eleanor	Snyder	Lawai	HI	96765
ronna	mceldowney	laupahoehoe	HI	96764
robert	mceldowney	laupahoehoe	HI	96764
Ronna	McEldowney	Laupahoehoe	HI	96764
Randy	Bartlett	Lahaina	HI	96761
wayne	cochran	lahaina	HI	96761
ELLE	COCHRAN	laHAINA	HI	96761
Kathy	Corcoran	Lahaina	HI	96761
Deborah	DiPiero	Lahaina	HI	96761
Judith	Epstein	Lahaina	HI	96761
Lori	Fernandez	Lahaina	HI	96761
Sophie	Foulkes-Taylor	Lahaina	HI	96761
Stuart	Kahan	Lahaina	HI	96761
Vicki	McCarty	Lahaina	HI	96761
Jane	Saeger	Lahaina	HI	96761
Jim	Albertini	Kurtistown	HI	96760
Diana	Miller	Kurtistown	HI	96760
Kristie	Nakasato	Kurtistown	HI	96760
s	sayles	kurtistown	HI	96760
Deanna	Summers	Haiku	HI	96760
Lori	Buchanan	Kualapuu	HI	96757

Tommy	Cook	Koloa	HI	96756
anita	cook	koloa	HI	96756
Jeri	Di Pietro	Koloa	HI	96756
Friends of	GMO Free Kaua`i	Koloa	HI	96756
Haunani	Kaiminaauao	Koloa	HI	96756
Tony	Kilbert	Koloa	HI	96756
Ken	Posney	Koloa	HI	96756
Lynne	Torres	Koloa	HI	96756
william	cote	kapaau	HI	96755
Pamela	Day	Kapaau	HI	96755
leia	lawrence	kapaau	HI	96755
Dana	Moss	Kapaau	HI	96755
JIM	PEDERSEN	KAPAAU	HI	96755
Beryl	Blaich	Kilauea	HI	96754
Aimee	Brown	Kilauea	HI	96754
Blake	Drolson	Kilauea	HI	96754
Val	Hertzon	Kilauea	HI	96754
Mary Hunter	Leach	Kilauea	HI	96754
Jorgen	Lien	Kilauea	HI	96754
sue	lindequist	kilauea	HI	96754
Maria	Maitino	Kilauea	HI	96754
Lila	Mortell	Kilauea	HI	96754
Caitlin	Ross Odom	Kilauea	HI	96754
Kelly	Sato	Kilauea	HI	96754
Monika	Seiz	Kilauea	HI	96754
Michal	Stover	Kilauea	HI	96754
Bridget	Tampus	Kilauea	HI	96754
robin	Torquati	Kilauea	HI	96754
steven	valiere	Kilauea , Kaua`	HI	96754
Wandalea	Walker	Kilauea	HI	96754
Lee	Altenberg	Kihei	HI	96753
Andrea	Baer	Kihei	HI	96753
Marguerite	Beavers	Kihei	HI	96753
MARGO	Cruse	kihei	HI	96753
Susan	Douglas	KIHEI	HI	96753
zach	franks	kihei	HI	96753
Cynthia Unmani	Groves, Groves,Healt	Kihei	HI	96753
naima	hills	kihei	HI	96753
Judy	Jarvie	Kihei	HI	96753
Bettina	Jones	Kihei	HI	96753
Skye	Loe	Kihe'i	HI	96753
Mayumi	Marks	Kihei	HI	96753
Alison	Miller	Kihei	HI	96753
lisa	modika	kihei	HI	96753
pamela	Palencia	Kihei	HI	96753
Frances	Pitzer	Kihei	HI	96753
kelly	prince	kihei	HI	96753
Elaine	Starrett	Kihei	HI	96753
Claire	Stucklen	Kihei	HI	96753
Susan	Walsh	Kihei	HI	96753
Donna	Werner	Kihei	HI	96753

anita	wintner	kihei	HI	96753
mark	young	kihei	HI	96753
Barbara	Childers	Kekaha	HI	96752
CC	Peyton	Kekaha	HI	96752
Susan L.	Gierman	Kealakekua	HI	96750
Nancy	Redfeather	kealakekua	HI	96750
Bobbie	Alicen	Kea'au	HI	96749
Diamond	Keahi	Keaau	HI	96749
Guadalupe	Ojeda	Keaau	HI	96749
Tutabelle	Ojeda	Keaau	HI	96749
Keith	Okimoto	Keaau	HI	96749
Ellen	Okuma	KeaÃ-au	HI	96749
Anthony	Olayon	Kea'au	HI	96749
Elin	Sand	Kea'au	HI	96749
John	Schinnerer	Kea'au	HI	96749
esther	szegedy	Kea'au	HI	96749
wainani	texeira	keaau	HI	96749
Ingrid	Tillman	KeaÃ-au	HI	96749
Makanamaikalani	Tomono	Kea'au	HI	96749
Valerie	Tweiten	Keaau	HI	96749
Vicki	Vierra	Keaau	HI	96749
Leimomi	Wheeler	Keaau	HI	96749
Catherine	Aki	Kauanakakai	HI	96748
Malia	Akutagawa	Kaunakakai	HI	96748
Ella	Alcon	Kaunakakai	HI	96748
Kevin	Brown	Kaunakakai	HI	96748
Kawika	Estrella	Kaunakakai	HI	96748
phil	kay	Kaunakakai	HI	96748
Napua	Leong	kaunakakai	HI	96748
Nancy	McPherson	Kaunakakai	HI	96748
Bridget	Mowat	Kaunakakai	HI	96748
Sharon	Naehu	Kaunakakai	HI	96748
Shirlee	Newman	Kaunakakai	HI	96748
Pohakamalamalam	Palmer	Kaunakakai	HI	96748
Penny	Rawlins-Martin	Kaunakakai	HI	96748
walter	ritte	kaunakakai	HI	96748
Jamie	Ronzello	kaunakakai	HI	96748
Gandharva Mahina	Ross	Kaunakakai	HI	96748
Ann	Van Eps	Kaunakakai	HI	96748
Faye	Wallace	Kaunakakai	HI	96748
Harmonee	Williams	Kaunakakai	HI	96748
Matt	Yamashita	Kaunakakai	HI	96748
Tiffany	Anderson	Kapaa	HI	96746
christine	bandsma	kapaa	HI	96746
Karena	Biber	Kapa'a	HI	96746
Kaeo	Bradford	Kapaa	HI	96746
Carrie	Brennan	Kapaa	HI	96746
Laura	Espaillat	Kapaa	HI	96746
Limor	Farber	kapaa	HI	96746
Margery	Freeman	KapaÃ-a	HI	96746
Lester	Gale	Kapa'a	HI	96746

Rosemarie	Grassa	Kapa'a	HI	96746
Sandra	Herndon	Kapaa	HI	96746
Fern	Holland	Kapa'a, Kauai	HI	96746
Jennifer	Ire	Kapa'a	HI	96746
lisa	jobson	kapaa	HI	96746
Teresa	Johnston	kapaa	HI	96746
Joan	Levy	Kapaa	HI	96746
tracy	lyman	kapaa	HI	96746
David Makana	MARTIN	Kapaa	HI	96746
Paul	Massey	Kapaa	HI	96746
Kaitlyn	McKee	Kapaa	HI	96746
Beverly	Montel	Kapa'a	HI	96746
Jessica	Murray	Kapaa	HI	96746
ashley	osler	Kappa -	HI	96746
Puanani	Rogers	Kapaa	HI	96746
Annlia	Russell	kapaa	HI	96746
Megan	Saari	Kapaa	HI	96746
Marissa Leimakan	Sperry	Kapaa	HI	96746
Ken	Taylor	Kapaa	HI	96746
james	trujilloq	Kapaa	HI	96746
Karen	Alvarado	Kailua Kona	HI	96745
Marjorie	Erway	Kailua-Kona	HI	96745
Adele	Henkel	Kailua Kona	HI	96745
Lydia	Hooser	Kailua-Kona	HI	96745
Lei	Kihoi	Kailua-Kona	HI	96745
kathryn	reynolds	Kailua Kona	HI	96745
Melinda	Ahn	Kaneohe	HI	96744
Kuuleianuhea	Awo-Chun	Kaneohe	HI	96744
Bishops	Bishop	Kaneohe	HI	96744
trond	borg	kaneohe	HI	96744
celeste	borges	kaneohe	HI	96744
Mara L. B.	Chang	KÃ¤ne`ohe	HI	96744
Donald	Cooke	Kaneohe	HI	96744
JOHN	FOX	KANEOHE	HI	96744
Liam Gray	Gray	Kaneohe	HI	96744
mike	irvine	Kaneohe	HI	96744
Kamuela	Kala'i	Kaneohe	HI	96744
Annette	KaohelauliÃ-i	KaneÃ-ohe	HI	96744
Dave	Kisor	Kaneohe	HI	96744
royce	kovacich	kaneohe	HI	96744
Anitra	Pickett	Kaneohe	HI	96744
LorrieAnn	Santos	Kane`ohe	HI	96744
LorrieAnn	Santos	Kaneohe	HI	96744
Pilipo	Souza	Kaneohe	HI	96744
Laulani	Teale	Kane'ohe	HI	96744
Marti	Townsend	Kaneohe	HI	96744
Patrice	Walker	Kaneohe	HI	96744
Amy	Wiecking	Kane'ohe	HI	96744
Waimea	Williams	Kaneohe	HI	96744
Thomas	Young	Kaneohe	HI	96744
Rosemary	Alles	Kameula	HI	96743

Michelle	Baydo	Kamuela	HI	96743
Katie	Benioni	Kamulea	HI	96743
Janice	Brencick	Kamuela	HI	96743
Kauanoelehua	Chang	Kamuela	HI	96743
Michele	Chavez-Pardini	Kamuela	HI	96743
lisa	Damon	Kamuela	HI	96743
Haroldeen	Gillette	Kamuela	HI	96743
Lani Loring	Howell	Kamuela	HI	96743
maxine	kahaulelio	kamuela	HI	96743
Keala	Kahuanui	Kamuela	HI	96743
Ekela	Kahuanui	Kamuela	HI	96743
Haunani	Kalama	Kamuela	HI	96743
Erin	Lindsey	Kamuela	HI	96743
Sara	McCay	Kamuela	HI	96743
Mahina	Patterson	Kamuela	HI	96743
Douglas	Phillips	Kamuela	HI	96743
Jeff	Sacher	Kamuela	HI	96743
Marge	White	Kamuela	HI	96743
Billie	Dawson	Kalaheo	HI	96741
Mary Lu	Kelley	Kalaheo	HI	96741
Mary	Stone	Kalaheo	HI	96741
Susan	Bender	Kailua-Kona	HI	96740
Brucella	Berard	Kailua-Kona	HI	96740
Thalia	Davis	Kailua-Kona	HI	96740
Gwen	Ilaban	Kailua-Kona	HI	96740
Lorraine	Kohn	Kailua Kona	HI	96740
Kamuela	Meheula Naihe	Kailua Kona	HI	96740
janice	palma-glennie	kailua-kona	HI	96740
Ho'ala	Rivera	Kailua Kona	HI	96740
claire	Sanders	Kailua Kona	HI	96740
Deborah	Sevy	Kailua-Kona	HI	96740
Aggelige	Spanos	Kailua-Kona	HI	96740
Rowena	Vaca	Kailua Kona	HI	96740
Cynthia	Cynthia Taylor	Keauhou	HI	96739
Miranda	Watson	Keauhou	HI	96739
Lehua	Kaulukukui	Waikoloa	HI	96738
Nancy	Scarola	Waikoloa	HI	96738
Bob	Zeller	Ocean View	HI	96737
Jacques	Bargiel	Kailua	HI	96734
Kristin	Bathen	Kailua	HI	96734
Alanna	Bender	Kailua	HI	96734
Bernice K	Bishop-Kanoa	Kailua	HI	96734
Amelia	Borofsky	Kailua	HI	96734
Maile	Bryan	Kailua	HI	96734
Roland	Chang	Kailua	HI	96734
Mele	Coelho	Kailua	HI	96734
Sephera	Dandurand	Kailua	HI	96734
Neil	Frazer, PhD	Kailua	HI	96734
christina	Gauen	kailua	HI	96734
Carlton Kalani	Handley JR.	kailua	HI	96734
Andrea	jepson	Kailua	HI	96734

Jenefer	Miles	kailua	HI	96734
Kauakea	Olds	Kailua, O'ahu	HI	96734
Kory	Payne	Kailua	HI	96734
Kim	Payton	Kailua	HI	96734
Jenn	Perell	Kailua	HI	96734
becky	robison	kailua	HI	96734
Ernette Haaheo	Scanlan	Kailua	HI	96734
Moanike'ala	Sitch	Kailua	HI	96734
Thomas	Tizard	Kailua	HI	96734
Nicholas	Wilhoite	Kailua	HI	96734
Leslie	Yee Hoy	Kailua	HI	96734
CarolLee	Averill	Kahului	HI	96732
Marie Elena	Juario	Kahului	HI	96732
Ramon	Mitra	Kahului	HI	96732
Ramon	Mitra	Kahului	HI	96732
Cynthia Kahaulani	Sablas	Kahului	HI	96732
Jessica	DelaCruz	Kahuku	HI	96731
Olini	Maile	Kahuku	HI	96731
Margaret	Primacio	Kahuku	HI	96731
Noyita	Saravia	Kahuku	HI	96731
lauren	achitoff	Kaaawa	HI	96730
Lia	Cain	honokaa	HI	96727
Sunee	Campbell	honokaa	HI	96727
Ben	Discoe	Honokaa	HI	96727
william	hardisty	honokaa	HI	96727
Susan	James	Honokaa	HI	96727
Z	Johnson	Honokaa	HI	96727
Nalei	Kahakalau	Honokaa	HI	96727
Valerie Y.O.	Kim	Honokaa	HI	96727
Miranda	Lewitsky	Honokaa	HI	96727
Joshua	Mangauil	Honoka'a	HI	96727
hillary	marsh	honokaa	HI	96727
Joyce	Marvel-Benoist	Honoka'a	HI	96727
Maureen	McGraw	Honokaa	HI	96727
cynthia	McKean	Honokaa	HI	96727
Thomas	Pahio	Honokaa	HI	96727
Verdean	Pahio	Honokaa	HI	96727
Deynna	Pahio	Honokaa	HI	96727
susan	sanders	Paauhau	HI	96727
leilea	satori	honoka'a	HI	96727
Raymond	Tokareff	Honokaa	HI	96727
Ru	Carley	Honaunau	HI	96726
Kathleen	Carr	Honaunau	HI	96726
David	Coy	Honaunau	HI	96726
Shayne	Fillmore	Honaunau	HI	96726
Francesca	Fillmore	Honaunau	HI	96726
douglas	fox	honaunau	HI	96726
wayne	levin	honolulu	HI	96726
Esta	Marshall	Honaunau	HI	96726
Dana YK	Shim-Palama	KALAHEO	HI	96726
Walter	Andrade	Holualoa	HI	96725

Jeri	Baumgardner	Holualoa	HI	96725
Craig	Elevitch	Holualoa	HI	96725
Shannon Taylor	Monkowski	Holualoa	HI	96725
Jane	Rubey	Holualoa	HI	96725
Shannon	Rudolph	Holualoa	HI	96725
Terry	Tokuda	Holualoa	HI	96725
Kathy	Conery	Princeville	HI	96722
Ron	Dixon	Princeville	HI	96722
heidi and gary	garcia	princeville	HI	96722
Kathleen	Luiten	Princeville	HI	96722
jeani	martin	princeville	HI	96722
Brad	Parsons	Princeville	HI	96722
Ina	Roessler	princeville	HI	96722
Andrea	Slevin	Princeville	HI	96722
Dharma	Wease	Princeville	HI	96722
noel	al-khatib	hilo	HI	96721
David	Bishaw	Hilo	HI	96721
Aurelia	Castagnetti	Hilo	HI	96721
Amy	Cutler	Hilo	HI	96721
Cory (Martha)	Harden	Hilo	HI	96721
Kanoe	Kapu	Hilo	HI	96721
Mark	Lewis	Hilo	HI	96721
Odette	Rickert	Hilo	HI	96721
Janet	Taylor	Hilo	HI	96721
Marcia	Timboy	Hilo	HI	96721
J.	Zender	Hilo	HI	96721
Julie	Alessio	Hilo	HI	96720
Sharol	Awai	Hilo	HI	96720
oli malamalama	aweau/ turalde	hilo	HI	96720
Kamuela	Bannister	Hilo	HI	96720
Nalani	Barrett	Hilo,	HI	96720
Mariah	Bath	Hilo	HI	96720
Hooulu	Bueltmann	Hilo	HI	96720
nohealani	casperson	hilo	HI	96720
Lisa	Clark	Hilo	HI	96720
Victoria	Fiore	Hilo	HI	96720
Jesse	Fujimoto	Hilo	HI	96720
Ronald	Fujiyoshi	Hilo	HI	96720
Mahealani	Jones	Hilo	HI	96720
Keoki	Kahumoku	Hilo	HI	96720
Keani	Kaleimamanu	Hilo	HI	96720
Linda M.	Karr	Hilo	HI	96720
Rebecca Kapolei	Kiili	Hilo	HI	96720
Akeamakamae	Kiyuna	Hilo	HI	96720
Jeffrey	Lagrimas	Hilo	HI	96720
Prana	Mandoe	Hilo	HI	96720
Jenna	Mangiboyat	Hilo	HI	96720
John	Maxwell	Hilo	HI	96720
Randal	McEndree	Hilo	HI	96720
Lahela	Parker-Bailey	Hilo	HI	96720
James	Pili	Hilo	HI	96720

Ellen	Posner	Hilo	HI	96720
Deirdre Moana	Tavares	Hilo	HI	96720
Leenelle	Tomooka	Hilo	HI	96720
Mililani B.	Trask	Hilo	HI	96720
Mililani	Trask	Hilo	HI	96720
leihulu	watson	hilo	HI	96720
Wendy	Wells	Hilo	HI	96720
Ron	Whitmore	Hilo	HI	96720
Avis	Yoshioka	Hilo	HI	96720
josiane	beauvais	hawi	HI	96719
Richard	Benton	Hawi	HI	96719
Michal	Carrillo	Hawi	HI	96719
Jeannie	Marcom	Hawi	HI	96719
Natalie	Young	Hawi	HI	96719
Ahulani	Wright	Hau'ula	HI	96717
Linda Louise	Harmon	Hanapepe	HI	96716
Linda	Pascatore	Hanapepe	HI	96716
Tim	Andres	hanalei	HI	96714
Lynda	Davis	Hanalei	HI	96714
Stephanie	Fitzgerald	Hanalei	HI	96714
Lauryn	Galindo	hanalei	HI	96714
Miguel	Godinez	Hanalei	HI	96714
Claudia	Herfurt	Hanalei	HI	96714
Jason	Ito	Hanalei	HI	96714
Scott	Jarvis	Hanalei	HI	96714
rachel	kattlove	hanalei	HI	96714
chris	kobayashi	hanalei	HI	96714
Diane	Krieger	Hanalei	HI	96714
Holly	Lazo	Hanalei	HI	96714
Sylvia	Partridge	Hanalei	HI	96714
susan	patner	hanalei	HI	96714
Samantha	Shetzline	Hanalei	HI	96714
kathy	valier	Hanalei	HI	96714
Kathryn	Childs	Hana	HI	96713
Cee	Elbert	Hana	HI	96713
Theodore	Firestone	Hana	HI	96713
Mililani	Hanchett Krause	Hana	HI	96713
Seth	Raabe	Hana	HI	96713
aerie	WATERS	hana	HI	96713
Karen	Atwood	Haleiwa	HI	96712
Sara	Bartlett-Valente	Haleiwa	HI	96712
Tinker	Blomfield	Haleiwa	HI	96712
Mary	Brewer	Haleiwa	HI	96712
Patrick	Doyle	Haleiwa	HI	96712
Zenna	Galagaran	Haleiwa	HI	96712
Gary	Gunder	Haleiwa	HI	96712
Josie	Hoh	Haleiwa	HI	96712
Mary	Lacques	Haleiwa	HI	96712
Michael	Saiz	Haleiwa	HI	96712
Jeff	Haun	Hakalau	HI	96710
andrew	binstock	haiku	HI	96708

Ralph	Boomer	Haiku, Maui	HI	96708
Dawn	Boucher	Haiku	HI	96708
Margaret	Campbell	Haiku	HI	96708
Shay	Chan Hodges	Haiku	HI	96708
Sharon	Fairclo	Haiku	HI	96708
Bernard	Fickert	Haiku	HI	96708
Laura	Giubardo	Haiku	HI	96708
Mary C.	Goodman	Haiku	HI	96708
Joan	Heartfield	Haiku	HI	96708
Steven	Hookano	haiku	HI	96708
jennifer	jensen	HAiku	HI	96708
Lisa	Kasprzycki	Haiku	HI	96708
Barb	Kay	Haiku	HI	96708
Barb	Kay	Haiku	HI	96708
Naia	Kelly	Haiku	HI	96708
Angela	Kepler	Haiku	HI	96708
Mahina	Lenta	haiku	HI	96708
madeleine	migenes	Haiku	HI	96708
Sodengi	Mills	Haiku	HI	96708
Robert	Mitnick	Haiku, Maui	HI	96708
Kyle	Nakanelua	Haiku	HI	96708
Anne	Pierce	Haiku	HI	96708
Heaven	Pua	Keanae	HI	96708
Valentine	Redo	Keanae	HI	96708
Robin	Reinhart	Haku	HI	96708
Helen anne	Schonwalter	Haiku	HI	96708
Suzanne	Villeneuve	Haiku	HI	96708
Jan	Celebrado	Kapolei	HI	96707
EVELYN	SOUZA	Kapolei	HI	96707
Keoki	Baclayon	Ewa Beach	HI	96706
pauahi	hookano	ewa beach	HI	96706
Carolyn	Norman	Ewa Beach	HI	96706
Scharlene	Freeman	Eleele	HI	96705
Linnea	Heu	Ele'ele	HI	96705
Deborah	Anapol	Captain Cook	HI	96704
Diannad	DeRosa	Captain Cook	HI	96704
Christine	Makahilahila	Captain Cook	HI	96704
Owen	Moore	Captain Cook	HI	96704
Anna	Subiono	Captain Cook	HI	96704
gia	baiocchi	Anahola	HI	96703
Andrea	brower	Anahola	HI	96703
Andrea	Brower	Anahola	HI	96703
Nola	Conn	Anahola	HI	96703
Selina	Heaton	Anahola	HI	96703
Lorilani	Keohokalole-Torio	Anahola	HI	96703
Lindyl	Lanham	Anahola	HI	96703
Rebecca	Miller	Anahola	HI	96703
Abilynn	Rita	Anahola	HI	96703
Leonard W	Rita jr	Anahola	HI	96703
Tracey	Schavone	Anahola	HI	96703
Vicki	Spina	Anahola	HI	96703

Erica	Taniguchi	Anahola	HI	96703
Debi	Wilson	Anahola	HI	96703
Pualani	Baptista	Aiea	HI	96701
Alexis	Horio	Aiea	HI	96701
Myranda	Silva	Aiea	HI	96701
Marti	Townsend	Aiea	HI	96701
Jenna	Byrne	Willits	CA	95490
PHYLLIS	FLOWERS	WILLITS	CA	95490
MABEL	LONG	WILLITS	CA	95490
FREDDIE	LONG	WILLITS	CA	95490
beverlea	weaver	willits	CA	95490
Kerry	Beck	Sebastopol	CA	95472
Gina	Covina	Laytonville	CA	95454
Sharon	Paltin	Laytonville	CA	95454
Dixie	van der Kamp	Santa Rosa	CA	95404
Peter	Sanderson	Santa Rosa	CA	95401
Leslie	Santos	Merced	CA	95340
Pat	Nakamura	Stockton	CA	95219
Neil	Ordinario	San Jose	CA	95148
Alexander	Jelinek	San Jose	CA	95136
Karen	Affonso	San Jose	CA	95130
Earlene	Cuelho Alexiou	Soquel	CA	95073
Alexa	Watson	Santa Cruz	CA	95062
Patricia	Matejcek	Santa Cruz	CA	95060
Dennis	Lynch	Felton	CA	95018
Toni A.	Wolfson,RN	Felton	CA	95018
Joseph	Nu'uanu, S.M.	Cupertino	CA	95014
Shirley	Asuncion	san anselmo	CA	94960
Laura	Lee	Larkspur	CA	94939
Tara	Cornelisse	San Rafael	CA	94903
Lisa	Chipkin	San Rafael	CA	94901
Kim	Hahn	San Rafael	CA	94901
Eileen	Harrington	Berkeley	CA	94709
Amy	Marsh	Albany	CA	94706
Marcia	Kerwit	Berkeley	CA	94702
Kathryn	Letkey	Oakland	CA	94610
Ariel	Curtis	oakland	CA	94609
norbert	farrell	oakland	CA	94602
sandra	morey	oakland	CA	94602
Aura	Lane	Oakland	CA	94601
Stepahine	Eike	Orinda	CA	94563
Dana	Dennison	Martinez	CA	94553
Donna	Weilenman	Martinez	CA	94553
Leilani	Birely	Lafayette	CA	94549
William	Golove	El Cerrito	CA	94530
Claire	Cummings	Angwin	CA	94508
Virginia	Velez	Alameda	CA	94501
jennifer	beck	foster city	CA	94404
Maya	Moiseyev	Palo Alto	CA	94306
Diane	Marshall	Hilo	HI	94270
Jesamyn	Angelica	San Francisco	CA	94121

Isao	Kaji	honolulu	HI	94121
Katey	Chikasuye	San Francisco	CA	94118
Timothy	Johnston	San Francisco	CA	94117
keali'i	forsberg	San francisco	CA	94115
Kathleen U'ilani	Campana	San Carlos	CA	94070
Stacy	Sullivan	Redwood City	CA	94061
Karen	Rudolph	Los Altos	CA	94022
Linda	Evans	Monterey	CA	93940
Kaela	Gallagher	San Luis Obisp	CA	93401
Mary	Elliott	Santa Barbara	CA	93130
Jaime and Cheryl	Snyder	Santa Barbara	CA	93130
Mawaekamaka	Copeland	Port Hueneme	CA	93041
Elisha	Belmont	Westminster	CA	92683
Cynthia	Simms	Laguna Niguel	CA	92677
Katie	Winchell	Huntington Bea	CA	92649
Jacqueline	Judd	Huntington Bea	CA	92646
robin	Rabens	Idyllwild	CA	92549
Lea	Lea Padilla	Redlands	CA	92373
Cindy	Williams	Yucca Valley	CA	92284
dinda	Evans	San Diego	CA	92177
John	Monte	San Diego	CA	92154
Theodora	Furtado	San Diego	CA	92115
Wendi	Faria	San Diego	HI	92101
Merle	O'Neill	Vista	CA	92081
Dolly Keahiolalo	Crawford	El Cajon	CA	92021
Amiee	Tomasello	El Cajon	CA	92021
Malia	Hall	San Diego	CA	91911
Chelice	Gilman	Bonita	CA	91910
Bryan	Matsumoto	Temple City	CA	91780
Anita	Arconado	San Dimas, CA	CA	91773
jackie	Raines	Ontario	CA	91762
Carolyn	Lunel	Etiwanda	CA	91739
roy	lunel	etiwanda	CA	91739
Kalai	Kamauoha	burbank	CA	91505
Angela	Spirrison	reseda	CA	91335
Cindy	Crawford	Long Beach	CA	90815
Thomas	Iannessa	Long Beach	CA	90808
Shien-lu	Stokesbary	Long Beach	CA	90804
Dona	van Bloemen	Santa Monica	CA	90403
Araceli	Perez	Culver City	CA	90230
Corey Ann	Lewin	West Hollywoo	CA	90069
Ken	Ng	LA	CA	90066
Lauri	Peacock	Hobbs	NM	88240
glory	dassi	El Prado	NM	87529
Nancy	London	Santa Fe	NM	87505
Richard	Welker	Santa Fe	NM	87505
Rose	Zellers	Albuquerque	NM	87112
Carrie	Rex	Albuquerque	NM	87105
Tricia	Egger	Sedona	AZ	86336
Kekama	Galioto	Tucson	AZ	85716
Kathy	Coryea	Kapaa	HI	85286

Kealoha	Robinson	Tempe	AZ	85285
Desdra	Dawning	Sun Lakes	AZ	85248
Brooke	Lind	Queen Creek	AZ	85242
Carolyn	Moore	Mesa	AZ	85215
Joseph	Joseph Bateman	Salt Lake City	UT	84103
Juanita Nalani	Benioni	Orem	UT	84097
caroline	Metzler	glenwood sprin	CO	81602
Kathy-Lyn	Allen	Pueblo	CO	81003
Pumehana	paisner	Boulder	CO	80301
tom	jackson	denver	CO	80219
Andrew	Hina	Denver	CO	80218
Jessica	Sittloh	Littleton	CO	80127
Shannon	Dodge	Centennial	CO	80122
Joshua	Garfein	Centennial	CO	80122
Diana	Lopez	Wheat Ridge	CO	80033
Terrie C	Williams	Vidor	TX	77662
Lisa	Marshall	Houston	TX	77070
cate	dapkus	dallas	TX	76021
mikel	Athon	cedar hill	TX	75104
donna	van renselaar	west fork	AR	72774
James	Lopez	Topeka	KS	66614
Cheryl	Rosenfeld	Columbia	MO	65202
Sara	Schmidt	Arnold	MO	63010
Ravi	Grover	Chicago	IL	60680
Diana	Fischer	Darien	IL	60561
Amy	Young	Bigfork	MT	59911
Jennifer	Johnson	Minneapolis	MN	55409
Paul	Moss	White Bear Lak	MN	55110
Jeffrey	Smith	Fairfield	IA	52556
Ramona	Fernandez	East Lansing	MI	48823
Susie	Pearson	DeWitt	MI	48820
Joan	VanSelous	Highland	MI	48356
Will	Ware	Detroit	MI	48226
Nancy	Langeneckert	Canton	MI	48187
Justin	Miller	Muncie	IN	47304
DIANA(ANIMAL	Martz - Animalspirit	INDIANAPOLI	IN	46217
Forrest	Hurst	Westfield	IN	46074
berton	Harrah	Hilliard	OH	43026
Lisa	Cash	42105	ot	42105
Kara Ann	Kahao	Hilo	HI	40160
Susan	Rasmussen	Quitman	MS	39355
Sarah	Kane	Knoxville	TN	37918
Donna	Cussac	Cleveland	TN	37311
Cathy	Robinson	Mobile	AL	36695
Elaine	Nichols	Oldsmar	FL	34677
April	Esterly	Sarasota	FL	34234
greg	moser	naples	FL	34114
Mary	Detrick	St. Petersburg	FL	33710
kathleen keahi	Keahi Winn	Bruges	ot	33520
Anna	Reycraft	North Miami	FL	33181
Kristine	Kadlac	Miami	FL	33176

Kike	Kike Carrazana	Miami	FL	33133
donald	stevens	winter park	FL	32792
Kameananiokalani	Walker	Cassadaga	FL	32706
Libbie	Hambleton	Destin	FL	32541
Sam	Chung-Hoon	Jacksonville Be	FL	32250
Pamela	Bennett	Chatsworth	GA	30705
Robert	Wagner	Lawrenceville	GA	30044
Deborah Lynn	Dickerson	Easley	SC	29642
Hallie	Van Patton	Asheville	NC	28804
Leimamo	Lind	Alexandria	VI	22314
briana	Wagner	hagerstown	MD	21740
Maria	Gallo	Lothian	MD	20711
Royelen Lee	Boykie	Washington	DC	20016
Kathleen	Kathleen Dockett	Washington	DC	20008
Andrew	Benson	Lewes	DE	19958
Bill	Marconi	Berwyn	HI	19312
tina	horowitz	philadelphia	PA	19143
Talia	Young	Philadelphia	PA	19107
daniel	greider	lancaster	PA	17601
Raenette	Rogers	Delta	PA	17314
Stephen	scribner	Elmira	NY	14904
Matthew	Russell	Deposit	NY	13754
Summer	Bradley	Utica	NY	13501
Jack	Lynch	Greenfield Cen	NY	12833
Margot Malia	Lynch	Greenfield Cen	NY	12833
BRYNA	BRYNA	BRYNA	HI	12345
Bobbi	Aqua	Sag Harbor	NY	11963
Tibor	Weinreb	Brooklyn	NY	11236
Jonathan	Schwartz	Brooklyn	NY	11231
Bryan	Milne	Brooklyn	NY	11211
lan	Lary	Brookyln	NY	11206
Debbie	Burack	New York	NY	10022
George	Held	New York	ot	10014
Kris	Kato	New York	NY	10003
Kris	Kato	New York	NY	10003
Viviane	Lerner	Hilo	HI	9672
Verbeke	Dominique	Izegem, Flande	ot	8870
Denise	Lytle	Fords	NJ	8863
Frederika	Ebel	Flemington	NJ	8822
David	Storch	Brick	NJ	8723
donnalene	sing	honolulu	HI	6816
CHANDA	Tuu'- Cedeno	Terryville	CT	6786
mark	franklin	pahoa	HI	6778
Ã…se	Borg	Arendal	ot	4848
Faith M.	Willcox	Westport	ME	4578
Maxine	Veale	Katoomba	ot	2780
Danielle	Ledward	Jamaica Plain	MA	2130
Marc	Albert	Sudbury	MA	1776
Raechel	Doughtyq	North Adams	MA	1247
clare	loprinzi	holualoa	HI	967
Sheila	Ward	San Juan	PR	927

Glen	Venezio	San Juan	PR	911
Carmen	L	Madrid	ot	0
Jonathan	Agoot	San Diego	CA	
William	Albritton	Honolulu	HI	
Linda	Anderson	Novato	CA	
	Ashworth	Lihue	HI	
Laurissa	Asuega	Wai'anae	HI	
Trevor	Atkins	Honolulu	HI	
Meghan	Au	Waimanalo	HI	
Kuuleianuhea	Awo-Chun	Waimanalo	HI	
BRIAN	BAPTISTA	Los Angeles	CA	
Sabrina	Baxter-Thrower	Oakland	CA	
Janise	Biehler-Moore	Hilo	HI	
George	Birchard	Sanford	NC	
Michelle	Blake	Honolulu	HI	
Anna	Bowman	Salem	OR	
Joseph	Bruchac	Greenfield Cent	NY	
keisha	byrd	UPPER MARL	MD	
Matthew	Chase	Reno	NV	
Natasha	Clarin	Ewa Beach	HI	
Scott	Coryea	Chandler	AZ	
Nelson	Crabbe	hilo	HI	
Scott	Crawford	Hana	HI	
bobby	crowe	new orleans	LA	
Jonathan	Daniels	Los Angeles	CA	
Dave	Davenport	Tijeras	NM	
Carmela	De Marco	Koloa	HI	
Leilani	Digmon	Honolulu	HI	
katherine	doyle	bradenton	FL	
Kuuwainani	Eaton	Hilo	HI	
K.	Elderts	Kahau'u	HI	
Bruce	Erickson	Pearl City	HI	
charlot	feuerhelm	Hilo	HI	
Andrea	Galas	Brooklyn	NY	
leon	gittens	inglewood	CA	
Mary	Goosby	Chicago	IL	
Ed	Greevy	Honolulu	HI	
arlen	guieb	Waianae	HI	
diana	gutierrez	garland	TX	
Peggy	Haissig	Lagunitas	CA	
Jeremy	Halinen	Tacoma	WA	
Ken	Hamabata	Los Angeles	CA	
Hina	HanapiHirata	kaunakakai	HI	
Lance	Hashida	Los Angeles	CA	
Umi-A-Liloa	Hekekia	Hilo	HI	
Mychale	Inagaki	Honolulu	HI	
Andrew	Ingraham Dwyer	Columbus	OH	
Dean	Jefferys	Mullumbimby	ot	
robin	johnston	haleiwa	HI	
Alex	Johnston	U.K	ot	
CURSTYN	KALAHIKI-SALIS	WAILUKU	HI	

Sarah	Kama	Honolulu	HI	
Kanani	Kasuya	Pearl City	HI	
cowboy	kiyota	pearl city	HI	
Deborah	Laub	Los Angeles	CA	
Meridith	Leo-Rowett	Dix Hills	NY	
Roberto	Lopez	Brooklyn	NY	
Chad	Lorenzo	Aiea	HI	
	Ly	Houston	TX	
MARY ANN	LYNCH	Greenfield Cent	NY	
Uilani	Macabio	Kamuela	HI	
Ian	Maioho	Kualapuu 9675	HI	
	Makaiau	Mililani	HI	
Yvonne	Manipon	Eugene	OR	
Yves	Martin	Los Angeles	CA	
j	martinez	Modesto	CA	
Karen	McCullough	Albuquerque	NM	
Maureen	McFadden	Santa Barbara	CA	
Michele	McKay	Honolulu	HI	
Karla	Meek	Honolulu	HI	
joseph	Meno	makawao	HI	
Alison	Miller	Kihei	HI	
Christopher	Minnes	Honolulu	HI	
Mark	Miyashiro	Kaneohe	HI	
Genevieve	Morgan	Pahoa	HI	
myra	naito	rosemead	CA	
Terri	Napeahi	Hilo	HI	
Donna	Nascimento	Pukalani, Maui	HI	
sarah	neal	kapa'a	HI	
andrea	owen	novato	CA	
aukai	pa'alua	SANTA CLAR	CA	
Terrilyn	Pacheco	Wailuku	HI	
Brandon	Page	Seattle	WA	
Ana	Page	Rochester	NY	
Angie	Palma	Hilo	HI	
Mikaele	Pitolo	Waianae	HI	
Darrell	Pojas	Mililani	HI	
Pamela	Polland	Kula	HI	
Sheryl	Porter	Kaneohe	HI	
Celeste	Pule	Hilo	HI	
Keala	Pule, Sr.	Hilo	HI	
Flo	Pulu	San Diego	CA	
Anuenue	Punua	Kaneohe	HI	
Aaron	Rosenstiel	Barbourville	KY	
Richard 'rich'	Roth	Tubac	AZ	
Chris	Rowett	Blue Point	NY	
Kolu	Ryan	los Angeles	CA	
Aubriann	Santiago	San Dimas	CA	
reena	SHAH	fort collins	CO	
Kaipoaloha	Simeona	Honolulu	HI	
Loke	Simon	Honolulu	HI	
	Sinclair	Honolulu	HI	

Julian	Sosa	Utica	NY	
Jeremy	Spear	Honolulu	HI	
Ellin	Stiteler	Gillette	WY	
Rayna	Strike	Wailuku	HI	
Ka'akapua	Swain	Hilo	HI	
Alison	Swigart	Honolulu	HI	
T.	Tajiri	Redondo Beach	CA	
kyle	thompson	austin	TX	
Onaona	Trask	Kurtistown	HI	
	Triggs	Templeton	CA	
chelsey	valmoja	waianae	HI	
Anne	Van Ornum	Raymond	WA	
Coleen Heanu	Weller	Hilo	HI	
michael	wells	san antonio	TX	
Edward	Wendt	Haiku	HI	
Elliott	Wong	Honolulu	HI	
A.	Zecha	Spokane	WA	
Atlanta	Cook	St. Agnes Corn	ot	TR5 0RD
David	Meanwell	Sutton	ot	SM3 9AQ
Angela	Cielo	Hilo	HI	Pahoa, HI
Andre	O'sullivan Anakela	Cork, Ireland.	ot	00004
Lindsay	McDougall	Toronto	ON	M4X1R3
Robert	Wolff	Kea'au	HI	Kea'au
Miwa	Tamanaha	Honolulu	HI	Honolulu
Doreen	Redford	Aiea	HI	Aiea
Loralee	Jacobson	Arlington	WA	98223-7938
Raphael	Kaliko	Honolulu	HI	96828-1031
Sandrea	Chun	Honolulu	HI	96822-1902
Sarah	White	Honolulu	HI	96819 #3
Karen	Victor	Honolulu	HI	96817-1829
Blossom	Hoffman	Honolulu	HI	96816-1224
Warren	Kundis	Mililani	HI	96789-2138
David M. K.	Inciong, II	Pearl City	HI	96782-2581
Nai`a	Newlight	Pa`ia	HI	96779-8110
Colleen	Egbert	Pahoa	HI	96778-7525
Joan	Lander	Naalehu	HI	96772-0029
Tony	Rich	Kamuela	HI	96743-8536
Frances	Yoshimitsu	Kailua	HI	96734-3910
Patricia	Blair	Kailua	HI	96734-2765
Kiope	Raymond	Kahului	HI	96732-1617
Leona	Toler	Hilo	HI	96720-4850
Ernest	Messersmith	Haiku	HI	96708-4899
Marcia	McDuffie	El Sobrante	CA	94803-3414
Marcia	McDuffie	Martinez	CA	94553-2406
Saran	Kirschbaum	Los Angeles	CA	90035-4110
Martina	Roels	Sint Niklaas-Be	ot	84635/9100
Edward M.	Dobson	Bluff	UT	84512-0008
Mel S	Stark	Sandwich	IL	60548-9318
Cynthia	Nadalin	Felton	PA	17322-8718
isobel	storch	Pittsburgh	PA	15206-1704
Erika	Comrie	Jamaica	NY	11432-1017

Mark	schuster	Kailua-Kona	HI	967454798
Patricia	Blair	Kailua	HI	967344410
Margaret	Rydant	Northborough	MA	15321229
jesse	soto	phoneix	AZ	850021
Leimomi	Martin	Juneau	AK	99901
Judith	Lyon	Anchorage	AK	99511
Lisa	Maahs	Anchorage	AK	99509
Janet	Smith	Vancouver	WA	98666
Den Mark	Wichar	Vancouver	WA	98660
Katy	Fogg	Olympia	WA	98501
Pam	Haight	Olympia	WA	98501
Forest	Shomer	Port Townsend	WA	98368
David Adam	Edelstein	Seattle	WA	98125
Victoria	Hanohano-Hong	Seattle	WA	98122
Beverly	Mendheim	Seattle	WA	98122
Zachary	Klaja	Seattle	WA	98102
Charles	Lawson	Kent	WA	98042
Wanda	Brown	Bend	OR	97702
Justin	Michelson	Kula	HI	97690
Joy	bannon	ashland	OR	97520
Demelza	Costa	Sweet Home	OR	97386
Lila	Liebmann	Portland	OR	97219
Leonore	Libeu	Portland	OR	97217
Sarah	Sullivan	Portland	OR	97206
Nancy	O'Harrow	Lake Oswego	OR	97068
Ralph	davis	Scappoose	OR	97056
Charles	Alger	Sandy	OR	97055
sandra	phillips	OREGON CIT	OR	97045
Santos	J	Mangilao	GU	96913

☆=KNOWN TARO FARMERS

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RESOLUTION ON GENETICALLY ENGINEERED TARO

We, the undersigned, TARO FARMERS are issuing the following resolution regarding genetically engineered taro, urging our local and state officials, the University of Hawaii, and other research institutions to take action to protect the integrity of taro.

We oppose the research and development of all varieties of genetically engineered taro.

Specifically,
We call for a statewide ban on any research or release of all varieties of genetically engineered taro and a ban on any patents involving taro.

	Name (Print)	Signature	Address	Phone Number	Email	Comments! or Need more info?
*	Charles F. Reppun	Charles F. Reppun	47-410 Lulani St. Kaneohe 96744	2396123		
*	Paul Reppun	Paul Reppun	47-415 Mahakea Rd. Kaneohe	2394223		
*	DAVID REPPUN	David Reppun	1310 Pahoa	9604788		
*	Jayson MockChew	Jayson MockChew	PO Box 627 Honokaa Hi 96727	775-0816		
*	Alberta MockChew	Alberta MockChew	P.O. BOX 627 Honokaa, HI 96727		Ph# 775-0815	
*	Kalae MockChew	Kalae MockChew	P.O. Box 627 Honokaa, HI 96727	775-0815		
*	Kualei Badua	Dorothy Badua	P.O. Box 5109 Kukuihaele 96727		bdbadua@aol.com	
*	Debbie Toko	Debbie Toko	P.O. Box 5010 Kukuihaele 96727	775-9863	—	
9 *	Donald Cooke	[signature]	47 146A Pulama Rd	239 5873	mana ulo@hotmail	
	David McEntee	[signature]	PO157 Hanalei, H: 96714	635-0308		

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	Name (Print)	Address or Town/Island	Phone Number	Email	Signature	Would you like more info?
*	Elaine Watari	P.O. Box 132 Hanalei, Hi 96714	826-6748		Elaine Watari	
*	E. Clarence Kaona	P.O. Bx 1289 Hanalei Hi 96714	823-9569		Clarence Kaona	
*	Waipa Foundation Stacy Sproat-Beck	PO BOX 1189 Hanalei, HI 96714	689-1815	ssproat@hotmail	[signature]	
*	[illegible] Makuiki	Haena	826 6757		[illegible] Makuiki	
*	Demetri Rivera	P.O. Box 114, Kilauea 96754	826.7836		[signature]	
*	Gary Koga	P.O. Box 323	828.1489		[signature]	
*	Adam Asquith	4654 Hanaala Rd. Kapaa	823-6598		[signature]	
*	Irwin Haraguchi	P.O. Box 1606 Hanalei 96714	828-0087		Irwin Haraguchi	
*	Glenn Haraguchi	P.O. Box 88 Hanalei	826-6459		GLENN HARAGUCHI	
*	Susan Mahuiki	P.O. Box 861 Hanalei	826-1629		[signature]	

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RESOLUTION ON GENETICALLY ENGINEERED TARO

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We call for a statewide ban on any research or release of all varieties of genetically engineered taro and a ban on any patents involving taro.

Name (Print)	Signature	Address	Phone Number	Email	Comments?
* GLADYS KANOA	Gladys Kanoa	PO B 791300 PAIA, Hi 96779	248-8449		farmer
* Kuulei Badua	Dorothy Badua	POB 5109 Kukuihaele Hi	775-9894		
* Kāwika Winter	[illegible]	PO Box 808 Hanalei, HI 96714	826-1668		Na Kakou e malama i ka Haloa!!!
* ~~Paul Reppun~~	~~Paul R~~	~~47-415 Mahakea Rd Kaneohe 96744~~	~~2394223~~		
* Keoki Fukumitsu	Keoki Fukumitsu	49-077 Johnson Rd Kaneohe Hi 96744	277-1823		
* Samson Santos	Samson Santos	46-257 Puunaue St Kaneohe HI 96744	342-3261		
* Ann Tsuha	Ann Tsuha	PO Box 38 Waikane, HI	242-4040		
* John L. Reppun	John L Reppun	47-229 Miomio Lp. Kaneohe, HI 96744	239-4810		
Gwen Kim	Gwen Kim	PO Box 300305 Kaaawa HI 96730	2378673		
* ~~Charlie Reppun~~	~~Charlie F. Reppun~~	~~47-410 Lulani St Kaneohe 96744~~	~~2396123~~		

RESOLUTION ON GENETICALLY ENGINEERED TARO

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Name (Print)	Signature	Address	Phone Number	Email	Comments?
Justin Ledford-Castro	Justin Ledford-Castro	47-529 Melekula rd.	239-4663		
Kamaehu Lopili	Kamaehu Lopili	P.O. Box 10079 Hilo, HI, 96721	808-854-1258		
Kaleo Kamakea-Ohelo	Kaleo Kamakea-Ohelo	41-272 Huli St 96795, HI	(808)239-7452		
Moani Heimuli	Moani Heimuli	47-471 Apau Loop	239-6559	moaniheimuli@yahoo.com	
Shyla Pakele	Shyla Pakele	48-477 E Kam. Hwy. Kaneohe HI. 96744	223-9046		
* Calvin Hoe ~~Calvin Hoe~~	Calvin Hoe	PO Box 5432	393 8762	calvinhoe_hlc@yahoo.com	Mahalo
Charlene Hoe	Charlene Hoe	P.O. Box 5432	235-9155	chhoe_hlc@yahoo.com	
Donald Cooke	Donald Dean Cooke	47-146A Pulama Rd 96744		manaulu@hotmail.com	
* ~~Paul Reppun~~	~~Paul Reppun~~	~~47-415 Mahakea Rd. Kaneohe 96744~~	~~2394223~~		
* Alex Bode	Alex Bode	1942-C Alaloa Kihei, Maui 96753	283-0738		

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Name (Print)	Signature	Address	Phone Number	Email	Comments?
Robert Brown	Robert Brown	1747A Hulu St.	599-2727		
Kane Turalde	[signature]	PO Box 1022 Waimea Hi 96796	6515984	Kaneswahine @AOL.com	
JACKIE SEELEY	JACKIE SEELEY	~~51~~-215 KE NUI RD ~~#E~~ HALEIWA, HI. 96712	343-4414	bllueeee@hotmail.com	
Ka'imi Hermosura	[signature]	P.O. Box 202 Hanalei HI 96714	346-7870		
Keoni Hookano	[signature]	4344 Anahola Rd	348-1478	Hoomanao mail	
Kaweweh Pundyke	[signature]	P.O. Box ~~880361~~ Pukalani 96788	757-2556	Maoliola@ Hotmail.com	
Neenka Hussey	[signature]	44139 Kahinani Way Kaneohe HI 96744	221 0247	ihussey@hawaii.edu	
Lane Kim	[signature]	PO Box 300305 Kaaawa, HI 96730	2378673	~~[illegible]~~	
Sharon Spencer	[signature]	P.O. Box 628 Hauula HI 96717	953 0257	—	
Thomas L Young Sr.	Thomas R. Young Sr.	46-193 Lilipuna Rd Kaneohe, HI 96744	381-9221	Kalogizer@yahoo.com	

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Name (Print)	Signature	Address	Phone Number	Email	Comments?
* Emerson Keahi	[signature]	P.O. Box 957 Hanalei 96714	6390230	[illegible] hotmail	
Scott Pomfry	[signature]	Bx 345 Kilauea 96754	639-8630		
Roland D. Sagum III	[signature]	P.O. Box 958 96765 Lawai, Hawaii	(808) 586-6280	RD33@ Kikiaola.com	
Michael Kaleikini	[signature]	PO Box 30 Pahoa, HI 96778	808.965.6233		
Marti Townsend	[signature]	P.O. Box 270112 Honolulu 96827	808-524-8220	marti@ kahea.org	
Mattie Kaeo	[signature]	38 Kauluwehi Pl. Kula 96790	298-3293	mattiekaeo@gmail.com	Awesome!
Orrin Kupau	[signature]	694 N. Kuakini St. Hon. Hawaii 96817	585-0755	okupau@ hotmail	
Charles Kanehailua	[signature]	89-1157 Pikaiolena St. Waianae 96792	375-7580	pulaa1950@ yahoo.com	
Mele Coelho	[signature]	1246 Mowai St. Kailua Hi. 96734	285-2450	cjmele@ hotmail.com	
Juanita Kawamoto-Brown	[signature]	1747A Hali St. Hon., Hi. 96817	808-429-3313	juanita@ farmfreshhawaii.com	

RESOLUTION ON GENETICALLY ENGINEERED TARO

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We oppose the research and development of all varieties of genetically engineered taro.

Specifically,
We call for a statewide ban on any research or release of all varieties of genetically engineered taro and a ban on any patents involving taro.

Name (Print)	Signature	Address	Phone Number	Email	Comments?
IHOR BASKO	[signature]	6240 Helena Kapaa	822-4229	drbwave vet@Hawaiilink .net	
* [illegible]	[signature]	BOX 957 HANALEI	6390230		
* FLORA QUICK	[signature]	BOX 19 HANALEI	6393698		
JULIANA DONA	[signature]	BOX 19 HANALEI	634-7037		
NED WHITLOCK	[signature]	PO BOX 689 KILAUEA HI 96754	651-1446		
Charlotte Kaai	[signature]	5116 Kawaihau Rd Kapaa HI 96746	822-4168		
Wu Hylton	[signature]	1644 Kanepoonui rd. Kapaa	822-1590		
MARY Ke Kuewa	[signature]	P.O. Box 1282 Pahoa, HI 96778-1282	(808)965-1688		
[illegible] Schiemer	[signature]	PO Box 1492	8082452038		
MARIE DAR	[signature]	5116 KAWAIHAU RD KAPAA, HI 96746	822-4168		

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RESOLUTION ON GENETICALLY ENGINEERED TARO

We, the undersigned, are issuing the following resolution regarding genetically engineered taro, urging our local and state officials, the University of Hawaii, and other research institutions to take action to protect the integrity of taro.

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We call for a statewide ban on any research or release of all varieties of genetically engineered taro and a ban on any patents involving taro.

Name (Print)	Signature	Address	Phone Number	Email	Occupation/Comments Need more info?
* Leanna Campos	[signature]	P.O Box 1096 Waimea HI 96796	335-0075	kekaimalu_26@yahoo.com	KTGA *
Derrick Barashin	[signature]	P.o. Box 1096 Waimea Hi	335-0075	" "	
Kerith Edwards	[signature]	6801 F Waipouli Rd Kapaa HI 96746	246-0233	kerithe@ischool.org	teacher @ I School
Heather Hoffin	[signature]	7060 Kahuna Rd Kapaa HI 96746	651-1671		
Jill Richardson	[signature]	1659 Wanaao Kapaa Hi	651-0717	jr@kauainature.com	Conservation ART
Richard DeMarco	[signature]	PO Box 1797 Kapaa HI 96746	822-0804		
Hope DeMarco	[signature]	6719 Waipouli Kapaa Hi	822-1723		
Suzanne Kashiwada	[signature]	POB 862 Kalaheo 96741	3328406		SW
GARY BLAICH	[signature]	POB 1434 Kilauea, HI 96754	8281438		
* DEAN NICOL NONAKA	[signature]	PO Box 227 Hanapepe	335-5136	rnonaka6@aol.com	KTGA *

W

RESOLUTION ON GENETICALLY ENGINEERED TARO

We, the undersigned, are issuing the following resolution regarding genetically engineered taro, urging our local and state officials, the University of Hawaii, and other research institutions to take action to protect the integrity of taro.

We oppose the research and development of all varieties of genetically engineered taro.

Specifically,
We call for a statewide ban on any research or release of all varieties of genetically engineered taro and a ban on any patents involving taro.

Name (Print)	Signature	Address	Phone Number	Email	Occupation/Comments Need more info?
Marleen Fu	[signature]	Box 581 Hanalei	826-0162	hanaleigirl@msn.com	
* Matthew Field	[signature]	Box 229 Kilauea	6511084	—	Taro Farmer
* Makana Martin	[signature]	Box 1172 Hanalei	826-6948		"
Kehaulani Kekua	[signature]	POB 1261 Kapaa	346-7574	Kauaiheritagecenter@kaiie.org	
[signature]	JAMES W. J. PARSONSON	P.O. Box 1333 Koloa			
[signature]	Desiree Dullayan Parsonson	Box 1333 Koloa	346-1052	jndparsonson@hotmail.com	
Schar Freeman	[signature]	Box 261 Eleele HI 96705	6392670	scharbear@yahoo.com	Artist
Nancy Kobayashi	[signature]	Box 44 Hanalei	8267836		
Michael Sussman	[signature]	407 [illegible]	822-16[illegible]		
Sherrie Orr	[signature]	P.O. Box 119 96796	3356868		

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Name (Print)	Signature	Address	Phone Number	Email	Occupation/Comments Need more info?
Carrie Brennan	[signature]	6050 A Kapahi Rd, Kapaa, HI 96746	822-4123	carriejbrennan@hotmail.com	naturopathic physician
Ginger Saiki	[signature]	332 Kihapai St. Kapa'a, HI 96746	822-7346	gsaiki@hawaii.rr.com	—
NICK GOOD	[signature]	4669 KAWAIHAU Rd 13 Kawaihau	828 1706	nickgood@[illegible].com	
* Daniel McCarty	[signature]	3735 C Omao Rd Kaloa 96756	6340348	danieldcmccarty 007@yahoo	* network notify
Thaddeus Krol	[signature]	P.O. Box 306 Friday Harbor WA 98250	360 3786938		Self emp.
* JoAnne Kaona	[signature]	P.O. Box 1289 Hanalei HI 96714	(808) 652-1159	jkaona@hawaii.edu	
Elizabeth Ako	[signature]	P.O. Box 1584 Kapaa, Hi 96746	822-5606		
Arlecia Booth	[signature]	6412 Kaahele St Kapaa Hi 96746	822-1702	—	SELF-EMP.
Kale	[signature]	PO Box 624 Anahola	634 5038	gassytutu@excite.com	KUMU KOKUA
Linda Shimoda	[signature]	2092B Manaiakalea Lihue HI 96766	245-9818	lja@shimodaworks.com	artist

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Name (Print)	Address or Town/Island	Phone Number	Email	Signature	Would you like more info?
David B. Hauwea	P.Box 23 Anahola	8220585[illegible]		David B. Hauwea	
CHARLES B PEREIRA	PBOX 441 ANAHOLA	822 8945		Charles B Pereira	
Danny Apana	P.O. Box 104 Kapaa			Danny Apana	
[illegible] Han Young	Box 232 Hanalei	8266265			
[illegible]	Box 232 Hanalei	8266265			
Richard Han Young	" " "	8269279			
Dudley Han Young	" " "	8267678			
[illegible] Han Young	" " "	8264717			
Warren Han Young	" " "	8266097			
[illegible] Han Young	" " "	8267285			

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Name (Print)	Signature	Address	Phone Number	Email	Comments! or Need more info?
* Kari Shozuya	Kari Shozuya	1540 Waianuenue Ave Hilo, HI 96720	808-256-0816	shozuya@ hawaii.edu	
* Ryan Like	Ryan Like	P.O Box 1189, Hanalei HI 96714	808-484-0898	rlike@hawaii.edu	
* Penny Levin	Penny Levin	224 AINAHOU PLACE WAILUKU, HI 96793	808-285-3947	pennysfh@ hawaii.rr.com	
Steven Kim	Steven Kim	PO Box 300308 Kaneohe, HI 96730	2378673 H 2938577 O	gkim@ glcc.org	
Mele Coelho	Mele Coelho	333 Aoloa St. #318 Kailua, Hi. 96734	285-2450	cjmele@ hotmail.com	
* SAMSON SANTOS	Samson Santos	46-257 Punowai St Kaneohe HI 96744	247-1063	FishN.poi 4-me.com	
Torao Nakamura	Torao Nakamura	5361 A Hanaa'a Rd	821-2521		
Daniel Angulo	Dal Angulo	5-5522 Kuhio Hwy Hanalei HI 96714	826-1065	Pullinin@yahoo.com	
Kathleen Davis	Kathleen Davis	616 Partee Dr. Grand Junction, Co 81504	970-242-4575	—	
James Ornellas	James Ornellas	P.O. Box 153 Kilauea Kauai Hi 96754	828-1521	—	

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Name (Print)	Signature	Address	Phone Number	Email	Occupation/Comments Need more info?
Harmonie Hawthorne	[signature]	PO Box 969 Kilauea	635-5735	Bakingirl@msn.com	chef
Sonia Gordines	Sonia Gordines	6721 Kawaihau Rd.	822-3894	Surfhillsunset@hotmail.com	
* Catherine K Ham Young	[signature]	PO Box 232 Hanalei 96714	652-0485 8266265		
* Stacy Sproat-Beck	[signature]	Box 596 Hanalei 96714	639-1815	s.sproat@hotmail.com	
INA ROESSLER	Ina Roessler	PO BOX 223749	828 1760	ws@KAUAIGEMS.COM	
NORBERT ROESSLER	[signature]	"	"	"	
Melissa Hosano	[signature]	9084 Albert Pinault		melihosan@msn.com	
Mason Edmonds	[signature]	4701 Waiakalua Rd.		macedoggo5@yahoo.com	
ROBERT DAY	[signature]	4136 NALANI LN.	826-9714	bobday1@hawaiiantel.net	
KOKO DAY	Koko Day	4136 NALANI LN.	8269714	bobday1@hawaiiantel.net	

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Name (Print)	Signature	Address	Phone Number	Email	Comments! or Need more info?
Warren Isip	Warren B. Isip	46-260 Heeia St Kāneʻohe, HI 96744	(808)358-0495 (808)247-7249	kiai_warren@hotmail.com	
* STEVEN HOOKANO	[illegible]	245 WAILUA RD. HAIKU Hi 96708	248-7847	1pauahi@yahoo.com	
* Shawn Rodo	Shawn Rodo	P.O. Box 211 Hana Maui 96713	248-8410		Stick to your Roots
* John Zink	John Zink	P O Box 254	2488974		
* Pauahi Bogac	[illegible]	245 Wailua Rd Haikū Hi 96708	2487847	1pauahi@yahoo.com	
* Alapaki Luke	[illegible]	PO Box 11085 Honolulu, HI 968[illegible]	945-1413		
* Rev Johnson	[illegible]	52-234 Kamehameha Hauula, HI 96717	237-1231		
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DAVID STRAUCH	[illegible]	2121-C ANUENUE ST HONOLULU 96822	988-1697	strauch@greenchopsticks.com	
Virginia McMenamin	VIRGINIA McMENAMIN	22 W. Union St Burlington, NJ 08016	609-386-9640	vmcmenamin@comcast.net	

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RESOLUTION ON GENETICALLY ENGINEERED TARO

We, the undersigned, TARO FARMERS are issuing the following resolution regarding genetically engineered taro, urging our local and state officials, the University of Hawaii, and other research institutions to take action to protect the integrity of taro.

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	Name (Print)	Address [redacted]	Phone Number	Email	Signature	Would you like more info?
*	Michael Fitzgerald	P.O. Box 816 Hanalei, HI	639-7590	[illegible]fitzgerald@verizon.net		
*	Samson Mahuiki Jr	P.O Box 861 Hanalei HI	826-1629			
*	Marvin Masada	P.O. Box 284 Kilauea	828-1081			
*	Geary Masada	" " "	"		Gmasada	
*	James Masada	PO Box 128 Hanalei	826-9834			
*	Charles Spencer	P.O. Box 98 Hanalei	826-6247			
*	Diana Spencer	P.O. Box 98 Hanalei	"			
	Reid K Yoshida	P.O. Box 73	652-9930			
*	Chris Kobayashi	PO Box 135 Hanalei	826-7836			
*	Demetri Rivera	P.O. Box 114 Kilauea	826-7836			

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Name (Print)	Signature	Address	Phone Number	Email	Comments?
PENNY LEVIN	[signature]	224 AINAHOU PL WAILUKU, HI 96793	(808) 288-3947		apprentice farmer.
KEONA MARK	[signature]	P.O. BOX 2 HALEIWA HI 96712	637-2778	Huikalo@aol.com	
PAULO FUJISHIRO	[signature]	P.O. Box 1967 Wailuku, Hi 96793	357-8812	popskamakakehaukeele@msn.com	
~~Donald D. Cooke~~	[signature]	~~47 146A PULAMA RD. KANEOHE, HI 96744~~		beenhadagain@hotmail	
VALENTINE CHING JR.	[signature]	61 Kaneohe Bay Dr. Kailua, Hi 96734	2542590	makua@hawaii.rr.com	
HAROLD W. ANC	[signature]	P.O. Box 713 Anahola, Hi, 96703	823-9776	STEPHANIE ANC@AOL.COM	

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Name (Print)	Signature	Address	Phone Number	Email	Occupation/Comments Need more info?
Phyllis Somers	Phyllis Somers	4334 Iolena St		psomers@ntbg.org	Public Outreach Spec
Stephanie Ramsey	[illegible]	2290 Kahalou St	651 6978	ramseykauai@msn.com	
* Jason K Ito	[illegible]	P.O Box 311 HANALEI HI 96714	630 1760	jkenjiito@yahoo.com	
MONIKA SEIZ	Monika Seiz	P.O. BOX 876 KILAUEA 96754	635 7317	monikaloha@earthlink.net	LMT
Moani Mahinai	Moani Mahinai	POB 292 Anahola 96703	346 0277	smo_mani@yahoo.com	

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	Name (Print)	Signature	Address	Phone Number	Email	Comments?
*	ALEX DEEG	[signature]	POB 223352 Princeville, HI. 96722	(808) 826-7587		
*	Michael G. Fitzgerald	[signature]	P.O. Box 154 Hanalei 96714	808 826 6468		
*	Rosalie V. Fitzgerald	[signature]	P.O. Box 154 Hanalei 96714	808 826-6468		
	EVELYN A. LUM	[signature]	P.O. BOX 163 Kilauea, HI 96754	(808) 639-1362		

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	Name (Print)	Address [redacted]	Phone Number	Email	Signature	Would you like more info?
TARO FARMER *	Bernard Makuaole	Waimea Box 212	3371557		Bernard K Makuaole	
*	Rawlins K Char	P.O Box 927 Kalaheo	337-1428		Rawlins K Char	
*	Linda Dusenberry	P. Box 404 Waimea	338-1075		Linda Dusenberry	
*	John K. Aana	P.O. Box 734 Waimea	335-3588		John K Aana	
	Jimmy Tyler	POBX 812 Waimea	338 2429		[illegible]	
	Tyson Nakamitsu	P.O. BOX 19 Waimea 96796	338 8326		T.N	
	Michael Karratti	P.O. BOX 601 Waimea	337-9927		[illegible]	

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	Name (Print)	Address [redacted]	Phone Number	Email	Signature	Would you like more info?
*	Thelma Aana	P.O.Box 1151	338-1810		Thelma Aana	
*	WILSON A. A'ANA	P.O.Box 1151	338-1810		Wilson Aana.	
*	Lane Turalde	PO Box 1072	6515984		[illegible]	
*	[illegible]	P.O Box 342	338 [illegible]		[illegible]	
*	Kekoa Aana	P.O. Box 734	335-35[illegible]		Kekoa Aana	
*	Kiyoshi Ueda	P O Bo 145	338 1450		Kiyoshi Ueda	
*	BERNARD MAKUAOLE	Box 212	337-1557			
*	RAWLINS CHAR	Box 927 KEKAHA	337-1428			
*	LINDA DUSENBERRY	Box 404 WAIMEA	338-1075			
*	JOHN K. AANA	Box 734 WAIMEA	335-3508		John K. Aana	