

CTAHR'S ROLE IN ENHANCING / SUSTAINING HAWAII'S NATURAL RESOURCES AND ENVIRONMENT

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INTRODUCTION

Hawaii's unique and beautiful tropical environment enriches the lives of local residents as well as providing a "paradise" which attracts visitors from around the world. Hawaii encompasses tremendous biological, physical, and social diversity within these small island ecosystems. The stability and function of natural resources, sustainability of agroecosystems, and the quality of the environment are intrinsically sensitive to the impacts of land use and management (see CTAHR POW 2000-2004, Goal 4). Historic patterns of land use emphasized large-scale agricultural plantations, extensive range lands, and forested conservation land. Today, plantation agriculture is declining and new diversified agriculture, forestry and urbanization are increasing. Extensive areas of degraded land (primarily by erosion) and idle lands (many former plantations) present special problems. Sound scientific tools and environmentally sustainable technologies are required for predicting and mitigating any detrimental impacts of land use change. The following specific issues highlight CTAHR's current and potential future contributions to enhancing Hawaii's natural resources and environment.

1) PROMOTING SUSTAINABLE AGRICULTURE

Improving the quality of the nation's groundwater and surface waters, increasing food safety, reducing pesticide risks, and improving the quality of our natural ecosystems are priorities of our national, state and local governments. CTAHR has a critical role to play in enabling farmers to make environmental improvements to meet these priorities and to stave off direct government regulation. CTAHR has made a huge impact on farmers' pest, soil fertility and waste management strategies that are helping to reduce agriculture's negative impact on the environment. The goal is to help farmers adopt new practices that are environmentally sound, profitable and acceptable to the community.

The invasion of new pests and pathogens, including rapidly reproducing plants, insects, and disease causing organisms, can devastate the expensive niche crops that we produce in Hawaii thereby destroying the limited economic opportunities of Hawaii's growers. Plant pathologists and entomologists identify new pests that continually invade our state and destroy our high value crops and gardens. New technologies are being developed at CTAHR to control insects by biocontrol methods and pathologists are testing new environmentally friendly chemicals extracted from mushrooms to control plant diseases. Also, Arnold Hara has developed the use of hot water treatment for controlling many insect pests. This simple non-toxic method is aiding the fruit and flower export industries of Hawaii. Similarly, plant selection and breeding for pest and disease control are important contributions of the college, which also provide environmental protection. For example, a basil cultivar highly resistant to fusarium wilt, a fungal disease which destroys

this valuable plant, has recently been cultivated in Hawaii. Also, two unique papaya cultivars, 'Rainbow' and 'SunUp' have been developed by CTAHR that are resistant to the devastating papaya ring spot virus. These new cultivars have been genetically engineered and contain part of the viral coat protein. This is a totally new and unique method to produce papaya cultivars resistant to this severe viral disease and according to producers, the new cultivars have saved the papaya industry on the Big Island.

Soil and plant analysis and fertilizer recommendations are a unique contribution of CTAHR in Hawaii. (There are currently no commercial labs in Hawaii and no other agencies provide recommendations). CTAHR's Agricultural Diagnostic Service Center (ADSC) believes that nearly 100 percent of farmers in Hawaii have an overabundance of phosphorus in their soil and yet many continue to apply fertilizers containing phosphorus. There are several farmers who have over 1000 ppm of phosphorus (35 ppm is considered adequate) in their soil but believe that they need to apply more phosphorus fertilizer. Too much phosphorus ties up micronutrients in the soil and can reduce yields. Excess phosphorus can degrade water quality and precipitate algae blooms. Similarly, improper application of nitrogen and other nutrients is thought to be frequent on Hawaii's farms, resort developments and home gardens. As an example in wetland taro, on-farm research showed Hanalei growers that they could maintain yields while reducing their application of nitrogen fertilizer from 700-800 lbs. per acre to 350 lbs. per acre and reducing phosphorus fertilizer use from 300-500 lbs. per acre to zero. This on-farm research will save farmers money while improving water quality in the Hanalei stream and estuary. Development of such nutrient management planning capabilities for Hawaii's farmers is called for both by the Natural Resources Conservation Service (NRCS) and in Hawaii's Coastal Nonpoint Source Pollution Control program, which both look to CTAHR for guidance.

During the past 20 years, there has been a major shift toward highly specialized and intensive livestock operations. Manure in livestock production facilities are now considered a major source of pollution. An interagency industry committee is in the process of finalizing guidelines for waste for the management of livestock. The Clean Water Act and Coastal Nonpoint Source Pollution Control program will require comprehensive nutrient management plans (CNMP's) of all livestock and agricultural farms in the near future

A CTAHR statewide program has been structured for 36 months (pending funds) to deliver the environmental assurance curriculum on all major islands and help producers learn to comply with present and future regulations. The project is helping producers foster the adaptation of technology of BMP's (deep litter concept, effluent irrigation practices, large-scale composting and lagoon management) as a result of educational curriculum and field demonstrations. The goal of this effort is to transform a waste product now considered a pollutant into a resource of value.

Hawaii's livestock industries contribute over \$70 million annually to the state's economy.. The Hawaiian Islands are highly dependant upon the quality and quantity of surface and ground water resources. The state currently imports 109,000 short tons of nitrogen in the form of fertilizer and compost. This is equivalent to ten times the amount manure produced by all of state's livestock industry combined. If the livestock industry could successfully compete with 10% of the imported market with locally produced compost, Hawaii's waste management

problem would be solved.

Other ways the college is helping farmers, gardeners and home owners become more sustainable are:

- a) Registering pesticides for use on Hawaii crops, favoring newer low-toxicity pesticides.
- b) Educating farmers and residents in the safe and economical use of pesticides and fertilizers.
- c) Creating new production technologies that reduce the use of pesticide and fertilizer use.
- d) Operating an Agriculture Diagnostics Service Center to help farmers and urban residents test their soil and identify pests to take appropriate action.
- e) Educating youth and the general public on water quality and other environmental issues.

While all of these areas could use more support here are some other areas where the college needs to do more and achieve greater impact:

1. Encourage organic agriculture. The organics industry is still small in this country but is growing at an astounding rate of 20 percent per year. In Europe organics is a much larger industry. Organic agriculture is knowledge-intensive and will require a strong research and training infrastructure to develop fully. CTAHR should create a full-time specialist/researcher position to work closely with the Hawaii Organic Farmers Association (HOFA) and farmers wishing to transition to organic production
2. Conduct more trials and demonstration projects with farmers to create and spread innovative practices that minimize use of pesticides and fertilizers while maintaining profitability. The national SARE (Sustainable Agriculture Research and Education) and Water Quality programs have been successful by requiring strong farmer involvement in research and education projects. Other states have developed their own programs to supplement federal funding. Hawaii's LISA (Low Input Sustainable Agriculture) program is such an effort but has not received funding from the state legislature for several years. CTAHR should seek legislative funding for LISA or a successor program offering on-farm research and education grants.
3. Increased research and extension to fight against tropical pests and pathogens is needed to aid the orchid, ornamental, tropical foliage/flower industry, fruit crops, vegetables and landscape/turf industries.
4. Increase funding for the livestock waste management to transition to new federal and state regulations. Because of inadequate staffing and the lack of funding, the writing of CNMP plans is done only on a limited basis. Current research and extension personnel are adequate to accomplish this goal. College funding of about \$25,000 per year is needed for the extension educational program. A full-time research coordinator should be hired to integrate existing college efforts and spearhead grant applications.

2) REFORESTATION AND FOREST ECOSYSTEM MANAGEMENT

With the decline in the sugar and pineapple industries, tens of thousands of acres of

agricultural land have become available in Hawaii, much more than is needed for intensive diversified agriculture. Many more thousands of acres are currently underutilized as unimproved range land. Reforestation offers an excellent opportunity to improve productivity and on these lands. In the past three years Kamehameha Schools has leased 16,000 acres of former sugar lands in Hamakua and 5,000 acres in Kau to Prudential Timber for commercial forestry. Parker Ranch has joined in by leasing 10,000 acres of former pasture lands. On Kauai, the Hawaiian Mahogany Company, a local firm, has leased 5,200 acres of former cane lands for commercial forestry. While most of the commercial leases so far involve growing short-rotation, relatively low value species such as eucalyptus and albizia, Strother Timberlands is experimenting with high-value timbers for reforestation of some of their 8,000 acres in Puna, most of which are currently in pasture. Since the 1970's, Kamehameha Schools has been reforesting other former ranch lands with koa and currently is managing 400 acres of young koa forest. Umikoa Ranch, also on the Big Island, is in the process of restoring koa to 800 acres of its ranch lands. Other large landowners, including Haleakala Ranch on Maui, Parker Ranch on the Big Island, and Kamehameha Schools on Oahu have also begun efforts in koa reforestation and are watching the progress of these projects. Commercial koa forestry could eventually be expanded to improve productivity and return native forests to thousands of acres. Small private landowners are experimenting with growing teak, mahogany, and various native species on every major island except Oahu. While acreages are small, about 2,000 statewide, these projects are producing high value timber and restoring native species to the landscape.

Sales from the current forest industry (including woodworking) probably have not increased much from the value of \$28 million in 1993. The industry is constrained by availability of raw material, and increased supplies of koa and other high-value woods from private lands could double this figure. The potential value of the short-rotation timber crops has been estimated at 30 to 40 million dollars. With the fast growth rates possible with tropical trees, Hawaii is uniquely positioned to receive tens of millions of dollars available for carbon sequestration forestry to counteract greenhouse effects. The new forest plantations have already generated jobs in depressed rural areas. While 200 - 400 forestry jobs will not replace the thousands of jobs lost in plantation agriculture, they will provide an important economic contribution to rural communities. Environmental benefits of investing in reforestation programs include improved water quality and increased habitat for native species. Many forest landowners dedicate part of their lands to preservation or restoration of native species. An NRCS pilot study showed that the standard preparation of former cane lands for reforestation planting increased infiltration by a factor of 10. Better infiltration and decreased runoff have led to decreased siltation of streams and coastal waters.

CTAHR has contributed to forestry statewide through our research in forest ecology, plantation growth and yield, tree nutrition, forest genetics, and agroforestry. Dr. James Fownes and his graduate students have investigated the ecology and management of koa and developed the state's only growth and yield model for our most important native timber tree. Dr. J. B. Friday is currently beginning a project on silviculture of young koa stands in cooperation with the USDA Forest Service Institute of Pacific Islands Forestry and the Hawaii Agriculture Research Center. Dr. James Brewbaker has selected improved varieties of koa for wood production, also in cooperation with the Hawaii Agriculture Research Center. Dr. Fownes and Dr. Russell Yost have led groundbreaking research into the nutrient use and fertilization of

tropical trees which has the potential to minimize inputs and optimize productivity for plantations throughout Hawaii. Dr. Mitiku Habte has pioneered the use of mycorrhizal fungi by native trees for reforestation of degraded lands. CTAHR economist Dr. John Yanagida produced the only economic survey of state's forest industry, which had a total value of \$28 million in 1993, before the current wave of reforestation. Dr. J. B. Friday has begun UH's first extension program in forestry to bring results of CTAHR research to landowners and users. As CTAHR has no forestry extension agents, extension work is carried out in cooperation with the Hawaii Division of Forestry and Wildlife and the USDA Natural Resources Conservation Service.

Two pressing problems for the forest industry are silviculture of koa and nutrition of plantation forests. If commercially successful methods of koa silviculture were worked out, landowners would be encouraged to establish more forests. The success or failure of many of the plantations going in now depends on proper soil management. CTAHR has a working fertilizer recommendation system (ADSC), but it does not include information for forest trees. To address these and other forestry problems, CTAHR needs a permanent silviculturist to develop a sound scientific basis for reforestation programs, one with a landscape perspective to interact both with the agricultural and environmental communities. While Dr. Fownes has made immense contributions, he is temporarily on leave, and if he resigns permanently a replacement would be essential to continuing CTAHR's forestry efforts. A permanently funded forestry extension program is also needed to bring benefits of the research to landowners. Dr. Friday is currently funded through a grant from the Fund for Rural America which is due to expire in April 2001.

Management of native forests in Hawaii is primarily concerned with mitigating the effects of alien invasive species. Approximately half of Hawaii's four million acres is forested, and virtually all of these forest face invasive weed problems. In some cases invasive weeds threaten economically important species, such as the banana poka vine which smothers koa. In other cases, invasive weeds may lead to loss of environmental benefits. Miconia shades out understory vegetation in wet forests and degrades the watershed. Fountain grass spreads fires through ranches and native dryland forests alike.

In addressing alien species weed problems, CTAHR's expertise in pesticides, pathology, and entomology complement the botanical and ecological work done the UH Conservation Biology program, and other agencies, particular the state Division of Forestry and Wildlife and the USDA Forest Service. Dr. Eduardo Trujillo, a plant pathologist, has collected fungi that specifically attack only the invading weeds in our forest. These fungi attack the leaves of banana poka, clidemia, and lantana, causing defoliation and greatly weakening or killing these invaders. No harm is done to our precious ohia, koa, and other native plants. Dr. Philip Motooka has discovered ways of applying herbicides more effectively. His methods and results from his many trials are used by natural area managers across the state as well as by ranchers and farmers.

CTAHR also is uniquely suited to link the agricultural production and conservation communities. Currently the agricultural industries are busy importing plants and animals which become invasive weed problems. CTAHR, especially through the Cooperative Extension Service, is trusted and ideally placed to get the message out on invasive species. The need is for extension programs in invasive species, starting with educating existing CES staff. CTAHR could also expand and multiply its efforts by training staff of other agencies and other groups

such as The Nature Conservancy in weed and pest control. The payoff would be in greatly reduced need for expensive control programs (e.g. the \$200,000 appropriated to control miconia) down the road.

Needs also exist for people who can work with local communities to ensure that sure conservation efforts are acceptable to local communities and in accord with local values and traditional land uses. Currently, conservation efforts such as fencing and ungulate exclusion often fall afoul of local desires for land use. Integrating conservation and use on forested lands could be a focus of CTAHR community development efforts.

3) BIOREMEDIATION

Urban, industrial, military and agricultural use of land has resulted in unintended soil contamination with hazardous heavy metals and organic compounds. Kahoolawe and Makua Valley alone will require hundreds of millions of dollars to remediate. The contaminated sediments of the Ala Wai Canal and Peal Harbor will require many millions more. Increasing awareness of risk to human health will compel state and federal governments to render hundreds of contaminated military sites in the Asia-Pacific region environmentally safe. When this occurs, the State must be ready to be the bioremediation center for the Asia-Pacific Region.

The CTAHR now has the research capability to detect and quantify soil contaminants, delineate boundaries and map the spatial variability of chemical contaminants in impacted areas. CTAHR also has the capability to screen native and locally adapted plant species for bioremediation. The College also operates a major agriculture-based remediation program entitled "Technology Development and Training in Bioremediation," and is involved in phytoremediation of pearl harbor sediment and the open burn/open detonation site in Makua Valley.

What CTAHR lacks and the state needs is an expansion of the capabilities of ADSC to allow routine analysis of large volumes of plant, soil, and water samples for bioremediation work. This laboratory must be certified to meet EPA quality assurance standards. Once established, such a laboratory can be made self-sustaining by collecting fees for analytical services. As it now stands, the state and other clients must send samples to mainland laboratories, and mainland firms are do much of the remediation work in the Asia-Pacific region. Two additional full-time laboratory technicians and new instruments (~\$350,000) are required to operate the expanded ADSC. The existence of such a laboratory will enable faculty to secure grants and contracts in the field of bioremediation which emphasizes tropical plants and soils. The goal of the expanded program should be to obtain grants and contracts totaling \$1 - 2 million annually.

The college also needs to make the State's rich natural resource inventories accessible to our clients to enable them to avoid land contamination and manage lands on a site specific basis. About 15 years ago, the College began developing HENRIS, the Hawaii Environmental and Natural Resource Information System. HENRIS was an innovative tool in its early years, but more powerful commercial GIS systems have since rendered HENRIS obsolete. The College current work with the Department of Agriculture and the Natural Resource Conservation Service

to display resource inventories in GIS format needs to be accelerated. One full time GIS specialist needs to work with the senior faculty members responsible for coordinating the work of the college with county, state and federal agencies. GIS software and hardware currently available in CTAHR are adequate and program acceleration is limited only by lack of support staff. Development of GIS and natural resource inventory capabilities will also be beneficial to the college's pest, nutrient, animal waste and forest management capabilities as discussed above.

4) CTAHR's INSTRUCTIONAL PROGRAMS IN NATURAL RESOURCES & ENVIRONMENTAL MANAGEMENT

The new strategic plan for CTAHR acknowledges broad-based commitments to balancing the need for productive agricultural systems with enhanced environmental quality. The associated college reorganization will reflect a strengthened programmatic commitment to this area via the establishment of new departments on Natural Resources and Environmental Management (NREM) and Plant and Environmental Protection Science (PEPS). Because of growing interest by the general public and businesses and expanding employment opportunities dealing with the environment, new undergraduate and graduate majors in natural resources and environmental management are being added, and the role of environmental engineering, plant and animal protection, bioremediation and the treatment of wastes from agri-industries in the college's curricula are increasing. Dealing with environmental problems crosscuts a wide array of disciplines. Therefore, the use of a multi-disciplinary approach in addressing such problems is part of the plan. We envisage that several interdepartmental courses, curricula, and projects will be implemented in the next five years to ensure efficiency and synergy in carrying out CTAHR's mandate for developing fully sustainable land use systems.

The new undergraduate programs in CTAHR that emphasize protection of the natural environment and wise management of our natural resources (primarily NREM and PEPS, but also including TPSS, MBBE and HNFAS) will train the people who will be operating, supporting and regulating Hawaii's agriculture industry in the future. These new programs can develop best by hiring key faculty whose primary mission is to teach. CTAHR should hire several "I" faculty to develop the undergraduate environmental programs.