Statewide Agricultural Land Use Baseline 2015

Prepared for

Hawai'i Department of Agriculture

Prepared by

University of Hawai'i at Hilo
Spatial Data Analysis & Visualization Research Lab

Jeffrey Melrose MURP
Ryan Perroy PhD
Sylvana Cares MA

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This report is dedicated to Hawai'i's farm and ranch communities and to the hard working men and women who shape the agricultural sector of Hawai'i's economy every day.

We would also like to acknowledge Department of Agriculture (DOA) Director Scott Enright for his singular commitment to make this project a reality and to use the information it contains as a tool to help shape new futures for Hawai'i's agricultural sector. Mahalo to DOA staff for their support of this effort.

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The project team included Dr. Ryan Perroy, Assistant Professor in Geography and Environmental Studies who served as the Principal Investigator and manages the Spatial Data Analysis and Visualization Lab at UH Hilo. Jeffrey Melrose served as the project manager and was the primary agricultural resource person on the project. He conducted the project outreach and wove the baseline together into a cohesive unit.

Sylvana Cares was the Geospatial Analyst and Cartographer who was primarily responsible for the maps and graphics in the report. Her solid work ethic and technical skills were essential to the projects completion. Student interns Leilani Yamasaki and Ian Seely also contributed, and Lei was responsible for producing many of the maps in the final report.

Thanks to Catherine Lampton for editing and layout support, and to Darin Igawa at the UHH Graphics Department for design and printing support.

EXECUTIVE SUMMARY

This report and the accompanying spatial data and derived cartographic materials represent an effort by the Hawai'i State Department of Agriculture to produce a current and comprehensive look at the footprint of commercial agricultural land use statewide. The goal is to improve our collective understanding about where and what Hawai'i farms in 2015.

The last time a statewide digital footprint for agriculture was prepared was 1980. Much has changed since then. The dramatic shift from the plantation era, which defined rural land use for over a century, to the current era of more diverse, intensive, and decentralized agriculture has been a profound transition. The initial post plantation transition period is mostly over, and Hawai'i has begun to manifest the kinds of trends that most likely will be the building blocks for future agricultural land use in the State.

Perhaps the most prominent shift has been a growing interest over the past decade among Hawai'i residents to increase the State's ability to produce more of its own food. More consumers are seeking access to local fresh produce, and retailers are responding by labeling local products and building new connections to local producers. Some grocers and many restaurants have made it part of their brand to promote fresh and flavorful local products and preparations.

Policy makers continue to look for ways to best manage agricultural land use issues, and a growing number of new, aspiring farmers are finding their voice to advocate for a more sustainable supply of local produce to offset food imports.

Despite this interest in local food produciton, Hawai'i's agricultural sector is still largely export oriented. Sugar, macadamias, coffee, commercial forestry and flowers, seed research, and other export crops acount for over 79% of the crops land use in the state.

This project is intended to inform the broader agricultural discussion and to place the local food conversation into a context with the broad array of farm and ranch activities and to identify: where agriculture occurs, what crops are grown, and what water sources are used to sustain production.

The January 2016 announcement of the pending closure of the state's last sugar plantation, HC&S on Maui, caps the end of Hawai'i's long plantation history. Although in 2015, Maui's sugar operation was the largest single crop in the state, that will change dramaticlaly in the years ahead. The future of agricultureal land use at HC&S is to be worked out over time and measured once again when this baseline is updated at some point in the future.

Some of the key findings of this baseline mapping effort are strictly numeric. We measure the relative scale of specific crop categories and their dispersal throughout the state. Other, more nuanced findings were informed by the many farmers and agricultural leaders interviewed as part of the information gathering process for this report. Some highlights follow from both the quantitative and qualitative observations conducted during this project.

HAWAI'I'S EVOLVING AGRICULTURAL FOOTPRINT

In 1980, Hawai'i had 350,830 acres in cropland and another 1.1 million acres in pasture use. In 2015, lands in active crop use dropped to 151,830 acres, and pasture shrunk to 761,430 acres. During the plantation era, Hawai'i reached its high tide mark in terms of acres in active agricultural production. It is highly unlikely that Hawai'i will ever see that amount of land in active crop production again. As a result, there is currently a surplus of agricultural land and water in the state that could be deployed for more intensive agriculture

use. Doing so is no longer solely up to large corporate decision makers but rather to a broad mix of smaller land owners throughout the state, and to the small supply of farmers and ranchers who are committed to doing the hard work of agriculture every day.

Transitions in Major Land Ownership Patterns

Many of the largest landowners around the state have sold off their vast fee simple lands and returned thousands of leased acres to their owners. Amfac, C. Brewer, and Theo Davies, once three of the "Big Five" largest landowners, no longer own any land in the state, and other once prominent estates have liquidated their land assets as well. This shift in the control of Hawai'i's agricultural land is a profound reality in rural Hawai'i; one that continues to reshape the who, how, what, and where of future agriculture in the State.

The Role of Central 'Oahu Agriculture

The agricultural lands in Central 'Oahu have become the primary center for local food production in Hawai'i. There is more diversified crop farming on the island of 'Oahu (9,860 acres) than there is in the rest of the state combined (7,000 acres). This is where Hawai'i's largest vegetable farmers operate and where the largest market of local produce exists. Producers on the neighbor islands who hope to access the 'Oahu market are at a competitive disadvantage due to shipping and handling costs. Continuing to build the demand for local produce is key to increasing farmers' options statewide.

Export Crops Dominate Agricultural Land Use

Export crops play a major role in Hawai'i's agricultural land use. Sugar, seed production, and macadamia nuts, three of the largest acreage crops, account for 55% of the total planted crop area in the state. Additionally, coffee, commercial forestry, flowers and foliage, pineapple, papaya, cattle, and the tropical fruit industries all depend in part on exports to sustain economic viability. This trend is not new to Hawai'i and continues to be a defining feature of agriculture in the state.

Local Fresh

Increasing Hawai'i's supply of local, fresh foods has become an increasingly high priority for many residents and public policy makers. Farmers and ranchers around the state are responding to this challenge. To sustain these efforts and meet new local food production goals set by the current governor, the farm community needs to work together to address rising food safety regulations, strive for competitive pricing, and build a new generation of farmers to carry on the work. Local consumers and institutional food buyers also need to continue supporting local farmers, including building more sustainable relationships with producers.

Rural Economy

The neighbor islands host 85% of Hawai'i's producing croplands and 73% of neighbor island cropland produces crops that are exported out of Hawai'i. These crops provide an important stability to Hawai'i's rural economy through jobs and both direct and indirect spending. Local food producers on the neighbor islands are generally small scale operations producing vegetables, root crops, tropical fruit, bananas, and specialty crops for both on island and statewide markets. These small to mid size producers are challenged by the relative efficiency of larger 'Oahu farmers and the cost of shipping produce to the 'Oahu marketplace. Many small farmers throughout the state are dependent on selling directly to consumers for their livelihood. Others focus on tapping into restaurant and resort markets, and/or

EXECUTIVE SUMMARY cont'd.

exploring value added approaches to market their produce. The long term viability of these small farmers depends on their own ingenuity and the support of their neighbors, distributors, and consumers to purchase what they produce. This support for small producers is important for the maintenance of Hawai'i's rural agricultural economy.

Counties Real Property Tax & Water Rates

The counties have important roles to play in supporting sustained farm and ranch activities. Real property tax programs that provide favorable assessment values for active crop and ranch lands help reduce costs and keep agricultural lands in active and productive management. County water provided to bonafide farmers and ranchers at beneficial rates also provides an important resource to aid in agricultural viability. This is particularly true in active agricultural areas like Kula Maui, Wai'anae 'Oahu, Kilauea Kaua'i and Kona Hawai'i, where County water and episodic rainfall are the only resources available to irrigate, clean, and process farm produce. Demand for clean domestic quality water from County systems to meet new farm food safety requirements is likely to increase in coming years.

Gentrification Caps Agricultural Expansion

The increasing value of Hawai'i's real estate has a significant impact on farmers' ability to afforably acquire and farm land. Productive farm areas like Kula Maui, Kilauea, Kaua'i, and South Hilo are undercut by increased real estate prices and by new owners without agricultural intentions. Land values are an important factor that has the effect of slowing farm activity statewide.

Agricultural Water

Affordable agricultural water is essential for Hawai'i's agricultural future. In anticipation of shifting climate patterns, the plantation era water collection, storage, and distribution infrastructure need strategic reinvestment to preserve their capacities to support new farm growth. Dam safety rules and other regulations tend to contribute to removal of these systems to avoid liability.

Farm Labor & Leadership

Much is said about the aging of the American farmer, and this is certainly true in Hawai'i. Building a new generation of farmers and ranchers is an important public policy goal, and there are multiple efforts underway to train new farmers statewide. From our statewide travels during this project, it is clear that immigrant farmers are the cornerstone of virtually every crop Hawai'i produces. First and second generation immigrants make up the bulk of Hawai'i's farm community, and without them, few crops would be available for either export or local consumption. Programs that focus specifically on building the skills and industry leadership capacity of immigrant and local farmers should be a priority in building Hawai'i's future agricultural economy.

Lack of Farm Data

This report provides a new source of farm data in terms of acreage and land use locations. It does not address crop production numbers, farm gate values, consumption patterns, or food imports because Hawai'i no longer makes a sustained effort to collect this important data. This lack of basic agricultural data makes it easy to pronounce new local food goals, but there is no real way to measure progress toward successful agriculture or enhanced local food self reliance. Deciding what data to collect, how to collect it, and sustaining the collection process are all critical elements of being able to measure Hawai'i's future agricultural progress.

INTRODUCTION

This report was prepared for the Hawai'i State Department of Agriculture (DOA) by the University of Hawai'i at Hilo Spatial Data Analysis and Visualization (SDAV) lab. It accompanies a comprehensive set of digital spatial datasets that depict the 2015 footprint of agriculture crops and pastureland in the State of Hawai'i.

These digital data are posted in the Geographic Information System (GIS) digital map library hosted by the State Office of Planning at http://planning.Hawaii.gov/gis/various maps/. They are also available on the State's DOA website at http://hdoa.Hawaii.gov/meetings reports/ along with this report and associated cartographic products.

The purpose of the project was to provide a current depiction of Hawai'i's commercial agricultural footprint as a tool to inform state policy makers, managers, and the broader agricultural community about *where* Hawai'i farms, *what crops* are being grown, and *what water sources* serve each area of agricultural production in 2015. This new mapping effort provides the opportunity to measure and better understand changes, both past and future.

The last time Hawai'i's agricultural footprint was mapped was in 1980. Back then, the state hosted fourteen sugar and four pineapple plantations that farmed over 300,000 acres statewide. In 2015, these two crops account for just over 40,000 acres or just 14% of their former land area. During the intervening 35 years, several new crops, particularly seed production and commercial forestry, have emerged to absorb some of the fallowed plantation land. Other crops have shifted, expanded, or contracted in response to changing land availability and market conditions.

Measuring and visualizing these changes on a region by region basis as done in this report, can shed new light on both the issues and opportunities reshaping Hawai'i's agricultural future. Periodic updates of the crop and pasture layer, should they be funded in the future, will enable managers to track change in Hawai'i's agricultural land use pattern and measure outcomes in terms of the expansion or retraction of agricultural production statewide.

The 2015 Agricultural Land Use Baseline was created from an assemblage of geospatial datasets, primarily high resolution WorldView 2 (2011 2013) satellite imagery that was used as a base layer for digitization. Additional datasets used in this work include GIS layers ('Agriculture and Farming', 'Inland Water Resources', and 'Cadastral and Land Descriptions') provided by the State of Hawai'i's Office of Planning Statewide GIS Program and other data provided by major landowners and managers. Digitized crop locations and boundaries were verified through a combination of on the ground site visits, meetings and presentations of draft layers with agricultural stakeholders and landowners, solicitations through a publicly accessible online web mapping portal, and spot checking using Google Earth™ and other high resolution imagery sources.

These data layers represent our best efforts to capture the scale and diversity of commercial agricultural activity in Hawai'i in 2015 and should be used for information purposes only. A more complete description of the Crop Mapping Protocols is included in the Appendix and is attached to the metadata associated with the digital crop layer.

In addition to the satellite imagery, County real property tax and agricultural water use data were also used to identify commercial farm operations. Data for both real property tax assessment and agricultural water use were collected from each county providing their most recent records, generally 2014 2015 data.

INTRODUCTION cont'd.

These data sources were used to verify mapped commercial farms and identify operations that might have been missed using the imagery alone. Not all properties that receive County agricultural tax assessment and reduced water ratess for agricultural uses were mapped due to the small scale of some of their operations and uncertainty as to the commercial nature of the use.

Project staff also spent weeks in the field visiting farms and land managers to verify and refine mapped crop layers. In several cases, private landowners shared their own digital data of crop use on their properties and/ or were helpful in reviewing draft maps to confirm or correct mapped crop boundaries.

WHAT IS A BASELINE?

Baselines provide a snapshot of current conditions and serve as a place from which to measure change. They differ from Plans in that they do not carry recommendations. Rather, they are a body of relevant information that can serve as a tool to provoke collective observation and inform discussion by policy makers, agricultural industry players, and the community.

This baseline focuses on spatial land use information that can be mapped digitally and displayed visually to inform readers of the current state of Hawai'i's commercial agricultural production. It is not intended to be comprehensive of all things agricultural in the state. Individual crop production data is outside the purview of this study, as is the collection of market and local food consumption data.

This baseline can be used as a tool to visualize the current status of Hawai'i's agriculture land use patterns and provide a common framework for collaborative thinking about factors driving current conditions. Shared insights can serve as a basis for informed strategic discussion about ways to promote growth of the agricultural industry in general and to aid in efforts to improve local food self reliance.

ACREAGE CAVEAT

Acreage data provided in this study may vary from acreage figures used by individual agricultural industries. In most cases, industry numbers reflect acres in actual production, field edge to field edge or actual planted acres. In this agricultural land use baseline, in field roads, field edges, warehouses, and related farm structures are all part of farm related uses. Gulches and un used lands were generally not counted. As a result, the crop acreage numbers provided in this report may be 10% or more than what industries might report. That difference is not intended to correct industry numbers but rather to express a broader metric of the area of land that is deployed to support a given agricultural use.

ROUNDING

Geographic Information System software measures areas within mapped polygons automatically down to the nth decimal point. Reporting data to that level of detail is not useful and can overstate the accuracy of the digitizing process. For the purpose of this report and accompanying maps, we have rounded all numbers to the tens and hundreds depending on size. More detailed acreage numbers can be generalized using the digital data provided to the Office of Planning's GIS Library of data and to the DOA website.

PREVIOUS AGRICULTURAL BASELINES

Hawai'i's agricultural footprint evolved in response to the subsistence needs of early Polynesian settlers on the most isolated archipelago on Earth. Hundreds of years before Western contact, Native Hawaiians built upon their stone and fiber-based culture and worked with each island's unique collection of flowing waters, rich offshore resources, soils, and forests to create a 100% sustainable food and material self-sufficient society for as many as 500,000 residents.

Figure 1 on the next page depicts what the Native Hawaiian footprint might have looked like 300 400 years ago. It emerged through a collaborative effort in 2014 between The Nature Conservancy (TNC) and the Office of Hawaiian Affairs (OHA). It was informed by a study done by a number of Hawai'i's most experienced archaeologists, cultural experts, and environmental scientists[1]. They examined existing statewide archaeological evidence, available information on native habitats, and how natural conditions may have presented in the pre Western contact era.

Maps were produced approximating what the native land use footprint might have looked like, where settlement occurred, and what lands may have been deployed to feeding and supporting the needs of the community.

Figure 1 represents the current understanding of Hawai'i's cultural and physical history. While subject to debate, it provides a useful place to launch a discussion about the history of Hawai'i's land use footprint.

The total pre contact footprint on all eight islands was estimated to be 380,000 acres[2], inclusive of settlement and food producing land use activities.

Lade oged, T N , K ch, P V, Gon, S M , Chadw ck, O A , Ha sho n, A S , &V o sek, P M (2009) Oppo n es and cons a n s o n ens ve ag c e n he Hawa an a ch pe ago p o o E opean con ac *Journal of Archaeological Science, 36*(0), 2374-2383 Lade oged, K ch, Gon e a ; Oppo n es and cons a n s o n ens ve ag c e n he Hawa an a ch pe ago p o o E opean con ac , Jo na o A chaeo og ca Sc ence, 2009

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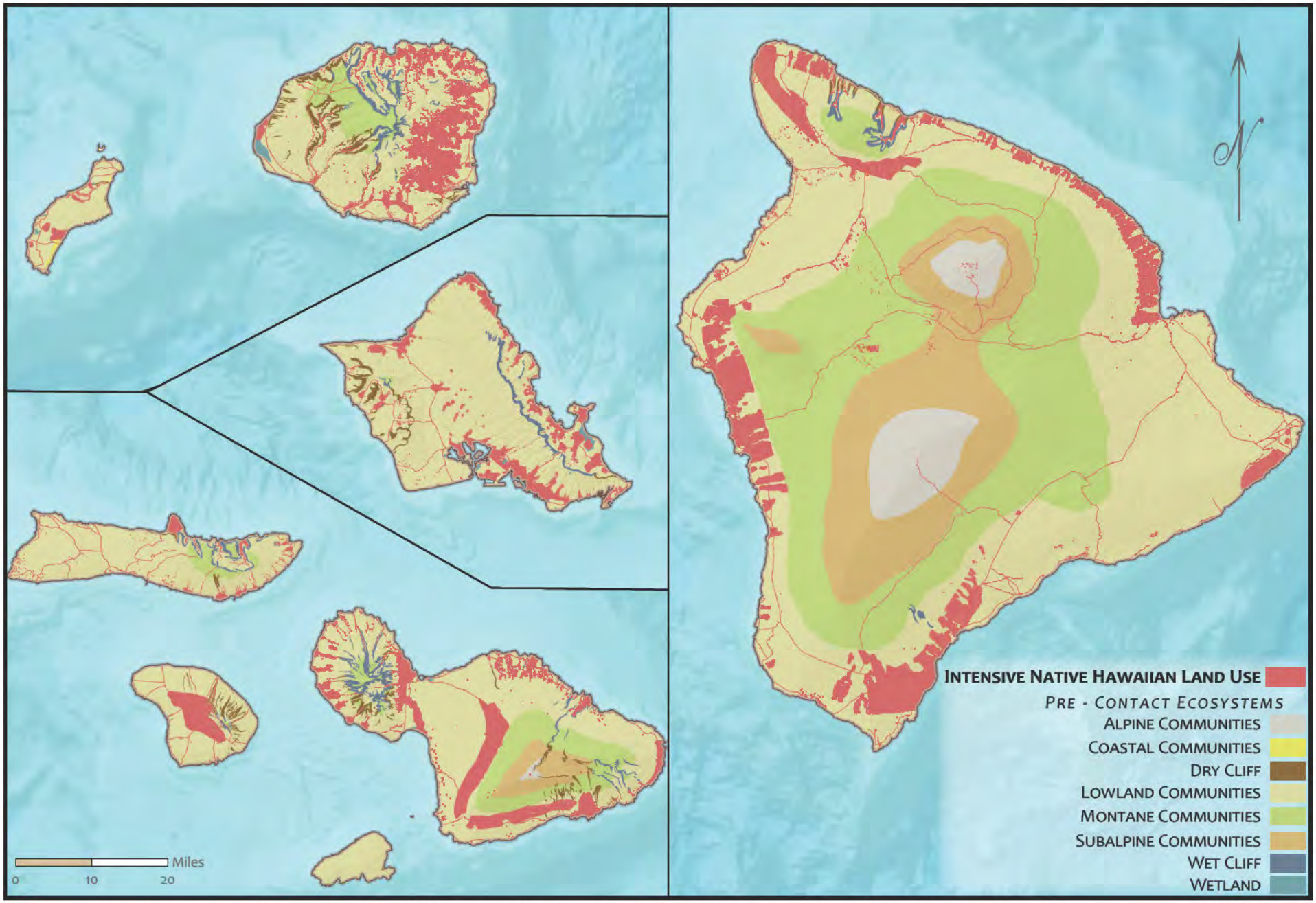


ESTIMATED NATIVE HAWAIIAN LAND UTILIZATION - PRE CONTACT

SOURCE: THE NATURE CONSERVANCY,
OFFICE OF HAWAIIAN AFFAIRS, AND
LADEFOGED ET AL. (2011)

UNIVERSITY of HAWAI'I HILO

SDAV UH HILO

Department of Agriculture
STATE OF HAWAII

PREVIOUS AGRICULTURAL BASELINES cont'd.

One of the first modern depictions of Hawai'i's land use footprint was developed by the Territorial Planning Board in 1937, more than 160 years after western contact. Island maps, shown on page 13, were prepared as part of a comprehensive report detailing land use patterns as well as social, environmental, and economic conditions in the Territory. The report was published as *An Historic Inventory of the Physical, Social, and Economic and Industrial Resources of the Territory of Hawai'i in 1939.*

Hawai'i's social and agricultural landscape was fully transformed by plantation agriculture. By 1937, 38 sugar and eight pineapple plantations cleared, planted, and maintained intensive mono cropping on 277,500 acres from the north shore of Kaua'i to the southern tip of the Big Island[1]. Natural flows of stream water were re engineered on windward slopes, and vast networks of ditches and tunnels were constructed to deliver the water to the new export crops. This was the heyday of the Big Five companies[2], many of which started as business partners with independent plantation owners and then acquired controlling interests as markets fluctuated and operations failed. The Big Five controlled Hawai'i's economy, fashioned its land use patterns, and shaped its political and social culture.

Plantation life defined most of rural Hawai'i, and agriculture dominated the islands' economy. Over 100,000 residents lived in plantation towns and camps[3], roughly 25% of the entire population. New towns arose around sugar and pineapple operations. Roads, bridges, and railroads connected remote areas, and labor camps were the center of rural community life. Ocean shipping linked the islands to each other

(continued next page)

FIGURE 1

Left: The red areas on the map depict the area of the Hawaiian Islands that may have been settled and farmed by Native Hawaiians prior to Western contact. The green and gray areas are the estimated boundaries of pre-contact ecoloigcal zones.

The map assumes a population of 500,000 people and is depicted based on input from archaeological evidence, natural resource insight, and informed speculation. It depicts island land use in a state of 100% food self sufficiency.

An H s o c Inven o y o he Phys ca , Soc a and Econom c and Ind s a Reso ces o he Te o y o Hawa ', pg 89

2 The "B g F ve" gene a y e e o a ge andown ng and ad ng compan es ha dom na ed Hawa ' 's econom c, po ca and soc a se ng om he a e 800's o he 980's They nc ded A exande and Ba dw n, C B ewe , Cas e and Cooke, Ame can Fac o s, and Theo Dav es

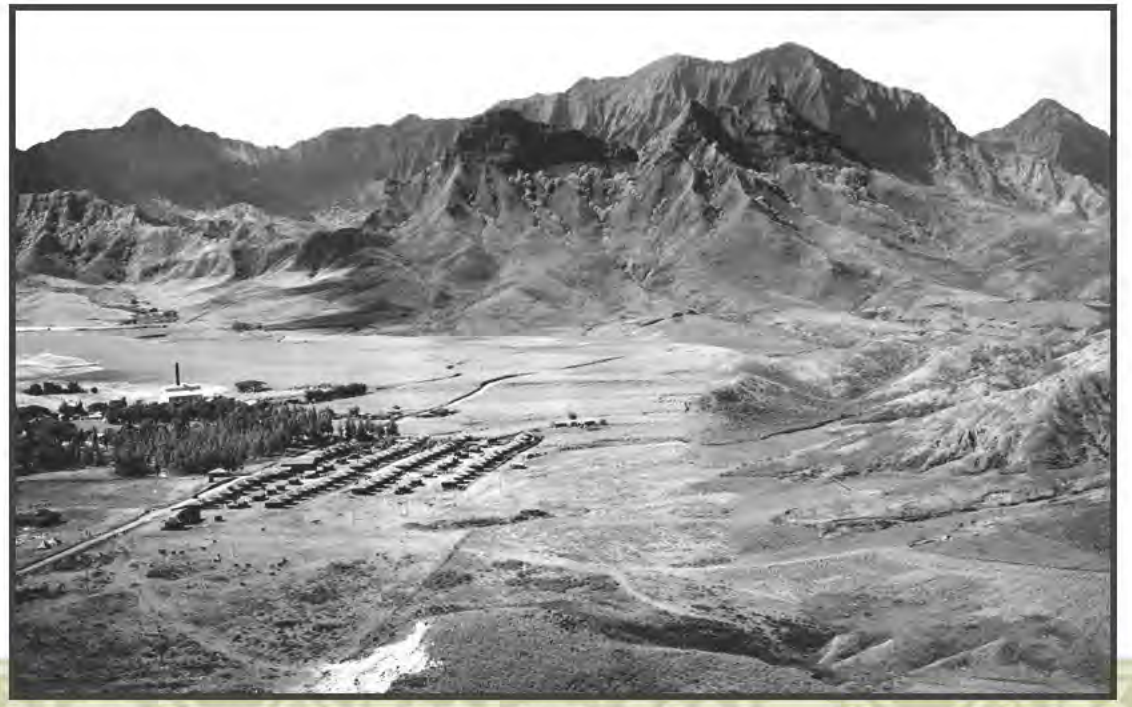
3 An H s o c Inven o y o he Phys ca , Soc a and Econom c and Ind s a Reso ces o he Te o y o Hawa ', pg 89

PREVIOUS AGRICULTURAL BASELINES cont'd.

and the rest of the world. Tourism was just beginning back then, and the role of the military was about to expand greatly with the onset of WWII.

Consumer food demands in 1937 were less complex than they are today. Most rural communities had local sources of milk, eggs, and meat. The range of food and merchandise on retail shelves included basic ingredients and fewer pre prepared and boutique items than we expect today. Grocery stores carried basic goods that could be stored for periods of time. Before refrigerated containers, food arriving on ships was canned, dried, or packed in ice, so much of the islands' fresh produce was grown locally.

In 1937, more than 2 million acres were categorized as grazing land statewide. The management of wild cattle was still a significant part of beef production in the islands, so grazing was mapped in all but areas that were specifically fenced off as watershed reserves.

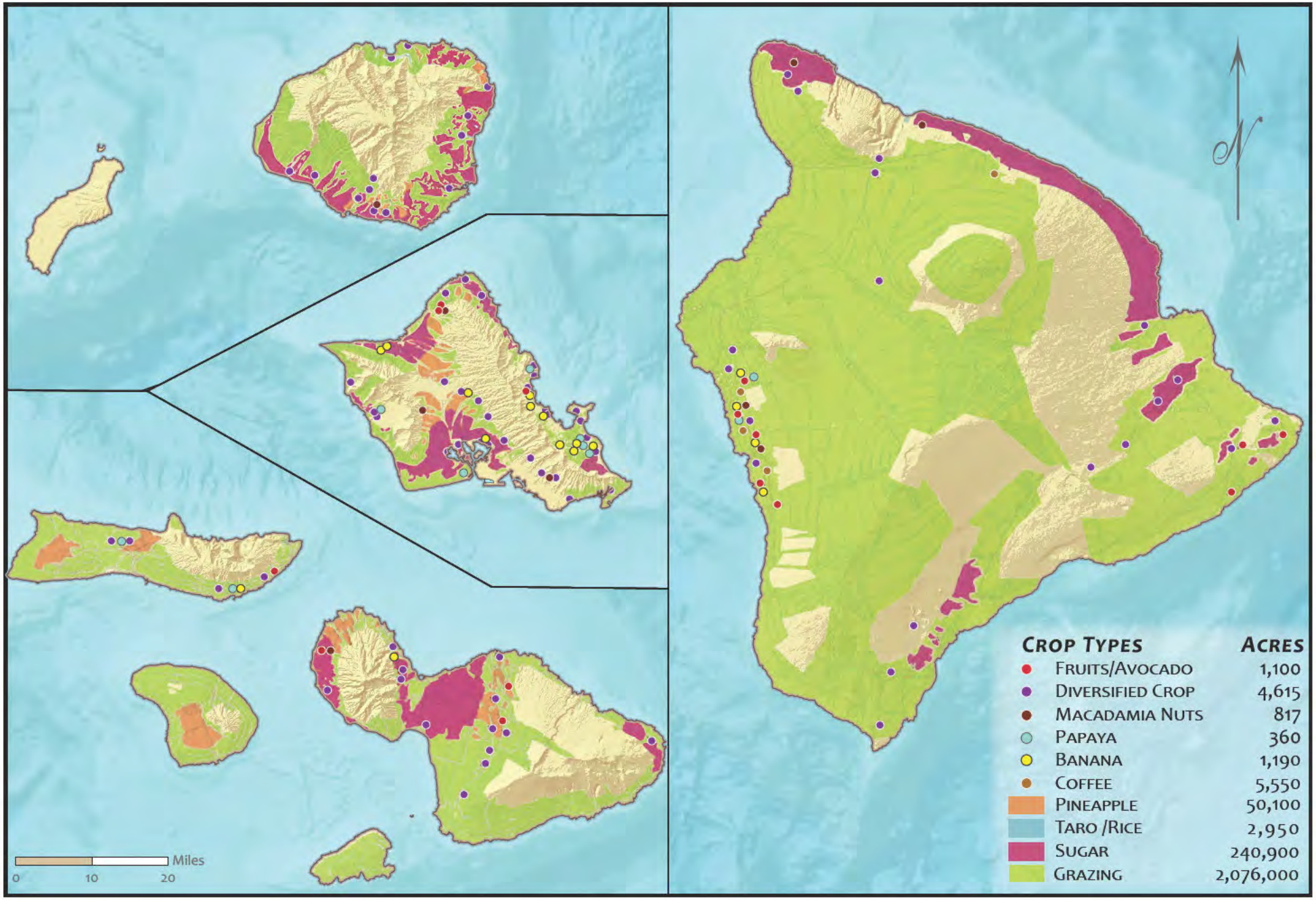


Waimānalo Sugar Plantation circa 1930. In the late 1930's, there were as many as 38 sugar plantations scattered throughout the Territory.

Pho o co esy o
O son T s

FIGURE 2

Right: The agricultural footprint of the Territory in 1937 shows sugar and pineappe plantation agriculture utilized 291,000 acres of land statewide. Cattle grazed over 2 million acres, nearly half of the state, and all beef produced in the islands stayed in the islands. Field crops were used mostly for corn and other grains to feed cattle and other livestock. Coffee was primarily grown in the Kona region. Macadamia nuts were just emerging commercially on Hawai'i Island, and the bulk of the commercial papaya crop was grown on 'Oahu. Hawai'i's vegetable crop was about equally split between 'Oahu and Maui with only about 600 acres on Kaua'i and Hawai'i Island collectively. Wetland crops like taro and rice were in decline due to weakening demand and stiff competition from imported rice that was becoming Hawai'i's most common starch.



Hawai'i's Agricultural Land Utilization (1937)

Source: Based on Data from the Territorial Planning Board Land Utilization Study

University of Hawai'i Hilo

SDAV UH Hilo

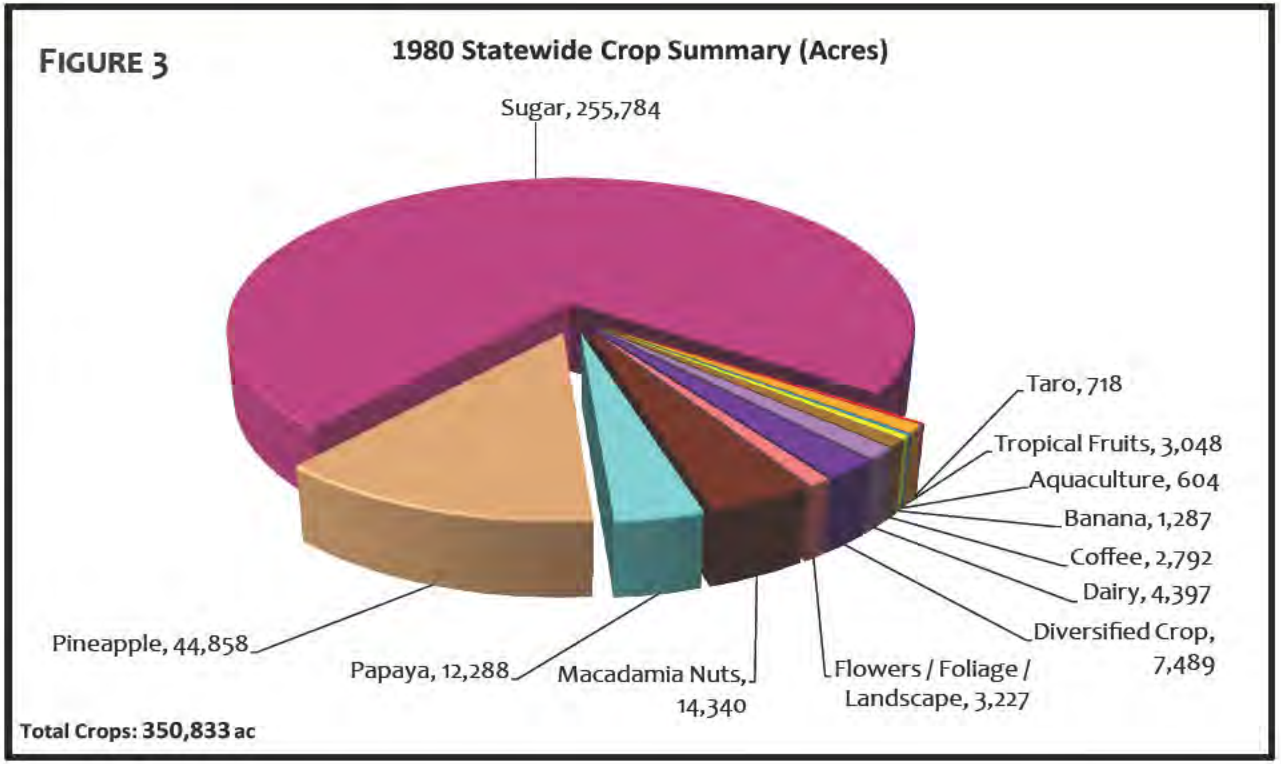
Department of Agriculture State of Hawaii

PREVIOUS AGRICULTURAL BASELINES cont'd.

In 1978-79, the DOA staff were tasked to create a comprehensive map of agricultural use statewide. They used information provided by the State DOA Planning and Development Section and the U.S. Soil Conservation Service to generate a series of 1:24,000 hand-drafted stabiline maps. These were then digitized by the State Office of Planning using emerging GIS technology. The resulting map, called the Agricultural Land Use Map (ALUM), was released in 1980. The ALUM was the most recent depiction of statewide agricultural land use prior to 2015.

In 1980, sugar and pineapple operations still dominated agricultural land use in rural Hawai'i. While plantations in Wai'anae, Waimānalo, Kahuku, Kohala, and Kilauea had gone out of sugar entirely since 1937, the total number of acres under the remaining fourteen sugar and four pineapple plantations remained at just under 300,000 acres. Pastureland was more tightly defined in 1980 to exclude expanding State Conservation areas, remote mountain areas, and lands not suitable for grazing. The 1980 total lands in pasture use included about 1.1 million acres, down from 2.1 million acres in 1937.

FIGURE 3

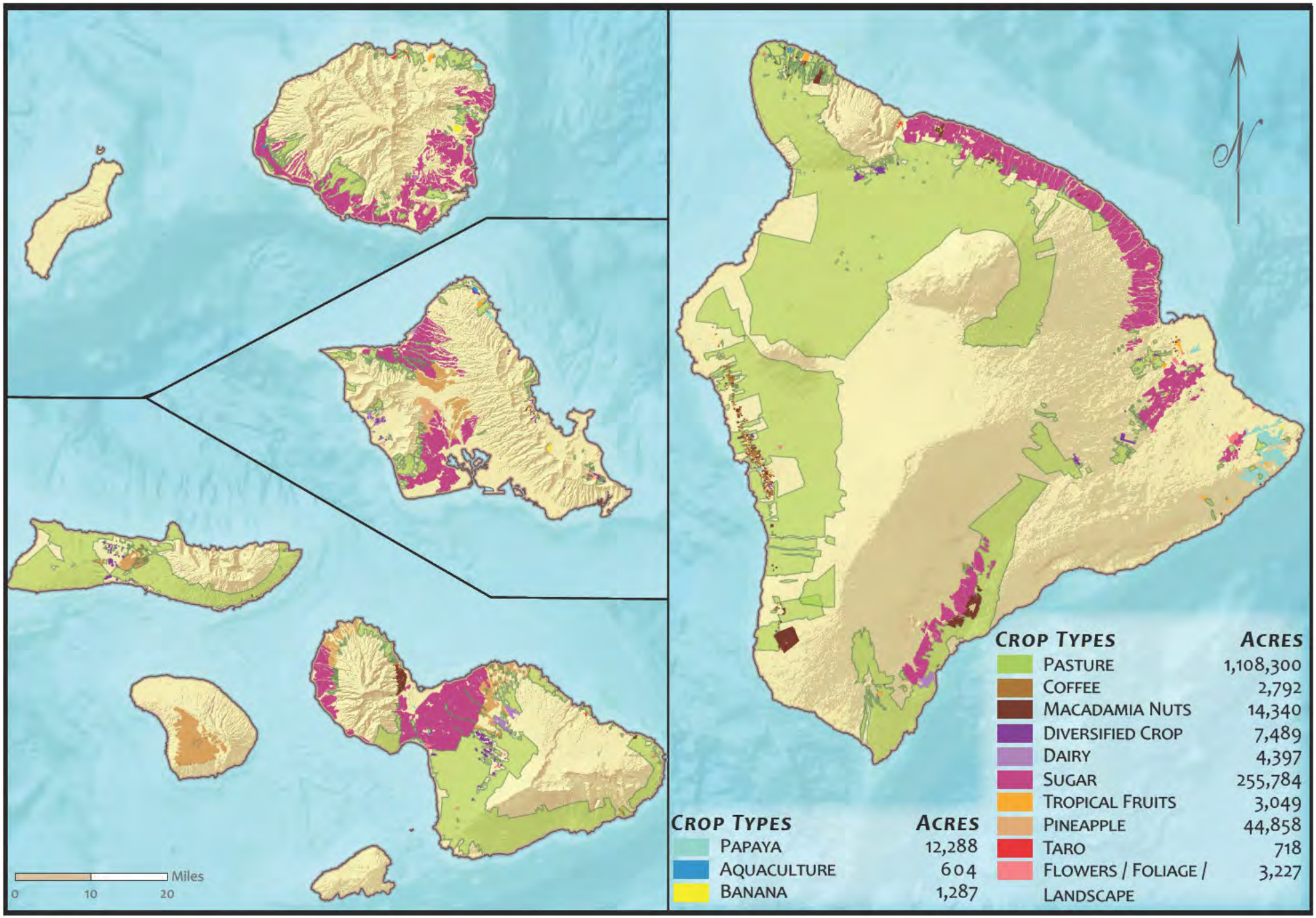


The list of other commercially grown crops expanded to some 50,000 acres statewide[1] in the 1980 mapping.

FIGURE 4

Right: The map shows the land in agricultural use in 1980, and the legend at the bottom shows the total acreage of each crop.

Papaya ac es n he 980 ALUM eflec s bo h p an ed ac es and ands ha we e a ow b n papaya o a on Papaya ac es n he 20 5 Base ne map eflec s j s he p an ed ac es



University of Hawai'i Hilo

SDAV UH Hilo

Hawai'i's Agricultural Land Utilization (1980)

Source: Department of Agriculture and State Office of Planning

Department of Agriculture
State of Hawaii

FORCES RESHAPING AGRICULTURE 1980-2015

Much has happened in Hawaiian agriculture in the 35 years since the 1980 ALUM data were released. Of the fourteen sugar plantations, thirteen have closed. Only the largest and most concentrated Hawai'i Commercial & Sugar (HC&S) plantation in the central plain of Maui is still in operation, and it, too, announced plans to shut down in early 2016. Pineapple plantations on Lana'i and Moloka'i closed, as did plantations and processing canneries on 'Oahu and Maui, leaving only a small number of fresh pineapple growers on 'Oahu and Maui.

Beginning with the closure of Puna Sugar Co. in the early 1980's, there was a cascade of sugar and pineapple plantation shutdowns that peaked in the 1990s and lingered into the early part of the 21st century. Corporate plantation profits had languished for decades and the value of land assets under many of plantation operations had increased substantially. International competition for sugar was increasingly shaped by geo political forces beyond Hawai'i's control, and new sources of sugar and alternative sweeteners were on the rise.

Pineapple operations also faced increased global competition, due in part to the transfer of Hawai'i based technology, varieties, and methods to Third World nations where labor costs and environmental oversight were less demanding. The political power of the Big Five decreased substantially after WWII, and the rise of organized labor improved working conditions and added new costs to plantation operations. As a result of these and other factors, Hawai'i's largest plantation companies began investing off shore and developing their real estate interests to harvest the value of "underperforming" agricultural land assets.

Plantation shutdowns were traumatic events in rural communities shaped by more than a century of mono-crop stability, ascribed leadership patterns, and long accepted community practices.

Plantation shutdowns were traumatic events in rural communities shaped by more than a century of mono crop stability, ascribed leadership patterns, and long accepted community practices. Sugar regions like the Hilo/Hāmākua coast or the South Shore of Kaua'i experienced multiple shutdowns that accentuated their impacts and rippled through island economies. Uncertainty about the future of rural economics and land use was widespread.

With each plantation shutdown went the equipment and manpower to manage large land areas, fight wildfires, repair roads, and maintain drainage and water delivery systems. Additionally, when the green sugar blanket was rolled back, the realities of each region's diverse ownership patterns re emerged. Public and private lessors were handed back control of their lands, many for the first time in over a century. Access to the mountain and the shoreline, once enabled by plantation management, were fenced and gated to protect cattle operations or provide privacy to new owners. Gone was open access to shorelines for fishermen, hunters, and gatherers in communities.

Right: Plantation closures were transformational events in rural Hawai'i. Thousands of acres were sold or returned to longtime lessors. New communities grew, and old leadership lost its cohesive voice. Many plantation workers took their specialized skills elsewhere, and much of the heavy equipment was sold at auction. While these changes happened differently in each region, their collective impact profoundly impacted the shape of rural Hawai'i today.

Pho o co esy o O son T s

E-HERALD
Sugar To Close
Hamakua Sugar calls it quits — closes March 31
Land Ownership Patterns Fracture
Communities are Transformed
SUGAR
Old ways die, a new spirit emerges
Sugar going, going, gone
Leadership is Redefined
Plantation worker leave the fields for work elsewhere
LAST HAUL FOR SUGAR
Waialua Sugar Co.'s shutdown means end of an era on Oahu and the loss of 174 jobs in this North Shore community
Ka'u Sugar
sugar takes a first step to oblivion
Heavy equipment is auctioned off and with it goes the capacity to manage regional infrastructure

FORCES RESHAPING AGRICULTURE 1980-2015 cont'd.

Government efforts to cushion the transition and rebuild rural economic vitality were initiated as each plantation closed. In the early 1970's the Kohala Task Force spent millions of public dollars to underwrite new business that promised to be large enough to absorb laid off union labor, to little avail.

Subsequent efforts under the Rural Economic Transition Assistance Hawai'i (RETA H) program offered small farmer support to get new crops established and rebuild local economic diversity. This effort was funded under what is now the National Institute of Food and Agriculture, part of the USDA. Over the seven years of operation in Hawai'i, RETA H dispersed $20 million in grants to 90 different agricultural projects that encompassed about 18,000 acres of former cane land.

As with all economic development efforts, some projects sustained operations after the money was gone while others did not.[1] Smaller private investments were made in developing new agricultural endeavors including the expansion of coffee and macadamia orchards and the growth of diversified crops in productive areas.

The largest single private investment in new agriculture was a forestry project on portions of the former Hāmākua Sugar Co. lands purchased in a foreclosure auction by Kamehameha Schools (KS). Approximately 17,000 acres of KS lands in rural Hilo and Hāmākua were leased to Prudential Timber Company and planted in eucalyptus trees for fiber export and future forest industry development. Other KS lands in Ka'ū were also planted in eucalyptus, as were roughly 4,000 acres of former pastureland in Hāmākua belonging to Parker Ranch. Forestry has grown to be the second largest agricultural endeavor in the state.

Another large private investment in Hawaiian agriculture occurred in the seed industry. As larger seed and chemical corporations found value in the research and the growing capacity of Hawai'i's former cane lands, they began to expand operations and purchase fee simple title from exiting landowners.

For much of the state, the quick solution for former plantation acreage was to fence fields and raise cattle. This proved to be a relatively inexpensive management practice and was a way to keep the weed species in check and reduce real property tax liabilities. It also enabled ranches to expand operations on some of the better agricultural land that had formerly been in plantation use.

Perhaps the biggest factor shaping agricultural land use since 1980 has been a profound change in land ownership.

Big Five companies like Amfac, C. Brewer, and Theo. Davis simply disappeared after selling their once vast land holdings to hundreds of new buyers, large and small. The breakup of the Campbell Estate and sales of land by Castle and Cooke, Dole, Grove Farm, Maui Land and Pineapple, and multiple smaller estate holdings are still reshaping the patterns and potentials for new agricultural land use. Long term landowners like KS, the W.H. Shipman Estate in Kea'au, and the Robinson family on Kaua'i face new challenges to keep their lands active and to produce sufficient revenue to support their fiscal expectations. State land managers are similarly challenged to redeploy public lands and waters to more diversified uses.

New agricultural land buyers are often wealthy individuals with a range of visions and expectations to enhance

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their land values. Buyers like the Edmund Olson Trust in Kaʻū and South Hilo have invested heavily to promote new agricultural ventures in their regions. Others have used federal income tax credits to support the planting of new coffee and fruit orchards or exotic hardwoods. Still others bought large tracts and resold them in smaller, pre existing parcels or as part of new land developments. This fracturing of historical land ownership patterns permanently ended large scale plantation operations and laid the foundation for what agricultural land use looks like in 2015 and beyond.

The sale of agricultural lands at prices that exceed the farmers' ability to farm economically is one of the strongest forces working against sustained agriculture in Hawai'i. Once productive lands in places like Kula, Maui and North Shore, Kaua'i have been transformed into country estates. Some of the potential for commercial agriculture has fallen victim to the global real estate market statewide.

Agricultural labor has transformed significantly since1980. Hawai'i's plantation communities had evolved into a highly structured and union represented labor force that played a large role in state politics and provided some valuable certainty for many workers. Today, aside from the HC&S plantation on Maui, some macadamia nut and papaya packing operations, and larger fresh pineapple operations, the union influence in supporting agricultural labor is a shadow of its former presence. Diversified farm activities generally lack the scale needed to support organized labor, and the smaller, more tenuous nature of today's operations cannot absorb the fixed costs associated with union contracts Many of today's independent farmers are new immigrants working with family members and are an increasingly important part of the current labor pool. Crops like coffee, macadamia, and some tropical fruits rely heavily on an influx of seasonal workers to cover harvest peaks. Many of these workers move on to other crops on the mainland when the Hawai'i harvest is complete.

HAWAI'I'S AGRICULTURAL FOOTPRINT 2015

Hawai'i's current agricultural footprint is a shadow of what it was in 1980. The once vast expanse of sugar and pineapple operations has been replaced with a scattering of much smaller farm operations throughout the state. Farming in Hawai'i has become more intensive, more decentralized, and more diverse. Figure 5 at right shows a summary by crop category, and Figure 6 at far right shows Hawai'i's agricultural footprint in 2015.

SUGAR CANE

In 2015, sugar (38,810 acres) remains Hawai'i's largest crop. Virtually all of it is associated with HC&S, whose longevity is attributed to near ideal conditions in central Maui: a consolidated location, reasonably flat land, good soil, effective management, persistent sunshine, and several sources of surface and ground water. HC&S reports 36,000 acres in production and the remaining 2,800 acres account for roads and support facilities.

In early 2016, HC&S announced plans to to end sugar operations on Maui. The next era of agricultural land use on Maui is still unclear and will take years to settle in.

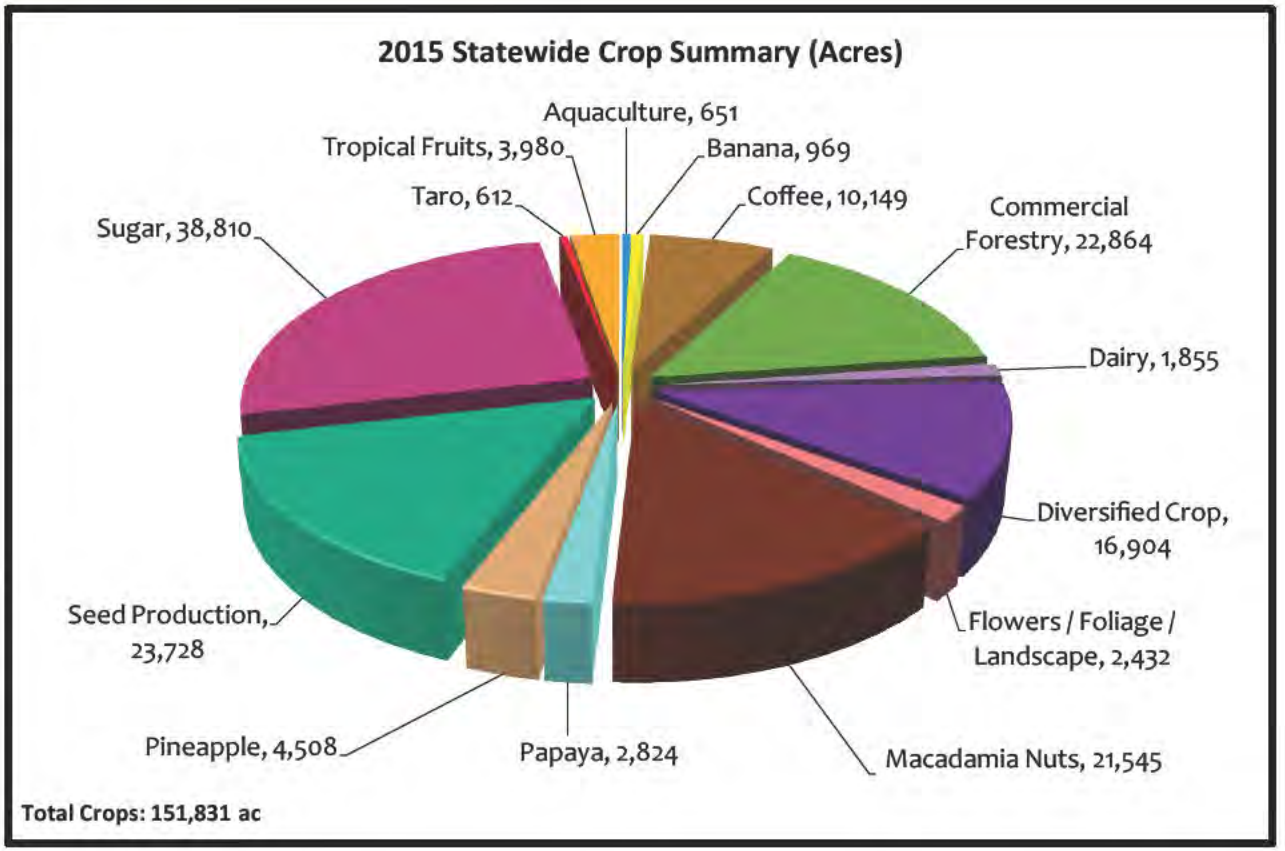
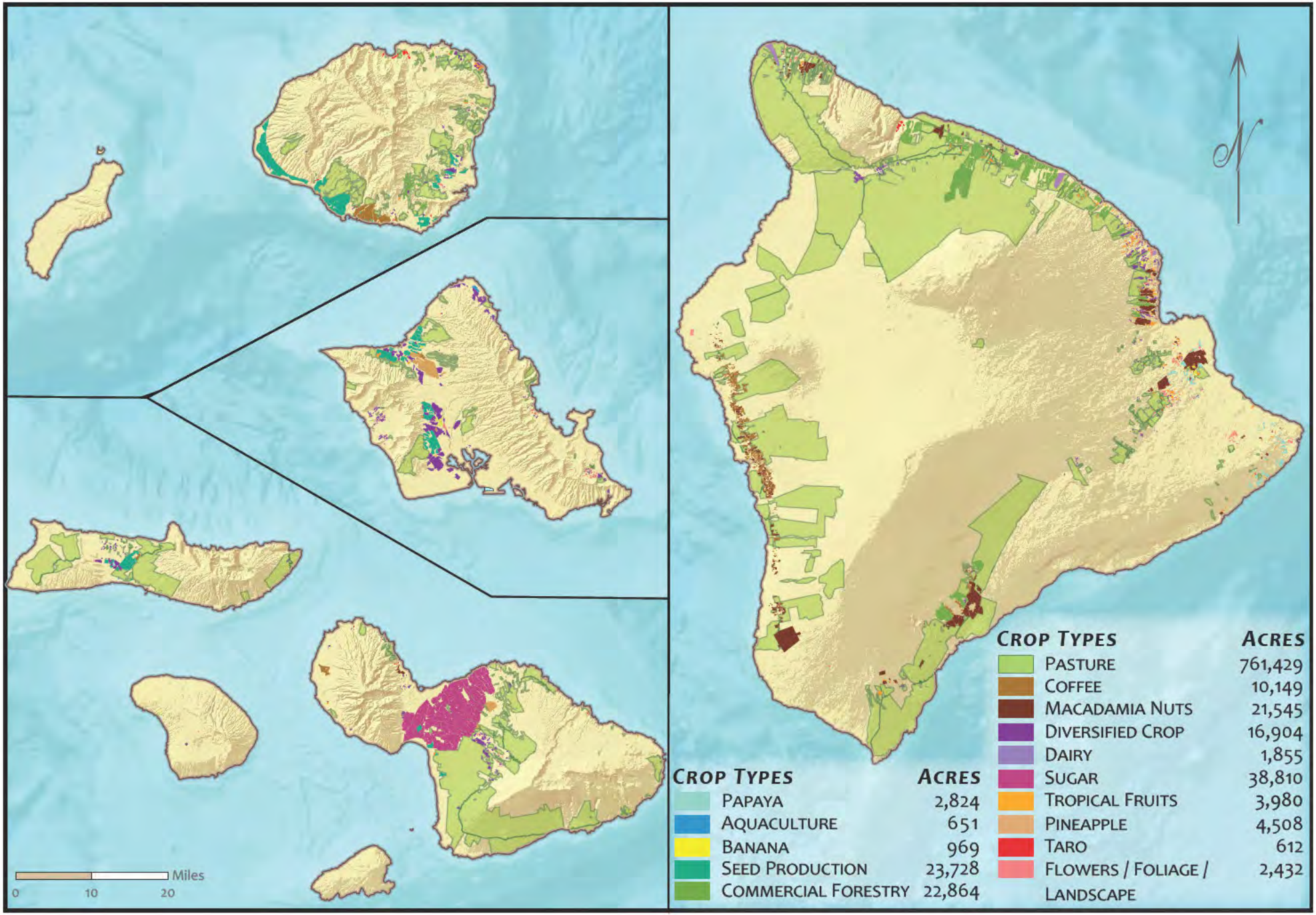


FIGURE 5

Above: Summary of total crop acres by crop category in 2015

FIGURE 6

Right: Hawai'i's agricultural footprint 2015



University of Hawai'i Hilo

SDAV UH Hilo

Hawai'i Agricultural Land Utilization (2015)

Department of Agriculture
State of Hawaii

SUGAR CANE CONT'D.

In 2014, HC&S produced between 150,000 and 200,000 tons of sugar and 60,000 tons of molasses on 38,800 total acres. They employed 750 employees with an annual payroll of $35 million. Mill and small hydro plants produced sufficient power to run milling and water pumping needs as well as 6% of Maui's total electrical demand.[1]

Portions of the Maui community have changed in 30 years. Many new residents are less willing to accept production practices like cane burning or the taking of stream water from windward stream networks to irrigate crops miles away. Legal and political pressures to change are a few of the externalities that shortened the life of Hawai'i's last sugar operation. Fortunately, HC&S has a long history of looking for alternative crops and ways to support new agricultural ventures.

Sugar cane is also grown by several small farmers on 'Oahu, Maui, and Kaua'i, mostly for raw cane juice to mix with local fruit juices in natural food products and to be processed into rum by several boutique distillers selling high end Hawai'i branded rum beverages.

1 Image courtesy HC&S.

Left: Sugar in central Maui is the largest single crop produced in the state.

Seed Production

The seed industry (23,720 acres) is the second largest land user in the state next to sugar. Its largest footprint is on the island of Kaua'i (13,230 ac.) followed by 'Oahu (7,350 acres), Moloka'i (2,340 acres) and Maui (750 acres). Five international companies make up 99% of this industry. The remaining 1% is comprised of smaller companies that grow crops such as sun hemp for seed and a variety of locally adapted vegetable crops for island farmers. Seed corn accounts for 95% of the seed crop grown in the state[2].

Seed companies can take advantage of Hawai'i's year round growing season to produce 3 4 crop cycles annually. In addition to research, several companies grow selected seed varieties as a source of planting material that gets multiplied on the mainland and then sold to farmers around the world. Seed exports in the 2013 2014 season were estimated to be 7.97 million pounds from a total of 4,840 harvested acres[3].

2 Loudat and Kasturi, Hawai'i Seed Crop Industry, Current and Potential Economic and Fiscal Contributions, 2013

3 USDA NASS, Pacific Region-Hawai'i Seed Crops, May 5, 2015

In 2013, the Hawaiian seed industry reported that it employed 1,397 management and farm workers and 96 workers associated with capital improvement projects. The industry claims to contribute over $264 million annually to Hawai'i's economy in the form of wages, taxes, and the purchase of agricultural materials and supplies[4]. Since the industry does not assign a value for the crop they produce, they calculate their economic contribution in terms of operational expenditures and not farm gate values.

Seed production is a less intensive user of land than most agricultural crops. The industry generally farms plots of 1 5 acres at a time with each planting area surrounded by a buffer zone to protect research objectives from being impacted by pollen drift. This buffer zone is an integral part of the seed industry agricultural practice and adds considerably to their overall footprint. The industry estimates that they farm only about 25% of the arable lands under their control at any one time. In addition, the seed companies often plant cover crops and periodically mow portions of their arable lands to build soil fertility and reduce windblown dust from open acres. Some companies are also exploring ways to partner with local farmers to grow crops on portions of their fallow fields.

4 Ibid

The rise of biotechnology as a tool to improve production and pest and herbicide resistance in a range of large commodity crops has grown rapidly in the last 20 years. The USDA's Economic Research Service reported in 2015 that over 90% of the corn, cotton, and soybean planted in the U.S. contains at least one of several genetically modified (GM) traits. While genetic seed engineering has been a boon to many farmers, their use has also become an increasingly controversial topic both locally and globally. Legislative efforts to ban GM crops have been proposed in several Hawai'i counties, and efforts to force labeling are beginning to gain traction in a variety of political environments nationally.

In addition to the large seed companies, several smaller farms produce seed for local use. The University of Hawai'i agriculture program has long been a source of locally adapted vegetable seed for island farmers. There are also small farms growing cover crop seed such as sun hemp and selected vegetables. These small scale seed operations are mapped as diversified crops in this baseline as seed production is most often just a part of their activities.

See photo on next page

HAWAI'I'S AGRICULTURAL FOOTPRINT 2015 cont'd.

Left: This aerial image of Kualapu'u, Moloka'i, shows how seed producers farm small plots surrounded by open land that serves as pollen buffers to prevent cross fertilization of research seeds.

Image co esy o Goog e Ea h and D g a G obe Med a

Commercial Forestry

Harvester at work on the Hāmākua Coast. Eucalyptus logs are bound for shipment to China where they are used to produce construction grade plywood, furniture framing, and pallet material for shipping among other things.

Co esy o B S o mon , Ame can Fo es Managemen , Inc

The third largest crop footprint in Hawai'i is commercial forestry at 22,860 acres. This is a category that was not a significant part of Hawai'i's agricultural portfolio in 1980. Most new plantings of forest products began after 1990, although smaller research plantings occurred prior in several regions statewide. The bulk of this new era of commercial forestry was planted on Hawai'i Island along the Hilo/Hāmākua coast and to a lesser degree, in the Pahala area of Ka'ū and on Kaua'i. The largest planting occurred on approximately 17,000 acres purchased by KS following the foreclosure of Hāmākua Sugar Co. These lands and others from Parker Ranch were leased to several investment interests and planted in eucalyptus varieties to produce wood fiber and biomass for energy production.

The first efforts to harvest the fast growing eucalyptus trees on the Hāmākua coast began in 2014. Logs are shipped out of Kawaihae Harbor to China for plywood veneer and other uses. These Hawai'i Island plantings also offer significant opportunity to produce a sustainable source of biomass for local electrical energy production. One opportunity may exist to produce up to 20MW of electricity to HELCO when the old Hilo Coast Processing power plant facility (aka Hu Honua) reopens. Establishing a steady market for biomass derived from smaller logs and tree tops in the commercial stands is an important step in securing a sustainable, multi product forest industry in the state.

On Kaua'i, roughly 1,300 acres were planted with eucalyptus in the Knutson Gap area. There is now a 9 MW power plant on the island to burn biomass from these trees that generates electricity for the Kaua'i Island Utility Cooperative (KIUC). Another 380 acres of exotic hardwoods have been planted near Kilauea on Kaua'i's north shore for the production of timber and specialty wood products. The rising global sensitivity to harvesting hardwoods from native forests around the world feeds a growing market for exotic hardwoods that can be produced in a more sustainable fashion from timber stands planted solely for the purpose of future harvest. This is also true for the local Hawaiian hardwood such as koa. There are multiple areas around the state where koa reforestation is occurring, much of it for native habitat restoration and cultural use. Most of these koa plantings on conservation land were not counted in this baseline because they were not commercial in nature.

HAWAI'I'S AGRICULTURAL FOOTPRINT 2015 cont'd.

Macadamia Nuts

Macadamia nut orchards make up the fourth largest crop footprint in the state, with 99% of the 21,400 acres planted on Hawai'i Island. This represents a 50% increase in acreage since 1980. Most planting has taken place in the Ka'ū, Puna, and South Hilo districts, but a significant number of smaller plantings exist on the Hilo Hāmākua coast and on the Kona coast where they are often intermixed with coffee.

Nut processing plants in Kea'au and Kawaihae produce roasted nuts and packaged candies for sale. Portions of the production are also shipped out in bulk to ice cream, cookie, and other food producers in the U.S. and internationally. Hawai'i's macadamia nut industry was largely built on the strength of the state's visitor industry. Roasted nuts and confections are a popular gift item to take home from Hawai'i, and over 50% of the production is sold locally and carried home by island visitors[1].

World prices for macadamia nuts have fluctuated over the years, which has made it periodically difficult for smaller island producers to sell their nuts at any price. Hawai'i is in global competition with growers in Australia, Brazil, and Kenya among others. As an example of how global the agricultural market place has become, one of Hawai'i's largest macadamia producers is currently shipping husked and dried in shell nuts to China to be hand cracked and shipped back to the mainland U.S. for processing. How long this practice will continue is to be determined, but it is an example of the lengths to which producers go to remain competitive.

Far left: A large macadamia orchard. Photo courtesy Andrew Hara.

Left: macadamias nuts ripening for harvest.

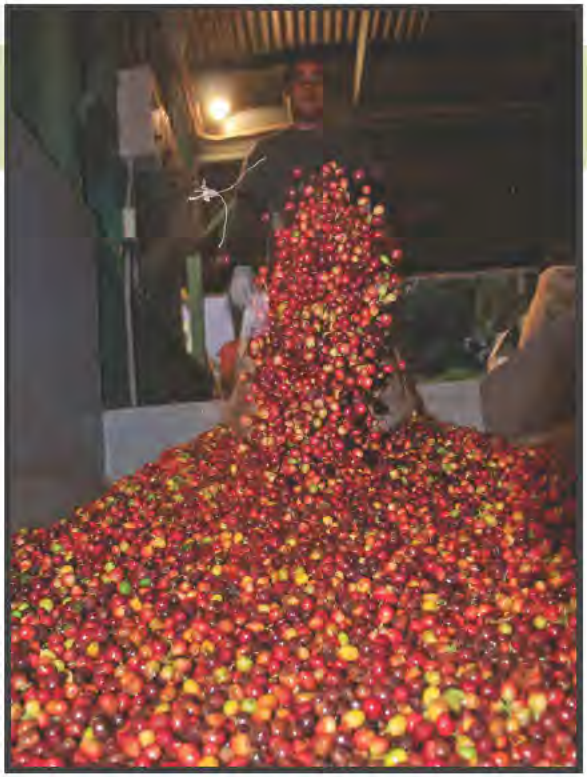
Based on d sc ss on w h seve a macadam a n p ocesso s

COFFEE

Coffee claims the fifth largest crop footprint in the state at 10,100 acres. Industry figures indicate in 2014, Hawai'i produced 8.1 million pounds of parchment equivalent coffee from 7,900 harvested acres with gross sales of $54.3 million[2].

Kona Coffee has been the hallmark of the state's coffee production for decades with an international reputation for quality. Roughly 1000 small farms, ranging in size from two to several hundred acres, stretch across 35 miles of North and South Kona between 1,000' and 2,500' elevation. In 2014, Kona growers produced approximately 20 million pounds of coffee cherry from 4,500 harvested acres[3]. Kona has multiple processing and roasting options, so small farmers can sell their crop as fresh cherry, as dried green parchment, or roasted and packaged for direct sale by internet and other means.

The recent introduction of the coffee berry borer beetle (CBB) has presented some significant challenges to the Hawai'i coffee industry. Although coffee cherry prices remain high, the percentage of CBB infested



Coffee cherries ready for pulping. Co esy o G eenwe Fa ms

beans varies from one grower to the next. In recent years, several processors who purchase coffee cherry have paid high prices, about $2.00/lb. as of 2015, regardless of the level of infestation. This practice risks impacting the quality of beans in the international marketplace. Preserving the quality reputation of Hawai'i's Coffee products is critical to retaining the strong industry reputation that the state currently enjoys.

Also located on Hawai'i Island, Ka'ū Coffee has a particularly unique story. Former cane workers planted coffee on fallow plantation fields following the shutdown of C. Brewer's Ka'ū Agribusiness Co. in the late 1990's. They were the pioneers in the Ka'u coffee industry that eventually established a celebrated reputation for high quality beans, many of which have placed well in international coffee tasting competitions. Selling nearly as well as Kona Coffee, Ka'ū produced 3.27 million pounds of cherry from roughly 500 harvested acres in 2014[4].

Beginning in the late 1980's, 7,600 acres of coffee were planted in large plantation style orchards on 'Oahu, Kaua'i, Maui, and Moloka'i. Located on relatively flat, arable lands that were formerly in sugar and pineapple production, these new plantation style orchards accommodate mechanical harvesting and have built their own distinct brand recognition. Other small scale coffee plantings have also sprung up on several farms in Kilauea, Puna, Hāmākua, and parts of upcountry Maui. Each of these small producers compete for their own quality reputation at prices well above their commodity coffee competition.

2 Presentation at the 2015 Hawai'i Coffee Growers Association
3 Ibid
4 Ibid

HAWAI'I'S AGRICULTURAL FOOTPRINT 2015 cont'd.

DIVERSIFIED CROPS

Diversified Crops comprise the sixth largest crop land use category in the state at 16,900 acres. This category includes a broad array of vegetable crops including leafy vegetables, dryland taro, potatoes, melons, cucumbers, tomatoes, ginger, etc. Fresh produce is grown mostly for local consumption, with some notable exceptions, on farms ranging from less than one acre to several thousand acres. 'Oahu is where most of Hawai'i's diversified agriculture is concentrated with more acres in diversified crop production than the rest of the state combined[1]. The bulk of this farming is conducted on 7,300 acres in the central plain of 'Oahu from 'Ewa to Hale'iwa on some of the state's best A and B class agricultural soils.

Other areas with concentrated diversified crops include Kahuku Punalu'u on 'Oahu (1,500 acres), Kula on Maui (1,150 acres), Ho'olehua on Moloka'i (930 acres), and North and South Hilo on Hawai'i Island (2,000 acres). Additionally, there are smaller concentrations of diversified farms in Kilauea/Moloa'a on Kaua'i (400 acres), Wai'anae on 'Oahu (520 acres), Lalamilo Puukapu (500 acres), and the Hāmākua Coast of Hawai'i Island (200 acres). Small scale (less than three acres) diversified farming takes place in virtually all districts in the state.

Left: Lettuce growing in Lalamilo Farm Lots on Hawai'i Island.

Right: Pineapples growing in Kunia on 'Oahu.

While the majority of the diversified crops grown in Hawai'i is for local consumption, there are two diversified agriculture crops that are grown primarily for the export market. On 'Oahu, roughly 500 acres are used to grow basil and other Asian spices (Thai ginger, moringa, betel leaf, and others[2]) that are air shipped to markets across the U.S. and Canada. Approximately 300 acres of these crops are planted in Wai'anae and several hundred more acres in the Kunia, 'Ewa, and the Kahuku areas. On Hawai'i Island, the major diversified crop export is Okinawan

1 'Oahu diversified crop production takes place on 9,800 acres Production from the neighbor islands is from 7,000 acres

2 Ag Hawai'i, publication of the Hawai'i Farm Bureau April-June 2012

sweet potato, which is grown on as many as 500 700 acres annually in South Hilo. This crop is treated at the irradiation facility in Kea'au to eliminate a boring beetle and impede sprouting and then shipped to Asian markets on the West Coast. In 2013, over 12 million pounds of sweet potato were treated and shipped out of Hawai'i Island to mainland markets[3].

Tracking the present day production of local diversified crops is difficult. In 2008, the DOA's Statistics of Hawai'i Agricultural publication tracked 35 different vegetable crops and estimated both their local production and import volumes. At that time, the State's Agricultural Statistics Report estimated that Hawai'i was producing 34% of its consumed vegetables. Unfortunately, in 2008 the State DOA laid off 25 agricultural statisticians, and since that time, there has been very little centralized data collection on a crop by crop basis. Tracking local farm production is further complicated by the rise of farmers' markets around the state in which sales are generally in cash, and farmers often report only a portion of their sales. Farmers tend to get their best returns from direct sales to consumers, restaurants, and other outlets, but there is no way to measure the volume sold this way or the revenues derived from it. Imports are also increasingly hard to track as "just in time delivery" in mixed product containers has become the norm for most retailers. Shipping records provide little useful information on hundreds of food outlets statewide.

Pineapple

Hawai'i's pineapple industry at 4,600 acres has shrunk substantially since the 1980's and is led by a small group of producers on Maui and 'Oahu. Dole Foods continues to farm roughly 3,000 acres in central 'Oahu, and the Haili'imaile Pineapple Company farms approximately 1,000 acres of the former Maui Pineapple plantation in Haili'imaile. A third grower farms smaller parcels in the Kunia area of 'Oahu. Present day pineapple production is strictly a fresh fruit business since the closure of the Dole, Maui Land and Pineapple Co., and Del Monte canneries. Fresh pineapple is sent to the mainland U.S., Canada, and Japan in bulk shipments and in small carry on boxes by visitors returning home.

The local fresh fruit market benefits from local pineapple producers who provide a nearly year round supply to local markets, restaurants, and hotels.

3 Personal communications, Eric Weinert, Hawai'i Pride, E-Beam processor

HAWAI'I'S AGRICULTURAL FOOTPRINT 2015 cont'd.

TROPICAL FRUIT

A wide range of tropical, sub tropical, and temperate fruit crops are grown commercially on 3,990 acres, each with its own seasonal pattern and market opportunity. Crops include mango, rambutan, longan, lychee, avocado, fig, breadfruit, jackfruit, dragon fruit, persimmon, and a mix of citrus (orange, lime, lemon, tangerine, etc.). Specialty fruit crops (abiu, soursop, jackfruit, finger limes, etc.) are being tested in small plantings. The fruit appears periodically in local markets.

Hawai'i Island accounts for 3,100 acres of the state's tropical fruit, largely in the Puna and South Hilo districts. Kaua'i has about 460 acres, 'Oahu has 220 acres, Kona 130 acres, Maui roughly 100 acres, and Moloka'i about 40 acres.

Fruit production is seasonal. For crops like mango, lychee, persimmon, and rambutan, fruit comes fast and, like many orchard crops, harvest volumes are very dependent on weather patterns that may have happened months prior to harvest. Longan can be induced to produce several fruitings per year and presents growers with an opportunity for year round sales. Several citrus varieties also have somewhat longer harvest windows, but large citrus growers on the mainland set the competitive price locally.

Hawai'i fruit exports to the west coast of the U.S. are constrained by treatment protocols aimed at keeping the Mediterranean fruit fly and other pests out of California's crops. Several of Hawai'i's fruits, including longan and rambutan, are being successfully treated for export with irradiation. Other crops do not fare as well during the treatment process.

The USDA approved new protocols for the export of Sharwil avocados to the West Coast, but the cost to construct the USDA certified packing facilities is proving to be a big hurdle for local avocado growers.

Both breadfruit and cacao are included in the tropical fruit category. There is a resurgence of breadfruit in the Hawaiian diet, but actual commercial crop production is still at an early stage. Breadfruit has a relatively short shelf life as a fresh fruit. This limits its market potential, but there are efforts to produce new, more stable products from breadfruit like breadfruit flour that could help generate future plantings.

Cacao is also a rising crop in Hawai'i's fruit portfolio. There are dozens of small cacao growers in the state, several of which are also processing their own beans and producing a variety of different local chocolate products. Cacao is a boutique crop for Hawai'i, producing a number of flavor variations and characteristics that can help distinguish it from other cacao producing areas.

A substantial number of tropical fruit trees have been planted throughout the state in small plots for personel use orchards. This promotes a decentralized and often non commercial trade in a variety of fruits harvested out of backyards. These private orchards

were not mapped for this project but should be acknowledged as a significant supply of available fruit that contributes to the local food supply.

Wetland Taro

Wetland taro is one of Hawai'i's most iconic crops with a deep cultural connection to Native Hawaiian culture. Grown on 610 acres where there is adequate stream water to keep the corm cool and saturated in the ground, taro produces a staple product appreciated around the state. This project mapped only wetland varieties of taro since they could be clearly identified in their wetland field setting. Commercial production of dryland taro is included in the Diversified Crop category for this report.

The Hānalei to Lumaha'i area of Kaua'i is the largest single concentration of taro production with 360 acres. Another 80 acres of wetland taro is grown in various other locations on Kaua'i, including former cane lands where water is provided by off stream irrigation.

Waipio Valley in Hāmākua on Hawai'i Island currently farms over 60 acres of taro, and 'Oahu's Ko'olauloa and Ko'olaupoko districts account for another 50 or more acres. Maui produces wetland taro on roughly 55 acres, primarily in the Keanae and Wailua areas.

Other Maui fields are located along Waihe'e, Waikapū, Kahakuloa, and Kaua'ula Streams.

Taro production is generally tied to the free flow of stream water, which is diverted into saturated fields (*lo'i*) by open ditches (*'awai*). Competition for this stream water by large agricultural users and some domestic water providers has resulted in a variety of extended legal battles over water use rights and the appropriate methods to deliver water to wetland taro producers who have a constitutional right to use the resource for taro. In addition to these legal battles, taro producers also face issues like invasive apple snails and taro blight. Some areas are also impacted by the presence of protected native water birds that elect to breed in the wetland environment.

The primary market for wetland taro is the production of poi. Poi is a staple in the Hawaiian diet and has become increasingly expensive in local markets. Some taro growers sell their corm for around $.70 per pound. Other taro farmers elect to process their own poi for direct sales to consumers.

Papaya

Commercial papaya production is concentrated in the Puna District on Hawai'i Island, in Ho'olehua on Moloka'i, and on the North Shore of 'Oahu on 2,800 total acres. Papaya's footprint, particularly in Puna, is larger than the actual producing acreage of the crop. Papaya farmers typically fallow their fields at the end of each three to four year cycle to minimize soil viruses and nematodes. In Puna, there are three to four times as many acres in rotation at any one point than acres actually producing fruit. For purposes of this study, only fields in active production were mapped. In 1980, both producing and fallow fields were mapped for a total of 12, 290 acres.

HAWAI'I'S AGRICULTURAL FOOTPRINT 2015 cont'd.

PAPAYA CONT'D.

Approximately 50 % of Hawai'i's papaya production is exported to mainland and other markets. The remainder stays in Hawai'i to serve local resident and visitor demand[1]. Four papaya packing houses in the Kea'au area use a heat treatment for fruit fly prior to shipment to the West Coast. There is also an E Beam irradiator to treat papaya and other tropical fruits for export.

Each packinghouse contracts its own set of farmers to plant on lands provided by the packinghouse. Approximately one third of the growers in Puna are independent of the packinghouses. These growers lease their own land and either sell to local markets or ship to places like Canada that do not require fruit fly treatment. There is one papaya grower on Moloka'i and several on 'Oahu who are both independent and sell most of their product locally.

Papaya Ringspot Virus (PRSV) first arrived in Hawai'i in 1937 and had majorly impacted 'Oahu's papaya industry by 1950. Within twelve years, production on 'Oahu dropped by 94%. This shifted the center of local production to the Puna region on Hawai'i Island.

In the 1990's, PRSV spread from backyard gardens to commercial papaya crops in Puna and threatened to eliminate the industry as it had on 'Oahu. In 1998, two new GM varieties were introduced that included a bit of the PRSV DNA as a vaccination against the disease. This introduced GM succeeded in limiting the spread of PRSV and essentially saved Hawai'i's papaya industry[2]. The GM of papaya has impacted marketing, particularly in areas like Japan where barriers exist to importing GM crops. Some local and mainland markets also express caution about GM products in general. Not all of Hawai'i's papaya crop has a

1 Personal communications with leaders in the papaya industry.
2 Plant Management Network, http://www.plantmanagement network.org/pub/php/review/2003/papaya/

transgenic gene however. In Puna, several growers still plant non GM solo papayas but in isolation from other fields. Moloka'i is still PRSV free, and there is a grower on 90 acres producing organic, GM free fruit selling locally and on the mainland U.S. 'Oahu's papaya production takes place in Laie, Kahuku, and in the Waialua area. There is no heat treatment facility on 'Oahu to support exports, but a new irradiator in Kunia offers opportunities to expand papaya exports out of state.

Left: Papaya packing at the Calavo Packing Plant in Kea'au.

Image co esy o E c We ne

Right: Anthuriums ready for sale at Green Point Nursery in Pana'ewa.

Flowers, Foliage & Landscape

The 2,420 acres of flower, foliage, and landscape industries produce a wide variety of crops including cut flowers, ti leaves, potted orchids, anthuriums, landscape plants, grass sod, foliage nurseries, and field stock. Two thirds, 1,610 acres, are on Hawai'i Island, and over 80% of Hawai'i Island's production is located in the South Hilo and Puna regions. Other regions with strong foliage and landscape productions include Waimānalo on 'Oahu, Kaloko Ag Park in Kona, and Puhi on Kaua'i.

National Agricultural Statistics Service (NASS) data from the 2012 Agricultural census indicates this category of crops has experienced a significant decline in Hawai'i since the last census report in 2007. Farm sales for a combination of floriculture crops dropped from $75.7 million to $45.6 million. Some of this decline may be due to cycles in the housing market and international competition in the orchid and cut flower businesses.

Purchases of landscape materials and house plants fell off as housing and resort development languished during the most recent recession cycle. Other factors include stiff completion from Asian and other markets which produce cut flowers and potted orchids at prices that compromise Hawai'i producers' ability to sustain profitability.

Large areas in the flowers and foliage crop category are covered in shade cloth and green houses where plants are potted in growing medium and put on benches until they reach market conditions. Similarly, anthurium and orchid industries grow their products in cinder and imported soil medium and are therefore not dependent on surrounding soil conditions. The grass sod industry also grows its product on a base of

HAWAI'I'S AGRICULTURAL FOOTPRINT 2015 cont'd.

FLOWERS, FOLIAGE & LANDSCAPE CONT'D.

compost laid on top of large plastic sheets. Sod does not require lands with rich soil but prefers a flat terrain with good drainage.

This sector of Hawai'i's agricultural production includes some of the state's most iconic products, including tropical flowers, lei making materials, palm trees, and the lush plant material that visitors associate with being in Hawai'i. Recent years have seen unprecedented efforts by various portions of the foliage and flower industries to collaborate across the breath of this crop category to keep Hawai'i products on the top of mind for U.S. and other consumers.

BANANAS

There are 970 acres of bananas in the state being grown commercially in plots over two to four acres. 530 acres, or 60% of the commercial production, are located in the Puna and South Hilo districts of Hawai'i Island, and the largest single banana grower is located in the Central Plain of 'Oahu. Bananas are grown in virtually every district in the state. Small wild or lightly managed stands appear throughout the state in gulches, along roadsides and in hundreds of rural backyards. As a result there is a significant informal supply of fruit that appears in farmers' markets and in peoples' backyards around the state.

There are many varieties of banana that grow in Hawai'i with some seasonal ranges and a variety of different tastes and uses. The primary market standard banana varieties include Williams, Valery, dwarf Brazilian, and apple bananas. Virtually all of Hawai'i's banana crop is consumed locally.

AQUACULTURE

There are 650 acres of aquacultural land in use in the state. The majority, 270 acres, is on 'Oahu, primarily in the North Shore/Kahuku area where shrimp is the largest product. Some Kahuku acres are not fully utilized and only a couple of acres remain in active production. Kaua'i has 180 acres, mostly in the Kekaha area where shrimp is the primary crop.

On Hawai'i Island there are 165 acres of aquaculture, much of it centered in Keāhole, Kona, at the Hawai'i Natural Energy Laboratory (NELHA). Products range from oysters, sea horses, and kampachi to algae and virus free shrimp. Several facilities also produce oyster fry to stock West Coast operations.

Right: Shrimp are raised in a sterile environment to produce high quality, disease free breeding stock.

Image co esy o Sh mp Imp ovemen Sys ems LLC

Livestock

Hawai'i raises a range of livestock including cattle, dairy cows, goats, sheep, horses, poultry and pigs. Poultry and pigs are raised in confined circumstances; others are raised in open pasture. This section focuses on the commercial livestock activities. Equestrian activities were not mapped as part of this study but deserve mention as contributing to the overall agricultural land use character. Horses are an assumed part of cattle ranching activities but available data doesn't specifically call out horse related activities.

Pasture

There are 761,420 acres of working pasture lands in the state as of 2015 with the large majority (73%) of these lands occuring on Hawai'i Island (see map on page 37). This number reflects a decrease from 1.2 million acres in 1980, which is due to several factors. One is the removal of large parcels from cattle operations by several large landowners. Another is the purchase of once active ranch lands by the National Park at Kahuku in Ka'ū and the Keamuku area in South Kohala by the U.S. Army for training purposes. The Department of Hawaiian Homes removed the bulk of their Hu'umula lands on Mauna Kea from cattle operations and KS ended pasture use at Keauhou Ranch near Volcano and in the Kona mauka area between Hualalai and Mauna Loa. New pasturelands have also been added since 1980 as former plantation lands reverted to pasture management. Some of these new lands can now be irrigated with former plantation water systems to improve year round grass growth for local beef.

Cattle

Hawai'i's cattle industry evolved from a small group of rugged *paniolo*, or Hawaiian cowboys, who captured wild cattle in the 1800s and early 1900s and built it into a mature industry. Until the 1970s, virtually all cattle were grazed, harvested, and consumed in the islands. Imported feed was

CATTLE CONT'D.

supplemented by locally grown field corn. Feed lots and slaughterhouses on 'Oahu, Maui, and Hawai'i Island processed the meat. During this period, Hawai'i's ranchers provided an estimated 30% of total beef demand for the state[1]. Today, hard working paniolo families and ranch hands manage 80% of the productive agricultural land in the state[2].

After global feed corn prices rose in the late 1980's, the practice of shipping young cattle to the mainland for grain and slaughter became more economically feasible than importing grain and slaughtering locally. This gave rise to the practice of shipping young steers and heifers in containers to the mainland where they could be trucked to available grass resources and ultimately delivered to feedlots and slaughterhouses in Oregon, California, and Colorado. These mainland facilities service millions of animals annually and operate with an economy of scale that cannot be duplicated in Hawai'i.

Ranches that focus on raising cattle to be sold before they are fully grown are referred to as *cow-calf operations*. There are many such operations across the cattle industry internationally. In 2014, two of Hawai'i's largest cow calf operations, Parker and Ponoholo Ranches in North Hawai'i Island, were among the top 25 largest such operations in the U.S.[3].

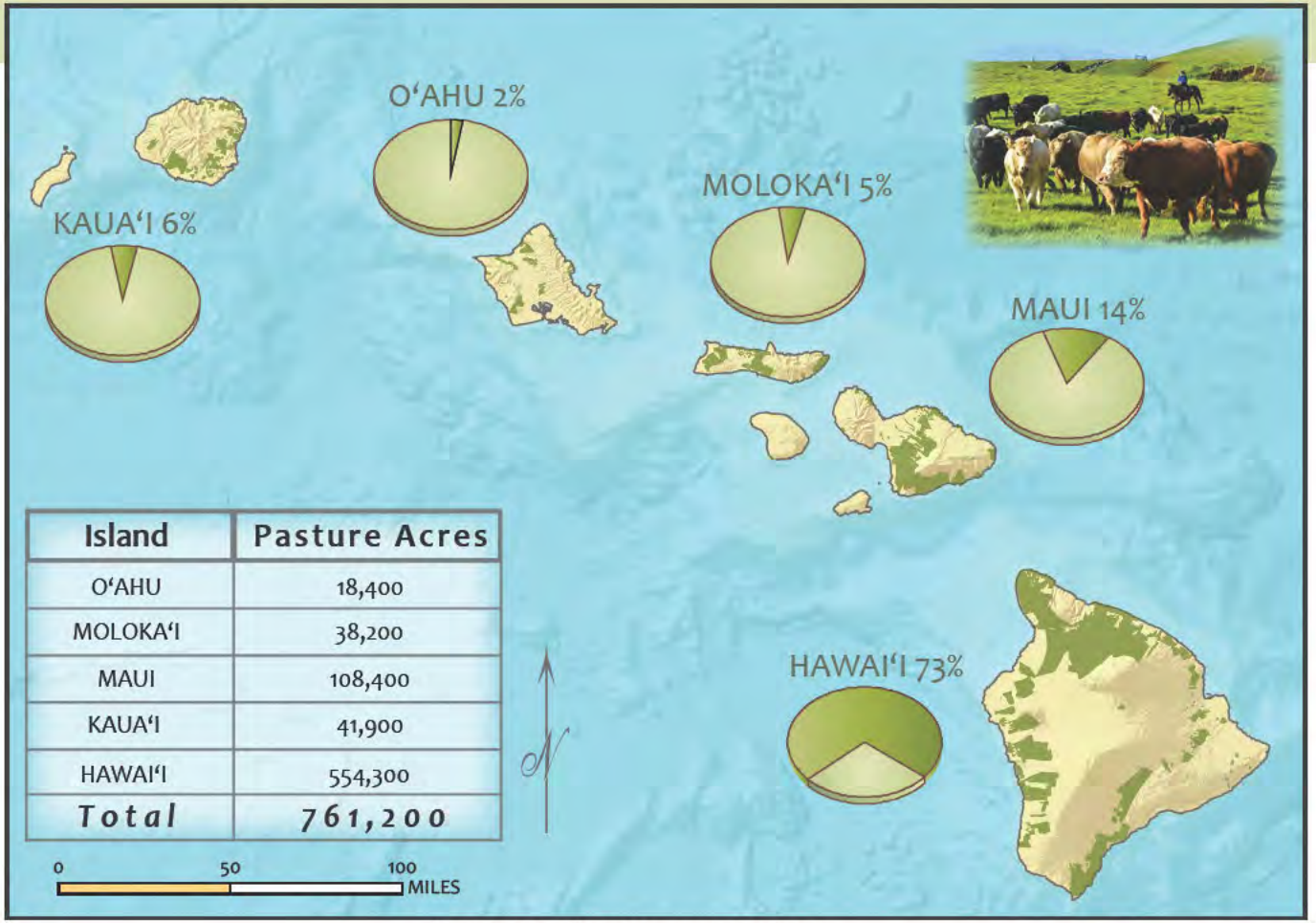
The majority of Hawai'i's marketed cattle are shipped to one of several ports on the West Coast of the U.S. and Canada. Some ranchers hold title to the animals through the fattening and slaughter process, others sell yearlings as they leave the ranch, and still others exercise the option to sell their animals on the mainland to herd consolidators at a variety of weights and locations. Cattle prices over the last several years are as high as they have ever been, and ranchers across the country are enjoying good years and rebuilding their herds after a long period of drought in the West. Prices are certain to adjust downward in 2016, but shipping Hawai'i's young cattle out of state is an important option for ranchers and is likely to remain a part of the local cattle industry into the future.

There are two certified cattle slaughterhouses on Hawai'i Island, three on Kaua'i, one each on Maui, Moloka'i, and 'Oahu. All of these operations are small by mainland standards and relatively expensive to operate. They are, however, the lifeblood of the local beef industry and important assets for Hawai'i's drive to be more food self reliant. Culled cows and bulls that have passed their useful service make up a significant portion of the local meat supply. This meat tends to end up in lower priced cuts and ground for burger and other uses. An increasing number of Hawai'i ranchers are choosing to keep their animals and sell their meat to a growing grass fed beef marketplace.

In 2014, the cattle industry shipped 32,900 cattle to the U.S. mainland, most of which were young steers and heifers[4]. USDA's Livestock Slaughter Report for 2014 found Hawai'i harvested 10,400 head statewide at an average live weight of 1,115 pounds for a total of 9.2 million pounds of meat[5]. This includes culled cows, bulls, and grass fed steers and heifers that produce both burger and better cuts of beef. As of January 2015, NASS reports Hawai'i's cattle herd to contain135,000 head.

1 Personal communications with Pono Von Holt, Pono Holo Ranch
2 Total crop and pasturelands in 2015 equals 913,260 acres 761,420 acres of pasture is 80% of that total
3 National Cattlemen's Beef Associations 28th annual edition of Directions; http://www.beefusa.org/beefindustrystatistics.aspx
4 Data from DOA Animal Control Branch based on veterinarian reports accompanying cattle shipments.
5 USDA Livestock Slaughter 2014 summary, April 2015, ISSN:0499-0544

Figures 8 and 9 provide a statewide look at pastureland based on annual rainfall. Rain is key to grass growth, so lands with significant amounts of both rain and sunshine are required for the development of local grass fed beef. A key to success in this market lies in the ability to affordably finish a steer on good, fresh grass to add weight and fat before harvest. Poorly finished local beef will have a negative impact on local consumers who can always purchase imported beef.



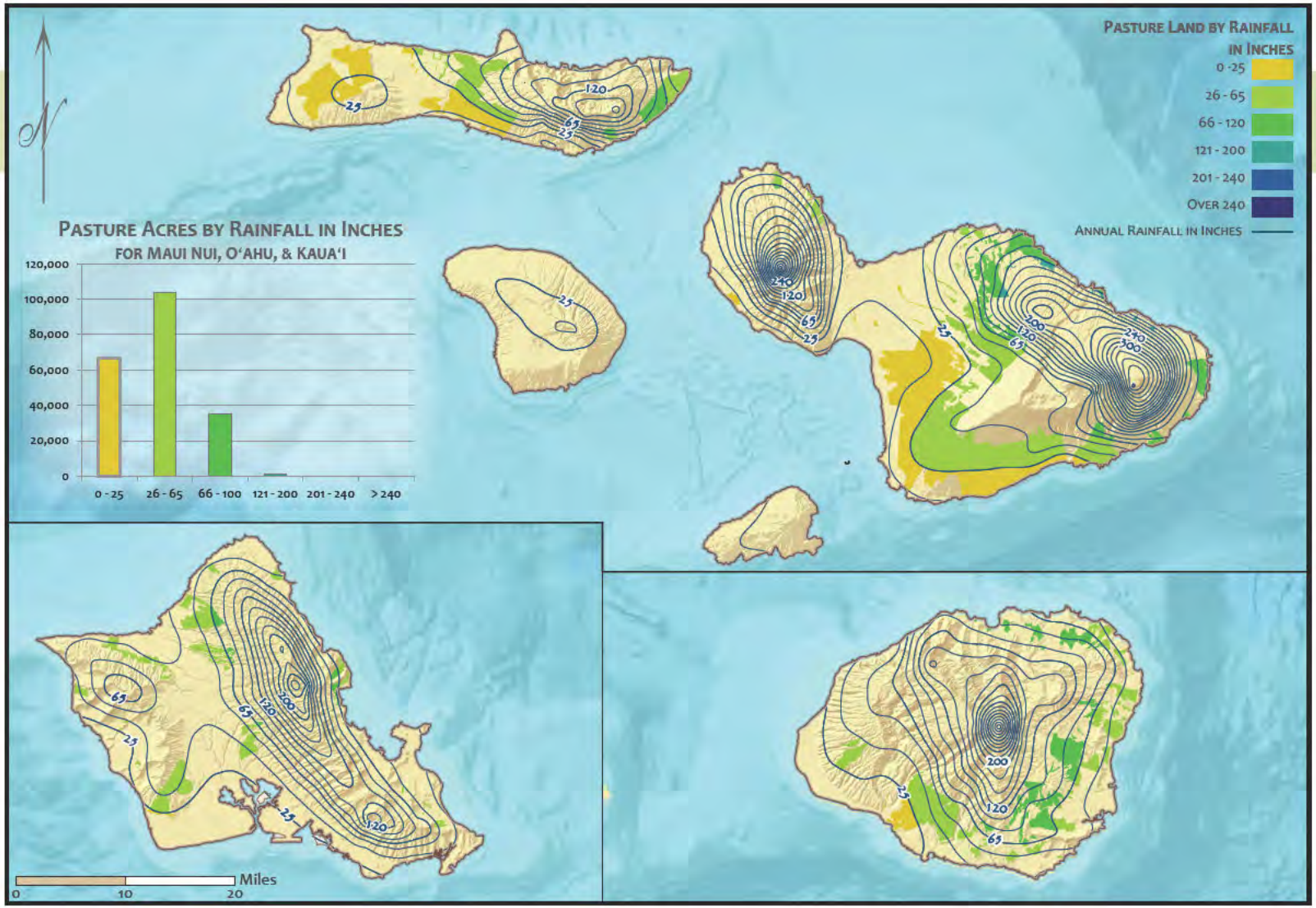
Island	Pasture Acres
O'AHU	18,400
MOLOKA'I	38,200
MAUI	108,400
KAUA'I	41,900
HAWAI'I	554,300
Total	***761,200***

FIGURE 7

Right: The map shows acres in pastureland in Hawai'i in 2015

ISLAND CONTRIBUTIONS TO STATEWIDE PASTURE ACRES (2015)

SOURCE: UPDATED FROM 1980 AGRICULTURAL LANDUSE USE MAPS



Figures 8 & 9

Annual rainfall is one of several key indicators of the ability of pastureland to support sustained grazing. The growth of a local grass-fed beef industry is dependent on being able to finish cattle on grassland with good quality feed to produce quality meat.

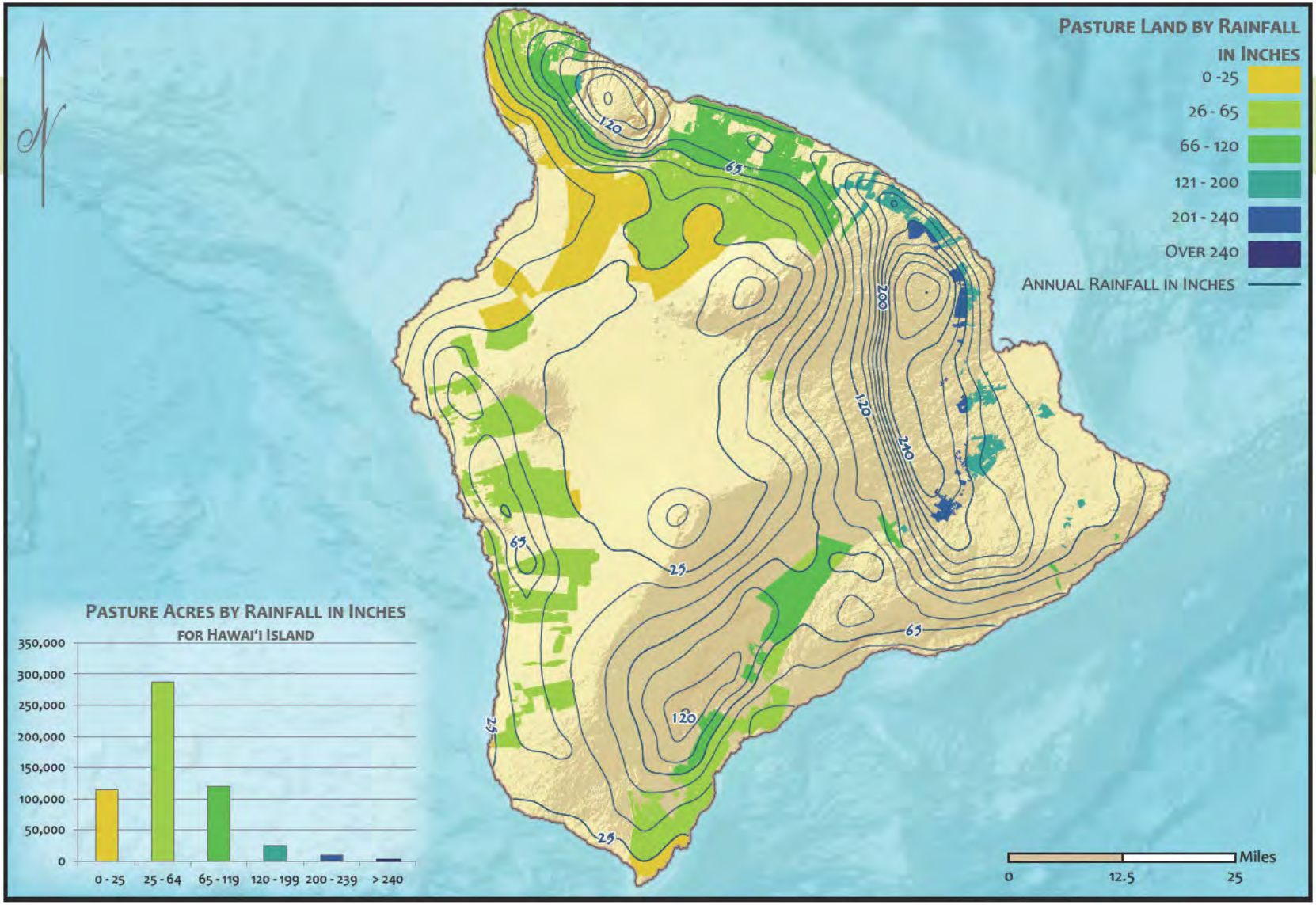
University of Hawai'i Hilo

SDAV UHHILO

Pasture Lands Summary by Rainfall (2015)

Source: Rainfall Atlas of Hawai'i

Department of Agriculture
State of Hawaii



University of Hawai'i Hilo

SDAV UH Hilo

Pasture Lands Summary by Rainfall (2015)

Source: Rainfall Atlas of Hawai'i

Department of Agriculture State of Hawaii

Sheep & Goats

Sheep and goats are both minor players in Hawai'i's livestock portfolio, but they are playing an increasing role in several of the state's larger ranches. Multi species grazing, particularly with cattle and sheep, is being explored on several ranches, and there is a market for local sheep and lamb in both the restaurant and retail markets.

NASS data reports that roughly 800 sheep were harvested at certified slaughterhouses in 2014 at an average live weight of 132 pounds for a total of 108,000 pounds[1]. The bottleneck for building larger commercial herds of sheep and goats lies in part with the cost of slaughter for smaller animals and the limited amount of slaughter time offered for them at local slaughterhouses. Efforts around the state to secure mobile slaughter units may give new options to producers to help cut the cost of certified processing. However, the economics of operating a mobile slaughter facility is still to be determined.

Goats are raised for meat and for their tenacity to attack exotic underbrush, which helps clear pasture lands of guava, Christmas berry, and other invasive species. In many cases, the intensive management of goat herds for this purpose produces better and longer lasting effects on pasture quality than the use of mechanical land clearing[2]. Goats are also sold for meat to a number of ethnic markets. Most of these animals are taken live off the ranch and harvested in informal settings that do not reach the local retail marketplace.

Dairy

There are two active dairy operations in the state, both on Hawai'i Island. Big Island Dairy in O'okala and Cloverleaf Dairy in North Kohala sell their milk to Meadow Gold where it is pasteurized and packaged at the only milk processing facility in Hilo. The bulk of Hawai'i Island's milk supply is sold on the island under

Mixed Species breeding being explored at Haleakalā Ranch on Maui.

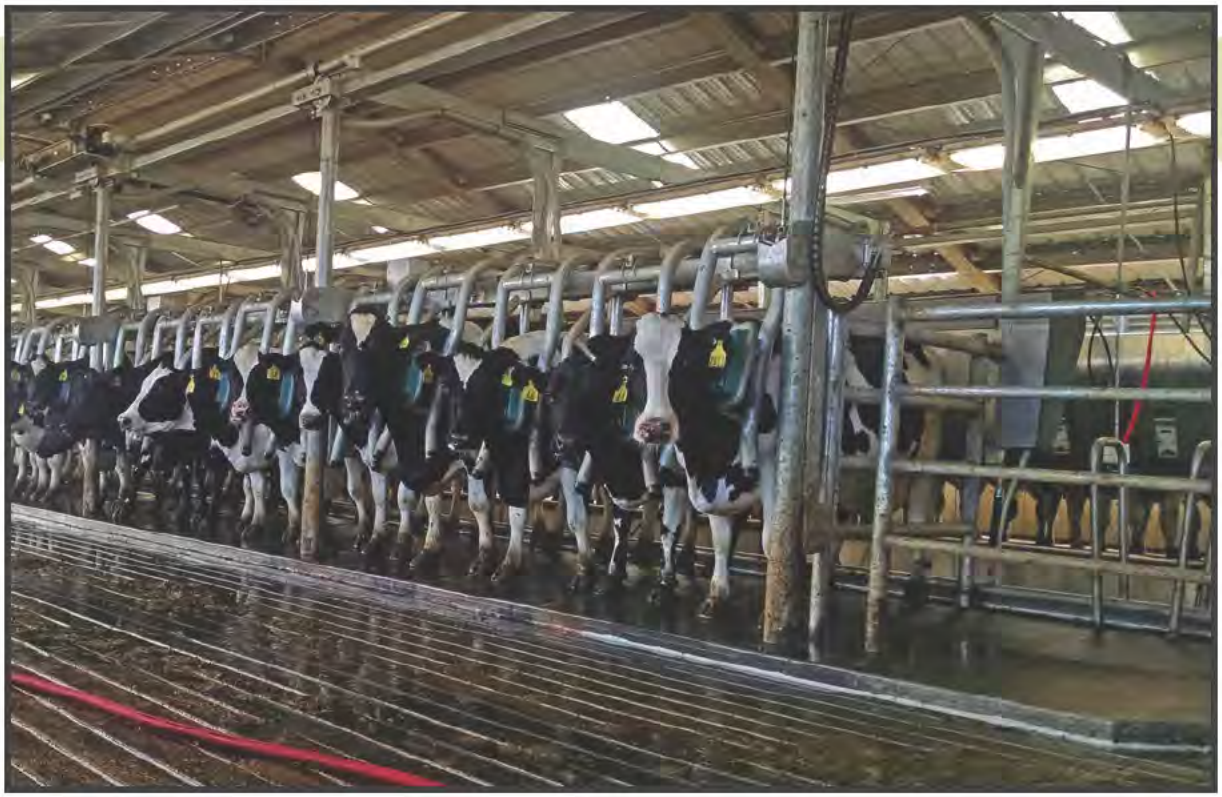
Co esy o Ha eaka ā Ranch

1 USDA NASS Slaughter Report 2014, pp 51, 52
2 Personal Communications, Lani Petrie, Kapapala Ranch

a number of different brands. Additionally, a portion of the local supply is branded as 'Hawai'i Fresh' and shipped off island to several grocery store chains around the state. During peak supply periods, portions of the Hawai'i Island milk supply is shipped in bulk to Honolulu and blended with mainland milk that makes up the bulk of Hawai'i's milk supply.

Based on data provided in August 2015 by the DOA's Milk Control Program, Hawai'i's dairies produce 3.3 million pounds of milk monthly or the equivalent of approximately 380,000 gallons per month[3]. The rest of Hawai'i's milk supply is either imported in bulk by Meadow Gold, re pasteurized and packaged in Honolulu, or imported in pre packaged form by one of several mainland milk producers. Hawai'i produces no organic milk, and aside from several small boutique cow and goat cheese producers, virtually all of Hawai'i's cheese and other milk products are imported from elsewhere.

Over the last three years, Big Island Dairy in O'okala has made significant investments to grow their herd and improve production and efficiency. They are now a state of the art operation that grows, and otherwise



sources, close to 40% of their feed from local sources. There are also plans for a new dairy on Kaua'i and another on the Hāmākua coast. Both are experiencing difficulty getting established.

Pigs

Pork production in the state has continued to decline over the last several decades. The high cost of imported feed and the increasing expense associated with meeting wastewater disposal and other environmental regulations have resulted in fewer large scale piggeries. The low cost of production for mega farms on the mainland also sets up stiff price competition for Hawai'i producers.

Much of the local pork is sold informally as wean offs to individuals for private use and to ethnic markets that prefer smaller animals. A *luau* market exists for larger pigs for parties and visitor luaus, but the bulk

3 Personal communications with Grant Tomita, Milk control Program Administrator

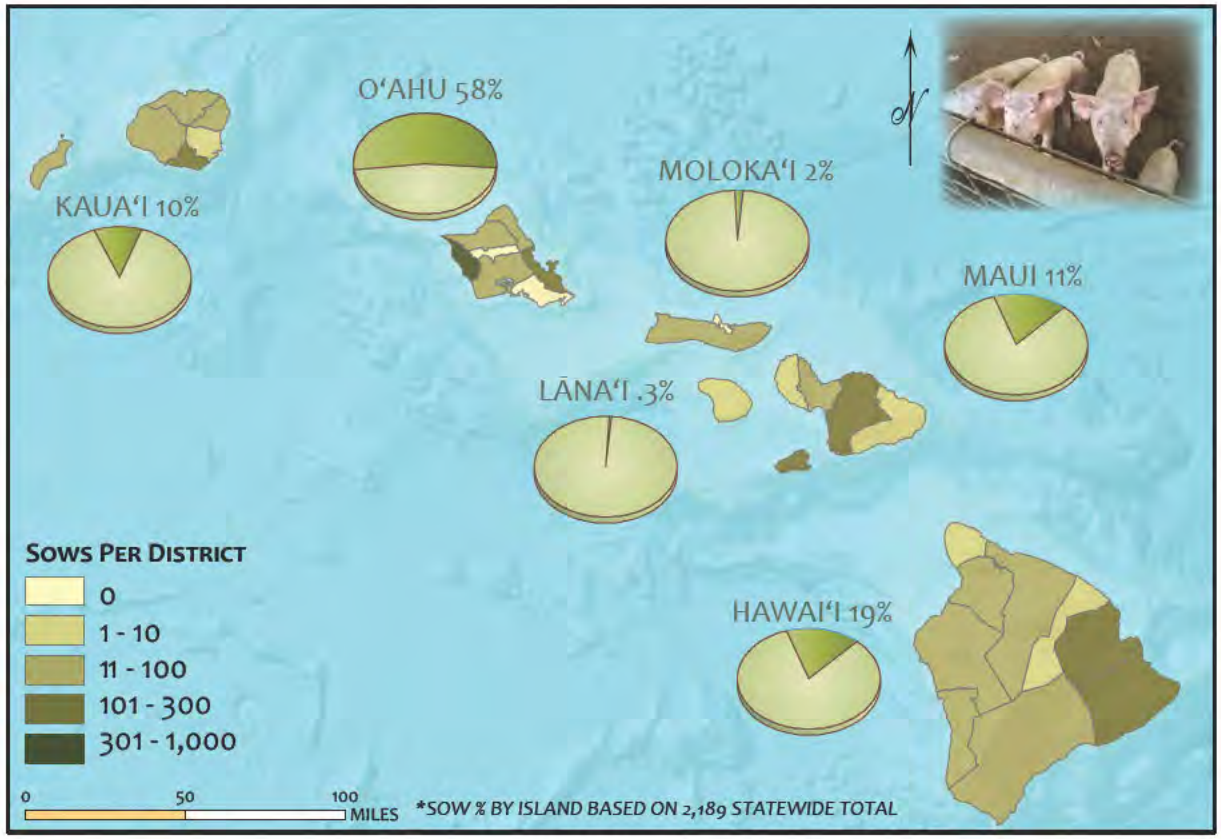
PIGS CONT'D.

of the pork sold in Hawai'i comes from imported sources. USDA's Slaughter Report for 2014 indicates that there were 13,672 hogs killed in slaughterhouses at an average live weight of 243 pounds. A significant portion of those are shipped live to Hawai'i from the mainland U.S. and sold to the fresh/hot pork market in Chinatown and elsewhere in the state.

Local pork production figures presented in Figure 10 come from an unpublished source at the State DOA Animal Disease Control Branch, which is tasked with inspecting animal operations and controlling outbreaks of animal diseases. Based on their 2014 data, there were 2,188 producing sows in the state. Each sow generally gives birth to an average of 8 piglets twice a year[4]. The largest percentage is on 'Oahu where the strongest market exists and where food scraps from restaurants and hotels can provide a steady supply of feed.

FIGURE 10

Right: Pork production summary for 2015



ISLAND CONTRIBUTIONS TO LOCAL PORK PRODUCTION (2015)

SOURCE: STATE OF HAWAI'I DEPARTMENT OF AGRICULTURE: ANIMAL DISEASE CONTROL BRANCH

4 Personal communications, Mike Dupont, CTAHR Livestock extension agent

There are a growing number of small piggeries beginning to adopt Korean Natural Farming techniques for raising hogs. This system uses a dry litter approach and indigenous microorganisms to decompose waste and maintain an odorless environment without the need for wastewater treatment facilities. This approach and other new farm designs offer hope that Hawai'i could be a bigger contributor to its own pork supply in the future.

POULTRY

There are four relatively large scale, egg producing poultry operations located on 'Oahu in Wai'anae, Waimānalo, and Wahiawā. Together they have roughly 230,000 laying hens that produce approximately 20% of the state's fresh egg demand[5].

The 2012 NASS Agricultural Census indicates that there are 523 farms in Hawai'i that farm nearly 250,000 chickens for egg production, a 32% increase in the number of chicken farms since 2007[6]. However, 518 of these farms have fewer than 400 chickens and 443 farms have fewer than 50 chickens each. This increase in chicken farms for egg purposes reflects a growth in the number of small egg producers who either raise egg laying fowl for home use or sell their fresh island eggs in an informal and generally unregulated marketplace.

There is no longer a certified slaughter facility to process poultry meat in the state. The last 'Oahu facility closed in 2005, and a smaller operation on Kaua'i closed in 2008[7]. The NASS 2012 Census reports that just 22 farms produced 2,639 broilers for meat. There is a small, but growing supply of free range broilers produced on small farms. These smaller operations can be granted an exemption from federal food safety requirements that require that a certified meat inspector be on site each time meat chickens are harvested. This exemption applies only to operations that process fewer than 20,000 meat chickens annually Restaurants and individuals are the primary market of local free range broilers.

Poultry production continues to struggle against imported competition and the rising cost of feed and other expenses. There is, however, a new egg facility planned for State lands near Schofield Barracks on 'Oahu. They propose to raise as many as one million laying hens on 'Oahu to contribute to local egg supply and possible export to other areas in the Pacific. This facility is still in the development phase.

5 Personal communication; Phyllis Simabukuro-Gieser, DOA Deputy, Ka Lei Eggs

6 2012 Census of Agriculture: Hawai'i, USDA National Agricultural Statistics Service, Vol 1 Geographic Area Series, Part 11, pg 25

7 Personal communication; Phylis Shimabukuro-Geiser

Honey Bees

Honey production in Hawai'i dates back to 1857 when the first beehives were successfully shipped to 'Oahu from the west coast of the U.S. The first commercial venture began in 1895, and honey and beeswax were first exported in 1897.

The first association of beekeepers was organized in 1907 to advance the emerging industry. One of its first acts was to work with the Territory to stop importing new bees as a protection from diseases that were devastating beekeepers in other regions.

In 1970, the largest honey operation in the Islands was located in Pu'uanahulu in North Kona. In 1973, this operation was bought by a major national honey producer, Powers Apiaries Inc., and moved to Kealakekua in South Kona. The area around Kealakekua Bay remains the center of commercial beekeeping in the Islands and is one of the largest concentrations of honey bees in the Pacific Basin.

The geographic isolation of Hawai'i and the prohibition against importing honey bees has afforded the islands decades of freedom from honeybee pests common in North America. This allowed honey bee management to be relatively minimal and unstructured, with little stock improvement efforts taking place. This lasted until 2007 when the Varroa mite (*Varroa destructor*) arrived on 'Oahu and Hawai'i Island in 2008. Shortly thereafter in 2010, the small hive beetle (SHB, *Aethina tumida*) was introduced and has been found on six islands. These pests have dramatically impacted beekeepers with sudden and significant colony losses. Both pest problems require vigilance and management techniques never before necessary in Hawai'i. Varroa and SHB are both tropically adapted and have exploded in Hawai'i's year round growing season and winterless climate. The state was ranked number two in the nation in 2014 for honey production per hive due, in part, to the variety of plants that flower year round[8]. Hawai'i also produces roughly 80% of the queen bees used in Canada and about 30% of the queens used in the mainland U.S.[9]. Most commercial beekeepers around the world will replace their queens yearly to maximize hive production, and Hawai'i's year round climate and isolation makes it a good place to produce new queens. Demand for early season queens exceeds Hawai'i's current capacity to produce them.

Queen bees from Hawai'i are a critical resource for all North American beekeeping because most fruits, nuts, vegetables, and seeds rely on honey bees for pollination. The queen industry in Hawai'i is largely an export business, but queens are also needed by local beekeepers to maintain robust, productive hives and to recover from losses. Queens cannot be imported or moved from Hawai'i Island and 'Oahu where Varroa is established, so developing queen businesses on non Varroa islands could help the industry as a whole.

In a 2010 unpublished analysis done with the assistance of NASS, the combined contribution of Hawai'i's honey industry revenues of honey, beeswax, and queen sales, along with the value of pollination dependent crops, contribute about $200 million dollars to the State[10].

The NASS 2012 Census on Agriculture indicated there were 203 beekeeping operations in Hawai'i.

FIGURE 11

Right: Managed bee colonies for 2015

8 USDA NASS Circular on US Honey Production ISSSN 1949-1492
9 USDA Foreign Agricultural Service, Canada Honey Production and Trade Update 2005, GAIN Report Number CA5083

10 Unpublished spreadsheet calculation of the value of pollen dependant crop sales for 2009 and 2010 prepared by the state's NASS Statistician, Mark Hudson.

* Total Bee Colonies for All Islands :18,660
* Total Bee Keepers Reporting: 226

HANALEI
KAWAIHAU
WAIMEA
LĪHU'E
KŌLOA
WAIMEA
KO'OLAULOA
WAIALUA
WAI'ANAE
WAHIAWĀ
KO'OLAUPOKO
EWA
HONOLULU
KALAWAO
MOLOKA'I
LAHAINA
WAILUKU
LĀNA'I
MAKAWAO
HANĀ
MAKAWAO

NORTH KOHALA
SOUTH KOHALA
HĀMĀKUA
NORTH HILO
SOUTH HILO
NORTH KONA
SOUTH KONA
PUNA
KA'Ū

Number of Colonies Per District

0
1 - 50
51 - 500
501 - 1,000
1,001 - 3,000
3,001 - 5,000
5,001 - 6,500

Miles
0 10 20

University of Hawai'i® Hilo

Managed Bee Colony Concentration per District (2015)

Source: DOA Apiary Program, Voluntary Beekeeper Registry

Department of Agriculture
State of Hawaii

HONEY BEES CONTD.

Subsequent NASS reports on the U.S. honey industry in 2013 indicated that there were 13,000 colonies in Hawai'i producing 1,079,000 pounds of honey. The value of commercial honey was $2.1 million based on average local honey price of $1.97 per pound[11]. Many of Hawai'i's beekeepers sell portions of their production in small, branded packages as opposed to bulk containers. This value added approach nets a higher honey price in the $5 to $40 per pound range.

Beeswax and queen sales are in addition to these honey sales. Although queen bee sales are confidential to the producer, some industry experts estimate they may be over $10 million annually[12].

The State's DOA Apiary program collects its own set of beekeeper and colony data as part of a Voluntary Beekeeper Inventory program. In 2015, this data indicates there are 224 beekeepers with 18,660 colonies. Using this unpublished data, a depiction of the relative concentrations of honey bee activity is provided in Figure 12 at right. This data also indicates 90% of all colonies are on Hawai'i Island, 6% are on Kaua'i, 3% on Maui, and 2% on 'Oahu[13]. A third of all colonies in the state are based in South Kona and play an important role in pollinating Kona's coffee, macadamia, and tropical fruit orchards in that area. Many commercial beekeepers transport their hives to follow regional plant flowering patterns and may be producing honey away from their base farms.

Hawai'i's wild honey bee colonies, once common statewide, will take some time to recover from the recent invasive infestations. This significant loss of pollination capacity makes it important for farmers and commercial beekeepers to work together to insure pollinators are present at the right times and places.

There are 62 known species of native bees in Hawai'i, and they occupy niches from sea level to over 10,000" elevation. Hawai'i's native bees do not gather in hives, nor do they produce honey for human consumption; they primarily pollinate native plants. The quantity of native bees is small in comparison to the number of managed bees, and several of the native species are candidates for the Federal Endangered Species List. Certain species suffer from loss of habitat as native plants decline. Native bee are not generally considered important pollinators of Hawai'i agricultural crops and do not appear to be impacted by the current suite of hive pests impacting the commercial honey bees.

A honey bee gathering pollen.

11 USDA NASS Crop Update ISSN 1949-1492

12 Informal estimate from several apiary sources based on 400,000 queen bees sold at $25 each

13 Unpublished data collected by the DOA Apiary program in 2015

ISLAND-BY-ISLAND AGRICULTURAL SUMMARIES 2015

FIGURE 12

Right: Crop totals by acreage and island for 2015

2015 Crop Summary by Acreage							
Crop Types	**Hawai'i**	**Kaua'i**	**Maui**	**Moloka'i**	**Lāna'i**	**O'ahu**	**State Total**
Aquaculture	165	183	-	28	-	274	*651*
Banana	536	26	62	-	-	345	*969*
Coffee	5,525	3,788	545	123	-	168	*10,149*
Commercial Forestry	21,061	1,743	33	-	-	26	*22,864*
Dairy	1,855	-	-	-	-	-	*1,855*
Diversified Crop	3,266	1,199	1,582	937	54	9,865	*16,904*
Flowers / Foliage / Landscape	1,612	165	134	26	10	484	*2,432*
Macadamia Nuts	21,359	-	186	-	-	-	*21,545*
Papaya	2,566	-	-	93	-	166	*2,824*
Pineapple	-	-	1,094	-	-	3,414	*4,508*
Seed Production	-	13,299	754	2,342	-	7,333	*23,728*
Sugar	-	-	38,810	-	-	-	*38,810*
Taro	61	443	54	2	-	51	*612*
Tropical Fruit	3,144	463	104	43	-	227	*3,980*
Crop Total:	***61,149***	***21,310***	***43,360***	***3,593***	***65***	***22,354***	***151,831***
Pasture	554,324	41,934	108,447	38,261	-	18,464	761,429
Total Agriculture	***615,473***	***63,244***	***151,808***	***41,854***	***65***	***40,818***	***913,261***

ISLAND-BY-ISLAND AGRICULTURAL SUMMARIES 2015

South Shore

Kaua'i's South Shore contains some of the state's most productive farmland. Sugar yields were often the highest in the state due to the steady sunshine, A and B class soils, and ample fresh water.

The South and West Shores of Kaua'i are composed of large consolidated tracts owned by the State, DHHL, the Robinson Family, Alexander and Baldwin (A&B), and Grove Farm. This land ownership pattern provides the stability to support larger farm ventures and maintain regional water systems. It also provides Kaua'i's residents with a reliable employment base and a responsive management capacity to address issues as they arise.

Lands in the Waimea Kekaha area are controlled by the state's Agricultural Development Corporation (ADC) and managed by the Kekaha Agricultural Association (KAA), which is a partnership of seed companies and water users in the region. KAA also manages the irrigation systems from the Waimea and Kōke'e Ditches.

Portions of the Kekaha plain are low lying and require the pumping of ground water into canals to keep large portions of the farmable lands from reverting to wetlands. Hydroelectric power units use water from the Waimea Kōke'e Ditches to drive turbines that pump the water. Without this alternative energy, the cost of electricity would render parts of the region unfit for farming. A dispute is pending before the State Water Commission about the Waimea Stream diversion, some of which drives the hydro plants.

South Kaua'i's land pattern provides the stability to support larger farm ventures and maintain water systems, which in turn supports a reliable employment base.

Some of the State property is located on higher ground along the road to Kōke'e State Park. Once in sugar, the land could support additional crops that prefer cooler, higher elevations, but currently contains only a small number of exploratory farms.

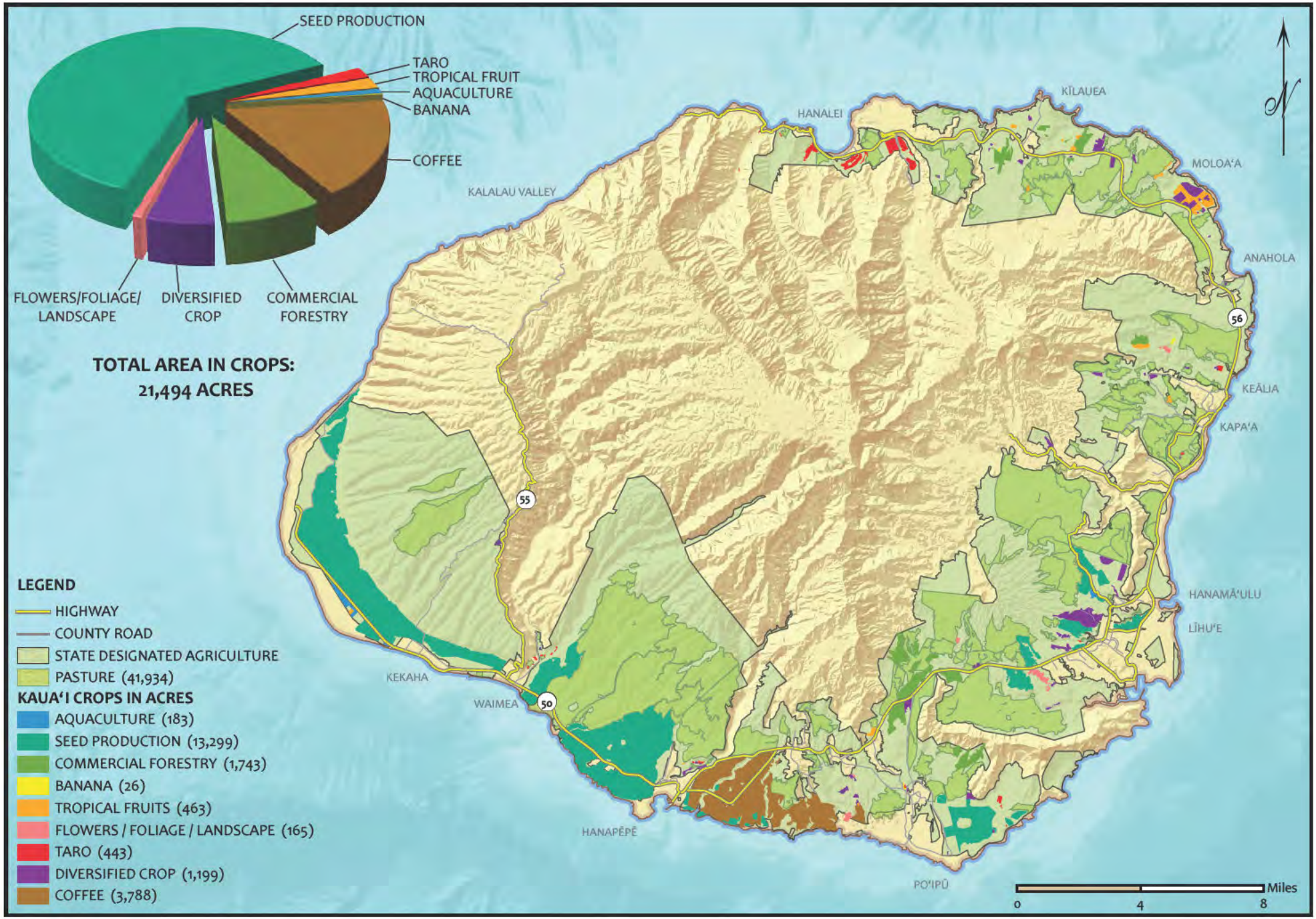
DHHL owns 15,000 acres above the coastal plain. Known to DHHL as the Waimea Uplands, these lands are rough, dry, and are used primarily for pasture. Kōke'e Ditch and associated reservoir improvements are partially on DHHL land, which could potentially enable more productive use of the Uplands. The challenges lie in finding farmers and marketable crops that match the terrain and soil conditions.

The Robinson Family is a *kama'aina* landowner who owns land between Waimea and Hanapepe. They lease a portion of their land to seed companies and manage the remainder in pastures to produce grass fed beef for the local market. A modular slaughter facility was recently installed to harvest their own cattle. The Robinsons manage water from the Olokele and Makaweli Streams for seed company lessees, cattle, and other irrigation needs.

A&B owns land from Hanapepe to Po'ipū and manages agricultural water from the Wahiawā Stream, Alexander Reservoir, and a ground water well (Pump 3) located in Hanapepe Valley. Following the closing of McBryde Sugar Co. in 1987, A&B developed over 5,000 acres of plantation coffee under the brand name Kaua'i Coffee. That planting has shrunk somewhat but remains a viable and important part of

FIGURE 13

Right: Kaua'i crop summary for 2015



UNIVERSITY of HAWAI'I HILO

SDAV UHHILO

KAUA'I CROP SUMMARY (2015)

Department of Agriculture STATE OF HAWAII

ISLAND-BY-ISLAND AGRICULTURAL SUMMARIES 2015 CONT'D.

SOUTH SHORE CONT'D.

Kaua'i's portfolio, producing 10.4 million pounds of cherry in 2014 2015[1].

Recently, the Kaua'i Coffee business was sold to Massimo Zanetti Beverage, USA, Inc., an Italian beverage company and one of the largest coffee roasters in the U.S. The new owner continues to expand A&B's coffee investment. After McBryde Sugar closed, A&B additionally opened up about 200 acres for an agricultural park in the lower Kalāheo area, which is only lightly farmed. A&B also developed Kukuiula Resort Community and has sold and subdivided portions in the Lāwai area into agricultural estate lots that display only limited agricultural activity.

Grove Farm is one of Kaua'i's oldest companies with properties extending from Po'ipū to Hānamaulu. Its lands are in several holding companies but are generally managed from the Grove Farm headquarters near Lihue. Grove Farm has an active agricultural leasing program that provides land and water to a range of operations including seed companies, small diversified farmers, a large landscape nursery, several taro farmers, and a number of cattle operations.

There is a new dairy proposed on its lands near Māhāulepū that is currently working to overcome a range of community, environmental, and business concerns. Grove Farm also leases several parcels to seed companies for single rotations of seed crops to help suppress a corn rust disease that flares up during the hot summer months.

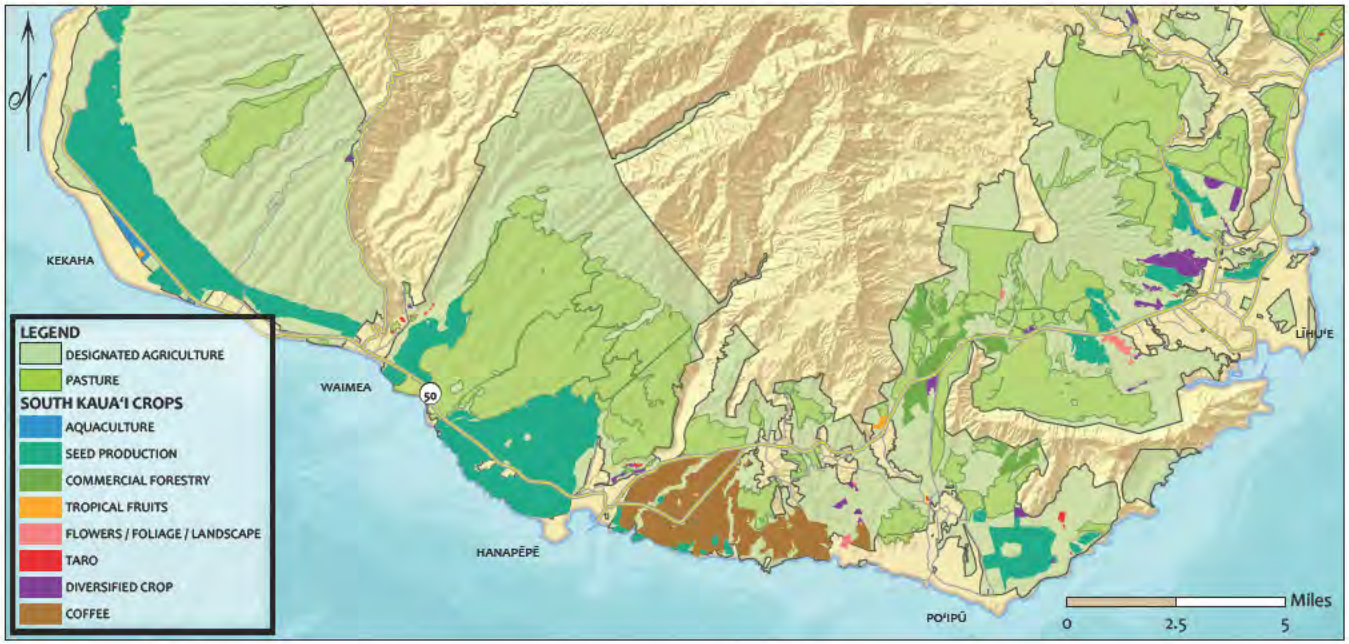


FIGURE 14

Above: South Shore of Kaua'i crop pattern 2015

20 5 Hawa ' Co ee G owe s P od c on Repo , K mo Fa cone , P es den

East Shore

Amfac Hawai'i's Lihue Plantation owned much of the land north of Hanamā'ulu on the east shore of Kaua'i before liquidating its land holdings in the 1990s. Purchased largely by wealthy individuals, much of Amfac's land has been developed into agricuiltural estates and used for small agricultural ventures. Much of this land remains in pasture and is lightly used.

Agricultural lands in the Waialua Homestead area are primarily residential with small pastures, orchards, and landscape plantings. The Waialua area and the State lands in Kālepa are serviced by a State owned agricultural water system controlled by the ADC and managed by the East Kaua'i Water Users Cooperative. Most users on this system run small cattle operations, but opportunity exists for more diversified farm use.

The DHHL lands in Anahola are largely idle but do present new opportunities for Hawaiian homesteaders to pursue commercial agriculture pending the repair of former plantation water sources and delivery systems. Adjoining private lands in Kealia are exploring new diversified crops, anchored by a wetland taro operation in the lowlands along the Kealia Stream that once produced sugar for Lihue Plantation.

The agricultural lands from Hānamaulu to Anahola, in general, are lightly used and could support more farm production than they do currently.

North Shore

Kaua'i's North Shore stretches from Moloa'a to the Na Pali Coast and hosts an array of sustained agricultural activity.

Moloa'a

Moloa'a currently supports 260 acres of tropical fruit and 250 acres of diversified crop production that are farmed in varying intensity. Water for

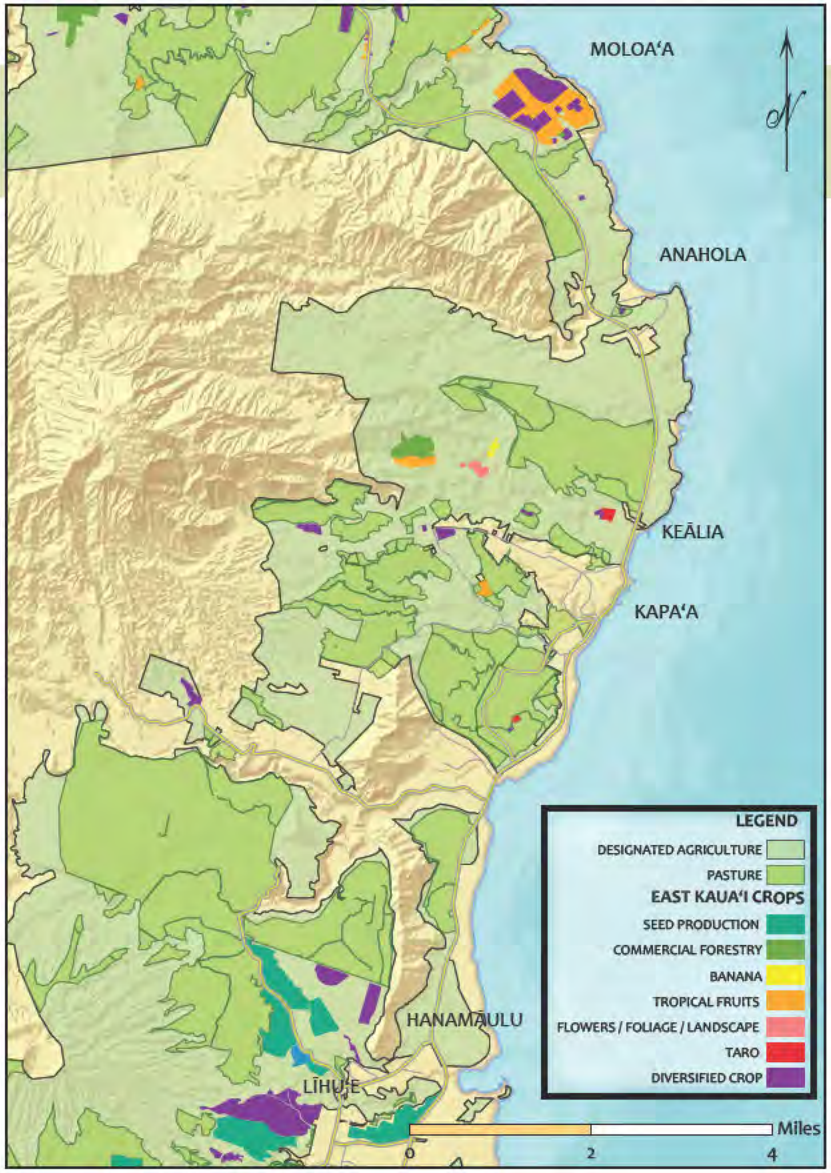


FIGURE 15 *Above: East Shore of Kaua'i crop pattern 2015*

ISLAND-BY-ISLAND AGRICULTURAL SUMMARIES 2015 CONT'D.

NORTH SHORE CONT'D.

Moloa'a comes from a ground water well on State lands located mauka of the Kuhio Highway against the ridge. The State Legislature allocated funds in 2015 to help replace the existing water source with a new well nearer the farm lots. Plans also include a pending initiative to install a facility to help North Shore farmers address food safety issues and expand their market penetration.

The Moloa'a lands were pineapple plantations until the late 1960's. In the early 1980's, the owner, Amfac, subdivided and leased farm lots to farmers exclusively for agricultural use. This provided access to farmlands without the cost of domestic improvements or the pressure to sell for residential purposes.

During the same time, a group of small farmers growing papaya developed an export treatment facility in nearby Kapa'a. The papaya industry grew and then subsided, but portions of the Moloa'a lands remained in small farm use under the non residential subdivision ordinance. In the 1990s, several small farmers began planting tropical fruit that remains a major part of Moloa'a crop mix.

The whole of the Moloa'a holdings went up for sale when Amfac began liquidating in the 1990s. Subsequent negotiations with the County resulted in some portions of the farmland being alloted for residential use and others restricted exclusively for farming. This saga of residential density vs. farming at Moloa'a highlights an important struggle in Hawai'i to keep land values affordable for farming by restraining other uses and minimizing new infrastructure costs.

KILAUEA

Agricultural lands around Kilauea town were in sugar use until 1971 when C. Brewer closed Kilauea Sugar. In 1982, Brewer planted what was to become the nation's largest guava orchard and processing center. The operation closed in 2007, and the lands were sold as part of Brewer's land liquidation efforts. At 390 acres, the largest crop in the region in 2015 is exotic hardwoods planted as a long term investment by several wealthy landowners.

The Kilauea area has become a new center for small farm operations on Kaua'i. Many North Shore residents are passionate about local food production, and there are several diversified farming efforts in the area around Kilauea town. Currently there are 157 acres in diversified crops and 67 acres in tropical fruit orchards.

Irrigation water in Kilauea comes largely from the County domestic system. There are 95 agricultural water meters in the Kilauea zip code, which represents nearly half of all the agricultural water meters on the island[1].

County water comes from ground water wells above Kilauea town. Some of Kilauea's irrigation and reservoir systems remain from the sugar era. Several of these reservoirs have been decommissioned or were breeched (Kaloko Dam). Others reservoirs have become less useful for farming purposes and more an amenity for new, estate homes surrounding them.

The Kilauea area and much of the North Shore has become a mecca for wealthy individuals looking to enjoy the region's remarkable mountain views and intimate seascapes. Celebrities and very wealthy individuals have built extensive estate complexes that emphasize privacy over agricultural use. Several of these new residents have made very significant contributions to the community and embraced using their lands for small scale farming and community gardens.

The real estate market in the area is robust and Kaua'i has long allowed agricultural condominiums that make it easier to process the subdivision of

1 Data provided by the Kaua'i County Dept. of Water Supply based on the zip code of the user.

agricultural lands. This results in a difficult set of circumstances for farming interests in the area where land availability is limited and land values exceed what most farmers can afford.

HĀNALEI

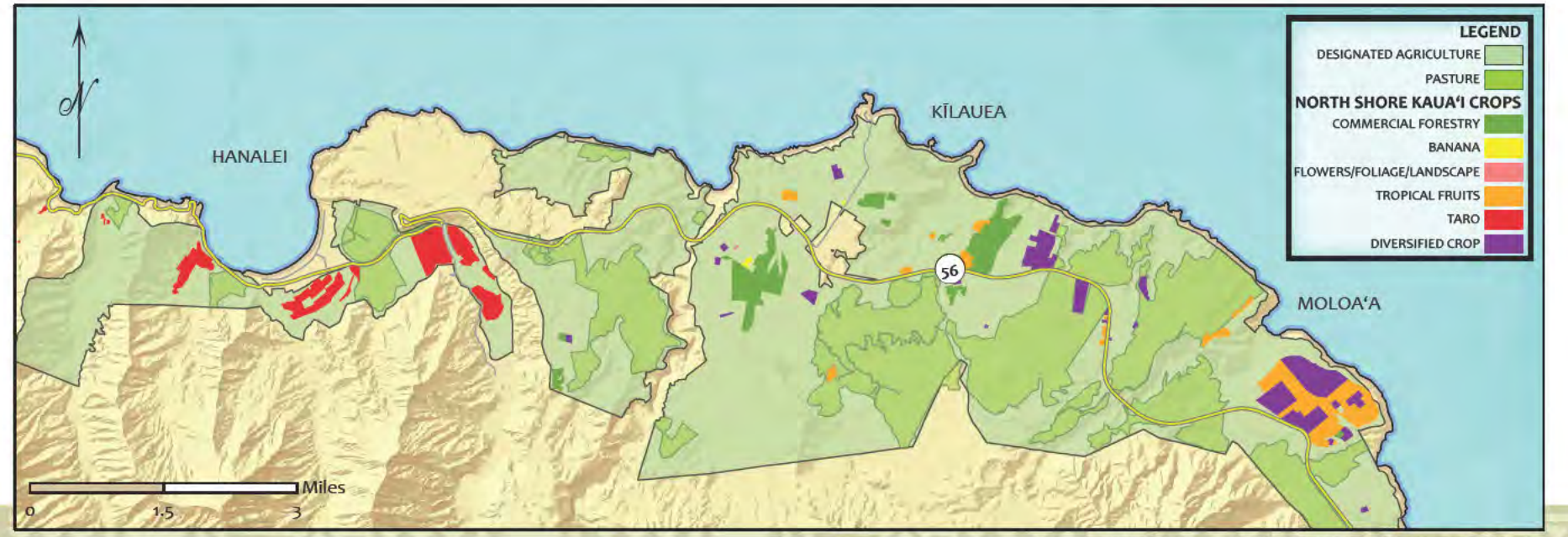
There are 366 acres of wetlands taro production between Hānalei to Lumahaʻi. This is the largest concentration of wetland taro production in the state. Taro production has decreased over the years as portions of the Hānalei wetlands became part of a National Wildlife Sanctuary for native water birds. The focus shifted from once productive taro lands to water bird habitat, which has prompted some growers to move elsewhere. Other challenges like taro blight and apple snails make it harder and harder to sustain the wetland taro farming.

LIVESTOCK ON KAUAʻI

There are roughly 42,000 acres in pasture stretching from the dry leeward coast to the wet grasslands on the North Shore. Three small private slaughter facilities on the island service local ranchers and support the local market for grass fed beef. Several larger ranchers also ship their yearlings to the U.S. mainland with other cattle producers. One of the state's largest remaining piggeries is located in the Kalāheo area, which provides a significant portion of the locally harvested fresh pork.

FIGURE 16

Below: North Shore of Kauaʻi crop pattern 2015



ISLAND-BY-ISLAND AGRICULTURAL SUMMARIES 2015 CONT'D.

Nearly one million people live on 'Oahu, or 70% of the state's population. Of the 22,500 acres in crop production on 'Oahu, 9,850 are in diversified crops, more than the rest of the state combined. Most of this production is fresh produce destined for uban Honolulu consumers.

WAI'ANAE COAST

For decades, the Wai'anae Coast of 'Oahu has been a major producer of food for local consumers. In the 1980's, several dairies, multiple piggeries, and a number of commercial poultry operations on the Wai'anae Coast sold all their products locally. Today, Wai'anae has two poultry operations, a small dairy producing boutique cheese products, and the state's largest concentration of piggeries with 52 operations and nearly 1000 producing sows[1]. In addition to livestock, there are over 520 acres of diversified crops grown in the district, 50 acres of landscape nursery operations, and a small collection of tropical fruit orchards. The only significant water in this dry, leeward region is provided by the city's domestic water system.

One of the biggest trends in crops in Wai'anae has been the production of sweet basil and Asian spices. Many of Wai'anae's landowners have elected to lease their lands to Thai and Cambodian farmers who air ship fresh basil to markets throughout the U.S. Roughly half of the active farming in Wai'anae, about 300 acres, is now dedicated to Asian spices for export.

Another agricultural land use trend is the conversion of farm lots into solar energy farms. Energy production is an allowable use on some agricultural land, and there is increasing pressure by solar developers to install large arrays in Wai'anae and other dry, sunny places in Central 'Oahu.

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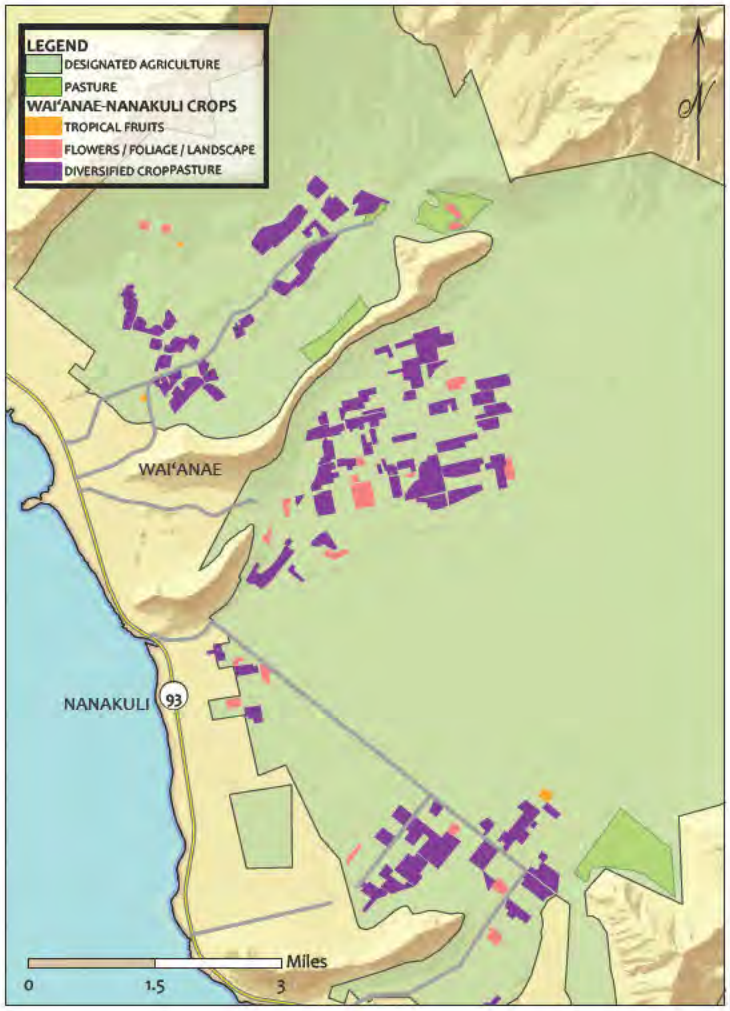
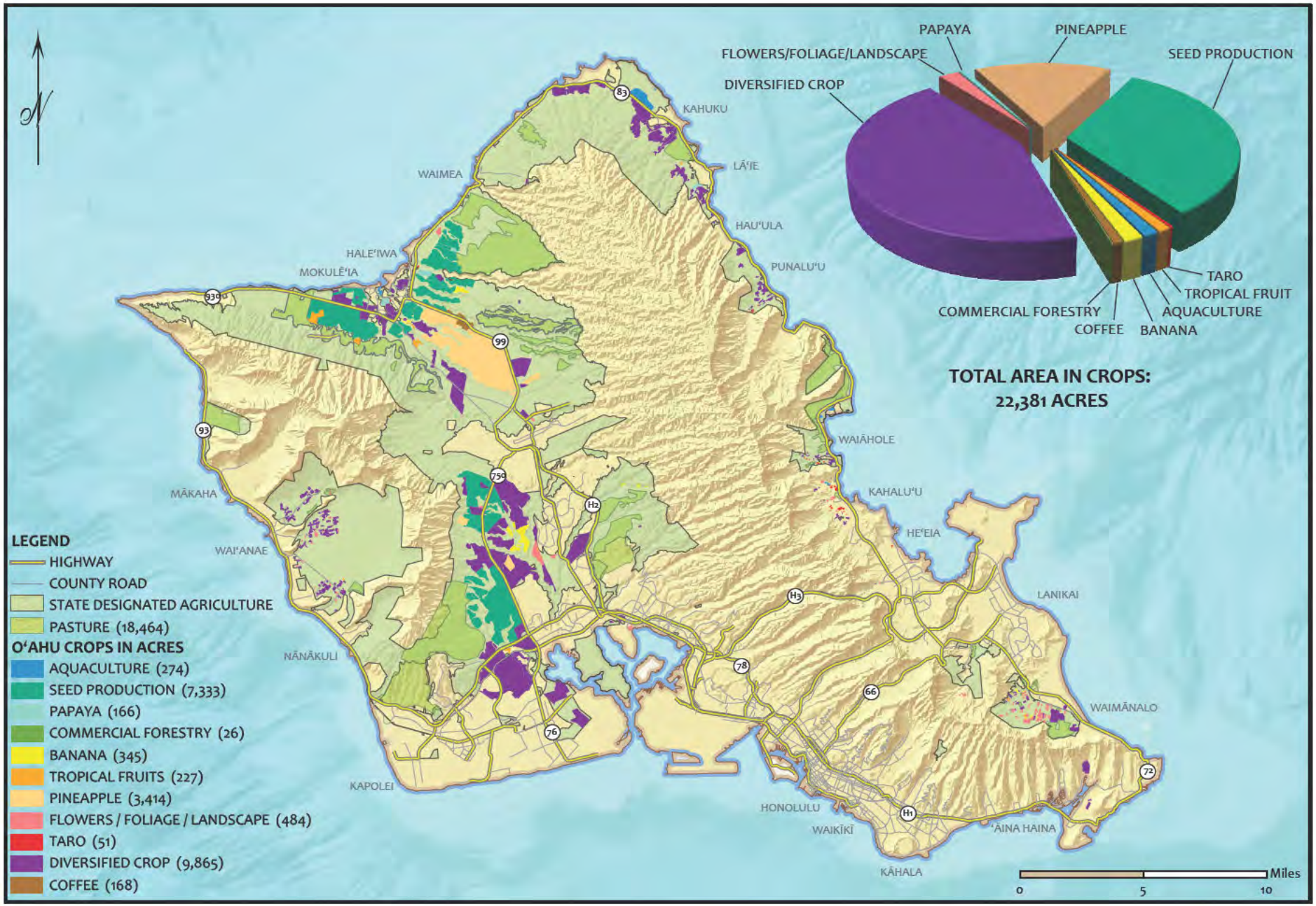


FIGURE 17

Left: The 2015 crop footprint along the Wai'anae Coast.

FIGURE 18

Right: The Island of 'Oahu's crop production 2015



O'AHU CROP SUMMARY (2015)

University of Hawai'i Hilo

SDAV UH Hilo

Department of Agriculture State of Hawaii

ISLAND-BY-ISLAND AGRICULTURAL SUMMARIES 2015 CONT'D.

WAIʻANAE COAST CONT'D.

Other products produced in Waiʻanae include green onions, beans, corn, Manoa lettuce, cabbage, and parsley. An array of organic vegetables are grown by the youth and new farmer training programs at Māʻo Organic Farms.

CENTRAL ʻOAHU PLAIN: ʻEWA TO WAIMEA BAY

The central plain of ʻOahu hosts some of Hawaiʻi's most productive agricultural land with A and B class soils and multiple sources of irrigation drawn from surface and ground water sources. These lands lie on the urban fringe of Honolulu and are subject to development pressure for housing and other urban uses.

Some of Hawaiʻi's largest diversified farmers operate on 7,300 acres of the central plain. These farms focus almost exclusively on import replacement food crops. Examples include Sugarland Farms, which is Hawaiʻi's largest vegetable and banana grower, and Aloun Farms, which produces a diverse mix of local fresh produce.

Large tracts of central ʻOahu have been sold in recent years as Campbell Estate has liquidated its holdings. Castle and Cooke and Dole Foods are also engaged in sales, which will impact the future of agriculture in the region. Smaller land holding estates are also selling their land in the area.

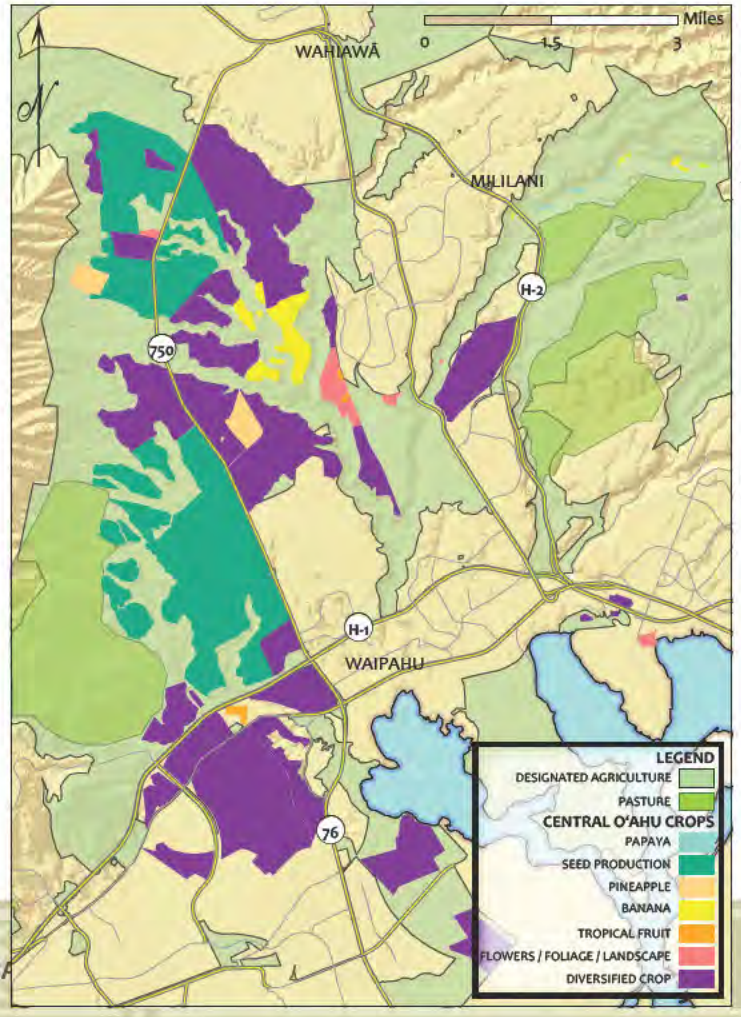


FIGURE 19

Left: The crop production on ʻOahu's Central Plain 2015

FIGURE 20

Right: North Shore of ʻOahu crop pattern 2015

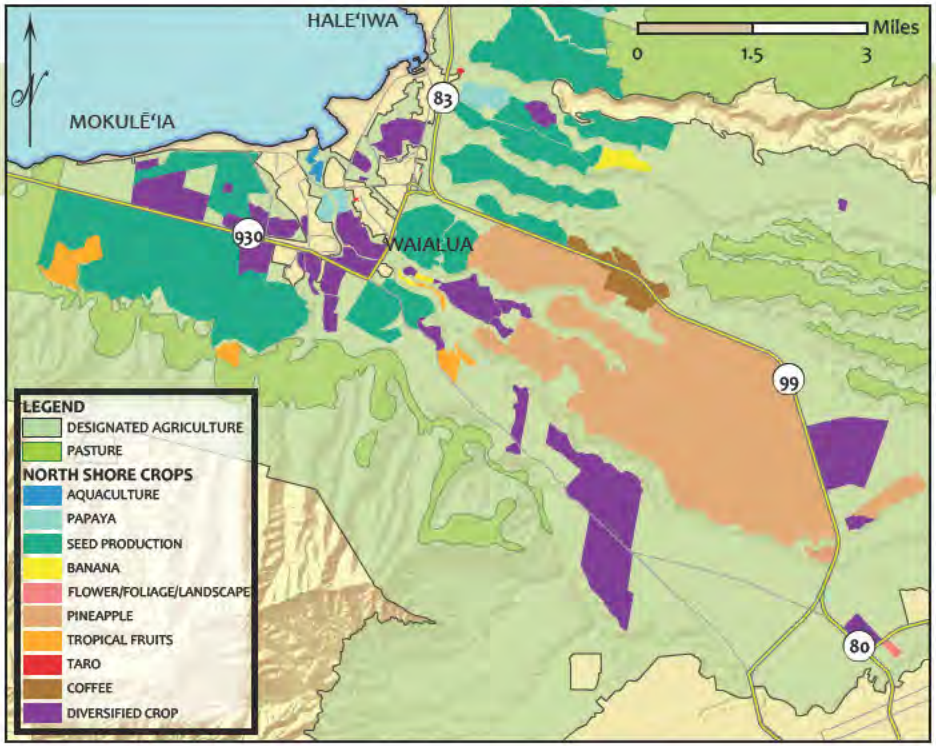
The State and the Office of Hawaiian Affairs (OHA) recently purchased 1,700 acres from the Galbraith Estate near Wahiawā to put them into new agriculture use. The 1,200 acres of State land are managed by the Agricultural Development Corp (ADC), and OHA took title to 500 acres around the important historic complex, Kūkaniloko. Several of Dole's properties in the Whitmore Village area were also purchased by the State to develop a food processing hub for local producers. The State continues to explore additional purchases on the northern slope of the central plain to insure the island's best farm lands remain in long term agricultural use.

Seed production is the second largest activity in Central ʻOahu with approximately 7,400 acres. Several seed

companies acquired fee simple interest in the central plain and have set up permanent facilities to support their farming and research agendas.

Dole Foods and several small growers continue to grow pineapple in central ʻOahu on roughly 3,500 acres. Fresh pineapple is sold locally and on the U.S. mainland. Dole also grows 160 acres of coffee under the Waialua Coffee Estate brand and is exploring the expansion of its cacao orchard to produce local chocolate. Over the years, Dole and Castle and Cooke explored a range of crops that might replace their sugar and pineapple operations. Some of their mango and tropical fruit orchards are still producing locally under farming agreements with other farmers.

In addition to these larger farm operations, there are approximately 1,800 acres of smaller, diversified farms near Waialua and Haleʻiwa. Some of these farmers were former employees of the Waialua Sugar Co. and continue to farm near where they live. There are



also about 100 acres of papaya, 60 acres of banana, 180 acres of tropical fruit, and 35 acres of foliage and landscape production in the Central Plain.

Kamehameha Schools' land at Kawailoa hosts a variety of farm activities from tubarose to hydroponic vegetables and nursery plants to seed crops. They also have plans to expand cattle operations. KS has invested in its farm and water infrastructure over the years and recently placed most of their Kawailoa lands in the Important Agricultural Lands district with the State Land Use Commission. The perpetual nature of KS's holdings bodes well for the sustained agricultural use of most of its North Shore properties.

Irrigation water in central ʻOahu comes from multiple sources. The Waiāhole Ditch and the Wilson Reservoir are the two largest surface sources with some additional supply coming from Helemano and Anahola Streams.

Wilson Reservoir water is also the recipient of treated waste water from Wahiawā town. This mixing of surface and reclaimed water, although beneficial from the perspective of recycling, limits the Wilson Reservoir from irrigating food crops. The mixed water can be used to drip irrigate pineapple and orchard crops because the water does not contact the fruit. Resolving regulatory limitation associated with the use of R 1 recycled water could expand food related agriculture north of Wahiawā to support more farms in the area.

In addition to surface water, much of the central plain is irrigated from ground water. The ʻEwa area draws low elevation water from caprock sources in the ʻEwa plain. Lands mauka of the Waiāhole Ditch draw more expensive pumped water from deep wells in the Kunia area. Farms on the North Shore also get water from ground water wells but at a lower elevation and hence at a lower cost to the farmer.

ISLAND-BY-ISLAND AGRICULTURAL SUMMARIES 2015 CONT'D.

Turtle Bay to Kahalu'u

The windward coast from Turtle Bay Resort to Kahalu'u supports nearly 2,000 acres of crop production: 1,600 acres in diversified crops, 220 ares in aquaculture, 50 acres in taro, 35 acres are in foliage and landscape, and 30 acres in papaya.

There are several variations of land ownership along the coast, but most of the production is done under lease to small farmers who produce a range of crops for local consumption.

Turtle Bay Resort leases and provides irrigation for several hundred acres mauka of their development. Turtle Bay management intends to build a stronger link between their farmland and resort operations to increase the volume of food safety certified crops available to their resort guests[1]. Hawai'i Reserves, the landowner for the Mormon Church in Laie, also sees their land as a resource to increase local food to their communities, including BYU Hawai'i, the Polynesian Cultural Center, and other business interests in the area[2]. The State DOA manages 225 acres in the Kahuku Ag Park and holds long term leases with small farmers on its 24 lots. KS also sees the Punalu'u Valley land in terms of its long term agricutlural potential and has invested in water system improvements to serve a mix of new farmers.

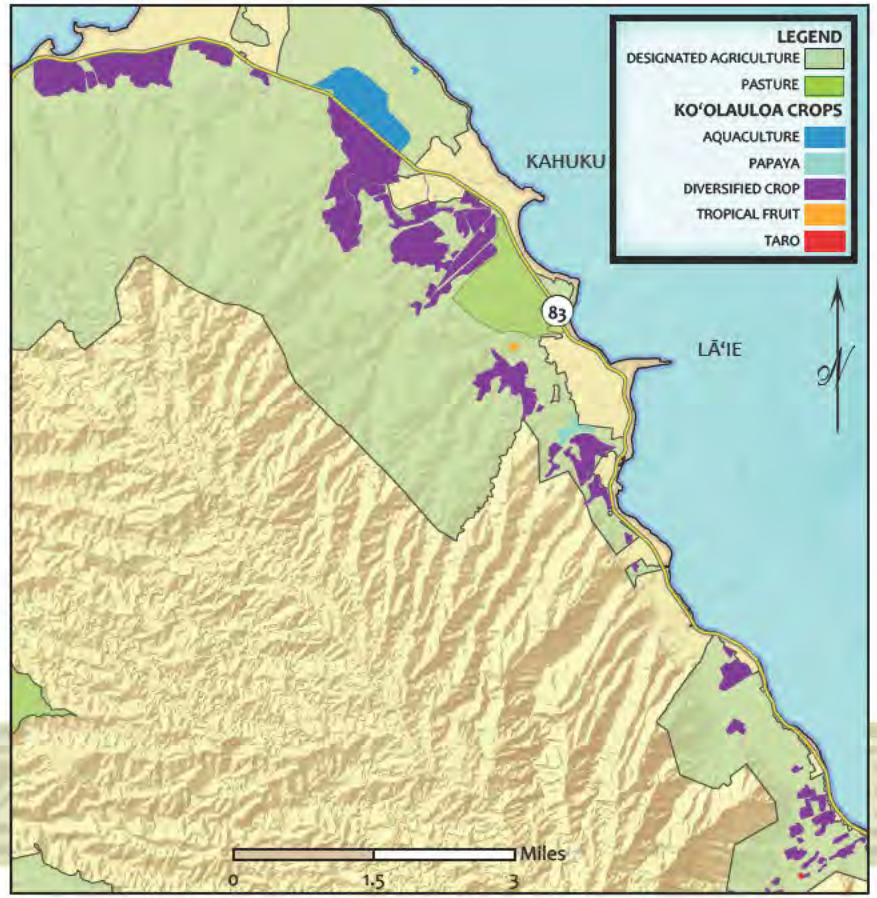
Approximately 180 acres of crops are grown on small private parcels between Waiāhole Valley and Kahalu'u, many of which are in the State Land Use Urban District. Production in this area includes 75 acres in diversified crops, 40 acres in wetland taro, 36 acres in foliage and landscape, and 25 acres in aquacultural pursuits. Water comes from a variety of sources including surface water from local streams, County domestic water, springs and ample rainfall.

1 Personal communications, Turtle Bay Land Management staff

2 Personal communication, Hawai'i Reserve Land Management staff

Waimānalo

Waimānalo supports approximately 450 acres of active production, the bulk of which is in landscape, foliage, and flower production. Roughly 200 acres are in diversified crops including the State's Waimānalo Experiment Station that conducts crop research and produces a number of Hawai'i adapted vegetable seed varieties sold to local farmers and gardeners. Portions of Waimānalo are served by the State operated Waimānalo Irrigation System. County water is also an important resource for some growers.



Waimānalo also supports a number of equestrian activities from horse boarding and training to polo. These were not mapped in this baseline effort, but they help preserve the area's open space and rural lifestyle.

Livestock on ʻOahu

Hosting only 2% of the State's pastureland, ʻOahu's 18,400 pasture acres are scattered around the island. There are a small number of ranchers who produce grass fed beef, calves for export, and bucking stock for rodeo events. Kualoa Ranch in windward ʻOahu has one of the largest pasture footprints on the island, managing a small herd on site and working with other ranchers and properties on the island. Grass is seasonal on the leeward coast, and cattle grazing helps to keep fire fuel loads down near residential communities.

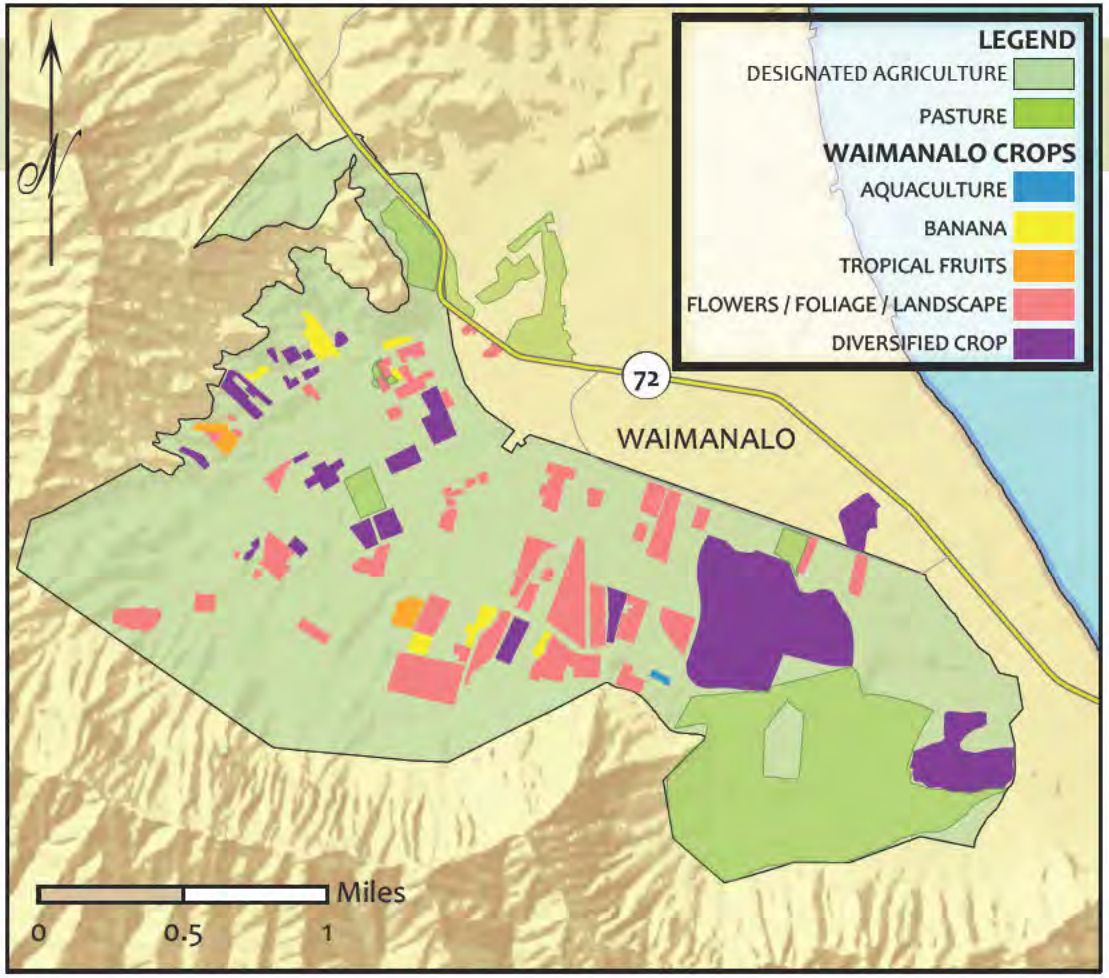
There is one State owned, multi species slaughter facility on ʻOahu located in the Barber's Point area. Though under utilized, this facility is an important asset in the overall mix of livestock industry support for the State. Several neighbor island ranchers send a portion of their animals to be harvested on ʻOahu when local slaughter operations are not available. This slaughterhouse also harvests pigs for the fresh pork market, some locally grown and others shipped from the mainland. ʻOahu supports over 50% of the state's pork production, much of it in Waiʻanae and Waimānalo due to their proximate access to food wastes from large institutions, restaurants, and hotels in and around ʻOahu's urban areas.

Figure 21

Left: Koʻolauloa crop pattern 2015

Figure 22

Right: Waimānalo crop pattern 2015



ISLAND-BY-ISLAND AGRICULTURAL SUMMARIES 2015 CONT'D.

Maui has undergone significant changes in agricultural land use since 1980 with the shutdown of Pioneer Mill Co. in Lahaina and Maui Land and Pineapple (MLP) operations in Honolua and Haili'imaile. Ongoing agriculture is currently anchored by HC&S operations and vegetable and foliage growers in Kula and Hā'ikū.

WEST MAUI

Until the 1990s, agriculture dominated the landscape in West Maui. The green slopes of Pioneer Mill once stretched from Ukumehame to Pukoli'i above Ka'anapali. MLP's operations stretched north from Mahinahina to beyond Honolua Bay. These two plantations farmed a combined 14,000 acres and drew fresh water from virtually every available stream on the southern face of the West Maui Mountains.

Sugar and pineapple are now gone from the West Maui region, and new agriculture has been slow to re emerge. Much of the former cropland has reverted to dry grass and shrubs that flush green after the rain and periodically burn off in wild fires as they dry in the hot Lahaina sun.

Amfac Hawai'i ended sugar operations at Pioneer Mill in 1999 and sold off its holdings over the next 10 years. Several investment groups purchased large portions of the land and pursued the development of small lot agricultural projects in Ukumehame, Olowalu, and Launiupoko. Former stream intakes and irrigation delivery systems in these areas were redesigned as an irrigation source for new owners who primarily use the water to support their lawns and landscaping. Several small farmers in the Launiupoko area include landscape nurseries and a small greenhouse for tomato and other vegetable crops.

The one major agricultural venture in the region is the Ka'anapali Coffee Company, farming roughly 400 acres in Pūkoli'i. Four coffee varieties produced 1.7 million pounds of cherry in the 2014 2015 crop year[1].

Portions of the Ka'anapali Coffee lands are part of a blended agricultural and real estate project that sells agricultural parcels planted in coffee and provides the owner with a selected house site, a managed coffee landscape, and an income for their production. This blend offers a model for opportunities elsewhere in the State. Ka'anapali Coffee primarily draws its irrigation water from surface intakes in Honokawai Valley.

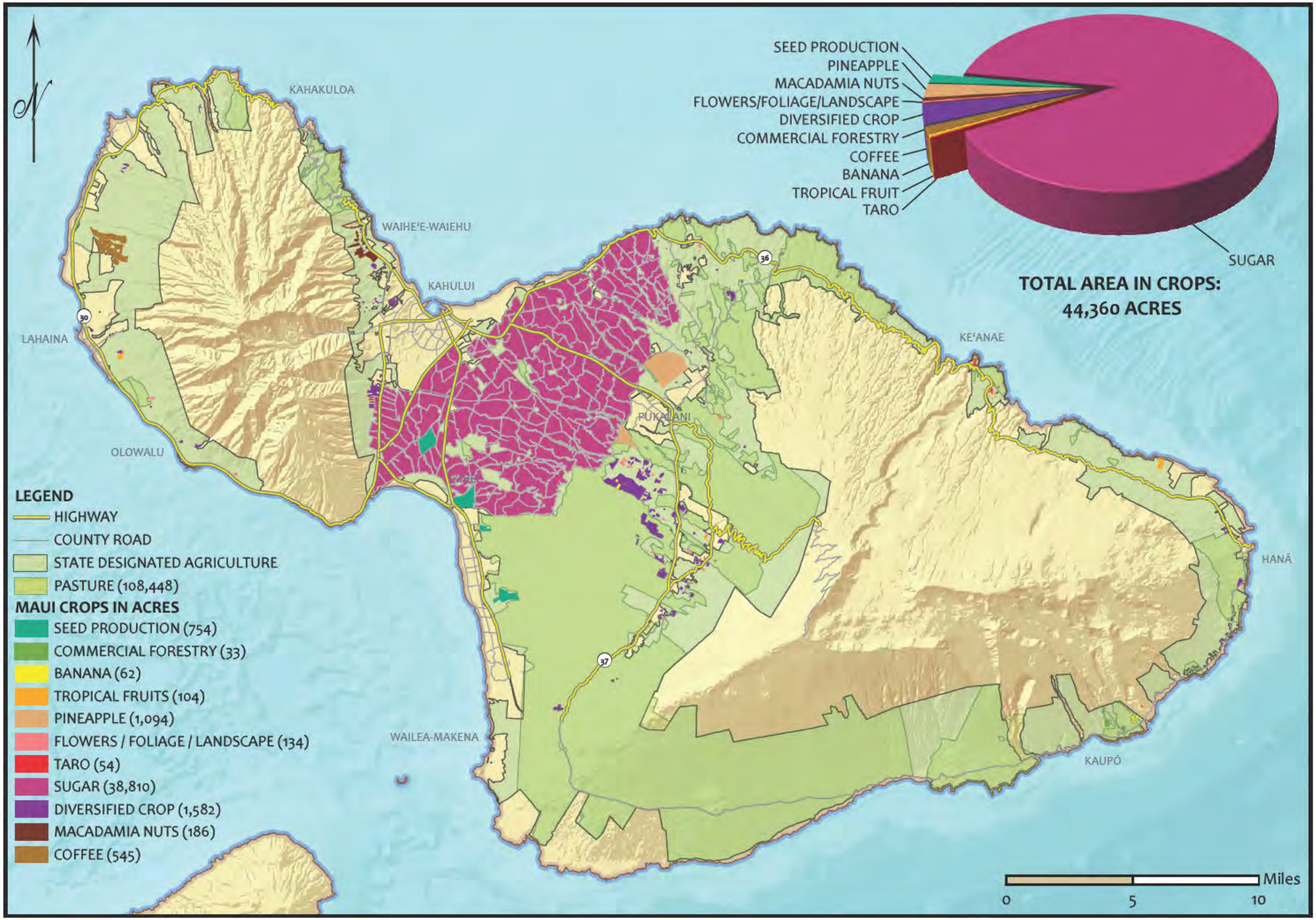
MLP retains ownership of much of its former pineapple lands in West Maui but is no longer involved in active agriculture. It continues to sell properties associated with the Kapalua resort and can be expected to shed other lands in the region as opportunities present themselves. Given the market for large estate properties in the Kapalua area, high land values will likely preclude serious commercial agriculture.

A long time leader in the management of the West Maui watershed, MLP continues to maintain a crew that supports conservation in their native forests that stretch from the ocean to the summit of West Maui. MLP continues to manage several stream intakes in Honolua and Honokōhau Valleys and the Honokōhau Ditch, which were once the backbone of the region's water delivery system. The Honokōhau system now delivers surface water to support resort and golf course use at Kapalua Resort. It also delivers several million gallons per day to the County Water Department at Māhinahina to be filtered and distributed for domestic use.

1 2015 Hawai'i Coffee Growers Production Report, Kimo Falconer, President

FIGURE 23

Right: Maui crop pattern 2015



MAUI CROP SUMMARY (2015)

University of Hawai'i Hilo

SDAV UH Hilo

Department of Agriculture
State of Hawaii

ISLAND-BY-ISLAND AGRICULTURAL SUMMARIES 2015 CONT'D.

WEST MAUI CONT'D.

During the plantation era, irrigation waters were drawn from many of the valleys above Lahaina, each serving a particular area and all tied together by the central stem of the Honokōhau Ditch. This system delivered water into the Wahikuli and Crater Hill Reservoirs on State lands above Lahaina Town, which held excess flow and allowed the water to be redirected north to the lowlands of Wahikuli or south beyond Lahainaluna School to Launiupoko.

During the period of low water demand following the plantation closings, these reservoirs were evaluated for their compliance to new safety regulations and were ultimately decommissioned. This put a permanent end to the regional nature of irrigation water systems in West Maui.

FIGURE 24

Above: West Maui crop pattern 2015

MAUI'S CENTRAL PLAIN

The isthmus between Haleakalā and the West Maui Mountains is home to HC&S, Hawai'i's last sugar plantation and the largest agricultural operation in the state. HC&S farms roughly 36,000 net acres of crop in a two year rotation and produces between 150,000 and 200,000 tons of sugar and 60,000 tons of molasses annually. It employs 750 employees with a payroll of $35 million annually. The mill and several small hydro plants produce sufficient power to run the milling and water pumping needs as well as 6% of the Maui's total electrical demand.[2]

In early 2016, HC&S announced plans to shut down sugar operations and is no longer planting sugar. This will precipitate a major transition in land use and future crop production. Details of this transition are still to be worked out.

Sugar is a water intensive crop that can, at times, require as much as a million gallons per 100 acres per day. Irrigation water for HC&S comes from three sources: surface sources in East Maui provided by East Maui Irrigation Company, surface flows from West Maui streams via the West Maui Water Company, and low elevation brackish wells located throughout the central plain.

Protracted legal actions over water rights to East and West Maui surface irrigation systems argue for and against returning currently diverted water to support in stream biota. Balancing the rights and responsibilities of taro farmers and stream advocates with the beneficial use of water for agricultural purposes has been time consuming, expensive, and contentious. Resolving the water use issues will be critical to enable future agricultural uses to emerge in the wake of HC&S's recent announcement.

HC&S has been exploring alternative crops and agricultural methods for decades. Now that sugar operations will

2 HC&S website, http://hcsugar.com/what-we-do/

be coming to an end, the results of this research will help to inform their future agricutural plans.

Upcountry Kula-Haʻikū

The upper slopes of Haleakalā between 800 3,500' elevations provide excellent growing conditions for a wide variety of leaf and root crops. There are 1,150 acres of diversified crops in the Kula area as well as nearly 85 acres of landscape and flowers, 20 acres of tropical fruit, and 16 acres of bananas.

Small vegetable, fruit, and flower growers farm 5 to 20 acre lots in the Kula Agricultural Park, and irrigation is provided to the park by surface sources flowing in the Hāmākua Ditch operated by HC&S. The rest of Kula's agricultural production depends on County water that comes from surface sources in the Waikamoi Forest Reserve, which are treated and filtered for domestic use. Both Kula Agricultural Park and County agricultural water rates are comparable at roughly $1.00/1,000 gals. County water is in short supply in the Kula area, and the demand for meters is more than the system can accommodate, which limits the availability of municipal water for agricultural use.

Maui has been working for more than 40 years on a new agricultural waterline at the 4,000' elevation. Referred to as the Kula Duel Waterline, it is intended to bring additional agricultural water from the Kahakapau Reservoir in the Waikamoi Forest area to serve Kula farmers and DHHL lands in Kēōkea. The waterline would provide relief for farmers waiting for meters and opportunities for expansion.

Agriculture in the Kula Makawao area reduced substantially between 1980 and 2015 as displayed in Figure 26. Loss of MLP's pineapple production, Haleakalā Dairy's operations near Makawao, and

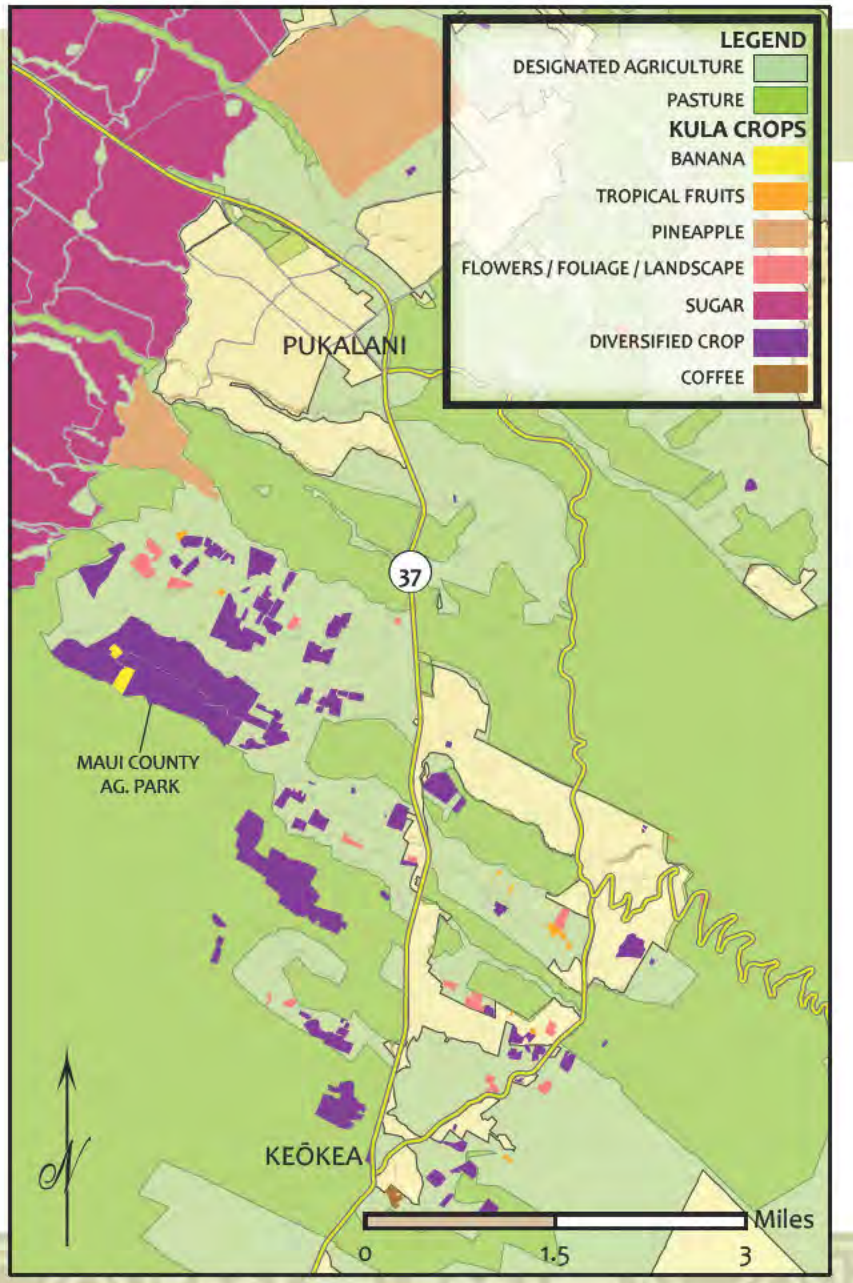


Figure 25

Right: Kula crop pattern 2015.

ISLAND-BY-ISLAND AGRICULTURAL SUMMARIES 2015 CONT'D.

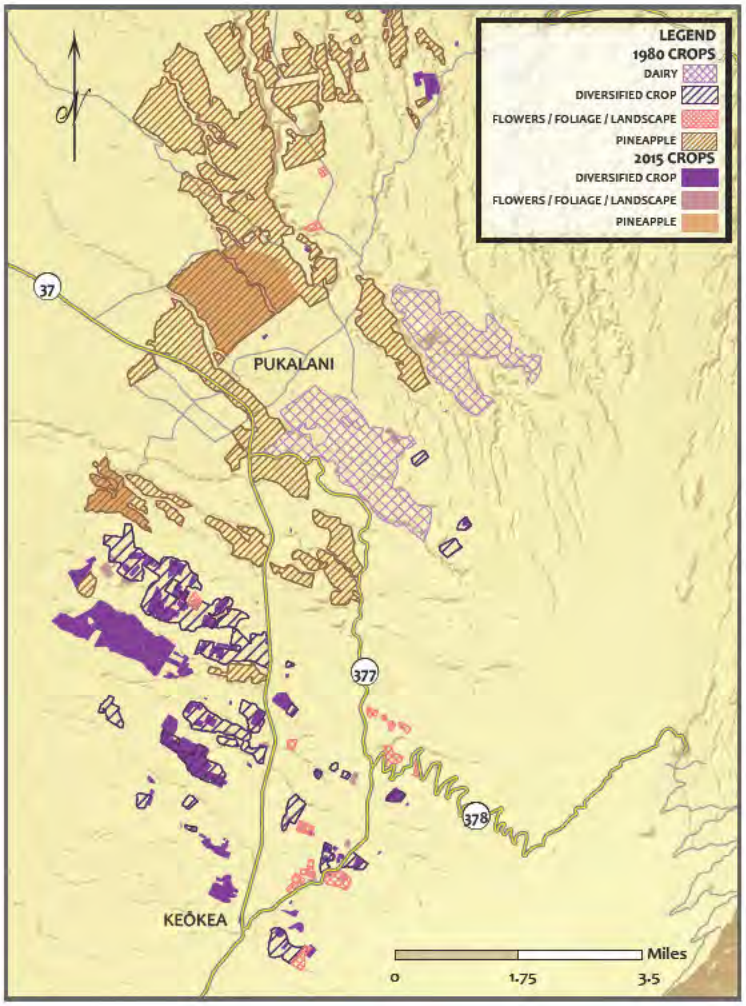


FIGURE 26

Left: The difference between crops grown in 1980 (cross hatched) and those mapped in 2015 (solid colors) shows the significant loss of intensive agriculture in the last 35 years..

UPCOUNTRY KULA-HA'IKŪ CONT'D.

reduced diversified crop production have resulted in the development of large residential estates on unused farmland.

The one area of Kula that has not seen a decline in productive agriculture is the County's Kula Agricultural Park located on Pūlehu Road. The County leases farm parcels with agricultural water to 20+ farmers at a reasonable rate. Since the County has no plans to sell these lands, farmers have the assurance that their tenure is not associated with real estate values. The County is planning to add acreage to the Ag Park to support the expansion of farming in the area.

Flower and foliage acres in upcountry Maui have receded since 1980, largely due to the reduction of acres planted in protea and cut flowers, which were once a big part of upcountry's portfolio.

The Ha'ikū region of Maui has largely been subdivided into lots of two or more acres, transforming most of the land use from active agriculture to rural residential estates. Despite this shift, virtually every parcel in Ha'ikū receives agricultural use status on its real property tax assessment. This is depicted in the aerial photo on the facing page. Agricultural use incentives in all Counties are important tools that support farmers. Without a clear standard for acceptable agricultural use or periodic inspection, these incentives are subject to misuse.

KE'ANAE TO KAUPŌ

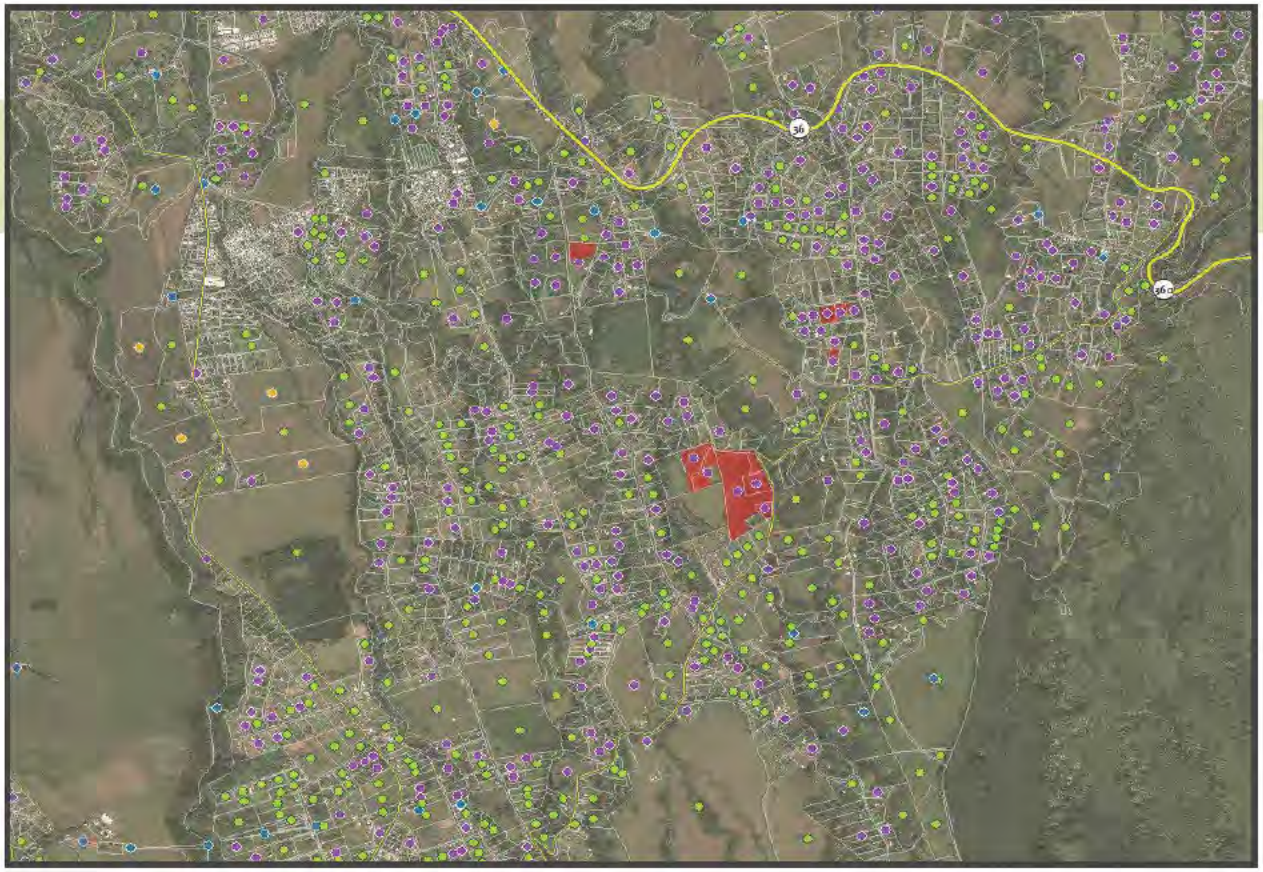
Agriculture along the windward coast of Haleakalā is limited to several taro farms in Ke'anae and Wailua and scattered crop and landscape material production in the Hāna and Kīpahulu areas. Dependable water supply and trucking distance to Maui's markets are persisitent challenges to farming stability in these areas. Taro farmers are engaged in multiple legal actions to secure adequate water and

stop diverting water from native streams to central Maui for plantation uses.

Other farmers from Hāna to Kaupō produce a range of flowers, tropical fruit, bananas, and other crops that are trucked to various Maui markets. The new owner of Hāna Ranch's land assets plans to produce organic produce for local consumption and use in their own restaurant outlet in Paʻiā.

CATTLE

The cattle industry on Maui manages roughly 108,000 acres of pastureland in a range of different environmental conditions. Maui ranchers are pioneers in their efforts to brand Maui cattle and to provide a local beef product to the Hawaiʻi marketplace. Efforts by the Maui Cattle Company set the bar for the state in terms of rancher collaboration. That collaboration has been severely tested by years of persistent drought that forced the reduction of herd size and by the rising price paid for feeder cattle on the mainland.



In 2015, the cattle industry on Maui is in a rebuilding mode, and the supply of grass fed animals to the local market is at a low point relative to what it was just five years ago. State records indicate the Maui ranchers shipped 2,400 animals to the mainland in 2014[3]. Ranchers are exploring new ways to generate revenue from ranch lands to supplement cattle operations. Several are exploring multi species grazing with sheep and goats, some are developing energy from wind and sun, and others are exploring agro tourism and adventure activities to help increase ranch revenues. One certified slaughterhouse on Maui near Makawao harvests a range of animals, which is important for the success of ranch activities on the island.

Above: Haʻikū properties with agricultural tax incentives are noted with green dots (pasture), purple dots (diversified crops), and orange dots (pineapple). Solid purple areas indicate active commercial farm activity. The majority of properties in Haʻikū receive reduced property tax assessments for agricultural use.

3 Data provided by the State Veterinarian in the State Division of Animal Industry

ISLAND-BY-ISLAND AGRICULTURAL SUMMARIES 2015 CONT'D.

HO'OLEHUA

Agriculture on Moloka'i centers around the Ho'olehua plain on land belonging to DHHL, the State, and Moloka'i Ranch. The largest users are seed companies that primarily lease land from Moloka'i Ranch. Seed companies farm 2,300 acres on Moloka'i and, in 2014 , employed over 220 people.

DHHL has 13,400 acres in Ho'olehua, of which 5,862 acres are designated for "Supplemental Agriculture" use in lots of 35 acres or larger. Another 2,138 acres of 2 4 acre lots are designated by DHHL's Moloka'i Master Plan as "Subsistence Agricultural" homesteads[2]. The homestead area is served by the Moloka'i Irrigation System, a State operated irrigation system that draws surface water from the East Moloka'i watershed and is supplemented by ground water from wells in Waikolu Valley on Moloka'i's remote north shore. Waters are stored in and delivered from the Kualapu'u Reservoir.

Prior to 1980, many Ho'olehua homesteaders leased their land to Del Monte for pineapple production. Today, some homesteaders farm a range of diversified crops, including sweet potatoes, dryland taro, cucumbers, tomatoes, macadamia nuts, bananas, and papayas. There are ongoing efforts to train new farmers to increase productivity, and a persistent movement strives to improve food self sufficiency and to manage the island's natural resources for long term sustainability.

The State's Moloka'i Agricultural Park contains 750 acres subdivided into 22 lots. The largest farmer grows organic vegetables and fruits, including a GM free papaya marketed statewide. Moloka'i is not currently subject to the PRSV that impacts the papayas on 'Oahu and Hawai'i Island. Moloka'i has also avoided infestation of the CBB beetle and the Varroa mite that has hampered the growth of the coffee and honey bee industries respectively elsewhere in the state.

The Moloka'i Coffee Company continues to produce a boutique brand from just over 100 acres in the Kualapu'u area. The original plantings were in excess of 300 acres but have been reduced through diminished production and land sales.

Exported products from Moloka'i include corn seed, cucumbers, dryland taro, coffee, beef, organic papaya, eggplant, and other vegetables. A portion of Moloka'i's food crop production stays on island for local consumption, but the limited market can lead to unsold surplus at times when there is seasonal abundance[3].

1 Hawai'i Business News, March 2015, pg 38
2 DHHL Moloka'i Regional Plan, 2010
3 Personal communication, Glenn Teves, Moloka'i CTAHR Extension Agent

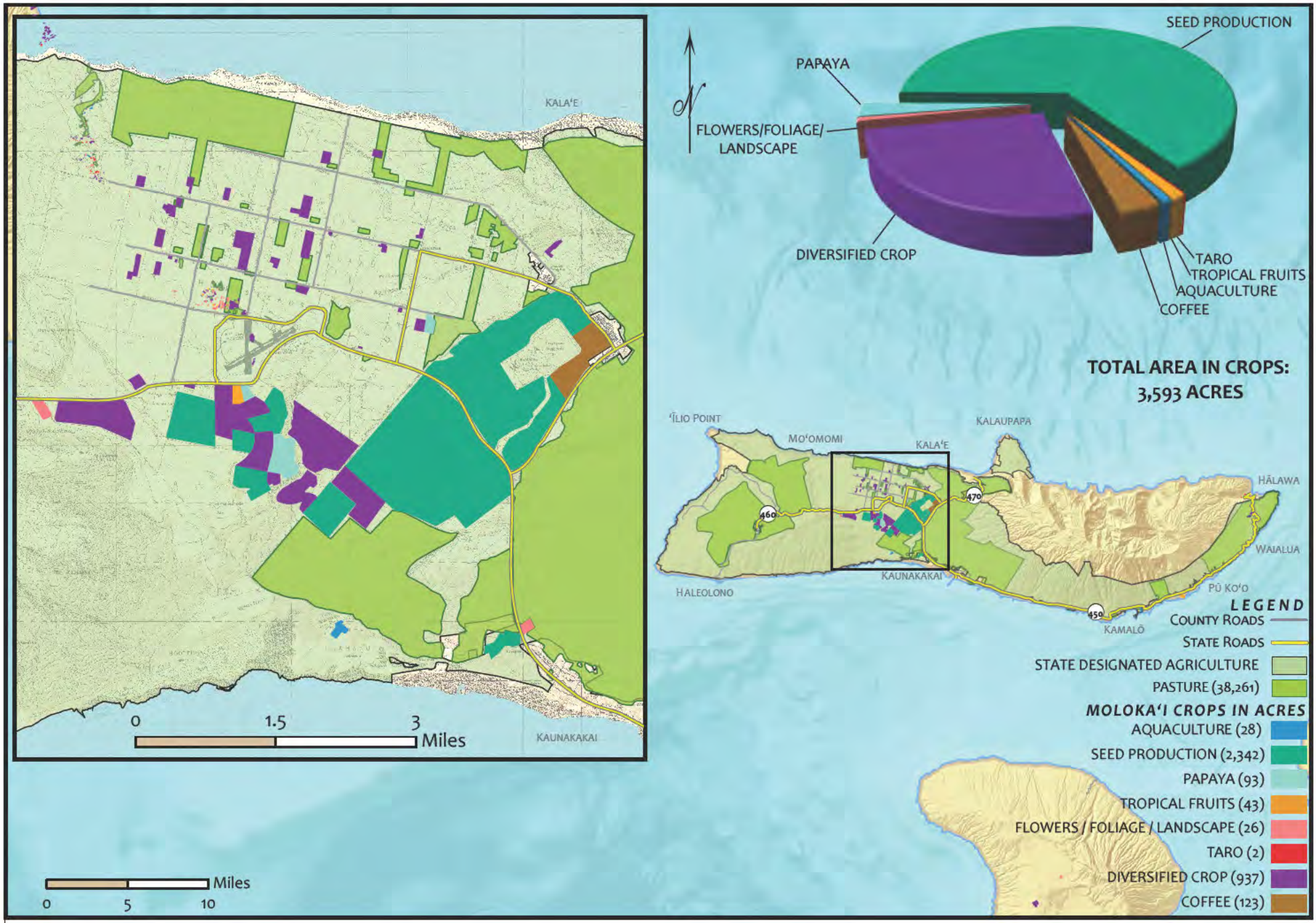
LIVESTOCK ON MOLOKA'I

Moloka'i has 39,200 acres in active pastureland. Cattle ranching is recovering from herd reductions, dry conditions, and changes in ownership at Moloka'i Ranch, the largest cattle operation on the island. Moloka'i Ranch produces grass fed beef from Angus and Wagyu cattle that is marketed locally and statewide. DHHL has a community pasture program on parcels around Kaunakakai that involves multiple cattle owners sharing pasturelands, and a number of smaller ranchers continue the island's long ranching tradition in east Moloka'i.

There is one slaughterhouse in Ho'olehua that is operated as a cooperative. Throughput at the facility is at a low point due to reduced supply. The plant also slaughters and cuts wild axis deer meat, which is prevalent and can be sold commercially under certain harvest conditions.

FIGURE 27

Right: Crop summaries for Moloka'i 2015



UNIVERSITY of HAWAI'I· HILO

SDAV UH HILO

MOLOKA'I CROP SUMMARY (2015)

Department of Agriculture STATE OF HAWAII

ISLAND-BY-ISLAND AGRICULTURAL SUMMARIES 2015 CONT'D.

Today, Lana'i's has about 50 acres in active crop production. Once known as Pineapple Island, Dole Foods farmed as many as 13,000 acres until operations shut down in 1992[1].

Ninety one percent of the island is owned by Pūlama Lāna'i, which is owned by Larry Ellison. Pūlama Lāna'i has plans to redevelop existing resort properties and add new support facilities. Owners have discussed additional agriculture ventures, but specific plans have yet to mature.

There is a small, lightly farmed agricultural park just outside of the Lāna'i airport. Most of the vegetables produced from this area supply resort restaurants on the island. In 2015, hotel operattions are under renovation, and the small fresh produce market created by hotel operators has all but vanished until hotel operations resume[2]. A second small parcel near Lāna'i City is used to support the landscape needs of the resort, and a temporary plant quarantine facility near Kāmalapau Harbor has been set up to insure imported plant material for the resorts does not introduce invasive pests.

Water for irrigation is limited on Lana'i as resort and golf activities capture the bulk of available water. Recycled water from the wastewater treatment facility is also available for agricultural use, but the current hiatus in resort operations has reduced its availability. Livestock is raised in a few small pastures with animals for home use.

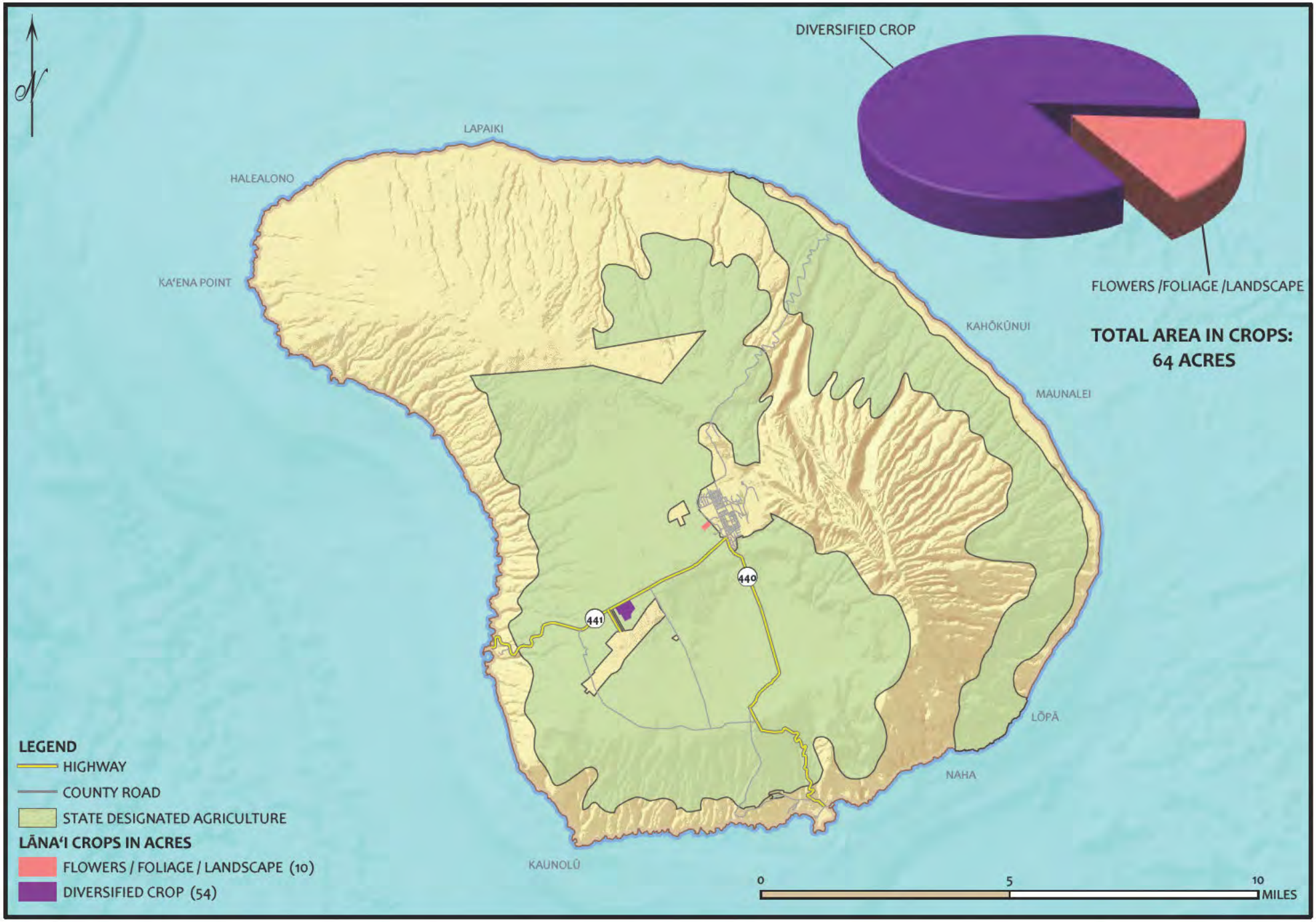
Above: Aerial view of Lana'i's Agricultural Park near the airport. Image courtesy of Google Earth and Digital Globe Media

FIGURE 28

Right: Lana'i crop pattern 2015

Hawa ' DOA, H s o y o Hawa ' 's Ag c e, h p //hdoa Hawa gov/b og/ag-eso ces/h s o y-o -ag c e- n-Hawa /

2 Pe sona comm n ca ons, A be a DeJe ey, Lāna' a me



University of Hawai'i Hilo

SDAV UH Hilo

LĀNA'I CROP SUMMARY (2015)

Department of Agriculture
State of Hawaii

ISLAND-BY-ISLAND AGRICULTURAL SUMMARIES 2015 CONT'D.

Hawai'i Island is the largest and youngest in the Hawaiian archipelago. It is the size of all the other islands put together, so it is no surprise it hosts 30% of the State's total crop area at 61,000 acres. Two-thirds are planted in macadamia nuts or commercial forestry. In addition, there are roughly 560,000 acres in pastureland, or 73% of the State's total.

NORTH KOHALA

North Kohala was once one of the most active agricultural areas on Hawai'i Island. For centuries, wetland taro was produced in the windward valley, and an extensive dryland field system stretched for miles along the mid level slopes of Kohala's leeward coast. By the 1860s, sugar began to replace subsistence farming as the primary agricultural activity. By the early 1900s, nearly 20,000 acres were planted in sugar, partially fed by a surface irrigation system that served six sugar mills and irrigated most leeward plantation fields. Sugar production ended in 1974, and new agricultural activity has emerged sporadically over the last 40 years.

The foliage industry, led by Kohala Nursery, was the first successful post plantation agricultural venture to develop from a series of unsuccessful efforts envisioned by the State's Kohala Task Force in the mid to late 1970's. For a time, Kohala Nursery was the biggest foliage plant exporter in the State. Rising competition and economic cycles, both locally and nationally, have seen the foliage industry grow and then recede. There are currently about 85 acres of land in North Kohala dedicated to foliage production, most of it in Honomaka'u and Kapa'au. Products include palms, potted plants, and landscape trees and shrubs.

Macadamia orchards were part of plantation diversification experiments in the 1960's. It was not until the early 1980's that commercial planting began in earnest. Today, over 1,080 un irrigated acres are planted in macadamia trees, and the success of growers and processors fluctuates with global market conditions.

Kohala is home to Clover Leaf Dairy, which moved into a State owned feedlot near 'Upolu Point in 1985. It operates on 840 acres and has 600 milking cows. The dairy has used Kohala Ditch water to irrigate pastureland to produce green chop, which has been used as feed to reduce the grain imports. Clover Leaf is one of only two commercial dairy operations in the State. Milk is sold to Meadow Gold Dairies and processed at its facility in Hilo.

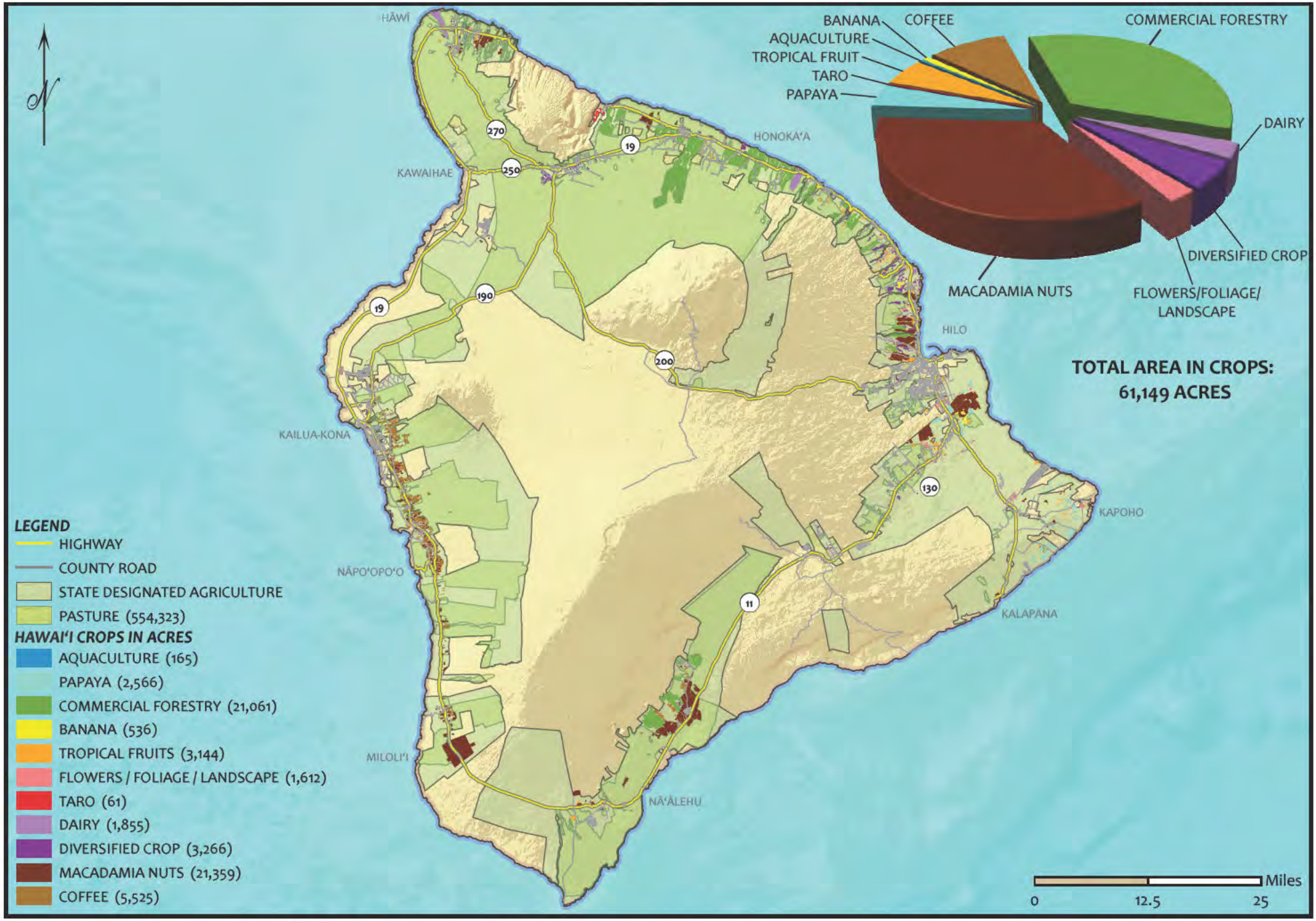
There is a small amount of diversified crop production in North Kohala although there is significant interest within the Kohala community to strive for community food self sufficiency. A Food Forum held in North Kohala in 2009 identified a relatively short list of five to six commercial farmers in the region, most of whom were organic vegetable growers who marketed their crops to local residents, restaurants, and to retail outlets around the Island. In addition to these commercial and private farm operations, there are several community based efforts to educate Kohala young people in the business of farming and to promote family farming for local self sufficiency.

There are about 150 acres of tropical fruit in the North Kohala district, most of which is sold locally or shipped to distributors on other islands.

Cattle production is the largest single agricultural land use in the district. Ponoholo, Kahuā, Kukuipahu, and Parker Ranches use much of Kohala's pastureland along with a number of smaller independent producers. The bulk of North Kohala's cattle are exported to the West Coast.

FIGURE 29

Right: Hawai'i Island crop pattern 2015



HAWAI'I ISLAND CROP SUMMARY (2015)

University of Hawai'i Hilo

SDAV UH Hilo

Department of Agriculture State of Hawaii

ISLAND-BY-ISLAND AGRICULTURAL SUMMARIES 2015 CONT'D.

NORTH KOHALA CONT'D.

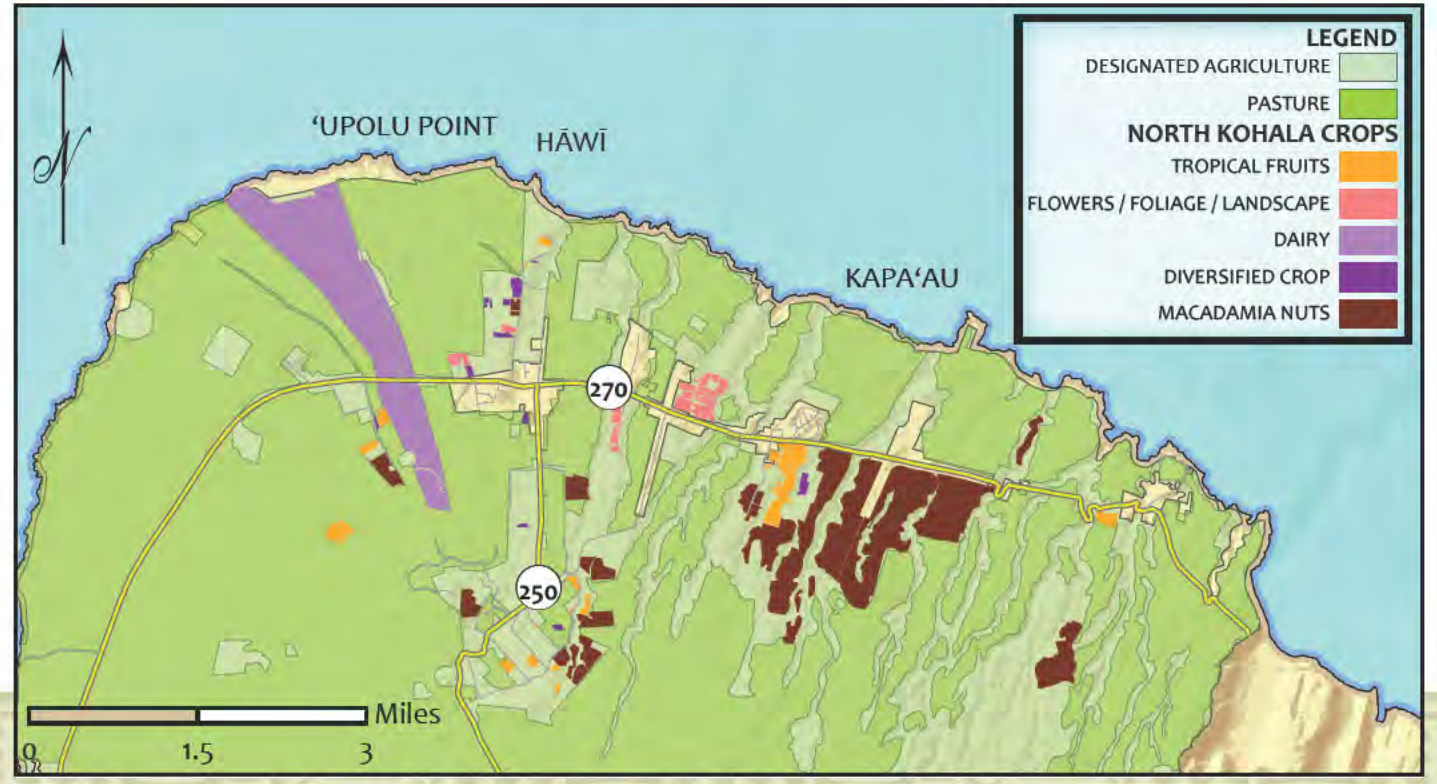
The Kohala Ditch was built in 1906 and is owned and operated by the district's largest landowner, Surety Kohala Ltd.

The ditch's principal stream intake is on land owned by KS in the remote east branch of Honokāne Valley. The Kohala Ditch is an anomaly in Hawai'i plantation irrigation systems.

It survived for nearly 40 years after the sugar industry shut down without being acquired or subsidized by the State or other government agency. As originally designed, the system had the capacity to convey an average of 30 to 40 million gallons per day (mgd) at high flow. A renovated intake in Honokāne now limits average flow to 10.0 mgd. The ditch is currently operational, but there are ongoing issues with trail access to intakes and the condition of flumes and distribution lines.

The largest income producers for the ditch are kayak float tours that use the ditch to transport visitors through the district on private flume adventures. There is also a small hydroelectric power plant near the end of the ditch, which has produced intermittent electrical power to the public utility company for several decades.

In addition to the Kohala Ditch, there are several perched water springs that provide reasonably dependable water. The privately owned Bond and Watt Tunnels in I'ole are two important resources. Together they produce approximately 1.5 mgd. Improvements are underway to replace piping and increase storage capacity so these sources can serve both domestic and agricultural uses on the 'Iole lands, now owned by The Kohala Institute.



SOUTH KOHALA

Farmland in South Kohala is concentrated around Waimea. Farm lots in Lālāmilo and Pu'ukapu account for about 500

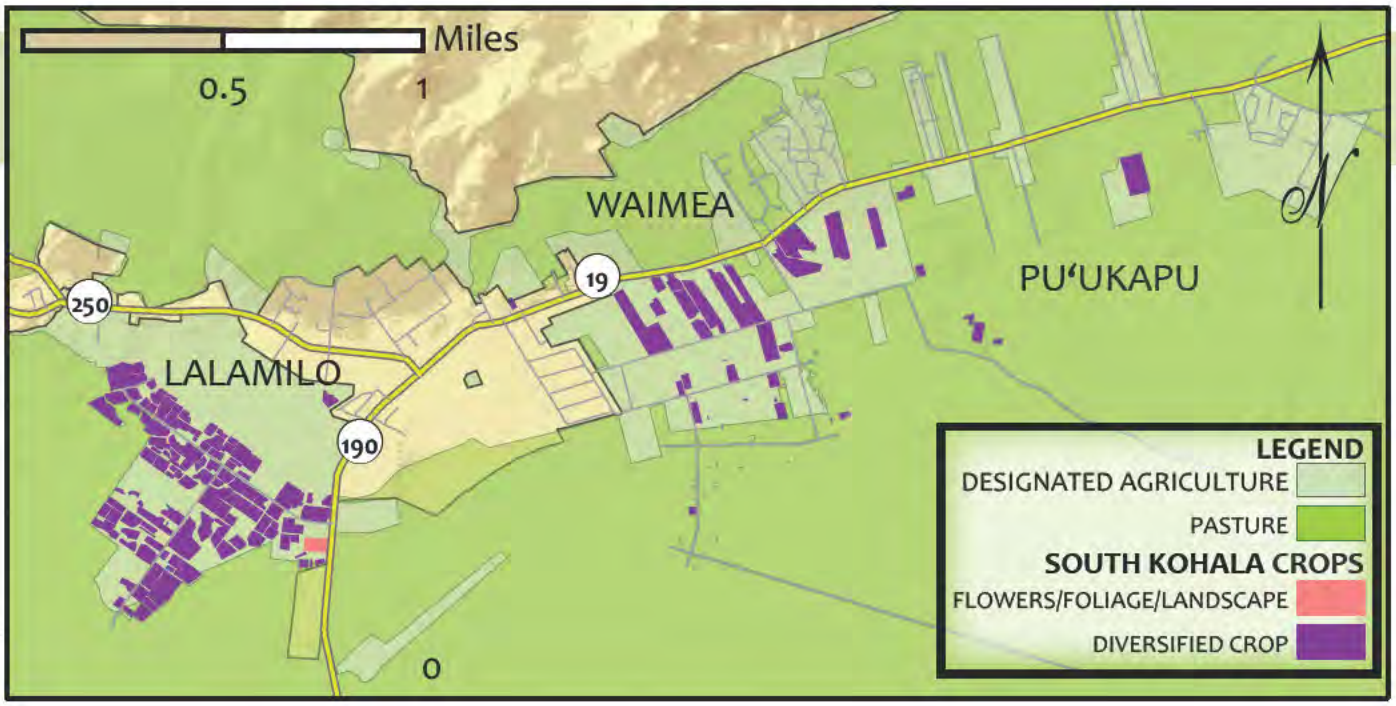


FIGURE 30

Left: North Kohala crop pattern 2015

FIGURE 31

Right: Waimea-South Kohala crop pattern 2015

acres of active truck crop production. These are some of the most productive food producing areas on the island. Crops include Chinese and head cabbage, tomatoes, cucumbers, sweet corn, pumpkins, celery, beets, strawberries, a wide variety of lettuces, and other leaf crops. Roughly 50% is exported to ʻOahu and other neighbor Islands[1]. Some of the Lālāmilo farmers cooperatively manage a State owned vacuum cooling plant and packing facility to help prepare crops for shipping.

There are approximately 25 farmers currently producing in this region. The bulk of Waimea produce is grown on land held in fee simple title. The Lālāmilo Farm Lots were initially state owned lands that were sold to farmers in the 1980s. Most parcels remain active, yet several have migrated to other business operations, including a veterinary facility, horse boarding and training facility, and an ice cream manufacturer.

In the Puʻukapu area, lands are held in fee simple title or leased to Hawaiian homesteaders from the DHHL. Very few DHHL parcels are in active production; most are in pasture. A greenhouse tomato and vegetable producer, WOW Farms, is expanding their family operation and assisting other homesteaders to use small greenhouses to produce both food and flowers. A larger homesteader initiative, Waimea Nui, is gaining traction to develop a modern processing facility on DHHL land.

Farming in Waimea is supported by the State owned and operated Waimea Irrigation System, which is 15 miles long and designed to deliver 400+ mg per year from the Kohala Mountain watershed. Water is collected from surface streams, sent by ditch and

1 Estimate derived from several personal communications with Lalamilo farmers

ISLAND-BY-ISLAND AGRICULTURAL SUMMARIES 2015 CONT'D.

SOUTH KOHALA CONT'D.

pipeline to several tanks and reservoirs in eastern Waimea, and then piped through Pu'ukapu to Lālāmilo. The Board of Agriculture sets the price for State operated systems, currently $.55/1000 gallons. When reservoir levels drop, water use can be restricted. Droughts in recent years have impacted water availability.

The Kohala Mountains provide surface water for several important collection systems to support domestic, agricultural, and pasture uses in the region. Watershed management efforts conducted by the Kohala Watershed Partnership help insure that these high level, gravity fed water sources are sustainable long term.

Parker Ranch is the largest landowner and agricultural business in the district. Owned by the Parker Ranch Foundation Trust, the ranch is dedicated to the support of several educational and medical beneficiaries in the Kohala region and to the betterment of the community as a whole. The cattle operations are primarily an export, cow/calf business since the 1980s. A major initiative in 2014 under the name of the Paniolo Cattle Company (PCC) was started to build a sustainable grass fed beef business with a portion of Parker's herd. PCC has committed to keeping 1,400 head on island annually to support the local food supply. PCC will need to overcome a number of difficult barriers to sustain their grass fed program, including the state's limited slaughter capacity and the need for steady rainfall in key areas to support grass growth. The success of this effort will also depend on the support of the consuming public to support local beef products in the marketplace.

HĀMĀKUA

Hāmākua shares a long plantation history with much of Hawai'i Island's windward coast. Sugar was the predominant crop on multiple plantations from the 1870s to 1994. Hāmākua also has a long ranching tradition that flourished on pastureland above the cane fields on the upper slope of Mauna Kea, and cattle operations remain a major industry.

FIGURE 32

Left: Hāmākua crop pattern 2015

The bankruptcy of Hāmākua Sugar Co. (HSC) in 1992 was a point of major transition in the district. The bulk of the HSC land, nearly 30,000 acres, was purchased in foreclosure by KS and then leased primarily for pasture and forestry use. KS is a long term landowner and has not sought to sell any of the lands they acquired in Hāmākua in the last 20 years. This long term view enabled KS to pursue long term forestry investments and to give ranchers relatively longer term leases than are available from other private landowners.

State lands in the district were leased to ranchers and to the Hāmākua Farmer's Cooperative (Co op). The Co op was created the mid 1990s to give former plantation workers access to State lands below the Hāmākua Ditch. Over the years, members experienced difficulties establishing new farms. Major repairs to the ditch and damage from earthquakes interrupted water flows for long periods, causing many farm closures.

The ditch is now in operation and the Co op (with 60 members) is expanding production. There are also a number of small, independent farms that produce vegetables and fruit for the local market. A new farmers market in Honoka'a, Hāmākua Harvest, hopes to provide additional opportunities for local farmers to sell directly to consumers.

The State DOA assumed control of the Hāmākua Ditch after the plantations shut down. The ditch once brought 30 to 40 mgd of surface water from multiple intakes at the back of Waipi'o Valley and served approximately 5,500 acres of former cane land from Waipi'o to Pa'auilo. The remaining 20,000+ acres of the sugar land in the Hāmākua District were un irrigated, relying on seasonal rainfalls of 60 to120 inches annually. Today, the ditch has the capacity to deliver 10 15 mgd to a range of farmers and ranchers between Kapulena and Pa'auilo. Only a portion of that flow is being utilized in 2015.

Taro productionin Waipi'o Valley.

The largest intensive agricultural crop in the Hāmākua region is eucalyptus forestry. There are over 14,500 acres in commercial production, most on lands leased from KS and Parker Ranch to mainland based forestry investors.

The forests were initially planted to produce wood fiber to be shipped off island for paper production on a seven to eight year rotation. A combination of market conditions, changing leasehold ownership, and export infrastructure issues caused harvest delays. In 2015, nearly 20 years after the trees were planted, they are being harvested as logs and shipped to China from Kawaihae Harbor.

The most likely long term market for a portion of Hāmākua forestry appears to

ISLAND-BY-ISLAND AGRICULTURAL SUMMARIES 2015 CONT'D.

HĀMĀKUA CONT'D.

be biomass for electricity generation. A market may also exist for select larger logs to be used for veneer and dimensional lumber. The forests are key assets in the development of Hawai'i Island's forest industry, but the opportunity has yet to be fully realized.

Macadamia nut orchards occupy 760 acres and are generally un irrigated. Some of the earliest commercial plantings were in the Kapulena area in the 1960 70's with additional orchards planted in the 1990s.

Waipi'o Valley continues to be the center of the island's wetland taro production. There are several hundred acres of former taro *lo'i*, of which about 61 acres are in active production. Most of the land is leased from Bishop Museum, the largest land holder in the valley floor. Several growers process their own taro into poi and sell directly to local consumers along the highway, at farmers markets, and in retail outlets.

The majority of agricultural lands in the Hāmākua district, running from the coastal cliffs to over 6,000' elevation, are used for cattle grazing. The availability of low cost stock and irrigation water from the Hāmākua Ditch offers additional opportunities to improve pasture capacity in areas served by the ditch.

The State owned and privately operated Hawai'i Beef Producers (HBP) slaughterhouse near Pa'auilo is one of two certified slaughterhouses on the Island. The HBP facilities and surrounding land provide some needed infrastructure to increase the supply of local grass fed beef.

One of the last two dairy operations in the State is located at the southern end of the district. Big Island Dairy leases about 2,000 acres from the State to graze nearly 1,200 dairy cows. All the

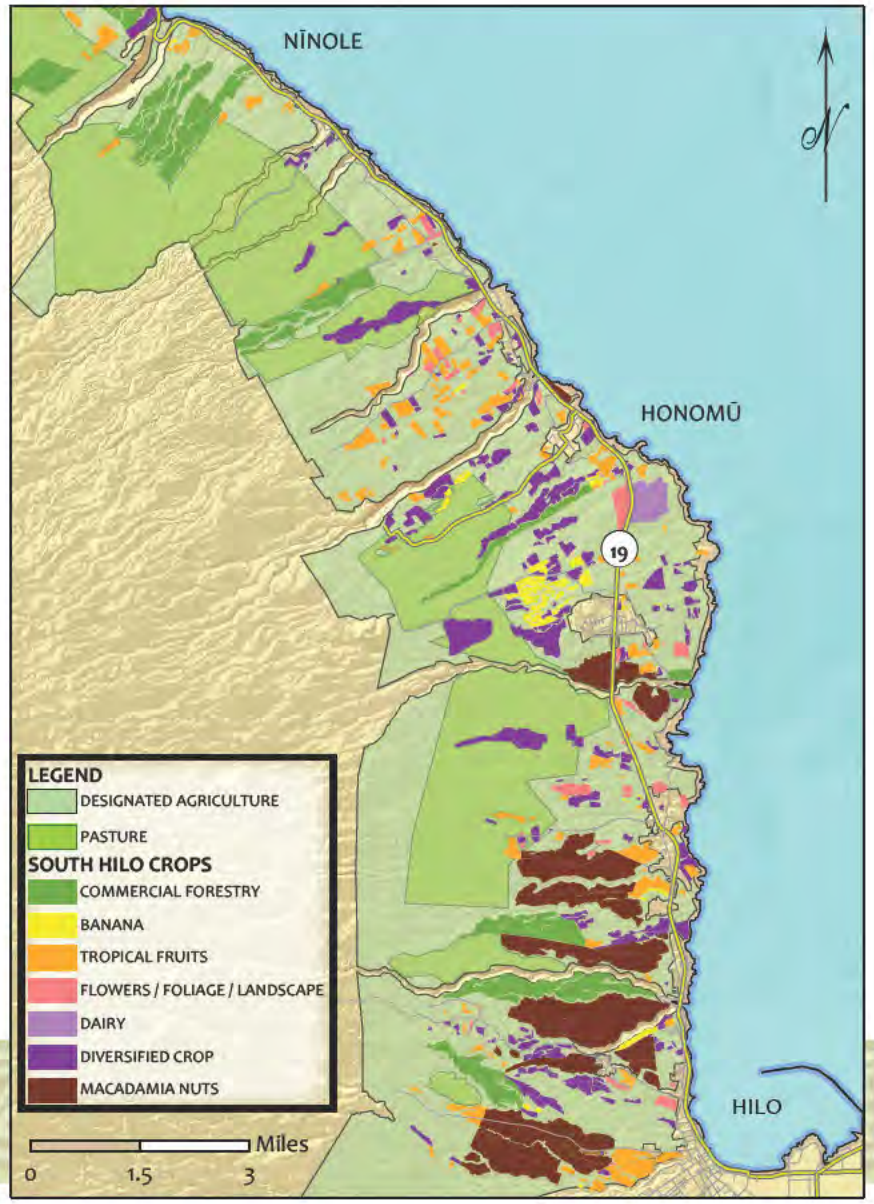


FIGURE 33

Right: South Hilo crop pattern 2015

milk is sold to Meadow Gold for processing and packaging. Big Island Dairy recently completed a multi million dollar upgrade to its operations and expanded its herd. They have 600 acres in feed corn, and produce approximately 40% of the feed needed for the dairy. Forage production reduces feed costs and adds several hundred acres of intensive farming to the Hilo Hāmākua coastline.

There are several foliage and flower operations and some fruit orchards in the district. Homestead landowners in Paʻauilo, Kalōpā, and Āhualoa operate a goat dairy, several apiaries, and plant tea and coffee.

North & South Hilo

The districts of North and South Hilo extend from the urban edge of Hilo to ʻOʻokala and are one of the State's most agriculturally productive regions. The lands along this stretch of windward coast receive 100 to 180 inches of rain annually and supported over a century of un irrigated sugar production. The land experiences less wind, has less slope, and receives slightly more southern exposure than Hāmākua. It is a patchwork of roughly 10,000 acres of crops, including vegetables, tropical fruit, macadamia, forestry, and foliage.

The two largest crops in the region, macadamia and forestry, each cover 3,000 acres. Tropical fruit orchards take up another 1,360 acres including rambutan, lychee, longan, mangosteen, and citrus. Diversified crops are planted on over 2,000 acres.

The largest diversified crop is Okinawan sweet potatoes with 500 800 acres in production annually. The bulk of the crop is exported to the U.S. mainland, and farmers are generally nomadic, looking for new land every year. Sweet potatoes are treated and shipped from the Hawaiʻi Pride irradiator plant in Keaʻau. In 2013, 12 million pounds of sweet potatoes were treated for export. Short term, nomadic plantings of sweet potatoes are not a preferred agricultural practice and do not contribute significantly to the local food supply.

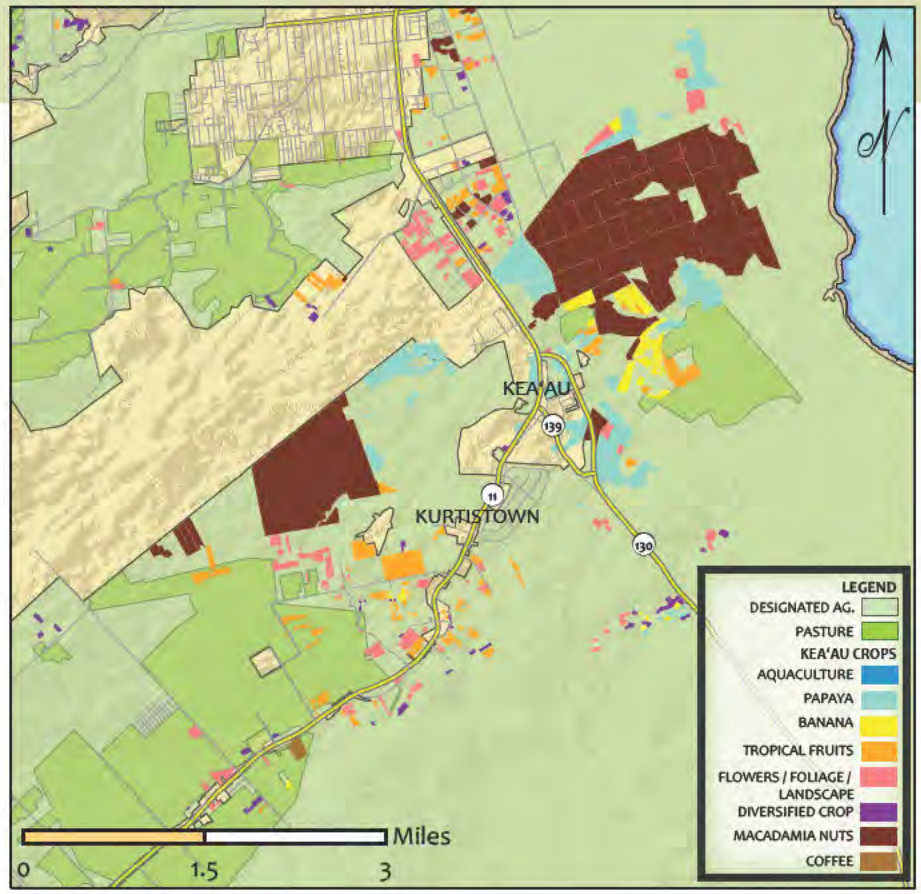


Figure 34

Keaʻau Puna crop pattern 2015

ISLAND-BY-ISLAND AGRICULTURAL SUMMARIES 2015 CONT'D.

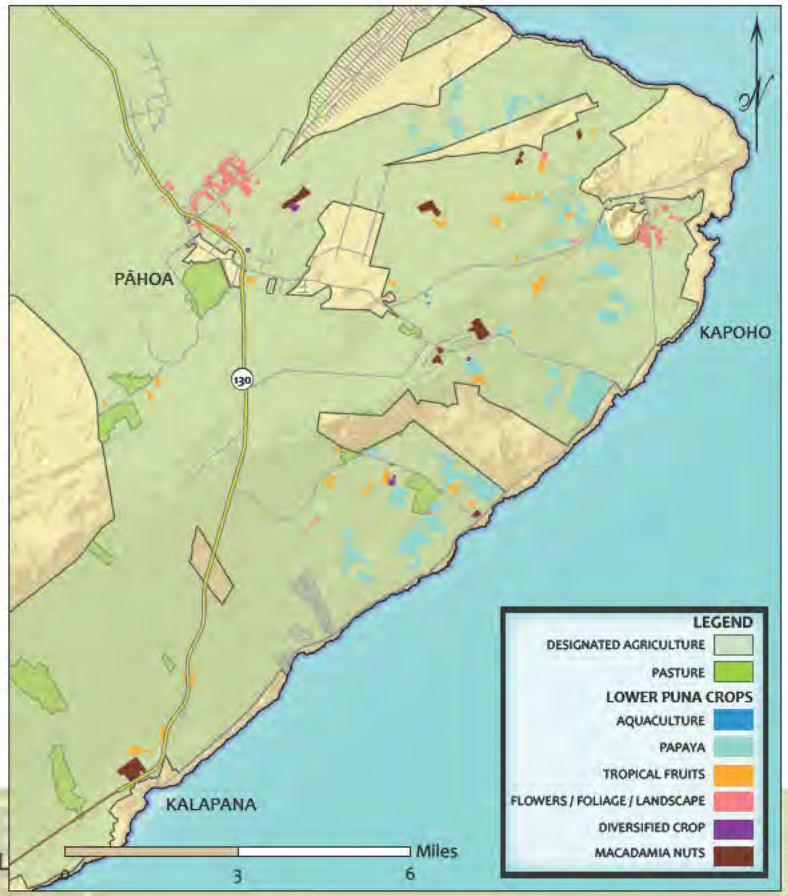
NORTH & SOUTH HILO CONT'D.

Flower and foliage industries grow product on 385 acres in the region. There are several nursery operations that grow several hundred acres of foliage cane stock in open field plantings. Specialty crops, such as hearts of palm, are grown on several farms and sold to high end restaurant markets across the County. There is a mushroom grower in Laupahoehoe producing an array of fresh mushrooms for local consumption and export. Small plantings of cacao and coffee are emerging, and in recent years, portions of the flat, low elevation land in Onomea have large plantings of feed corn for Big Island Dairy.

PUNA

The Puna district is home to most of the state's papaya industry (2,560 acres), much of its macadamia (4,270 acres) and tropical fruit production (960 acres), and a large portion of its foliage and flower production (921 acres). Puna also supports 240 acres of banana production, a small amount of coffee, and about 260 acres of diversified crops.

FIGURE 35 *Puna's crop pattern 2015*



It is a district with little soil and no regional irrigation system. Puna's agricultural success depends on ample rainfall, relatively inexpensive land costs, and a diversified workforce that can live affordably in non standard subdivisions and on water catchment. There is a growing portion of residents committed to sustainable, organic farming practices to feed themselves and their neighbors.

The foliage industry flourished in Puna from 1980 to 2000 but declined in recent years. Potted house plants are cultivated and shipped to local and mainland markets from large greenhouse operations. Landscape plants, palm trees, and other foliage crops nevertheless remain a significant part of Puna's agricultural palette.

In the 1990s, several growers began planting tropical fruit like rambutan, lychee, star fruit, and longan. This region is home to the largest grafted tree nursery in the State and was once the State's largest banana producer. Several smaller banana growers are continuing that tradition. Other specialty crops like noni, tea, coffee, and cacao are emerging on small parcels in the district.

The papaya industry is based in the Kea'au area with three papaya

processing facilities that treat fruit for export markets around the Pacific Rim. Production in 2014 was 11 million pounds. Approximately 50% was exported; the remaining 50% was sold locally[1]. Fruit flies necessitate treatment of all fruit prior to export to the U.S. mainland. Papaya is picked while it is mostly green and treated in chambers with hot water vapor to kill fruit fly larvae. Another treatment alternative is irradiation, generated from electricity. The Hawai'i Pride irradiator facility in Kea'au processes a small portion of the papaya crop as well as longan, rambutan, and most of the exported sweet potatoes.

Papayas are grown by a mix of farmers working with specific packing houses and independent growers. Packing houses account for roughly 60% of the island's production while independents contribute the remaining 40%[2]. Papaya's footprint, particularly in Puna, is somewhat larger than the actual producing acreage of the crop. Papaya farmers typically fallow their fields at the end of each three to four year cycle to minimize soil viruses and nematodes. In Puna, there are three to four times as many acres in rotation at any one point than acres actually producing fruit.

The cut flower and potted orchids have an important role to play in Puna. There are 920 acres of foliage and flower production including open field and greenhouse. Orchids, anthuriums, and potted plants are most often grown intensively under shade cloth or in greenhouses while tropical flowers, foliage, cane stock, palms, and other landscape species are grown in open fields. The State operates two paritally farmed agricultural parks primarily used for this industry, the Pahoa Ag Park with 553 acres and the Pana'ewa Ag Park with 460 acres.

Kapoho and Kurtistown also host concentrations of foliage and flower operations on private lands. This form of agriculture can be done on small parcels of less than an acre, which is ideal for Puna's extensive agricultural subdivisions. Networks of both large and small producers work collaboratively to move product from farm to market. The proximity of the harbor and airport facilities in Hilo is essential for this sector to sustain a presence in the global market.

Anthuriums produced under shade cloth in Puna.

The largest private landowner in Puna is the W.H. Shipman Estate with 10,000+ acres surrounding Kea'au town. The Shipmans are a kama'aina family with a long term view, making them important partners in the community effort to build Puna's agricultural potential.

KA'Ū

Agriculture in the district of Ka'ū is concentrated in the area around Pahala and Wood Valley, with a scattering of outlying orchards and small farms throughout the region. Ka'ū is best known for its 4,800 acres of macadamia nut orchards and its 660 acres of coffee. There are also 3,800

[1] Comm n ca on w h seve a papaya nd s y eade s
[2] Ib d

ISLAND-BY-ISLAND AGRICULTURAL SUMMARIES 2015 CONT'D.

KA'Ū CONT'D.

acres of eucalyptus forest and 50 acres of diversified crops.

Macadamia nuts have the largest agricultural footprint in Ka'ū. The bulk of the orchards were planted by C. Brewer, former owner of Ka'ū Sugar Co., and the Mauna Loa Macadamia brand. They planted over 4,000 acres of nuts dating back to the early 1980s. Additional acreage has been added by landowners for a total of roughly 4,800 acres. New owners operate most of the Pahala orchards under the Royal Hawaiian Macadamia brand.

Following the closure of Ka'ū Agribusiness in 1993, former sugar workers and their families pioneered an emerging coffee industry. Workers were offered short term leases to undivided lands in 1992, on which most planted coffee. This group of 40 farmers has held on to their coffee dreams for nearly 20 years, many of them with little or no certainty of their land tenure. Today, there are approximately 60 coffee farmers in the region and Ka'ū Coffee has achieved high standings in recent international cupping contests and is a growing contributor to Hawai'i's boutique coffee marketplace.

In the late 1990s, KS dedicated most of its former cane lands in the Pahala ara to roughly 3,800 acres of commercial eucalyptus forestry. The market for eucalyptus is still uncertain and the tree stands have been adversely impacted by drought and vog from Kilauea Volcano. KS has also planted 50 acres of koa on former cane land above Pahala for commercial harvest.

There are a small number of truck farmers in the Pahala area that produce vegetables for the local market. On South Point Road, an organic grower operates a small Community Supported

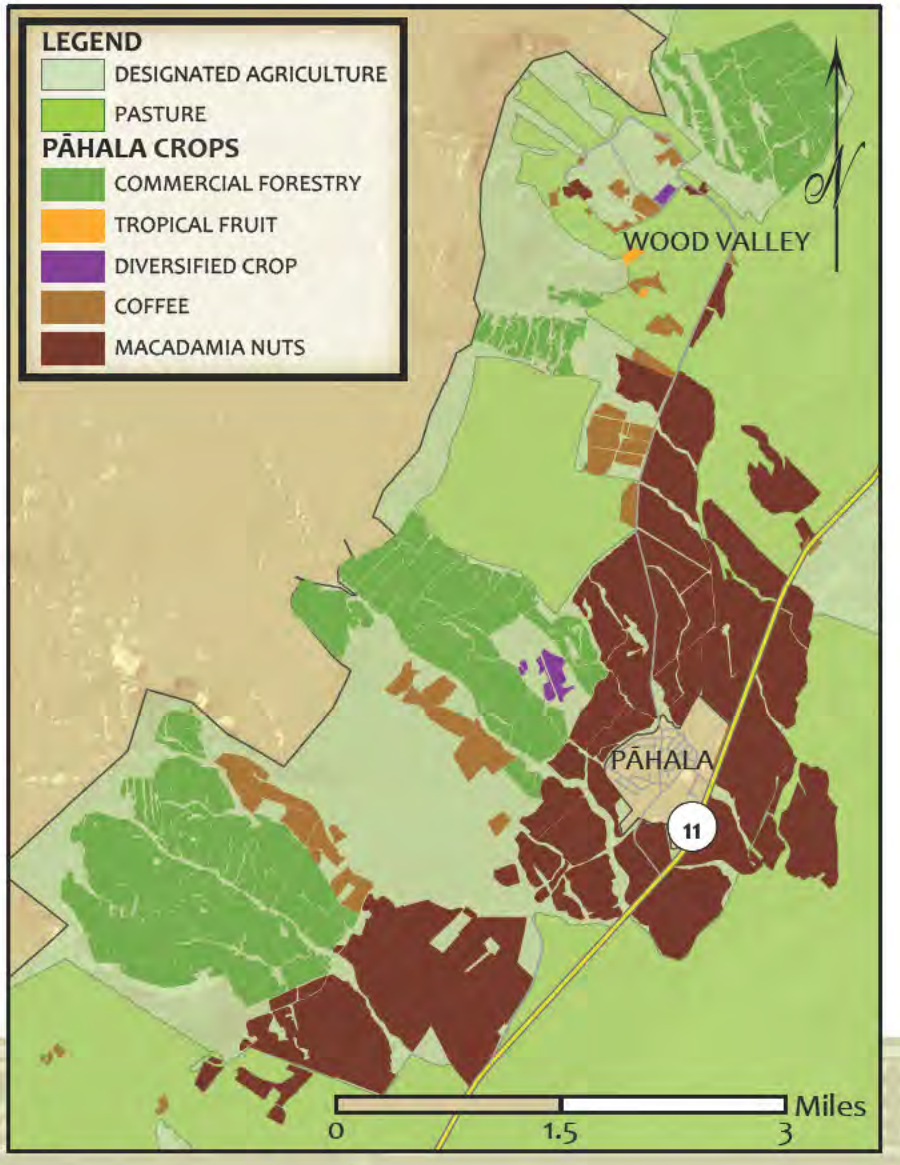


FIGURE 36

Right: Ka'u crop pattern 2015

Agricultural program (CSA) and there are rejuvenating citrus orchards nearby.

The cattle industry plays an important role on Ka'ū's agricultural lands. Larger ranches, such as Kapāpala and Kuahiwi and a variety of smaller operations, produce beef and goats for local consumption. Kuahiwi Ranch worked hard to develop its reputation for the local grass fed beef it delivers regularly to Whole Foods and Foodland. Ka'ū ranches also ship calves to the U.S. mainland.

Historically, Ka'ū sugar operations were un irrigated. There are, however, several dozen springs developed just above the mauka cane line at approximately 2000' elevation that were used for fluming cane and wash water for mill operations.

Kapāpala Ranch uses one of these springs and pumps the water more than 12 miles north of Wood Valley to remote pastures near the National Park boundary. A catchment and storage reservoir area have been constructed to reduce pumping costs and improve the dependability of ranch water supply.

The County Department of Water Supply (DWS) uses Hā'ao and Mountain House Springs to provide domestic water to Nā'ālehu. 'Alili Springs, above Pahala, was a source of domestic water for residents until 2007, when it was replaced by a deep well. 'Alili Springs is now used to support truck crop operations.

The future of these water sources is in the hands of the State's ADC, which holds the license to use them. The ADC is in the process of sub leasing water to individual farmer cooperatives, which will be responsibile for maintenance. There is an estimated three to five mgd of flow above Pahala town. Reconditioning old springs and improving delivery and storage systems will insure a significant, yet modest, amount of low cost water to support pasture and farming activities along the Ka'ū coastline.

North & South Kona

Kona's agricultural production is concentrated in a long, slender portion of the leeward slope of Hualālai and Mauna Loa, between 700' and 2,500' elevation. The lands are steep and rocky with rainfall patterns between 40" and 70" annually. This zone supports an array of orchard crops: 4,800 acres of coffee and 6,850 acres of macadamia nuts make up the bulk, along with 130 acres of tropical fruit and 190 acres of foliage and landscape plants.

Coffee was introduced to Kona in 1828, beginning a long history of boom and bust plantation style production. When large scale coffee operations failed in the 1920's and 30's, they were replaced by small farms on leasehold lots that allowed individual farmers to produce coffee using family labor. This decentralization of farm production helped to stabilize the coffee industry and laid the foundation for the small farm lot settlement pattern that defines land use in the region today.

Since 2000, a significant amount of new coffee has been planted in the Kona area, much of it in fields of 20 or more acres. Investment capital has flowed into the Kona coffee industry from both corporate sources and private investors. Federal agricultural tax credits have enabled some of the investments to be sheltered from taxation. Much of the new plantings occur on lands with large residences and manicured coffee estates.

Labor is an ongoing challenge for coffee growers. Harvest season requires hundreds of pickers and processors to produce about 20 million pounds of coffee cherry every year. Immigrant labor has been a mainstay of the industry for several decades, and as many as 1,000 1,500 seasonal workers from places like Mexico, Central America, and Micronesia are needed. Providing housing and meeting federal immigration requirements are two ongoing challenges for the industry.

ISLAND-BY-ISLAND AGRICULTURAL SUMMARIES 2015 CONT'D.

NORTH & SOUTH KONA CONT'D.

The Kona coffee industry faces other challenges as well. Although cherry prices remain in the vicinity of $2.00/lb., the supply is impacted by the coffee borer beetle (*Hypothenemus hampei*) which burrows into the bean and compromises its value. Extensive practices are required to combat the beetle and protect and preserve the Kona Coffee brand, quality, and value. Coffee is a decentralized industry with many small and several large producers and processors. Collaboration among farmers ebbs and flows, but it is essential for the industry to remain stable.

Macadamia nuts were initially planted on small parcels in the late 1950's. In 1962, the world's largest macadamia orchard was planted in Kapu'a in South Kona by MacFarms consisting of 3,900 acres between 1,200' and 2,500' elevation. Macadamia nuts are also planted throughout the Kona Coffee Belt in two to twenty acre orchards. Many are inter planted with coffee and other trees, creating a increase in diversified crop farms. This strategy provides multiple sources of income and a rich variety of food production, but it makes it difficult to measure due to the small scale and level of integration.

Orchard crops such as avocado, mango, and other tropical fruit began appearing in commercially in the 1980's. There are several orchards dedicated to just one or more of these crops, but it is common to see them mixed with coffee, macadamia, and other crops like rambutan, longan, and dragon fruit, which grow well and have both local and export markets.

Flower and foliage operations are concentrated in the State Agricultural Park near Keāhole Airport. There are several plumeria orchards and a number of landscape nurseries that service the resort and residential markets on the Kona Kohala coast. Tropical landscaping with flowers, fruit, and colored foliage is a hallmark of the Kona region and part of what defines the unique Kona experience.

Vegetable crops have a relatively small footprint in the Kona region due, in part, to the rocky soil and general topography of the region. There are, however, a significant number of small farms that produce a range of vegetables, and several commercial greenhouse operations produce tomatoes and cucumbers.

The bee industry in Hawai'i is based in South Kona, and several of the largest apiaries lie just above Kealakekua Bay. Kona is also the largest producer of queen bees in the Pacific, with several companies shipping hundreds of thousands of queens annually to restock apiaries around the world. Bees play an important role in pollinating Kona's coffee and macadamia orchards as well as many fruit and vegetable crops.

Cattle ranching has been a defining part of Kona's upcountry landscape for well over a century, but there are only a few remaining operations. Several large mauka ranches were sold or divided among family members in the 1990s and are now managed with less active intent to produce cattle. Ranching is still a part of Kona's identity and lifestyle, but beef production is a significantly lower priority than it was during much of the 20th century.

Several portions of former grazing land in both North and South Kona have become integrated into native forest protection programs by the Nature Conservancy, the State, and the U.S. Fish and Wildlife Service. KS, once a major lessor of ranch lands in the saddle between Hualālai and Mauna Loa, shifted its focus to recovery of native plant and bird species. It currently permits a very small amount of cattle activity in Kona.

LIVESTOCK

Hawai'i Island is where much of the state's grazing livestock is produced. There are 557,000 acres of active pastureland in elevations from near sea level to over 6,000 feet.

Ranching extends from backyard

producers of two to three animals a year to vast operations with herds in excess of 10,000. The largest percentage are cow calf operations that export yearling steers and heifers to the U.S. mainland. In 2014, Hawai'i Island shipped 25,700, or about 80% of the total state export to the U.S. mainland[2]. Another 900 1,000 head are raised for the grass fed market with more local producers shifting portions of their herd to remain at home. Mainland cattle prices have been unusually high in recent years, but prices are expected to adjust in the years ahead.

In 2014, Parker Ranch and the Ulupono Initiative partnered to create the Paniolo Cattle Company, which includes a commitment to hold back 1,400 animals annually for the local grass fed market. This will more than double the amount of local beef. Securing sufficient quality pastureland to finish animals efficiently is an ongoing issue, as is local slaughter capacity.

Consumer commitment to local beef is critical for ventures to succeed. Paniolo Cattle Company is an important initiative and needs support from many players to succeed.

There are two slaughterhouses, Hawai'i Beef Producers in Pa'auilo and Kūlana Foods in Hilo. Both are critical to the long term health of the cattle industry. Hawai'i Beef Producers harvests mainly cattle while Kūlana will also schedule the harvest of pigs and sheep. Certified slaughter capacity for smaller animals like sheep, pigs, and goats is limited and there is a movement to secure a mobile slaughterhouse to improve the situation.

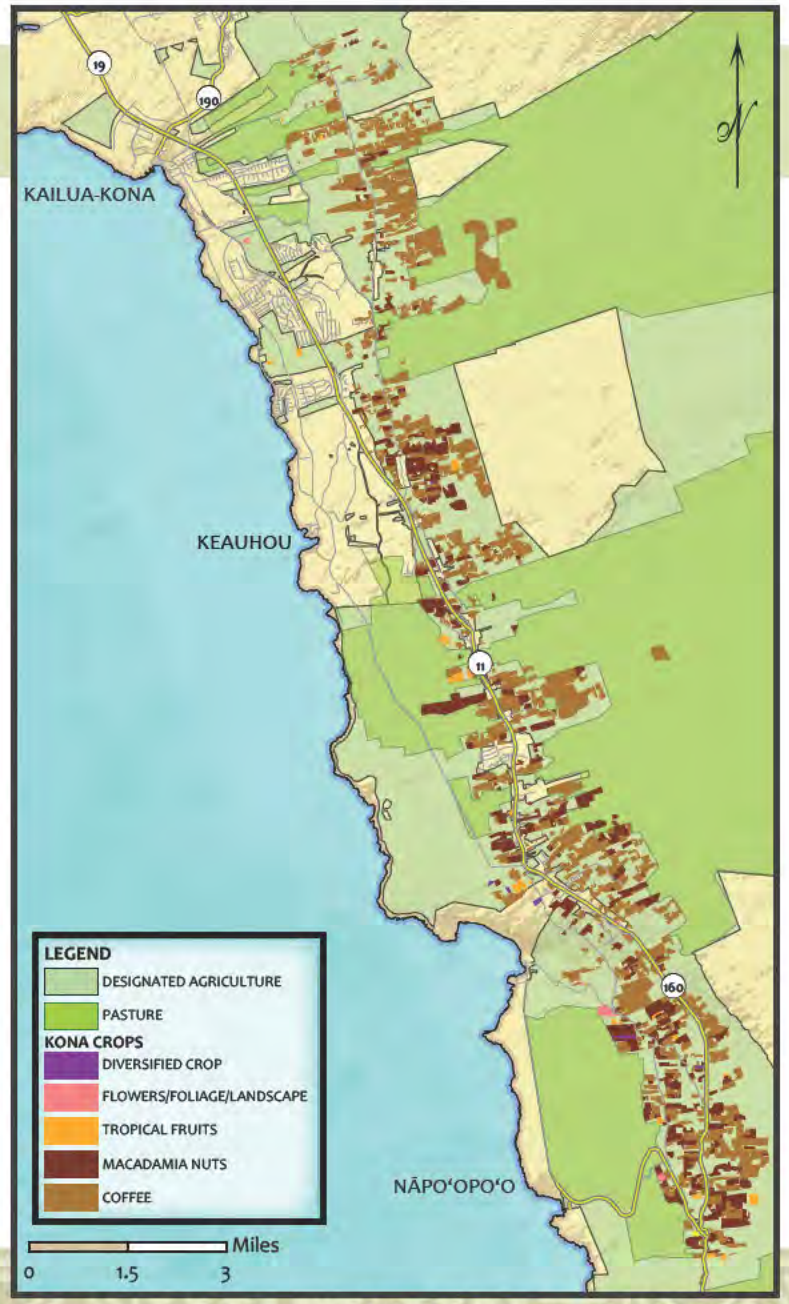


FIGURE 37

Right: Kona crop pattern 2015

2 Data provided by the State Veternarian in the State Division of Animal Industry

AGRICULTURAL WATER RESOURCES SUMMARY 2015

Irrigation water in Hawai'i comes in many forms and is managed by a variety of public and private entities at a range of prices. This section is intended to introduce that complexity and to map the variety of water systems that serve the state's major crop production areas.

There are multiple studies that have been, or are, being done by the DOA and others that more clearly lay out the details of each system and document their current state of water collection and delivery. That work is outside the scope of this study and we would defer to these other reports to bring the details forward on each of these systems.

As with most infrastructure issues, agricultural water systems require ongoing investment and maintenance to insure their viability. How state, county, and private investments are allocated to these systems and what priorities are followed are some of the key issues facing agriculture in the state today.

Matching infrastructure investment dollars to regions and systems that present the best opportunity to increase or sustain areas of existing agricultural production will take both collaborative thinking and political will to sustain.

The legacy of plantation era surface water collection and delivery systems is a valuable part of today's agricultural heritage. Many of these systems could never be rebuilt, regardless of price, and a clear strategy to determine which systems are going to be most important to support agriculture in the future would be most useful to chart the way forward. Each of these systems has their own problems and limitations. Most intake systems were designed to take the entire base flow of a stream and dump excesses somewhere further down the ditch system. This practice has impacted the natural flow of many streams in the state and often runs afoul of rules protecting native stream biota or

Vegetable crops in Lalamilo are irrigated from the Waimea system that draws surface water from the Kohala Mountain watershed.

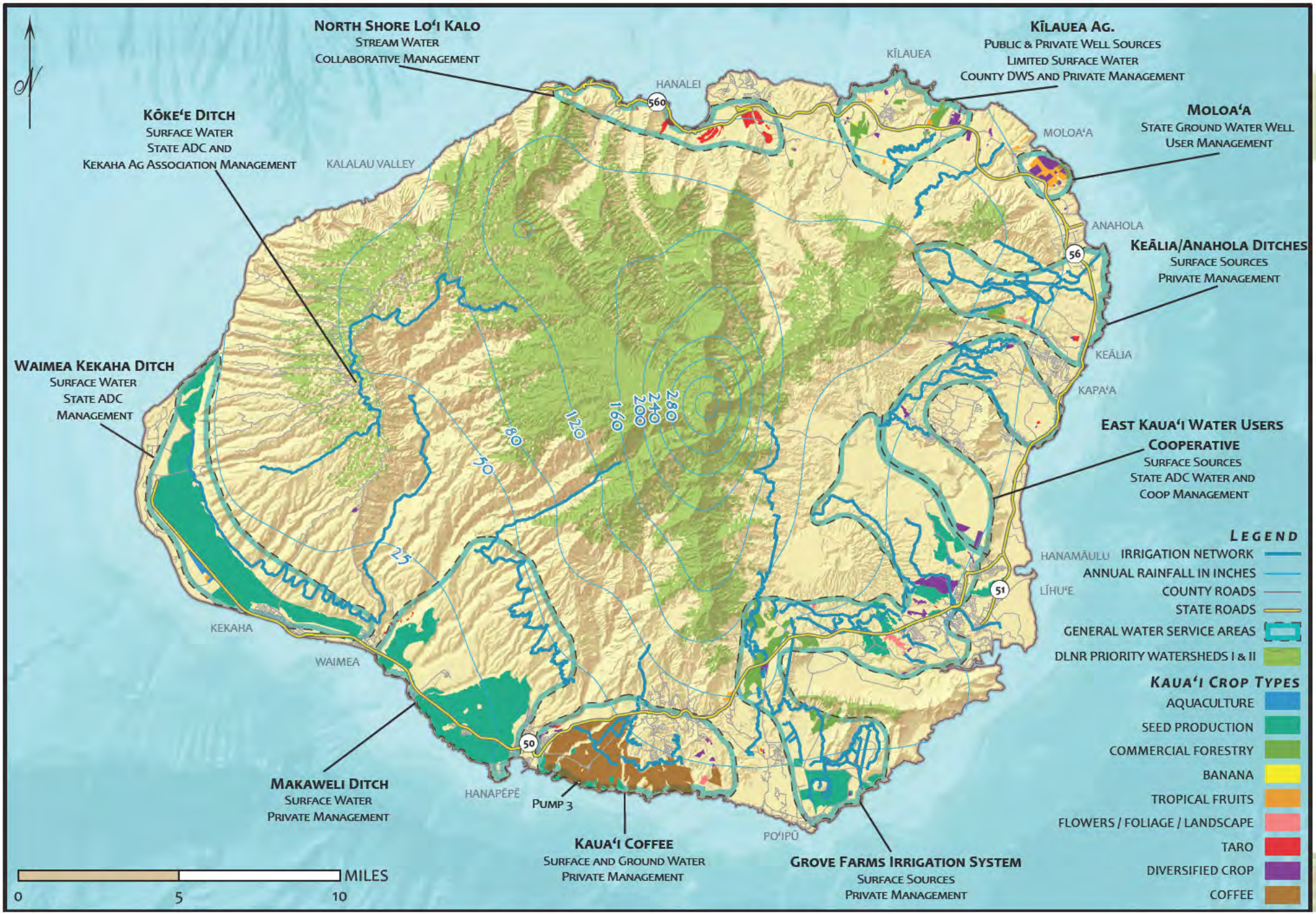
constitutional appurtenant rights of taro growers downstream. Court and Water Commission decisions at Waiāhole, East and West Maui, and many other places have affirmed the need to protect surface water as a public trust asset and to meet multiple goals in stream water collection and management. New intake designs and automated management systems may help improve historic practices. Many former plantation ditch systems are now operating at reduced flows that have been reset to match the reduced demand of emerging new agricultural uses.

The ability to store water in reservoirs is a key to managing drought conditions and for taking advantage of periodic high flow periods. This storage capacity may become an even bigger priority as anticipated impacts of climate change could change rainfall patterns statewide. New dam safety rules have made it difficult and expensive to retain existing reservoirs without major re investment and/or size reductions to avoid landowner liabilities. Public and private landowners around the state have responded to these liabilities by removing some of the most strategic water storage facilities in the state. If there is not a current agricultural use for the water, reservoirs are being decommissioned, and storage capacity is diminished. There is a need for a clear strategy to help preserve strategic water storage and expand it where demand exists for additional agricultural water.

The counties play an increasingly important role in delivering treated domestic water for agricultural use. Places like Waiʻanae, Kula, Kilauea, and Kona all are almost completely dependent on County water to support farm activities. The demand for treated domestic water for agricultural use is most likely to increase in the years ahead as food safety regulations require food producers to use treated water to wash their crops and prepare them for market. Each county DWS will need to deal with this increasing demand based on system and supply details, but clean, treated water is an increasingly important resource to support agriculture in the state. Agricultural water delivery is not part of the core role of municipal water providers, but the need for additional service to agricultural users is likely to grow in the years ahead.

Agricultural water transmission from perched springs in the Kaʻū Forest Reserve have been upgraded with public and private funds to insure irrigation waters in the Wood Valley-Pahala area of Hawaiʻi Island. Image co esy o Ron Te y

In the following water resource maps, Priority Watersheds are depicted in green on the upper slopes of each island as designated by the DLNR. These emphasized areas are important both for water capture and storage capacities and for their role as habitats for native flora and fauna. The linkage between public and private watershed protection initiatives and the development and use of waters down slope of the forestland is an important issue for the future of Hawaiian agriculture.

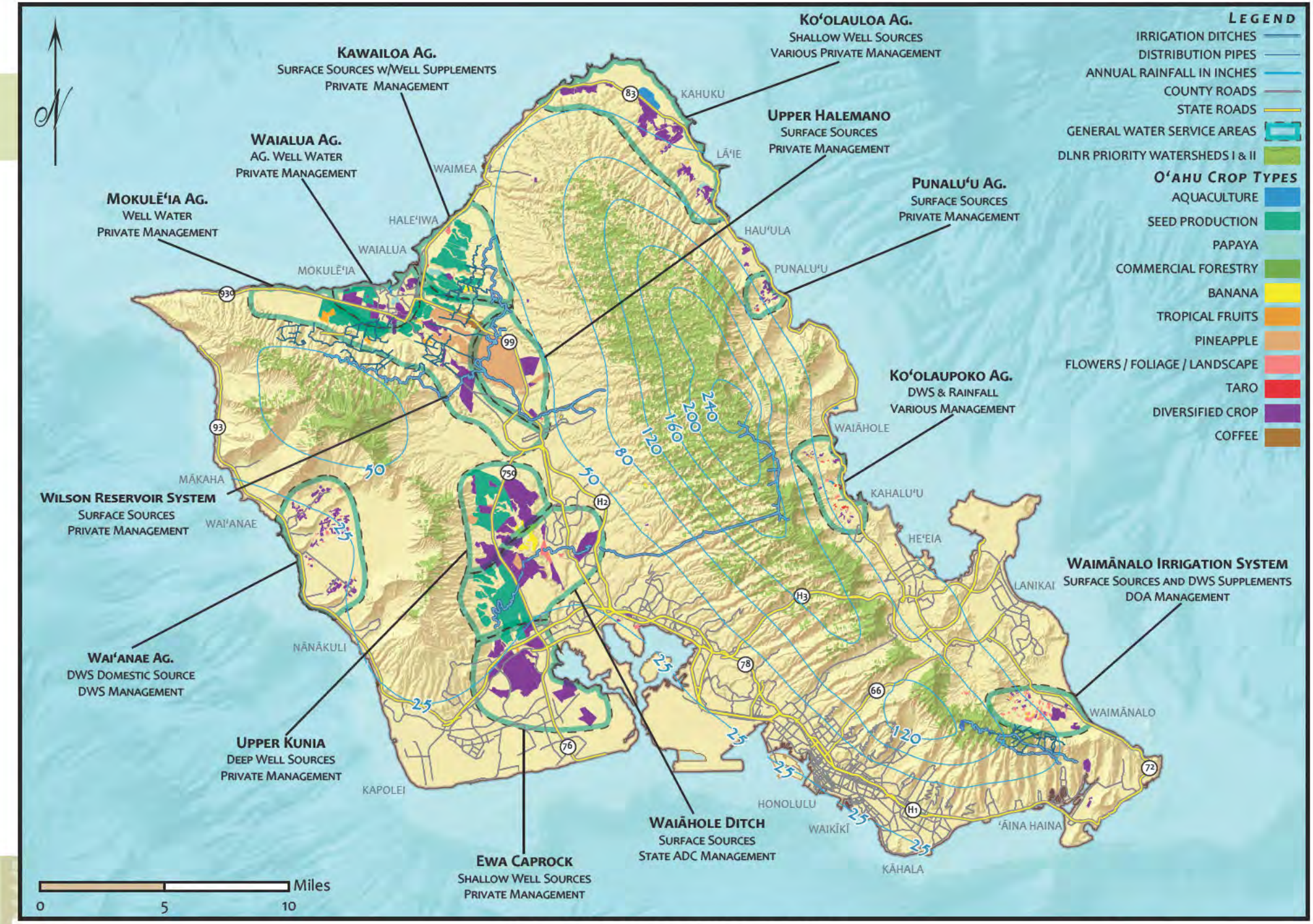


KAUAʻI AGRICULTURAL WATER RESOURCES (2015)

University of Hawaiʻi Hilo

SDAV UH Hilo

Department of Agriculture
State of Hawaii

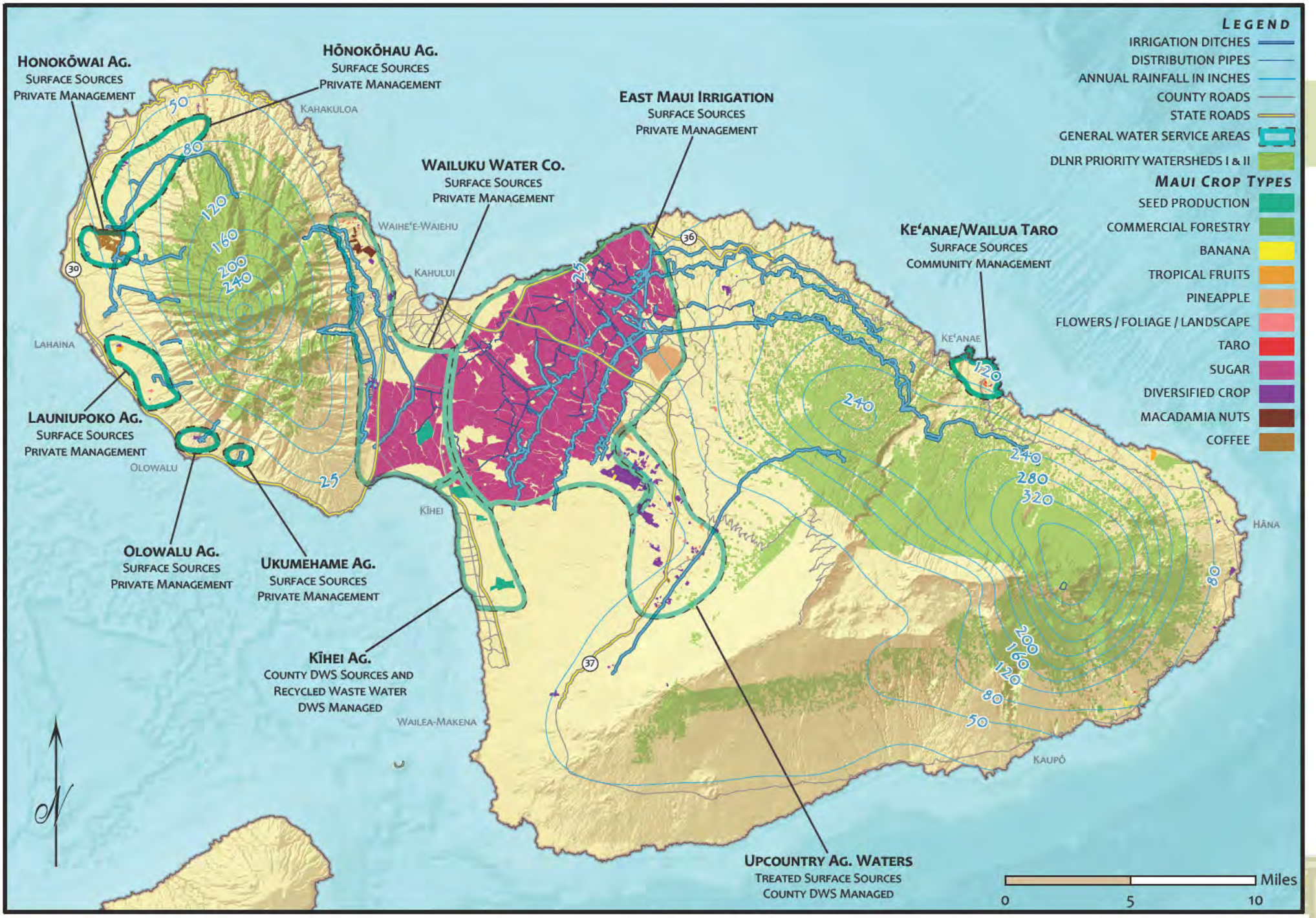


O'AHU AGRICULTURAL WATER RESOURCES (2015)

University of Hawai'i at Hilo

SDAV UH Hilo

Department of Agriculture
State of Hawaii

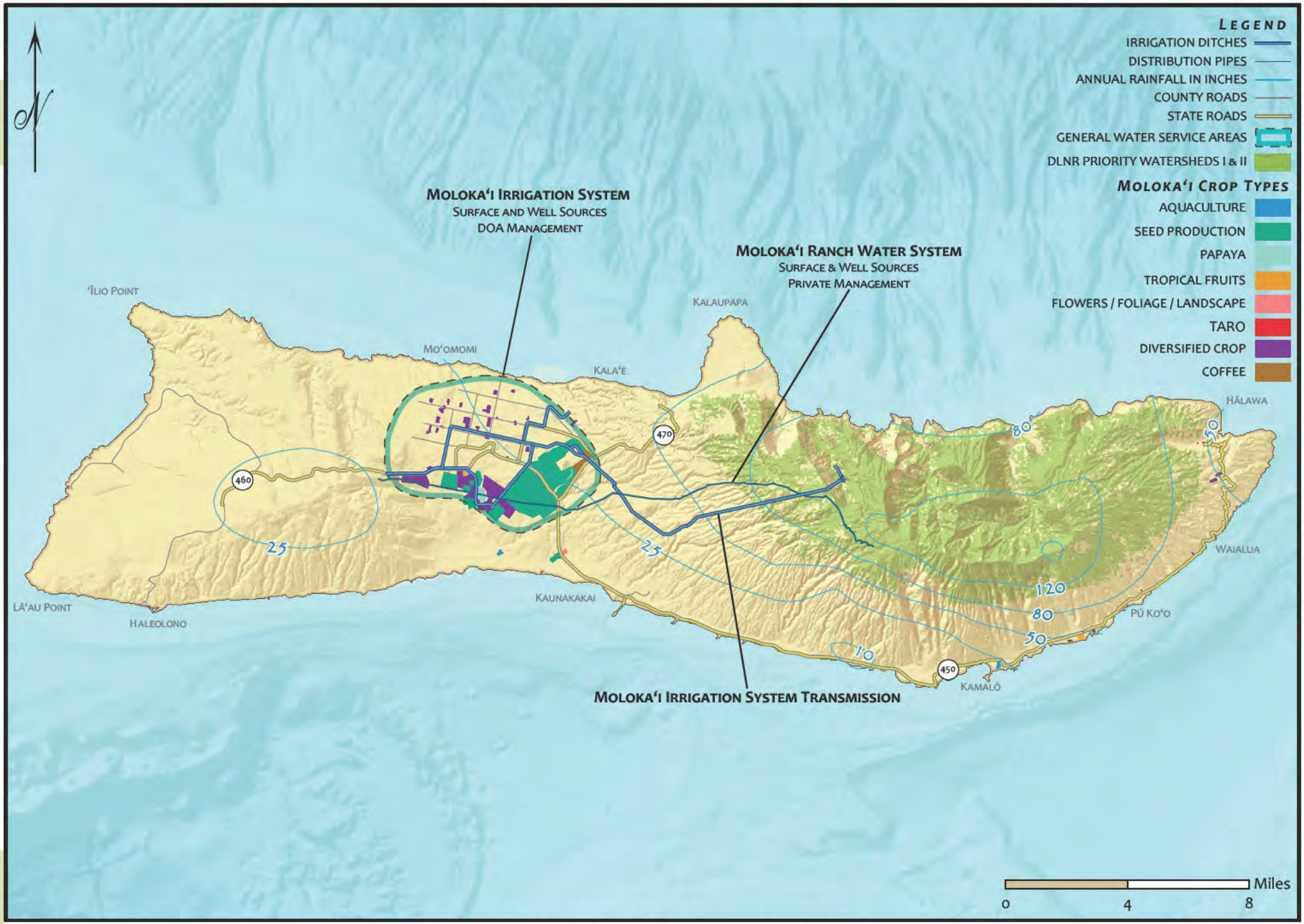


MAUI AGRICULTURAL WATER RESOURCES (2015)

University of Hawai'i Hilo

SDAV UH Hilo

Department of Agriculture
State of Hawaii



MOLOKA'I AGRICULTURAL WATER RESOURCES (2015)

UNIVERSITY of HAWAI'I HILO

SDAV UH HILO

Department of Agriculture STATE OF HAWAII

HAWAI'I AGRICULTURAL WATER RESOURCES (2015)

University of Hawai'i Hilo

SDAV UHHILO

Department of Agriculture
State of Hawaii

SUMMARY OF HAWAIʻI'S AGRICULTURAL WATER USE BY AREA SERVED

Service Area	Crops Produced	Water Source	Water Manager	Aquifer Unit
Kauaʻi				
Waimea- Kekaha	Seed Production, Diversified Crops, Aquaculture	Surface water; Waimea Canyon and Kokeʻe	State Ag Dev Corp (ADC) and Kekaha Agricultural Association KAA)	Waimea
Waimea -Hanapēpē	Seed Production and Cattle	Surface Water , Olokele and Makaweli Streams	Robinsons	Waimea
Hanapēpē to Poʻipū	Coffee, Nursery, Seed Production	Surface and Ground Water Alexander Reservoir and Pump 3	A&B and Kauaʻi Coffee	Lihue
Poʻipū to Līhuʻe	Seed Production, Diversified Crops, Landscape Nursury	Surface Waters from Various Stream Sources	Grove Farm and Subsidiaries	Lihue
Kālepa-Wailua	Pasture, Small Orchard and Landscape	Surface Water,Various Streams and Wailoa River	ADC, East Kauaʻi Water User's Coop	Lihue
Keālia/Anahola	Pasture, Diversified Crops	Surface Sources, Kealia and Anahola Streams	Keālia in private management; Anahola DHHL unmanaged	Lihue
Moloa'a Farm Lots	Tropical Fruit and Diversified Crops	State Ground Water Well	Moloaʻa Farmers	Lihue
Kilauea	Diverfified Crops, Tropical Fruit	DWS Ground Water with Limited Surface Water	County DWS and Private Users	Hanalei
Hanalei kalo	Wetland Taro	Surface Water from Various Streams	Taro Farmers	Hanalei

SUMMARY OF HAWAI'I'S AGRICULTURAL WATER USE BY AREA SERVED

Service Area	Crops Produced	Water Source	Water Manager	Aquifer Unit
	'Oahu			
Mā'ili to Mākaha	Diversified Crops, Poultry, Pigs, Dairy, Landscape Plants	DWS Ground Water Wells	City DWS Ag rate water	Waianae
Mokuleia coastline	Seed Production	Ground Water Wells	Dole and Seed Companies	North Shore
Waialua Farms	Diversifid Crops, Tropical Fruit, Seed Production	Ground Water Wells	Dole Food Hawaii	North Shore
Kawailoa Ag	Diversified crops, seed production, pasture	Surface Water, Anahola Stream and Ground Water Wells	Kamehameha Schools	North Shore
Upper North Shore	Pineapple, Coffee, Tropical Fruit, Banana and Papaya	Surface Water in Lake Wilson with Helemano Stream Back Up	Dole Foods	North Shore
Turtle Bay to Hau'ula	Diversified Crops, Aquaculture	Ground Water Wells	Various Private Systems	Windward
Punalu'u Ag	Diversified Crops, landscape plants	Surface Water, Punaluu Stream	Kamehameha Schools	Windward
Waiāhole to Kahalu'u	Diversified crops, Landscape Plants, Kalo	Surface Water, Springs and Domestic DWS Goundwater Sources	City DWS and Assorted Farmer Groups	Windward
Waimānalo	Landscape Plants, Diversified Crops, Banana	Maunawili Surface Water and DWS Ground Water Sources	State DOA and 'City DWS	Windward

Service Area	Crops Produced	Water Source	Water Manager	Aquifer Unit
Molokaʻi				
Hoʻolehua, Central Plain	Diversified Crops, Papaya, Coffee, Seed Production	Surface Water	DOA, Molokaʻi Irrigation System	North East Molokaʻi
Maui				
Ukumehame to Launiupoko	Home Landscape, Pasture, Diversified Crops	Small Surface water sources in adjoing valleys	Various land owners	Lahaina
Kaʻanapali	Coffee	Surface Water: Honokowai Stream	Kaanapali Coffee	Lahaina
Honokahau Ditch Service Area	Diversified Crops, Resort/golf landscape	Surface Water: Honokohau Valley	Maui Land and Pine	Lahaina
Waiheʻe to Maʻalaea	Sugar, Diversified Crops	Surface Waters from multiple streams	West Maui Water Company	Wailuku
Māliku to Maʻalaea	Sugar, Pineapple, Kula County Ag Park Diversified Crops	Surface waters from multiple streams	East Maui Irrigation (EMI) A&B	Koolau
Upcounty Kula	Diversified Crops, Tropical Fruit, Foliage/Landscape Plants	County DWS Treated Surface and Ground Water Sources	Maui DWS	Central
Kihei	Seed Production	County DWS and Recycled Water	Maui DWS	Central

SUMMARY OF HAWAIʻI'S AGRICULTURAL WATER USE BY AREA SERVED

Service Area	Crops Produced	Water Source	Water Manager	Aquifer Unit
Hawaiʻi				
Honomalino	Macadamia Nuts	Ground Water Wells	Mac Farms	S.W. Mauna Loa
Keāhole to Hoʻokena	Coffee, Macadamia, Diversied Crops, Tropical Fruit, Landscape Plants, Aquaculture	Rainfall and DWS Ground Water	County DWS	S.W Mauna Loa and Hualalai
Lālāmilo to Puʻukapu	Diversied Crops, Cattle	Surface Water; Kohala Mt Sources	DOA Waimea Irrigation System	Kohala
ʻUpolu to Nuiliʻi	Macadamis, Diversied Crops, Tropical Fruit	Surface Water: Honokane Valley	Kohala Ditch Co, Surety Kohala	Kohala
Kukuihaele to Paʻauilo	Diversified Crops, Macadamia and Cattle,	Surface Water from Waipio Valley	DOA Hamakua Ditch	Kohala
ʻOʻōkala	Dairy	Ground Water	Big Island Dairy	E. Mauna Kea
Laupahoehoe to Hilo	Diversified Crops, Tropical Fruit, Landscape Plants, Banana	Rainfall and small springs	Nature	E. Mauna Kea
Puna district	Papaya, Diversified Crops, Flowers, Landscape, Macadamia	Rainfall, Catchment and Small Private Wells	Nature	Kilauea
Pahala Makai	Macadamia Nuts	Ground Water Wells	Royal Hawaiian Macadamia	S.E. Mauna Loa
Mohoula to Wood Valley	Coffee, Macadamia, Diversified Crops	Perched Spring Sources	ADC and Area Coops	S.E. Mauna Loa

CROP MAPPING PROTOCOLS

The 2015 Hawai'i Statewide Agricultural Land Use Baseline 2015 layer was created to provide a snapshot of contemporary commercial agricultural land use activity in Hawai'i. It is based upon an assemblage of geospatial datasets, and primarily high-resolution WorldView-2 satellite imagery as a base layer for digitization.

Maps throughout this book were created using ArcGIS® software by Esri, utilizing GIS datasets ('Agriculture and Farming,' 'Inland Water Resources,' and 'Cadastral and Land Descriptions') provided by the state of Hawai'i, Office of Planning Statewide GIS Program and other data provided by major landowners and managers. Digitized crop locations and boundaries were verified through a combination of on the ground site visits, meetings and presentations of draft layers with agricultural stakeholders and landowners, solicitations through a publicly accessible online web mapping portal, and spot checking using Google Earth™ and other high resolution imagery sources.

In addition to the satellite imagery, County real property tax and agricultural water use data were also used to identify commercial farm operations. Data for both real property tax assessment and agricultural water use were collected from each county that provided their most recent records, generally from 2014 2015. Not all properties that receive County agricultural tax assessment rates or reduced water cost for agricultural uses were mapped due to the small scale of some of their operations. These data sources were used to verify mapped commercial farms and identify operations that might have been missed using the imagery alone.

The 2015 Hawai'i Statewide Agricultural Land Use Baseline layer represents our best efforts to capture the scale and diversity of commercial agricultural activity in Hawai'i in 2015 and should be used for information purposes only.

2015 HAWAI'I CROP LAYER SPONSOR

Funding for the 2015 Hawai'i Statewide Agricultural Land Use Baseline was provided by the Hawai'i State Department of Agriculture. The University of Hawai'i at Hilo Spatial Data Analysis and Visualization (SDAV) Laboratory carried out the work under the direction of Dr. R. L. Perroy, Project Manager Jeffrey Melrose, and Cartographer Sylvana Cares.

NO WARRANTY

We have made every effort to make all images, maps, graphs, data, and other information provided for this project accurate and error free. However, we do not guarantee the accuracy of any images, maps, graphs, data, or other information. All content is provided without warranty of any kind and is not intended for any regulatory use.

CROP MAPPING PROTOCOLS

The following protocols were used to generate the 2015 Hawai'i Statewide Agricultural Land Use Baseline data layers:

- This project focused on commercial agricultural operations with a three acre minimum crop mapping area. Understanding the importance of smaller scale producers to Hawai'i's agricultural community, commercial operations less than three acres were included where they could be reasonably identified.
- Mapped units follow actual cropped areas as identified in satellite imagery, not TMK parcel boundaries.
- Agricultural lands, which did not display actual vegetation growth but appeared to be part of an active agricultural rotation (freshly tilled fields, etc.), were included in acreage summaries.
- For papaya and other crops that rotate every three to four years, mapping efforts focused on active production areas and did not include fallowed fields.
- Packing or processing facilities and in field access roads were generally included in acreage summaries.
- Homes, reservoirs, un farmable gulches, and major roadways separating field areas were not mapped.
- "Agri scaping" of private residences was not mapped.
- Small backyard orchards and what appear to be home use vegetable gardens were not mapped.
- Equestrian uses, including arenas and boarding and riding facilities, were not mapped.
- Rooster cultivation was not mapped.
- Piggeries were not mapped. Available data on pork production is summarized in the text and figures of the accompanying report.
- Poultry farms were not mapped. Available data on egg and poultry production is summarized in the text of the accompanying report.

CROP CATEGORIES & CONSIDERATIONS

- **AQUACULTURE** includes active shrimp farms, working fishponds, algae raceways, and research/production facilities.
- **BANANAS** include fields in contiguous plantings larger than 2 3 acres. Throughout the state, bananas are also cultivated in gulches, along farm boundaries, and in small patches within smaller, diversified farm operations. These smaller mixed plantings are generally incorporated into the surrounding farm and labeled as Diversified Crops.
- **COFFEE** includes both larger plantation type scale operations on Moloka'i, Maui and Kaua'i, and smaller farm plantings larger than 2 acres in coffee growing regions like Kona, Ka'u, and elsewhere. The North and South Kona region on Hawai'i Island were difficult to map accurately based on a practice some farmers have adopted to plant both macadamia nuts and coffee on the same ground. The mature nature of the orchard dominated agricultural practices in Kona made it challenging to confidently discern these coffee macadamia crop boundaries from satellite imagery.
- **COMMERCIAL FORESTRY** plantings include both short and long rotation tree crops. Plantings include eucalyptus and other species intended for timber, fiber or energy production, and higher value hardwoods like koa and mahogany planted for eventual commercial harvest and not for native forest restoration.
- **DAIRY** includes core milking and on farm processing facilities, the surrounding pastures, croplands under active dairy use.
- **DIVERSIFIED CROPS** includes a wide range of products that are grown either outdoors or in greenhouses. The category includes many of Hawai'i's small farms and much of its local, fresh vegetables including tomato, cucumbers, leaf crops, beans, and asparagus. This category also includes smaller plantings such as banana, tropical fruit, papaya, and coffee that were too small to map out individually. Also included in the category are export crops such as Okinawan sweet potato, basil, and Asian spices that make up an estimated 500 1,000 acres of farmland on 'Oahu and South Hilo.
- **FLOWERS, FOLIAGE & LANDSCAPING** includes a wide variety of products including hothouse or shade cloth grown orchids, anthuriums, tropical flowers, potted nursery plants, field stock, sod farms, and landscape trees.
- **MACADAMIA NUTS** include orchards that appear to be actively maintained and harvested. Orchards range from hundreds of acres in South Kona, Ka'ū, and Puna to small and mid size plantings throughout Hawai'i Island. Portions of abandoned plantings near Wailuku, Maui were not counted.

CROP CATEGORIES & CONSIDERATIONS

§ **PAPAYAS** are mapped in areas where significant commercial papaya production occurs. Mapping efforts focused on just those lands that appeared to be planted and in active production. Fallow lands that might be available for future papaya planting were not mapped but are an important part of what the papaya industry needs to produce in a sustainable fashion. Smaller plantings of papaya on mixed crop farms are mapped as Diversified Crops.

§ **PASTURE** includes areas in active commercial cattle operation where fencing is apparent and water troughs and/or cattle trails can be identified. Small pasture plots in diverse, rural homesteads were not the focus of this mapping effort but were included where larger parcels and contiguous pasture areas were present. Lands that were formerly in pasture use but have now been purchased by the military (Keʻāmūku and S. Kohala), the National Park Service (Kahuku Ranch and Kaʻū), or withdrawn from pasture in favor of native forest restoration (i.e., Keauhou Ranch, Kaʻū or Hakalau Preserve, Hāmākua) were not included in the pasture layer. Rangelands that are fenced and grazed only seasonally are mapped as pastureland.

§ **PINEAPPLES** include areas planted in large to mid size operations primarily on ʻOahu and Maui. Smaller plantings mixed within smaller diversified farm operations are mapped and labeled as Diversified Crops.

§ **SEED PRODUCTION** includes all arable lands in use by the seed companies at the time of this survey. Areas depicted include in field roads, pollen drift buffers, and areas managed for future crop rotation. Net acres actually planted in corn or other seed crops will be substantially less than the gross acres depicted. The industry estimates that they use approximately 25% of their farmable land at any time for active growing.

§ **SUGAR** includes areas planted in sugar cane. HC&S grows the majority of sugar cane in the central plain of Maui. HC&S provided the GIS data they use to manage their field operations. Several smaller plantings were identified on other islands where the crop is used to produce rum or cane that is carved into swizzle sticks for the visitor market.

§ **TARO** includes crops grown only in wetland settings. Dryland taro is included in the Diversified Crops category.

§ **TROPICAL FRUIT** includes a range of products such as rambutan, avocado, longan, lychee, citrus, cacao, and other orchard fruit trees planted for commercial harvest. Small backyard orchards were not mapped and are not counted in the summary of tropical fruit acreage.

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