HARC

Hawaii Agriculture Research Center

ANNUAL REPORT 2010

BOARD OF DIRECTORS

Board of Directors

EXECUTIVE DIRECTOR'S LETTER

To our Board of Directors, Members, Clients and Friends,

Hawaii Agriculture Research Center completed its second year as a community-based, non-profit agricultural scientific organization and its 116th year since the organization's inception supporting agriculture production and the business of agriculture in Hawaii.

This 2010 Annual Report provides an update on the development of the Kunia Village property and its financial condition, while continuing to provide a summary of research accomplishments. The scientific projects, technical details and results are available on our website. We are continuing our 100-years ago highlights. Don't miss it!

During this year, HARC started on the rehabilitation of the Kunia Village housing sector. We applied for approximately $13M to renovate or construct up to 41 of the 121 farm worker housing units allowed on the property. Applications included USDA Rural Development for an Agricultural Worker Housing loan and for rental subsidies, Low Income Housing Tax Credits and Hawaii's Rental Housing Trust Fund. Rural Development and the State's Historic Preservation Office are working on finalizing an agreement regarding historic preservation on the site.

HARC also began leasing the agriculturally related structures on the property to expanding agri-businesses. We are very excited about having Oils of Aloha, Takenaka Landscaping, No Ka Oi Feed Store, Asagi Fresh Foods, Kunia Country Farms, Crop Production Services (formerly UAP), Pa'ina Hawaii, Central Oahu Agricultural Cooperative, and Manulele Cane Company, LLC.

We are also excited about the future development of an agriculture park of approximately 200 acres near the Kunia Village for lease to small farmers by the Hawaii Agricultural Foundation and the 150-acre Department of Agriculture's Kunia Agricultural Park. The Kunia Village complex will provide the infrastructure support needed by these small farms as well as a centralized site for a farmers' market. By bringing these farming and agriculturally related businesses together at one central Oahu location, HARC hopes to increase the competitiveness of Hawaii's agriculture and to benefit Oahu consumers with locally grown products.

HARC's financial struggles continue through the organization's transition and this difficult economic period. We put off to 2011 the capital campaign mentioned in my report last year. We thank the Board and staff for their 100% participation in initiating this campaign. We are grateful to Mr. William D. Balfour, Jr., Mr. William W. Paty, Jr., and Mr. Frederick E. Trotter for volunteering to help us in this undertaking. HARC's goal is to eliminate its debt developed during the construction of our laboratory, transition between facilities and lack of interest-generating performance of our endowment.

We thank our board for their time and expertise. I thank the staff for their unwavering loyalty through some very trying years. We appreciate those that continue to support us and our many volunteers.

Respectfully,

Stephanie A. Whalen
Executive Director

According to the 1947 issue of the Hawaiian Planters' Record, "There were no changes of importance at the [Experiment] Station during 1910"; nonetheless, management by a sole Director in Charge of all divisions of the Station was deemed beneficial upon completion of the first year. The Organic Act of the Territory of Hawaii was amended granting certain powers to a newly created Land Board in the areas of sale of government land, lease of agricultural lands, and the opening of agricultural lands for homestead settlement. The introduction of Russian laborers from Manchuria was abandoned after immigrants became dissatisfied; Filipino immigrants satisfactorily filled the gaps created by other laborers leaving. The 24-mile Hamakua Ditch on the island of Hawaii was completed. Very favorable progress was made in introducing and establishing a parasitic fly to combat the cane borer (note, the flies originated in New Guinea and had to be transported by way of Australia via steamer). R. S. Hosmer said removing the sheep, goats and cattle should be the first step in reclaiming Kahoolawe.

Halley's comet was visible from earth, which later that year passed through its tail. Boy Scouts of America was founded. Korea's monarchy terminated after abdication of the emperor, which followed the Japan-Korea Annexation Treaty. Born: Bonnie Parker (of Bonnie and Clyde notoriety), Robert Koch (Nobel laureate, one of the founders of microbiology); Died: Mark Twain, Florence Nightingale, and Leo Tolstoy.

Picture of Scientific Staff of the Experiment Station – 1910. Front row – left to right: A. Warren. W. J. Hartung, A. E. Jordan, L. D. Larsen, J. H. Wale. Second row: R. S. Norris, G. H. Tuttle, R. C. L. Perkins, C. F. Eckart, Noel Deerr, F. W. Terry. Third Row: E. G. Clarke, D. C. Broderick, O. H. Swezey, J. F. Melanphy, E. M. Ehrhorn (visitor), H. L. Lyon, S. S. Peck, W. R. R. Potter, F. R. Werthmueller.

Kunia Village: HARC's application to the USDA RD for funding to renovate the Kunia Village housing was ranked first in the nation. Plans have been drawn to divide the Village into 3 areas to facilitate funding. Rural Community Assistance Corporation was instrumental in coordinating efforts. The fire protection upgrades to the Village have been completed.

Kunia Village Development Corporation was created as a 501(c)(3) housing corporation (1) to take advantage of government financing opportunities and manage the overall development of the housing units, (2) to facilitate a phased development and financing approach by partitioning the property into 10 condominium lots, (3) to construct 41 new and renovated units in condominium lot LCE 3 by commencement of the first of three planned phases, and (4) to attract private investment upon conditional approval of a $3M Rural Development loan and an application for assistance through tax credits through Hawaii's Low Income Housing Tax Credits and their Rental Housing Trust Fund.

Experiment Station: Having celebrated our first anniversary of having obtained a perpetual agricultural conservation easement, we were found to have been in compliance with all terms of the agreement as determined by the required annual inspection as conducted by a third party.

Aerial photograph of the HARC Experiment Station

(more detailed information can be found on our website)

Sugarcane:

In recent years, sugar yields have declined, in part due to the sugarcane yellow leaf virus (SCYLV). In addition, drought is the most serious environmental factor limiting the productivity of agricultural crops, including sugarcane. We are undertaking a proven transgenic technology to develop drought-tolerant and virus-resistant sugarcane. Transgenic lines have been produced by the biolistic bombardment method; molecular analyses are being conducted to verify the presence and expression of the functional genes. The greenhouse assay (testing the efficacy of transgenic sugarcane against the infection of SCYLV) was completed using a sensitive PCR-based detection method. Plant growth data including sucrose concentration were collected on the transgenic plants. We concluded that transgenic sugarcane has good resistance to SCYLV and the resistance level was comparable to the natural resistance in the best commercial cultivars in Hawaii.

We have carried out partial sequencing experiments of PCR products of SCYLV present in sugarcane cultivars in Hawaii. A mixture of different races was discovered in one cultivar. The leaves from symptomatic and asymptomatic plants of this cultivar may contain different mixtures of viruses based on our sequence result; similar results were also discovered by Dr. Ewald Komor in Germany. It may indicate the plant has a defense mechanism which can splice the virus in certain regions or the virus itself has a different degree of virulence in the plant infection process.

Breeding

Sugarcane breeding for high sugar production continued. We provided 50,000 seedlings obtained from poly crosses of 2009 to HC&S where the selection program for high sugar yield (FT1-FT7) is ongoing.

Biofuel

Energy canes, which produce high biomass, are one of the promising feedstock crops for energy. We initiated breeding of sugarcane/energy cane with high biomass using a wide range of germplasm in the 2010 flowering season. Wild species of *Saccharum* including *S. spontaneum*, *S. robustan*, *Erianthus* and their hybrids were used to produce progeny with high biomass in Hawaii's environment.

HARC collaborated with various partners in seed production, micropropagation and molecular marker development research. We took advantage of our efficient flower production for crossing varieties which are difficult to cross on the mainland. We made 27 crosses for Louisiana growers from among their commercially important parents. Seeds were obtained from the crosses of parents which had never flowered on the mainland.

Collaboration with University of Illinois for improvement of fuel stock grasses continued. Yield trial was conducted for 10 sugarcane varieties and wild relatives on Maui with HC&S. Molecular analysis of expressed genes in young leaves and internode samples of each variety were conducted at the University of Illinois. We harvested total sugarcane biomass from all 30 plots in May and obtained biomass and sugar data.

Phenotypic data, including stalk characteristics, sugar content, fiber content, and biomass yield, of F2 progeny from selected F1 parents of *S. officinarum* LA Purple x *S. robustum* Mol 5829 were collected from 207 plants 12 months after planting. F2 plants with extreme phenotypes (top and bottom 50) were selected, and a replicated trial of 120 entries was initiated at the Experiment Station in August 2010.

Suppression of flowering can not only improve biomass production of sugarcane and other biofuel grasses but is also important in containment of weedy species or transgenic plants. We have cloned a gene encoding a key regulator for flowering induction from sugarcane and *Brachypodium distachyon*, a model plant for grasses with a sequenced genome and a fast genetic transformation protocol. To demonstrate the utility of this gene in flowering control of biofuel crops, a gene construct to suppress this key gene in *B. distachyon* has been completed and tissue cultures are being initiated for transformation.

Coffee:

New arabica coffee hybrids developed with Hawaii Coffee Growers Association (HCGA) are being selected for cupping quality and bean size. They are being tested at Hawaii coffee growers' fields. We improved the protocol of clonal propagation by somatic embryogenesis of the selected plants.

The function of a gene expressed differently in two coffee varieties was verified using transgenic *Arabidopsis*. The expression of this gene correlates with the increase of branching or bushy appearance of the plants. Additional molecular markers were identified in arabica mapping population by collaboration with University of Illinois and Texas A&M.

Perennial peanut as ground cover between rows of our coffee germplasm planting.

Papaya:

Several candidate genes for papaya sex determination have been identified based on the genome sequences of the male-specific region and the corresponding X region. We have made expression and silencing constructs for these candidate genes and initiated the processes of verifying their functions through a transgenic approach. In addition, a large papaya population has been produced from chemically-treated seeds for the purpose of identifying sex-reversal mutant(s) to further confirm the functions of candidate genes.

Virus-resistant transgenic papaya hermaphrodites were micropropagated for experiments and for sale to growers. Selections were compared for growth and yield in three different locations. A paper describing resistance of papaya to bacterial internal yellowing disease and a review chapter on transgenic papayas worldwide were published.

Papaya proteomic and genomic approaches were utilized to study the plant disease resistance mechanisms to *Phytophthora*, a major root pathogen infecting papaya. Genome-wide analysis of the papaya genomic database revealed a small but structurally diverse NBS-type resistance gene family, making it suitable for functional studies aimed at understanding plant-resistance genes. Proteomics analysis based on two-dimensional gel imaging followed by 2D-LC-MS/MS enabled us to identify the differential expressed proteins involved in plant's defense or stress-related responses, which will be useful to dissect plant defense mechanisms. Seven molecular markers linked with *P. palmivora* tolerance in *Carica papaya* were also identified using the amplified fragment length polymorphism method and these markers have been developed as biomarkers for selection of resistance or tolerant varieties in papaya breeding. The candidate resistance genes flanked by those markers are being cloned and studied. In order to verify the functional roles of these genes, *Arabidopsis* mutants are being analyzed for gain or loss of resistance to fungal or oomycete pathogens.

Wild relative of Solo papaya, Vasconcellea goudotiana, also called highland papaya or mountain papaya, is resistant to Phytophthora spp.

In addition to the solo papaya, its wild relatives, *Vasconcellea goudotiana*, also called highland papaya or mountain papaya, appear to have evolved R-genes effective against *Phytophthora spp*. Screening of this species with *P. palmivora* resulted in the identification of marked resistance to the pathogen characterized by minimal disease symptoms that the plant is capable of outgrowing. This form of resistance, characterized by disease rate-reduction, was reported for the potato R-gene *Rpi-blb1* cloned from *S. bulbocastanum*. The main objective of this proposed study is to clone all of the *Phytophthora* R-genes from *V. goudotiana* utilizing new high throughput sequencing technology. The cloned *Phytophthora* R-genes will be used for intergression of *Phytophthora* resistance into *C. papaya* by transgenic technology.

Forestry:

Acacia koa is the most important endemic timber species in Hawaii from an economic, ecological and cultural perspective. Koa wilt is a vascular disease causing dieback in native forests and high rates of seedling mortality in low to mid-elevation plantings. High mortality from koa wilt is one of the major factors limiting koa reforestation. HARC's forestry program is working with the United States Forest Service and private landowners to develop disease-resistant koa through traditional breeding methods. In 2010, over 75 koa families were screened for wilt resistance in greenhouse inoculation trials. The most resistant families were further propagated from seed, rooted cuttings and micropropagation for evaluation in field trials. Additionally, over 250 koa families were collected from native forests and will be screened for disease resistance in 2011. For a more complete description of HARC's koa breeding program, please see:

http://www.fs.fed.us/r8/foresthealth/publications/nursery/IUFRO_7_03_04_HiloProc.pdf

The long-term goal of the program is the development of eco-region specific, disease-resistant koa that is well adapted to the local environment. The results of 2010 and previous years indicate that this is an achievable goal and we are confident that our work will result in the increased deployment of koa throughout Hawaii.

Taro:

To assist conventional taro breeding, we are working in collaboration with Drs. Susan Miyasaka and Mike Shintaku at University of Hawaii and Dr. Kurt Lamour at University of Tennessee to improve Hawaiian taro's resistance to taro leaf blight (TLB). The objectives of this project are to maintain and enhance the production of taro, and to control the invasive, non-indigenous disease TLB; specifically to: 1) develop additional taro populations segregating for TLB resistance and new TLB-resistant cultivars, 2) identify oxalate oxidase homologs in taro, 3) identify genetic markers associated with TLB resistance for marker-assisted selection of resistant taro germplasm, and 4) develop genetic and physical resources for *Phytophthora colocasiae*.

Anthurium:

Anthuriums transformed for bacterial blight and nematode resistance by HARC are being field tested in Hilo by the USDA Pacific Basin Agricultural Research Center (PBARC) to identify resistant individuals. Micropropagation improvements are being developed to speed the availability of any new resistant cultivars developed. Bacterial blight resistance through marker-assisted breeding is also being sought in a joint project between HARC and the University of Hawaii. Bioassays and DNA analysis data on 300 segregating seedlings will be used to discover markers for resistance. Blue- and purple-colored anthurium flowers may result from a HARC/UH joint project using genes from other flower crops. Nematode resistance genes developed earlier in a study supported by Hawaii Department of Agriculture were received.

See www.harc-hspa.com for more details.

Appreciation:

We would like to express our appreciation to 1a) Harold and Eric Tanouye, Green Point Nurseries and 1b) Grayson Inouye, Pacific Floral Exchange for the cut flowers that they sent for HARC's Christmas party at Kunia Village; 2) Pioneer Hi-Bred International for their monetary contribution allowing HARC to further its educational mission.

Name it:

Be the first to e-mail BVance@harc-hspa.com the scientific name of the pictured plant and you will be listed as the winner of contest in next year's annual report (sorry, but HARC employees and their immediate family members are ineligible):

Combined Statement of Activities

For the Fiscal Year Ending June 30, 2010

OPERATING INCOME	**$ 1,900,532**
EXPENSES	
Program Expenses	$ 2,723,504
Supporting Services Expense	$ 912,088
TOTAL EXPENSES	**$ 3,635,592**
EXCESS OF EXPENSES OVER REVENUES	**-$ 1,735,060**
FOUNDATION GAINS ON INVESTMENTS	$ 952,549
HARC PENSION-RELATED CHANGES	-$ 999,608
SALE OF EASEMENT	$ 2,595,828
KUNIA VILLAGE DONATION	$ 7,567,523
NET ASSETS AT BEGINNING OF YEAR	**$ 9,557,669**
NET ASSETS AT END OF YEAR	**$ 17,872,901**

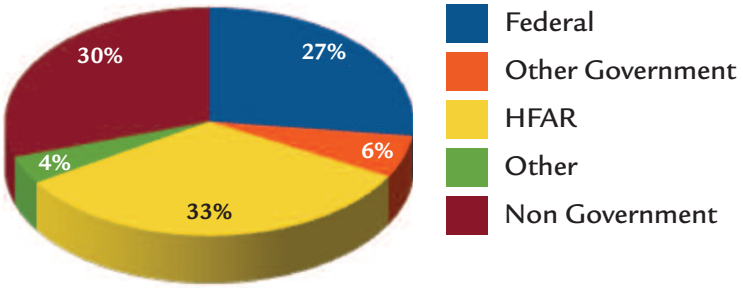
For the year ending June 30, 2010 HARC had an operating loss of $1,801,060 compared to a budgeted operating loss of $1,035,891 (includes depreciation). Almost half of the $765,169 variance was in revenue shortfalls – federal projects that did not materialize and private contracts that were either deferred or canceled. While salaries & wages were down almost $200,000 from last year they were still over budget as the closing of Maui operations was delayed an extra 3 months. Utilities, including communications, were over budget by $60,000 due to escalating costs and power consumption. The former Del Monte plantation site (Kunia Village) was donated in November 2009 and the Kunia experiment farm property easement closed in September 2009. Stock market conditions improved and HFAR realized a net gain of $952,549 and the gains in the pension plan investments were offset by pension payouts and accounted for a combined $4,600,966 decrease in the value of the HFAR and Pension Fund investments and pension benefit payouts and fees totaled $1,034,681.

Consolidated Financial Position

(as of 6/30/2010)

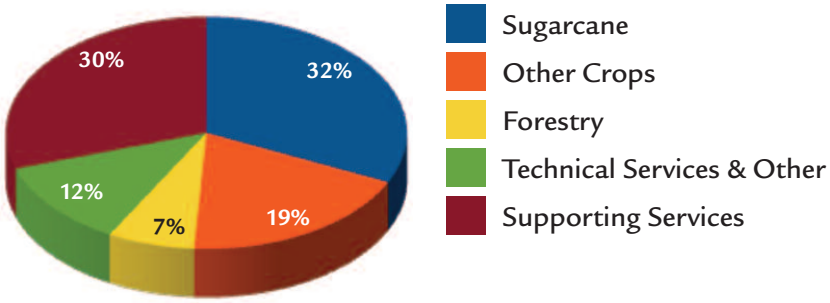
Current Assets	$ 510,009
Property and Equipment (Net)	$ 17,542,457
Investments	$ 10,919,242
Pension Assets (Net)	$ 8,659
Total Assets	$28,980,367
Current Liabilities	$ 7,045,446
Net Pension Liability	$ 3,996,020
Net Assets – Unrestricted	$ 17,938,901
Total Liabilities & Net Assets	**$28,980,367**

2010 - Income by Source



63% of HARC's revenue came from its business operations (active research projects and services); 4% from rents and contributions (in Other category); and 33% from its foundation the Hawaii Foundation for Agriculture Research (HFAR).

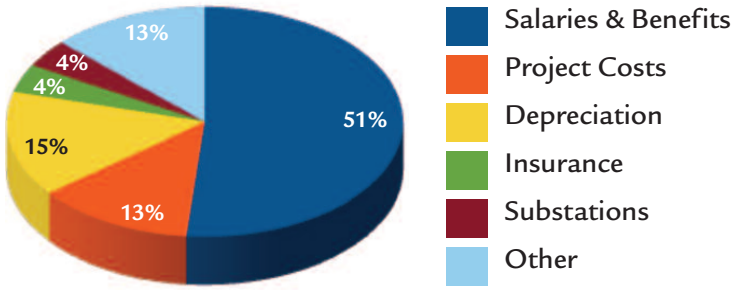
2010 - Expenses by Project Type



Expenses are identified as either a "direct" cost of doing business (and expensed to a specific project) or an "indirect" cost (no project identified) and expensed to a Support Services account.

Later, all indirect costs (such as utilities, admin & accounting salaries, office supplies, audit, legal, payroll services, and so forth) are "allocated" among all the cost centers (including Support Services) based on percentage of payroll for each program. After allocation Sugarcane-related projects accounted for 32% for the firm's costs while Forestry-related ones accounted for 7%. HARC's Support Services costs represented 30% of the firm's total costs and Other Crops (which includes papaya, coffee, anthurium, banana, cacao, taro) for 19% of the total. The remaining 12% (Technical/Analytical Services & Other) includes chemistry, pathology, field-related trials, conservation improvements and accounting services.

2010 - Functional Expenses



Salaries & Benefits totaling $1,882,313 account for 52% of all expenses. Depreciation expenses, with the addition of the new research facility, now account for 13% ($539,164) and Insurance costs account for 4% ($161,771). Project costs represented 13% of the total costs ($460,117). Substation expenses represent 4% ($127,742) and include costs to operate and maintain the Maunawili and Kunia field stations (utilities, supplies, minor building & equipment repairs and lease rent, but not salaries & benefits). Other ($464,485) includes professional fees, supplies, taxes, communications, vehicle upkeep, maintenance & repair, and so forth.

Donors

Fundraising plans are in the making. Stay tuned.

HARC Officers

Ms. Stephanie A. Whalen
Executive Director

Dr. Blake Vance
Assistant Director

Mr. David Kula
Controller

HARC's Mission

To support a viable agricultural sector by researching and applying relevant science and technology to achieve practical solutions and by identifying new agricultural opportunities.

HARC's Purpose

1) to perform scientific research in production agriculture;

2) to develop and demonstrate appropriate technologies in support of production agricultural research in order to promote rural community economic vitality through agriculture;

3) to educate the public regarding the scientific research and the practice of agriculture by providing information and training in agricultural and natural resource conservation principles;

4) to provide training and rehabilitation programs for agricultural workers;

5) to support the development of agriculture in general by development of agribusiness opportunities.

Some of the the library's space-saving, mobile stacks

Cultivars of Hawaiian sugarcane (Saccharum officinarum)
- photo courtesy of Maui Nui Botanical Gardens, Kahului, Maui

Administration and Support Staff

Stephanie Whalen, Executive Director
Dr. Blake Vance, Assistant Director
David Kula, Controller
Florida Chow, Human Resources
Becky Clark, Bookkeeper
Ryan Funayama, Accountant
Ladislao Gonzalez, Watchman, Maintenance
Michael Kaufmann, Forestry Assistant
Ann Marsteller, Librarian
Patrick Nakoa, Building Maintenance
Cynthia Pinick, Executive Secretary

Staff

Nicklos Dudley, Forester
Dr. Mel Jackson, Director of Product Development and Services
Dr. Chifumi Nagai, Senior Scientist, Plant Breeding/Biotechnology
Lance Santo, Agronomist/Field Coordinator
Dr. Susan Schenck, Plant Pathologist
Ben Somera, Sugar Technologist
Dr. Ming-Li Wang, Molecular Biologist
Aileen Yeh, Hawaii Coordinator
Dr. Y. Judy Zhu, Biochemist

Research Associates

Dr. Xiaoling He
Dr. Ruizong Jia
Dr. Heather McCafferty
Dr. Ratnesh Singh

Laboratory Research Assistants and Experimentalists

Arlene Lewis, Laboratory Assistant
Susan Ancheta, Laboratory Assistant
Sayaka Aoki, Research Assistant
Jamie Barton, Research Assistant
Josephine Buenafe, Experimentalist
Jamie Clayton, Research Assistant
Rebecca Heinig, Research Assistant
Tyler Jones, Research Assistant
Terryl Leong, Special Projects Assistant
Marjorie Ortega, Laboratory Assistant
Josienellie Rulona, Laboratory Assistant
Sachiko Saito, Laboratory Assistant
George Yamamoto, Special Projects Assistant

Kunia and Maunawili Substations

Rudy Dizor, Experimentalist
Angel Galvez, Experimentalist
Roland Fernandez, Experimentalist
Roger Styan, Experimentalist, Supervisor

Maui Substation

Artemio Bacay, Field Worker
Edison Bacay, Field Worker
Teodoro Bonilla, Field Worker
Romeo Cachola, Field Worker
Wilson Galiza, Foreman

Students

Ching Man Wai, University of Hawaiii
Katrina Pulido, Waipahu H.S.
Angie Sakamoto, Waipahu H.S.

Collaborators

Dr. Maureen Fitch, Plant Physiologist
Dr. Paul Moore, Plant Physiologist
Andrew Nelson
Larry Tochiki

Emeritus

Dr. Kuo-Kao Wu
Dr. Robert V. Osgood

Affiliated Scientists

Dr. Ray Ming
Dr. Qingyi Yu

Volunteers

Andrew Aki
Jared Doerr
Adam Gutowski
Carol Murakami
Frederick Ota
Alvin Toda
Patricia Tomasa
Blair Willette

Hawaii Agriculture Research Center
P.O. Box 100
Kunia, Hawaii 96759
808-621-1350
www.harc-hspa.com