O‘AHU AGRICULTURE:  
SITUATION, OUTLOOK AND ISSUES

Fields in a Setting Sun by Susie Y. Anderson
O‘AHU AGRICULTURE: SITUATION, OUTLOOK AND ISSUES

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EXECUTIVE SUMMARY

The situation and outlook for the agricultural use of land on O‘ahu are summarized below.

1. SUPPLY, USE AND AVAILABILITY OF FARMLAND

a. Supply of Good Farm Land

O‘ahu has about 42,620 acres of high-quality farmland outside the Urban and Rural Community Growth Boundaries of the City and County of Honolulu (the City). This accounting excludes land that is under military control and is not available for farming, and land that will be used to expand the wildlife refuge near Kahuku.

O‘ahu’s largest concentrations of high-quality farmland located outside the City’s Community Growth Boundaries are in Kunia and on the North Shore. These are O‘ahu’s “core” farmlands and are best-suited for large-scale farming. They are among the highest-quality agricultural lands in Hawai‘i. Smaller amounts of high-quality farmland are scattered throughout Ko‘olau Loa, Ko‘olau Poko, and Wai‘anae—they are best-suited for small family farms.

b. Uses of Farmland

In 2008, O‘ahu had about 11,000 acres in crop, including about 6,200 acres for specialty crops (primarily seed corn, pineapple, and floriculture and nursery products); about 900 acres in fruits other than pineapple; and about 3,900 acres in vegetable and melon crops. Seed companies have replaced sugar and pineapple companies as the largest users of farmland on O‘ahu, and the highest bidders for farmland.

With the recent expansion of the seed industry on O‘ahu following their purchases of land, the 2010 estimate for the total amount of land farmed on O‘ahu is about 12,000 acres.

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1. In this report, the term “high-quality farmland” refers to land that has an LSB rating of A or B, or an ALISH rating of Prime or Unique. The term “good farmland” is similar to “high-quality farmland,” but does not have a precise definition based on soil ratings.
This includes about 2,425 acres in ‘Ewa and Central O‘ahu within the City’s Community Growth Boundaries, and about 9,575 acres outside the Boundaries.

c. **Available Farmland**

Assuming that the farms within the Growth Boundaries eventually will relocate to land outside the Boundaries, over 30,000 acres of good farmland on O‘ahu will remain available for growing additional crops (42,620 acres – 12,000 acres). In addition, some land that is already farmed can be farmed far more intensely, thereby increasing production without requiring more land.

Water improvements will be needed to farm some fields that are now fallow or are used for grazing cattle. Also, some of the available farmlands have limitations that preclude growing certain types of crops (e.g., low-elevation crops cannot be grown on high-elevation fields).

2. **ECONOMIC CONTRIBUTION**

a. **Sales**

In 2008, O‘ahu’s farmers and ranchers generated about $184.6 million in direct sales, and about $380.3 million in direct and indirect sales. Also, agriculture tourism adds to farm and ranch revenues: about $14.2 million in 2006.

b. **Exports**

In 2008, agricultural exports comprised about 85% of Hawai‘i’s farm and livestock sales. For O‘ahu, the major export crops were seeds and ornamentals.

c. **Self-sufficiency**

Statewide, Hawai‘i farmers supplied about 32% of the fresh fruit consumed locally in 2008, about 34% of the fresh vegetables and melons, about 20% of the eggs, about 10% of the milk, about 4.5% of the beef, and about 3.9% of the pork. Self-sufficiency is high (over 70%) for many of the commercially successful crops grown in Hawai‘i.
d. Employment and Payroll

In 2007, Oʻahu’s farmers and ranchers provided about 2,580 direct jobs, and about 3,870 direct-plus-indirect jobs. This is about 0.8% of all jobs on Oʻahu. While agriculture is a significant contributor to Hawaiʻi’s economy, it is no longer a pillar of the economy as it was before statehood.

On average, about 9 acres are required to produce one farm job.

Farm and ranch wages average about 37% below the average wage on Oʻahu.

3. AGRICULTURAL TRENDS

Even though Hawaiʻi has favorable conditions for agriculture (such as year-round growing conditions), technological advances (e.g., new sweeteners), logistical improvements, international trade agreements, and other changes in economic conditions have contributed to major declines in many crops and livestock activities in Hawaiʻi.

a. Land in Crop

From 1980 to 2008, land in crop on Oʻahu declined by about 36,900 acres (77%) due largely to the decline and closure of sugarcane and pineapple plantations.

From 1994 to 1999, acreage in vegetables, melons, and fruits other than pineapple increased by about 4,560 acres on Oʻahu. The increase was due to the increased availability of land on Oʻahu, although some of the increase stemmed from a shift in production from the Neighbor Islands. This gain was followed by a 1,700-acre decline during the past decade.

Since 1990, the greatest agricultural success in Hawaiʻi has been seed crops: statewide acreage has increased at an average rate of over 300 acres per year, with much of this acreage being on Oʻahu.

b. Water Use

From 1980 to 2008, water use for agriculture on Oʻahu declined by about 208 million gallons per day (mgd)—about 88%. For perspective, this decrease exceeds the 146.3 mgd of drinking water delivered by the Honolulu Board of Water Supply in 2008. The substantial decline in water requirements is explained by (1) the 77% decline in the amount of land in crop, and (2) diversified crops use much less water than did sugarcane.
c. Livestock

As with land in crop, there has been a large decline in livestock on O‘ahu. From 1980 to 2008, the number of chickens decreased by about 675,000 animals (a decline of 60%). Since 2005, data on O‘ahu’s chicken operations have no longer been disclosed due to the small number of farms.

From 1980 to 2008, the number of pigs on O‘ahu declined by about 26,000 animals (73%).

In 1980, O‘ahu had about 13,300 dairy cows (including calves). However, the last major dairy on O‘ahu closed in 2008.

The number of beef cattle also declined due to the 1991 closure of O‘ahu’s only feedlot. Since 1995, however, grazing cattle on ranches has fluctuated around 5,000 head.

The decline in the number of livestock in Hawai‘i is due largely to the fact that importing meat, milk and eggs has become cheaper than importing feed.

d. Agricultural Employment Trends

From 1982 to 2002, O‘ahu’s total agricultural employment—including self-employed farmers and unpaid family farm workers—declined by 1,125 jobs (31%). From about 1995 to 2002, agricultural employment changed little. Employment data after 2002 does not include self-employed farmers and unpaid family farm workers.

4. Outlook for Agriculture

a. Farm Displacement and Relocation

Over a period of 20+ years, planned and proposed urban development by private developers and the State will displace about 2,425 acres now being farmed in ‘Ewa and Central O‘ahu—acreage that is within the City’s Community Growth Boundaries. As noted above, ample farmland is available to relocate the displaced farms. Affected farmers already have secured replacement land for over 900 acres. Successful farm relocations will require farmers to adjust their crop varieties and cultivation practices due to the different agronomic conditions.
b. **Plantation-scale Export Crops**

Although sugarcane and pineapple fields once carpeted O‘ahu, only about 2,500 acres of Dole’s pineapple operation remain. This farm is now too small to be considered a plantation, and most of the pineapple is grown for local consumption.

Intensive explorations to find large-scale export crops to replace sugarcane and pineapple have spanned the past 40 years, but without success at the scale of plantation agriculture. Even if a replacement crop is found, assembling land for a large plantation on O‘ahu would be difficult since available fields are scattered, and ownership is now more dispersed.

c. **Feed Crops**

A number of attempts have been made to grow feed crops on O‘ahu, but without significant long-term commercial success. The major problems have been (1) pests (particularly birds that eat the grains before they are harvested); (2) humidity that is too high to dry hay properly; and (3) high production costs when compared to mainland farms.

d. **Biofuel Crops**

Biofuel plantations on O‘ahu are unlikely because of high development costs, low per-acre returns when compared to most other crops, difficulty in assembling land, and more promising alternatives.

One of the more promising alternatives would be to produce ethanol from sugar derived from “cellulosic” sources. Sugar that is locked in the complex carbohydrates of plants would be separated into fermentable sugars using new technology that is now in the early stages of commercialization. Feedstock could include the large supply of yard clippings and agricultural waste that are already collected then hauled to ‘Ewa for composting. This new technology promises much higher ethanol yields per ton of biomass because the entire plant can be used as feedstock. Also, using green waste would eliminate costs for farmland, irrigation water, farm labor, fertilizer, farm equipment, hauling, etc. Finally, the operator could receive a tipping fee to dispose of the green waste.

The second promising approach for biofuel would be to produce biodiesel from algae. One of the advantages of algae is its high per-acre yield of vegetable oil (about 5,000 gallons to 15,000 gallons per year), and the corresponding high per-acre returns. Also, good farmland is not required since algae is grown in open or covered ponds. The water source can include wastewater, brackish water, or seawater.
e. Other Diversified Crops

Assuming that the necessary water improvements are made, the supply of good farmland appears to be more than sufficient to accommodate demand for farmland in the foreseeable future. Continuation of past crop acreage trends suggests only modest growth for most crops over the next 20 years, with the exception of seed crops which could grow by a few thousand acres on O‘ahu. Also, the land supply appears more than sufficient to accommodate realistic increases in (1) self-sufficiency (i.e., import substitution of fresh fruits, vegetables and melons), and (2) new export crops.

The supply of farmland does not appear to be the limiting factor to the growth of agriculture. Instead, the limiting factor is likely to be the size of the market that can be supplied profitably by Hawai‘i farmers.

f. Livestock

Cattle grazing is the largest user of agricultural land on O‘ahu, including (1) good farmland for which there is insufficient demand from farmers, and (2) land that is unsuitable for farming. Although returns are low, the industry is expected to continue because cattle grazing provides important benefits, including reduced risks of fire and reduced property taxes. Cattle ranches in Hawai‘i are cow-and-calf operations wherein most of the weaned calves are shipped to the mainland where they are finished, slaughtered, and processed. Unlike the mainland, Hawai‘i’s cattle ranges are productive year around; however, the costs of feed and processing are far lower on the mainland.

All of the major dairies on O‘ahu have closed, and past trends suggest further declines in chicken and pig operations. The declines have been due to low-cost competition from the mainland, the high cost of imported feed, and difficulties in growing feed in Hawai‘i.

5. Agricultural Issues

a. Trade, Self-sufficiency and Food Security

Benefits of Specialization and Trade

Hawai‘i’s agriculture is dominated by exports (about 85% of sales in 2008), while most of the food is imported (about 66% of the fresh fruits and vegetables consumed in Hawai‘i). In 2008, less than 15,000 acres statewide were used to supply food to Hawai‘i markets, or about 16% of the 91,500 acres farmed.
Such extensive trade is the result of improvements in shipping logistics and open markets for trade. Consumers benefit by having more choices, lower prices for most foods and, correspondingly, higher standards of living.

Given the large release of farmland from plantation agriculture, land has not been a limiting factor for Hawai‘i agriculture for decades, nor is land expected to be a limiting factor in the foreseeable future. Consequently, the use of farmland for export crops has not and, for the foreseeable future, is not expected to affect significantly the amount of food produced in Hawai‘i for local consumption, or the prices of locally grown food.

Risks to Food Security

Even though trade benefits consumers, relying on imports creates a risk to Hawai‘i’s food security. An interruption in shipping services—for whatever reason—could result in difficulties in importing fresh fruits and vegetables, canned goods, fish, meats, milk, eggs, etc. At the same time, it would also be difficult for Hawaii to export crops, thereby freeing about 65,000 acres statewide (2010 estimate) for replanting to supply local markets. This is in addition to the 177,000 ±10,000 acres of farmland that is fallow or used for grazing cattle. If an interruption in shipping results from a catastrophic event, there would be little time to increase local food production, and food shortages could result. But if the interruption in shipping occurs slowly—possibly due to rising fuel costs—there would be time to replant.

Although increased self-sufficiency could increase food security related to a possible interruption in shipping, it could decrease food security in the event of widespread crop failures—such as that which can occur with a hurricane.

Economic Benefits of Increased Self-sufficiency

If increased food self-sufficiency were to occur then, instead of sending dollars out of state for imported foods, more money would be spent in Hawai‘i, thereby increasing jobs and incomes in Hawai‘i. Using 2005 data, agricultural economists with the UH College of Tropical Agriculture and Human Resources estimated that increasing local production of fresh fruits and vegetables to 100% self-sufficiency would generate about 4,430 direct and indirect jobs. The corresponding figure for livestock (beef, pork, eggs and milk) is about 10,200 jobs. The authors of the UH study note that “…even though Hawai‘i can conceivably grow anything that we consume, the quest to achieve 100% food self-sufficiency is impractical, unattainable and perhaps impossible, as it imposes too high a cost for society.” As a result, “… Hawai‘i will probably continue to import most of its food supply …”
Executive Summary

The benefits of increased food self-sufficiency merit government support for farming in terms of farm education and training, extension services, State Ag parks, improvements to irrigation systems, marketing local produce, research, favorable taxes for farms and farming activities, etc. But large subsidies for agriculture could result in higher taxes, while restrictions on food imports (assuming that they would be legal) and/or onerous mandates to purchase local foods could result in higher food prices and less variety in foods if competition from low-cost imports were to be reduced. Also, any addition to agricultural employment due to increased food self-sufficiency could be offset by job losses elsewhere in the economy due to the diversion of resources and expenditures. Whether or not there would be a net benefit to Hawai‘i residents would depend upon the circumstances.

Land for Increased Self-sufficiency and Food Security

From a land-use perspective, the issue of increased self-sufficiency/food security suggests the following question: To what extent should agricultural land be preserved in the event that it might be needed in the future to supply more food to the Hawai‘i market?

Achieving 100% self-sufficiency in fresh fruit and vegetables would require about 30,000 additional acres statewide (an increase from 15,000 acres to 45,000 acres). This figure for additional acreage is high in that (1) 100% self-sufficiency is unrealistic, and (2) more intensive farming than is currently the case would greatly reduce the amount of land required. Nevertheless, the additional land required is small compared to the estimated 177,000 acres ±10,000 acres of good farmland that is available statewide, plus the 65,000 acres (2010 estimate) that could come available if exporting crops is no longer feasible.

For O‘ahu, about 23,000 additional acres would be required for 100% self-sufficiency in fresh produce assuming no inter-island shipping. Again this estimate is high. This compares to over 30,000 acres of good farmland that is available on O‘ahu outside the Community Growth Boundaries, plus about 4,700 acres used for export and non-food crops that could come available if needed. Regarding possible Neighbor Island production to supply the Honolulu market, this is clearly viable. Shipping costs to O‘ahu are partially offset by lower rents for farmland on the Neighbor Islands.

For the foreseeable future, both O‘ahu and the state appear to have sufficient farmland for (1) realistic (and unrealistic) levels of self-sufficiency in fresh produce crops, (2) export crops, and (3) realistic levels of animal feed crops and energy crops. Thus, any additional land preserved for future food security—such as not urbanizing land within the City’s Community Growth Boundaries—might never be needed for this purpose.
b. Agricultural Subdivisions, Farm Use

Even though considerable farmland is available on O‘ahu, some small farmers report that they have problems finding affordable land to lease. This is especially true of farmers who want property where a farmhouse is allowed.

Some of the available parcels on O‘ahu are over 1,000 acres, which is too much land for most small farmers. Landowners report that it is unprofitable to subdivide large parcels into small lots for lease to farmers who want to live in a house on the property. Typical agricultural rents received by the landowners are too low to finance the City requirements of paved roads, underground water, electrical power, wastewater disposal, etc. However, for leased land, State law exempts an agricultural subdivision from County subdivision standards provided that (1) the principal use of the land is for agriculture, (2) no temporary or permanent dwelling is built on the property, and (3) the term for the lease is the greater of 5 years or the property-tax agricultural dedication period. The resulting agricultural lot may have gravel roads, surface water pipes, and no electrical power.

A common alternative for subdividing agricultural land for farming is to license small, unsubdivided lots to farmers. The major difference between a lease and a license is that a lease can be mortgaged to obtain a farm loan, while a license cannot. Also, a farm dwelling would not be allowed.

On O‘ahu, a less common alternative for making land available to small farmers is condominium ownership of agricultural lots, possibly combined with cluster development of farm dwellings that would reduce the cost of providing roads, drinking water, electricity, waste disposal, etc. Another alternative for subdividing agricultural land that is under consideration by the City is to develop rural infrastructure standards that would allow farm dwellings to be served by less expensive infrastructure, provided that controls are in place to ensure agricultural use of the property.

c. Agricultural Subdivisions, Residential Use

In addition to subdividing agricultural land for farming, occasionally agricultural lots on O‘ahu have been subdivided for large-lot homes. They conform to the zoning code provided that agricultural activity takes place on the property, even if the agricultural activity is minimal. Agricultural subdivisions with expensive homes are commonly referred to as gentleman farms or gentleman estates.
Even though limited agriculture may take place on agricultural subdivisions for large-lot homes, for the most part they are tantamount to scattered large-lot residential development outside the City’s Community Growth Boundaries. The City opposes such development, especially those that would be located on high-quality farmland, or which would be far from existing communities. However, an agricultural subdivision must be approved by the City if all standards are met. Even though developers explore developing agricultural subdivision for large-lot homes on O‘ahu, very few agricultural subdivisions have been developed on O‘ahu in recent years—either because approvals were not granted or, if they were granted, satisfying the City’s infrastructure requirements would have been too expensive. If the State Department of Agriculture informs the City that a developer’s agricultural feasibility study is acceptable then, in order to obtain subdivision approval, the City will require the developer to provide paved roads built to City standards, all utility connections, a source of drinking water, wastewater disposal, etc. Such infrastructure requirements can be very expensive when shared among a small number of homes that are far from existing infrastructure. Agricultural subdivisions are more common on the Neighbor Islands than O‘ahu because of less expensive infrastructure requirements.

d. Planned Urbanization of Agricultural Land

A common perception in Hawai‘i is that urban sprawl onto O‘ahu’s limited supply of farmland is rampant, with little control by the City or State. In practice, however, nearly all developments on O‘ahu are within the City’s Community Growth Boundaries. Furthermore, most new residential projects in ‘Ewa and Central O‘ahu are comprised of small-lot, single-family homes mixed with multi-family homes. Most lots for single-family homes range from 3,500 to 5,000 square feet, or about half the size of lots in many older neighborhoods on O‘ahu. This development pattern reduces the amount of land required for new communities.

Consistent with the City’s plan to develop the Second City of Kapolei, most urban development of agricultural land over the past two decades has occurred in ‘Ewa. The State has supported this plan with numerous approvals of private projects along with major State investments in ‘Ewa (e.g., State residential and commercial projects, UH-West O‘ahu, freeway improvements, etc.).

2. Under existing subdivision rules, the City can allow an agricultural subdivision to have less expensive streets with grass shoulders instead of sidewalks, and overhead utilities lines instead of underground lines.
City plans favor developing ʻEwa and Central Oʻahu because redeveloping the urban core is likely to accommodate only a portion of Oʻahu’s economic and population growth. Also, the City rejected the option of urbanizing outlying parts of the island which would have preserved the good farmland in ʻEwa and Central Oʻahu. This option was rejected because of (1) strong community opposition (“Keep the country country.”), (2) the high infrastructure costs associated with scattered development, and (3) sufficient land in ʻEwa and Central Oʻahu to accommodate projected growth.

e. Reconfiguring and Relocating Farms

Ongoing, planned, and proposed development in ʻEwa and proposed development in Central Oʻahu will continue to force affected farmers to gradually reduce the size of their farms, and eventually to relocate their operations. This transition could last 20 more years or longer as the lands are gradually urbanized. The affected farmers leased the fields at discounted rents after the City designated the lands for urban development.

Reconfiguring and relocating farms is common and appropriate when farmers lease land in the path of the planned urban expansion of a growing city. For diversified-crop farmers who supply nearby markets, locating their farms on the edge of town may be ideal for them because of the lower trucking costs. And until the lands are urbanized, the best “temporary” use of these lands is often farming. But when urbanization does occur, the farmers incur the expense and disruption of relocating their farms to other areas. This, however, is offset by the decades of below-market rents they paid for the temporary use of the land.

Because of the eventual displacement of farms in ʻEwa and Central Oʻahu, landowners on the North Shore and elsewhere should anticipate that these farms could be relocating to their areas. This may require upgrades and repairs to the Wahiawa Irrigation System, possibly with government assistance. Also, the City will have to complete its scheduled upgrade of the Wahiawa Wastewater Treatment Plant so that its discharged water into Lake Wilson will be rated R-1 and can be used to irrigate vegetable and melon crops.

f. Intensive Livestock Farms

Intensive livestock farms (dairies, pig farms and poultry farms) require little land compared to crop farming or ranching. Also, the land does not have to be high-quality farmland. Nevertheless, finding land on Oʻahu for intensive livestock operations can be a challenge because such farms generally are located in coastal areas. This is because the State Department of Health guidelines for livestock waste management favor locating livestock...
facilities and related waste systems *makai* of the Underground Injection Control Line—i.e., in coastal areas. The purpose of the guidelines is to reduce the risk of contaminating aquifers used for drinking water, which are located *mauka* of the line.

Locating intensive livestock farms on coastal land presents two problems to farmers. First, small coastal parcels may be unaffordable for livestock operations. Second, intensive livestock operations may create nuisance issues if homes are nearby.

g. **Agricultural Land Values and Rents**

A concern that is sometimes expressed is whether the development of agricultural land in ‘Ewa and Central O‘ahu will cause a general increase in agricultural land values and/or rents which, in turn, could cause some farmers to be displaced because they are unable to afford the higher land costs.

Development in ‘Ewa and Central O‘ahu reduces the development pressures on farmlands that are outside the City’s Community Growth Boundaries. In turn, the reduced development pressure on these farmlands should result in slightly lower agricultural land values than would otherwise be the case.

However, development in ‘Ewa and Central O‘ahu will decrease the supply of farmland on O‘ahu which, in turn, could cause farm rents to be bid up slightly. Any increase in rents is expected to be small in view of (1) the acreage of the farms to be relocated (about 2,425 acres), and (2) the supply of good farmland that will remain available outside of the City’s Community Growth Boundaries after these farms are relocated (over 30,000 acres).

h. **New Technology**

New technologies could affect the long-term requirements for farmland and irrigation water in Hawai‘i. For example, VertiCrop is a commercial system that combines vertically stacked hydroponics trays and a greenhouse to facilitate high-density production of vegetables and other suitable crops in a controlled environment. The greenhouse can be located in an industrial area without having to use high-quality farmland. Per-acre yields are about 20 times those of conventional field farming but use about 5% as much water. Locating the greenhouse near an urban market reduces shipping costs and delivery times, and increases food security.

One of the more promising technologies for overcoming water shortages is the Dutyion Root Hydration System (dRHS), also known as the Subsurface Vapor Transfer Irrigation
System. This system has been under development by a British company in cooperation with DuPont. The dRHS system delivers water vapor to plant roots via buried hoses made from a special material. The hoses—which are filled with brackish water, seawater, or wastewater under low pressure—allow water vapor but not salts to pass through the hose material to irrigate plants. No expensive desalination plant is required and, as a result, no high-pressure pumps or high-pressure pumping, no fine filtering, and no water purification are required. Advantages of the dRHS are its simplicity and the corresponding low capital and operating costs. The system has been proven by a number of field trials throughout the world and with many different types of crops. If the system is commercially successful, it could eventually reduce the amount of potable groundwater and surface water required to cultivate many crops, and open up new areas for farming.

i. Property Taxes

Regarding capital-intensive farming approaches such as VertiCrop, the land could be dedicated for agriculture even if the zoning is industrial or commercial. However, for a property that has mixed use (such as a greenhouse on the roof of an industrial building that houses non-agricultural activities), the agricultural portion of a property may not qualify for an agricultural dedication. Also, a greenhouse or other agriculture-related building would not qualify for reduced property taxes.

To foster fair competition between capital-intensive farming approaches and field farming, modifications to the property tax system may be warranted to (1) split the land value between agricultural and non-agricultural uses for land that is zoned industrial or commercial, (2) allow an agricultural dedication for the agricultural portion of the land, and (3) provide reduced property taxes for agricultural buildings and related improvements.
O‘AHU AGRICULTURE: SITUATION, OUTLOOK AND ISSUES

1. INTRODUCTION

a. Content and Purpose

This report provides an assessment of (1) agronomic resources on O‘ahu, (2) the current situation and outlook for agriculture, and (3) issues affecting agricultural land. The material covers food crops, seed crops, flowers and nursery products, biofuel crops, commercial forests, aquaculture, and livestock activities.

The material was prepared to provide information to the City & County of Honolulu (the City) to assist it in giving proper consideration to agriculture in updating the “General Plan of the City and County of Honolulu.” Much of the focus of this report is on land-use issues.

b. Organization of the Report

The sections below provide information on the following:

— Agricultural resources and conditions
— Agricultural activity and its economic contributions
— Agricultural trends
— Factors affecting agriculture
— Availability of farmland
— Potential land requirements for crops
— Cattle grazing
— State and County agricultural policies
— Agricultural issues.

Supporting maps, tables and figures (graphs) are at the end of the report.
c. Sources of Information

Most of the statistical data on agricultural activity is from the annual “Statistics of Hawaiʻi Agriculture” which, at the time of this report, provided historical data up to 2008, and limited data for 2009. For certain crops, historic and current data are not available at the county level and sometimes not at the state level because of non-disclosure requirements. Where possible, best estimates were provided based on information from farmers and landowners. Most of the resource maps are from the State or from State data.

Information on agricultural land and water resources, activities, potential, and issues derives from decades of consulting by the principal for government agencies, farmers, landowners, and developers of projects that affect agriculture. The impact assessments have included projects that advance agriculture (e.g., agricultural plans and water improvements), as well as urban and other projects which displaced agricultural activities.

d. Consultants

The analysis was conducted by Plasch Econ Pacific LLC, a Hawaiʻi-based economic-consulting firm specializing in economic development (including agriculture), land and resource economics, feasibility studies, valuations, market analysis, public policy analysis, and the economic and fiscal impacts of projects. The principal has been a Hawaiʻi-based economic consultant since 1971.

Helber Hastert & Fee Planners prepared Maps 2 and 6 using a Geographic Information System (GIS) and layers provided by the State, and calculated the acreages associated with these and other maps.
2. AGRICULTURAL RESOURCES AND CONDITIONS

Provided below is information on O‘ahu’s agricultural resources and conditions, and the supply of high-quality farmland.\(^1\)

a. Agricultural Land

O‘ahu has about 122,927 acres in the State Agricultural District (32% of the island), including farmland, grazing land, and “junk” land categorized as Agricultural because it was unsuitable for the other Districts.

About 109,243 acres of the agricultural land are outside the City’s Urban and Rural Community Growth Boundaries (see Maps 1 and 2). Most of the 13,684 acres within the Community Growth Boundaries are located in ‘Ewa, Makakilo, Central O‘ahu, Hale‘iwa, and Pūpūkea. Pūpūkea is a large, decades-old agricultural subdivision that was developed on former pineapple land.

Over a period of 30 years or so, it is assumed in this report that the agricultural lands that are within the Community Growth Boundaries could be developed.

b. Soil Ratings

Two classification systems are commonly used to rate soils in Hawai‘i: (1) Overall Productivity Rating by the Land Study Bureau (LSB ratings), and (2) Agricultural Lands of Importance to the State of Hawai‘i (ALISH ratings).

**LSB Rating: Overall Productivity Ratings**

In the late 1960s, the University of Hawai‘i (UH) Land Study Bureau (LSB) developed the Overall Productivity Rating, which classifies soils according to five levels, with “A” representing the class of highest productivity and “E” the lowest. For each soil type, the report provides two ratings: (1) a rating assuming fields are irrigated, and (2) a rating assuming that fields are not irrigated. The rating maps shown in the LSB report, and the LSB

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1. In this report, the term “high-quality farmland” refers to land that has an LSB rating of A or B, or an ALISH rating of Prime or Unique. The term “good farmland” is similar to “high-quality farmland,” but does not have a precise definition based on soil ratings. In practice, an area that is farmed may be comprised of “high-quality farmland” intermixed with some lower rated land, all of which would be considered “good farmland.”
GIS layers provided by the State, are based on lands that were irrigated in the early 1970s when the LSB report was prepared for O‘ahu. Since irrigation systems have expanded beyond the fields that were irrigated in the early 1970s, the State’s LSB layer underestimates the amount of high-quality land (i.e., lands rated A or B).

In 2010, O‘ahu had about 41,400 acres of farmland rated A and B in the Agricultural District—this compares to about 53,040 acres that were rated A and B in 1972, but which included land in all three districts on O‘ahu (Agricultural, Urban and Conservation).

Of the 41,400 acres rated A and B, about 4,750 acres were within the City’s Urban Growth Boundary, and another 2,710 acres were used by the military or have been acquired by the Federal government for eventual expansion of the James Campbell National Wildlife Refuge (see Subsection 2.k). Thus, about 33,940 acres of A- or B-rated agricultural land outside the City’s Growth Boundary remain available for farming. This figure is low since it is based on fields that were irrigated in the early 1970s.

**ALISH Rating: Agricultural Lands of Importance in the State of Hawai‘i**

ALISH ratings were developed in 1977 by the Soil Conservation Service (now known as the Natural Resources Conservation Service), the UH College of Tropical Agriculture and Human Resources, and the State Department of Agriculture. This system classifies land into three broad categories: (a) Prime agricultural land, which is land that is best-suited for the production of crops because of its ability to sustain high yields with relatively little input and with the least damage to the environment; (b) Unique agricultural land which is non-Prime agricultural land used for the production of specific high-value crops; and (c) Other agricultural land which is non-Prime and non-Unique agricultural land that is important to the production of crops. The ratings shown in the ALISH maps are based on lands that were irrigated in the mid-1970s. Since irrigation systems have expanded beyond the fields that were irrigated in the 1970s, the State’s ALISH layer underestimates the amount of high-quality land (i.e., lands rated Prime and Unique).

In 2010, O‘ahu had about 46,190 acres rated as Prime or Unique in the Agricultural District, of which about 5,830 acres were within the City’s Urban Growth Boundary, and another 3,560 acres were used by the military or have been acquired by the Federal government for eventual expansion of the James Campbell National Wildlife Refuge (see Subsection 2.k). Thus about 36,800 acres of Prime or Unique agricultural land outside the City’s Growth Boundary remain available for farming. This figure is low since it is based on fields that were irrigated in the 1970s.
c. **Soil Characteristics**

Consistent with the above soil ratings, the higher quality lands exhibit the following soil characteristics: deep (over 30 inches), moderate to well-drained, non-stony to slightly stony, and moderate to well-suited for machine tillability.

d. **Elevations**

O‘ahu farmland ranges in elevation from about 3 feet in coastal regions (e.g., Mokulē‘ia) to over 1,350 feet in Central O‘ahu near Whitmore Village.

e. **Slopes**

Higher quality farmland has slopes ranging from 0% to 10%. Steeper lands can be farmed, but erosion during rainstorms and the cost of controlling the erosion become significant.

f. **Climatic Conditions**

Like other areas in Hawai‘i, O‘ahu has a mild *semitropical* climate that is due primarily to three factors: (1) Hawai‘i’s mid-Pacific location near the Tropic of Cancer, (2) the surrounding warm ocean waters that vary little in temperature between the winter and summer seasons, and (3) the prevailing northeasterly tradewinds that bring air having temperatures that are close to those of the surrounding waters.

**Solar Radiation**

Average solar radiation ranges from less than 400 calories per square centimeter per day for some higher elevation farmlands on O‘ahu to over 500 calories for some coastal farmlands (Map 5).

**Rainfall**

Average rainfall ranges from less than 24 inches per year for some coastal farmlands to over 60 inches per year for some farmlands in the foothills (Map 6). Unlike most tropical areas, winter rather than summer is the rainy season in Hawai‘i.
Temperatures

Near the ocean, the average low temperature ranges from about 60° Fahrenheit in the winter to about 65°F in the summer, while the average high temperature ranges from just under 75°F in the winter to about 85°F in the summer. As a general rule, mean temperatures in Hawaii drop at the rate of about 1°F for each 200- to 300-foot increase in elevation.

Winds

Except for fields located in leeward valleys and other protected areas, agricultural areas on O‘ahu are exposed to strong northeasterly tradewinds. Because of strong tradewinds and occasional storms, many fields require windbreaks to protect crops from wind damage.

g. Irrigation Systems

Surface Water

Major surface irrigation systems on O‘ahu include the following:

— Waiāhole Irrigation System

As limited by the State Water Commission, the Waiāhole Irrigation System transports 12.57 million gallons per day (mgd) of water from windward O‘ahu to fields in Central O‘ahu and Kunia. During the 1980s when O‘ahu Sugar Company was still operating, the system transported 25 to 30 mgd. The current charge for delivering water is 51.7 cents per 1,000 gallons. Because the State claims ownership of all surface and groundwater, water companies can only charge for the delivery of water regardless of the demand and scarcity value of the water.

— Wahiawa Irrigation System and Related Ditch Systems

Wahiawa Irrigation System extends downhill from Wahiawa Reservoir (Lake Wilson), to fields in Mokulē‘ia, Waialua, Hale‘iwa, and near Waimea Bay. Three other systems feed into this main ditch: the Helemano Ditch and Tanada Reservoir on Dole land, and Ōpae‘ula Ditch and Kamananui Ditch on Kamehameha Schools land.

During sugar operations, this system supplied about 40 mgd, including about 30 mgd from Lake Wilson and 3 to 4 mgd from each of the smaller ditch systems. However, the capacity of the Wahiawa Irrigation
System has been reduced because Lake Wilson is now maintained at a lower level for safety reasons; some syphons have been replaced with new syphons having smaller diameter pipes; and sections of the ditch system need repair. As the demand for water increases, it is expected that improvements will be made so that the system will deliver more water. Because of the cost, government assistance may be required.

During heavy rainstorms, the City discharges partially treated wastewater into Lake Wilson from its Wahiawa Wastewater Treatment Plant. As a result of this discharge, the State Department of Health (DOH) rates the quality of the water from Lake Wilson as R-2. According to DOH guidelines, R-2 water can be used to irrigate crops such as seed corn, tree crops (e.g., papaya and coffee), and crops that are processed sufficiently to kill pathogens. However, R-2 water cannot be used to irrigate vegetable crops that are not processed. Vegetable crops on the North Shore are irrigated with groundwater or with water from the smaller ditch systems before the water flows into the Wahiawa Irrigation System.

Following scheduled upgrades to the Wahiawa Wastewater Treatment Plant in 2011, partially treated wastewater will no longer be discharged into Lake Wilson. As a result, the discharge will be rated R-1 which, like untainted water, can be used to irrigate any crop using any type of irrigation system.

In early 2010, Dole charged 36 cents per 1,000 gallons to deliver water from the Wahiawa Irrigation System.

— Other Ditch Systems

O‘ahu has two other ditch systems that remain from past sugarcane operations: the State’s Waimānalo Irrigation System (Maunawili Ditch) which delivers water from Maunawili to farms in Waimānalo, and the Punalu‘u Ditch which delivers water from mauka sources to farms in Punalu‘u.

The State charges 47.5 cents per 1,000 gallons to deliver water from its systems.
Groundwater

A number of groundwater wells supply water to farmlands throughout O‘ahu. Most wells are located at lower elevations, although some wells pump perched water at higher elevations. Historically, groundwater wells supplied about 40 mgd of water to irrigate the Waialua Sugar Company fields on the North Shore. Currently, the delivery charge for groundwater on the North Shore is about 50 cents per 1,000 gallons.

The State’s Kahuku Irrigation System delivers groundwater to the State Kahuku Ag Park. The charge is 47.5 cents per 1,000 gallons. Many smaller farms rely on water from the City’s Board of Water Supply, which charges farmers $1.19 per 1,000 gallons.

Other Sources

Some farmers divert water from nearby streams (e.g., farms in Waihole, Waikane and Hale‘iwa), or obtain water from springs on their property.

h. Irrigated Lands

In general, the irrigated lands are those with higher soil ratings: the A and B rated land shown in the LSB Map, and the Prime and Unique rated land in the ALISH Map.

i. Locational Advantage

The fields on O‘ahu are well-located for farmers who serve the Honolulu consumer market and export markets. This is due to the short trucking distance to the Honolulu markets, the Honolulu International Airport, and Honolulu Harbor. In the U.S. mainland market, however, farmers in Hawai‘i must ship their goods overseas and compete against farmers on the mainland and in Mexico, Central and South America, the Caribbean, Australia, New Zealand, Southeast Asia, etc. Most of the competing farm areas have lower production and delivery costs than Hawai‘i does. Competing against Mexico is particularly difficult given the North America Free Trade Agreement (NAFTA) and Mexico’s proximity to major U.S. markets.

j. Land Tenure

Large Landowners

Map 7 shows the large landowners as of 2006. The major owners of good farmland in 2006 included: Castle & Cooke (now Dole Food Company Hawai‘i for lands north of
Wahiawa), George Galbraith Trust, James Campbell Estate (now The James Campbell Company), Kamehameha Schools, and Mark A Robinson Trust.

Since Map 7 was prepared, there have been major on-going changes in farmland ownership. The James Campbell Company has sold all or nearly all of its farmland in Kunia and Kahuku. Buyers of land in Kunia include major seed companies, other farm companies, and the U.S. Army and an affiliated land-holding company for land near Schofield Barracks. Castle & Cooke has sold some farmland to seed companies and to other farm companies, and additional farmland is for sale. Galbraith Trust has sold some of its land and its remaining land is for sale. Within a decade or so, only two large owners of good farmland might remain: Kamehameha Schools with most of its farmland on the North Shore and, to a much lesser extent, Robinson Trust in Kunia.

State Ag Parks

The State operates four Ag Parks on O‘ahu:

— Waimānalo Ag Park: 126 acres subdivided into 14 lots, with water provided by the State.
— Wai‘anae Ag Park: 150 acres subdivided into 17 lots, with water provided by the City.
— Kahuku Ag Park: 686 acres subdivided into 25 lots, with water provided by the State.
— Kalaeloa Ag Park: 10 acres subdivided into two lots, with water provided by the City.

Except for two lots in Wai‘anae, all the lots are leased.

In addition to the four existing Ag Parks, a 150-acre State Ag Park is planned as part of Royal Kunia.

Lease and License Terms

Many owners of farmland lease or license their land to farmers in parcels ranging in size from 1 acre or less to several hundred acres. The durations of the agreements range from as short as 1 year to decades, with 5 years being typical for major landowners. If major investments are required, then agreements tend to be longer.
State leases run from 15 to 55 years. Farm dwellings are not allowed unless approved by the Board of Agriculture.

As indicated, two types of land agreements are used to provide land to farmers: leases and licenses. The advantage of a leased parcel is that it can be mortgaged to obtain a farm loan. But when a parcel is leased, it must be identified in formal lease documents by its Tax Map Key (TMK). Since some TMKs exceed 1,000 acres and include many fields, they are too large for small farmers who need smaller plots of land. However, subdividing the land into smaller parcels can be expensive for the landowner (see Subsection 10.c).

A license is more flexible than a lease in that there is no requirement that the land be identified by a TMK. For example, some licensed parcels on the North Shore are identified by their former sugarcane field number, are relatively small (40 to 100 acres which is suitable for small farmers), and comprise only a portion of a TMK. Thus, a license avoids the high cost of subdividing a large TMK into smaller TMKs suitable for leasing to small farmers. The disadvantage of a license, however, is that it cannot be mortgaged to obtain a farm loan. For certain lands licensed to small farmers, the landowners retain the option of relocating the farmers to comparable lands if the landowner subsequently chooses to use the land for other crops.

In some cases, a farmer will lease or license land, then sublease or sublicense a portion of the land to one or more smaller farmers.

**Rents**

For large fields of good irrigated farmland leased or licensed to farmers, annual rents in 2010 were about $275 per acre for privately owned land. However, rents may be higher in special situations, such as when spring water is available. Rents for small parcels tend to be higher because of higher management costs. If a parcel allows a farmhouse, then the rent will include an additional fee for the house lot and possibly the house if it is owned by the landowner. Rents for land within the City’s Community Growth Boundaries normally are discounted because the farmers have temporary use of the land, although such temporary use may last for decades. The discounted rents help offset the farmers’ costs of relocating their farms in the future.

State rents are set at market rates and depend upon on the size of the parcel, agronomic conditions, water, etc. In 2010, annual per-acre rents for farmland within the State Ag Parks ranged from $120 to $502, and averaged $375.
For grazing land that is leased or licensed to ranchers, annual rents range from as low as $0 per acre per year to over $20, depending upon location, terrain, the availability of water, the existence of fencing and other security features, how much rain falls in the area to grow grass to feed the cattle, etc.

**k. Core and Other High-Quality Farmlands**

In Map 2, the dark green area shows the land on Oʻahu that, in 2010, had an LSB rating of A or B, or had an ALISH rating of Prime or Unique. These lands constitute Oʻahu’s high-quality farmlands. For the most part, these lands have the following characteristics:

- Soils that are deep, well-drained, largely free of stones and, as a result, are highly rated.
- Terrain that is flat or gently sloping which reduces erosion.
- High solar radiation (over 400 calories per square centimeter per day).
- Access to irrigation water.

About 47,280 acres of the high-quality farmlands are within the State’s Agricultural District, but outside the City’s Community Growth Boundaries. Subtracting about 4,860 acres of Federal lands that are not currently available for farming or, in the future, will not be available for farming (see below), about 42,620 acres of high-quality farmland are (1) within the State’s Agricultural District, (2) outside the City’s Community Growth Boundaries, and (3) remain available for farming.

This acreage can be split into three parts: (1) about 28,120 acres that have an LSB rating of A or B, and an ALISH rating of Prime or Unique (i.e., both LSB and ALISH); (2) about 5,820 acres that have an LSB rating of A or B, but lack an ALISH rating of Prime or Unique (i.e., LSB but not ALISH); and (3) about 8,680 acres that have an ALISH rating of Prime or Unique but lack an LSB rating of A or B (i.e., ALISH but not LSB).

Federal lands that are not available for farming include military land at Lualualei Valley, Waipio Peninsula, and Schofield Barracks. Although the Lualualei land is not available for farming, it is leased to a rancher for grazing cattle. And in the future, portions of Waipio Peninsula could be leased out by the Navy for farming as was the case before Oʻahu Sugar Company ceased operations. In Kahuku, land now used for aquaculture and farming has been acquired by the U.S. Fish and Wildlife Service for eventual expansion of the James Campbell National Wildlife Refuge (see Subsection 7.a).
O‘ahu’s largest concentrations of high-quality farmland located outside the City’s Community Growth Boundaries are in Kunia, and on the North Shore. These are O‘ahu’s “core” farmlands and are best suited for large-scale farming. They are among the highest-quality agricultural lands in Hawai‘i.

Smaller amounts of good farmland are scattered throughout Ko‘olau Loa, Ko‘olau Poko, and Wai‘anae. These areas are best-suited for small family farms.
3. AGRICULTURAL ACTIVITIES AND THEIR ECONOMIC CONTRIBUTIONS

This section provides information on agricultural activities in the state and on O‘ahu for 1980 and 2008, and the economic contributions of agriculture to O‘ahu in 2007 and 2008.

a. Agricultural Activities: 1980

Farm Acreage and Crops

For the greater part of a century, the better farmlands on O‘ahu were used to grow sugarcane and pineapple. Map 8 shows the extent of plantation agriculture for the years 1978 to 1980. O‘ahu Sugar Company grew sugarcane in ‘Ewa, Kunia and Waiawa. Waialua Sugar Company grew sugarcane on the North Shore. Dole and Del Monte grew pineapple on higher elevation fields in Central O‘ahu and the North Shore. Most of Dole’s fields were east of Kamehameha Highway, and most of Del Monte’s were west of the highway. Diversified crops—that is, all crops other than sugarcane and pineapple—were grown in rural areas throughout O‘ahu.

The first two columns in Table 1 provide information on the extent of agricultural activity for both the state and O‘ahu in 1980. The 1980 O‘ahu data correspond to Map 8. State figures are shown because O‘ahu data are not disclosed for many crops due to the small number of operations. Even though O‘ahu data are not disclosed, the state data reveal small acreages for many crops that are grown for the Hawai‘i market. Within each category, items in Table 1 are listed in descending size based on the 2008 O‘ahu data.

In 1980, land in crop on O‘ahu totaled 47,900 acres, including 33,100 acres in sugarcane (69%), 11,500 acres in pineapple (24%), 800 acres in fruits other than pineapple (2%), 1,400 acres in vegetables and melons (3%), and 1,400 acres in other crops (seed corn, taro, flowers and nursery products, feed crops, etc., amounting to 3%). The acreage given for vegetable and melon crops is for harvested acreage, not the amount of land farmed. Because the land may yield more than one crop per year, the acreage may be counted more than once. On the other hand, many vegetable and melon farmers fallow much of their land. Since these two factors offset one another, harvested acreage approximates the amount of land farmed.

Irrigation Water

Excluding reuse, O‘ahu farmers used about 237 million gallons per day (mgd) in 1980 to irrigate their crops (Table 1, Section 1.b).
Sugarcane used an average of about 10,000 gallons of water per acre per day with furrow irrigation, and about 8,000 gallons with drip irrigation. Pineapple averaged about 2,000 gallons per acre per day for land in crop, or about 1,600 gallons for land farmed, assuming that an average of 80% of the land was kept in crop and 20% was kept fallow. Most diversified crops averaged about 4,000 gallons per acre per day for land in crop. This translates to an average of 1,000 to 4,000 gallons of water per day for land farmed, depending upon the amount of falling. Some large vegetable and melon farms with ample land may keep only about 33% to 50% of their land in crop. Seed companies farm only about 25% of their land since seed corn is grown in small patches in order to prevent cross-pollination among varieties.

Livestock

In 1980, O‘ahu had 19,800 beef cattle (including calves), 11,600 dairy cows, 35,400 pigs and hogs, 860,000 layer chickens, and 258,000 non-layer chickens (Table 1, Section 1.c). In that year, O‘ahu had more chickens (1.1 million) than residents (762,534).

Farm and Livestock Operations

Also in 1980, O‘ahu had about 1,000 farm and livestock operations (Table 1, Section 1.d).

b. Agricultural Activities: 2008

Farm Acreage and Crops

In 2008, crops that were grown commercially on O‘ahu included, but are not limited to: asparagus, atemoya, beans (green, bush and snap), bell peppers, bittermelon, broccoli, burdock, cantaloupe, carrots, cauliflower, celery, Chinese peas, Chinese peas, cocoa, coffee, cucumbers, daikon, dasheen, dry onions, eggplant, flowers and nursery products, ginger root, green onions, green peppers, guava, head and semi-head lettuces, herbs, honeydew melons, limes, longan, lotus root, lychee, mango, Manoa lettuce, mustard cabbage, noni, oranges, Oriental squash, parsley, pineapple, persimmon, potatoes, pumpkins, radish, rambutan, romaine, seed crops, sod, starfruit, sweet corn, sweet potatoes, tangerines, taro, watercress, and watermelons. Livestock activities include, but are not limited to: cattle grazing, pigs and hogs, chickens for eggs and meat, goats, honey, and aquaculture.
Map 9 shows the general location of agricultural activity on O‘ahu in 2008, and Table 1 shows information on the extent of activity for both the state and O‘ahu. For a specific crop, the third column in Table 1 provides information on the extent of state exports; the fourth column provides information on self-sufficiency; and the next two columns provide information on state and O‘ahu acreages for the crop. For 2008, the amount of land in Specialty Crops was adjusted downward by 2,400 acres for both the State and O‘ahu, and land in Vegetable and Melon Crops was increased by the same amount to adjust for the fact that some vegetable and melon farmland was listed under Other Crops because of non-disclosure requirements.

As shown in Section 1.a of Table 1, O‘ahu had about 11,000 acres in crop in 2008, or about 12% of the state total of land in crop. O‘ahu cropland included about 6,200 acres in specialty crops (about 8% of the state total); about 900 acres in fruits other than pineapple (about 15% of the state total); and 3,900 acres in vegetable and melon crops (about 71% of the state total). For O‘ahu, the primary specialty crops were seed corn, pineapple, and floriculture and nursery products.

As indicated, most farmland on O‘ahu and the state is used for export crops—over 70,000 acres (76.5%) statewide in 2008. Although not shown in Table 1, pineapple acreage on O‘ahu declined to about 2,500 acres in 2010, with most pineapple now being grown for the Hawai‘i market—not for export. Also, Dole relocated all of its pineapple operations to fields on the North Shore near its packing plant, base yard, and offices.

In terms of acreage, the largest farm operations on O‘ahu are (1) seed companies with farms located in Kunia and the North Shore; (2) a group of related farms managed by Larry Jefts who grows a variety of vegetable and melon crops in Kunia, ‘Ewa, and the North Shore; and (3) Aloun Farms which grows a variety of vegetable and melon crops in ‘Ewa and Central O‘ahu, and which leased land on the North Shore recently. Unlike other major farmers, Aloun Farms leased much of its land within the City’s Community Growth Boundaries. The seed companies have replaced sugar and pineapple companies as the highest bidders for farmland, giving them access to much of the best land in Hawai‘i.

2. The 2007 Census of Agriculture, Hawai‘i State and County Data reports 9,518 acres of harvested cropland for O‘ahu. Land from which two or more crops were harvested was counted only once. However, harvested cropland excludes much of the pineapple acreage—i.e., the pineapple land that was not harvested in 2007 as well as the fallow land between pineapple plantings. Summing the acres of harvested cropland, the excluded pineapple land, and 1-year of growth in seed acreage provides about 11,000 acres farmed in 2008.
Irrigation Water

Water requirements for irrigating crops on Oʻahu are estimated at about 29 mgd for 2008 (Table 1, Section 1.b).

In 2008, per-acre water use was similar to that in 1980. However, there was more fallowing in 2008 than in 1980. Some of the major vegetable and melon farmers who have access to considerable land now keep about one-third to one-half of their land in crop. Also, Dole reports that they are fallowing more land.

Livestock

The largest use of agricultural land on Oʻahu and in the state is for ranching. In fact, most useable agricultural land that is not used for crop farming is used for grazing cattle. In 2008 Oʻahu had 4,400 beef cattle (including calves), a few dairy cows, and 9,400 pigs and hogs (Table 1, Section 1.c). Data on Oʻahu chicken farms is no longer disclosed because of the small number of farms. Most of the intensive livestock operations are in Waiʻanae.

Farm and Livestock Operations

As shown in Section 1.d of Table 1, in 2008 Oʻahu had 634 farms, 144 livestock operations, and 172 other commodity operations (seeds, aquaculture, goats, sheep, etc.), for a total of 950 operations. Flowers and nursery products accounted for the largest number of operations.


For 2008, Table 2 summarizes the size of the Oʻahu market for food production, and the economic contributions of agriculture on Oʻahu. Employment data are for 2007.

Market

In 2008, Oʻahu’s resident-plus-visitor de facto population was about 934,300 people (Table 2, Section 2.a). Residents spent about $2.93 billion on food (about $9,545 per household), of which about $300 million was for fresh, frozen and canned fruits and vegetables (about $981 per household).

Sales

Oʻahu farmers sold about $167.7 million in farm products in 2008 (about $15,250 per acre) while livestock operations sold about $16.9 million, for a total of about $184.6 million
(Table 2, Section 2.b). In addition, farmers and their employees purchased goods and services to support their farms and families. These indirect sales totaled about $195.7 million. Thus, in 2008, O‘ahu’s agricultural activity generated about $380.3 million in direct and indirect sales.

Agriculture tourism adds to farm and ranch revenues: about $14.2 million in 2006 for O‘ahu. However, because fields are not secure, farmers and livestock operators are subjected to theft and vandalism. In 2008, this loss combined with expenditures for security was valued at $3.9 million for O‘ahu.

Exports

In 2008, agricultural exports comprised about 85% of Hawai‘i’s farm and livestock sales, while local consumption amounted to about 15% of sales. Export percentages of individual crops and livestock products are shown in Table 1. For O‘ahu, the major export crops were seeds and ornamentals.

Self-sufficiency

Statewide, Hawai‘i farmers supplied about 32% of the fresh fruit consumed locally in 2008, and about 34% of the fresh vegetables and melons. Self-sufficiency percentages of individual crops are shown in Table 1. Self-sufficiency is high (over 70%) for many of the commercially successful crops grown in Hawai‘i, including: pineapple, sweet potatoes, head cabbage, sweet corn, cucumbers, Chinese cabbage, green onions, mustard cabbage, and watercress.

Statewide, Hawai‘i livestock operators supplied about 20% of the eggs consumed locally in 2008, about 10% of the milk, about 4.5% of the beef, and about 3.9% of the pork.

Employment and Payroll

For 2007, O‘ahu’s agricultural employment is shown in Section 2.d of Table 2. Hired workers accounted for 1,535 agricultural jobs while self-employed and unpaid family farm workers accounted for an estimated 1,040 jobs, for a total of about 2,580 jobs. Purchases of goods and services by farms, livestock operators, and their employees generated about 1,290 indirect jobs. Thus, total employment supported by agricultural activity was about 3,870 jobs, or about 0.8% of all jobs on O‘ahu. While agriculture is a significant contributor to Hawai‘i’s economy, it is no longer a pillar of the economy as it was before statehood.
On average, about 11 farm jobs are supported for each 100 acres in crop. Inversely, about 9 acres are required to produce one farm job.

In 2007, annual wages averaged $25,192 for O‘ahu farm workers, $27,033 for livestock workers, and $28,503 for support workers. In 2008, the seed industry reported a higher average annual wage for its O‘ahu workers: $35,200. For comparison, the average wage for all O‘ahu employees was $40,784 in 2007. The low farm wages are due primarily to (1) competition from low-cost imports, (2) limited opportunities for some workers because they lack English-language skills and other skills, and (3) part-time farmers who farm for the lifestyle rather than for the income.

Payroll was about $39.5 million for all agricultural jobs (crop farming, livestock, and support activities), about $42.5 million for indirect jobs supported by agriculture, for a total of about $82 million.

**Lifestyle and Country Ambience**

Many of the farms on O‘ahu are commercial operations that provide the sole or primary source of income for the farmers who run them, as well as for the employees who help work the farms. Farming is a difficult and demanding occupation, but the lifestyle appeals to many people: it is a healthy outdoor physical activity; small farmers control their own time and efforts; and they receive great satisfaction from growing food, working with nature, and taking care of the land.

Many other farms are semi-commercial operations, where the farmers have chosen a lifestyle which may generate cash to supplement family incomes, but also provides the satisfaction that comes from growing crops for family and friends (commonly referred to as subsistence agriculture). To varying degrees, some farmers engage in what could be termed “recreational farming.” For some, farming goes beyond being a desirable lifestyle to also embrace cultural restoration, preservation and education (e.g., wetland taro farming and aquaculture in restored fishponds).

Both farmers and non-farming residents report that they appreciate, enjoy, highly value, and want to preserve the rural lifestyle and country ambience provided by agricultural activities. This ambience is provided by large and small farms, large pastures with cattle and horses, expansive greenery and open space, small rural communities, roadside stands offering farm-fresh fruits and vegetables, etc. The rural areas also contribute to attracting visitors to O‘ahu.
4. **Agricultural Trends**

Selected agricultural trends for the state, O‘ahu and the Neighbor Islands are discussed below and shown in Figures 1 through 8.

**a. Crop Acreage Trends, Statewide: All Crops**

As shown in Figure 1, which covers the entire state, a vast amount of land has been released from plantation agriculture: about 267,500 acres between 1968 and 2009. Over this same period, the demand for land for diversified crops increased by about 21,500 acres (about 8% of the land released from plantation agriculture). In total, land in crop declined from about 327,500 acres in 1968 to about 81,500 acres in 2009, for a total loss of about 246,000 acres (75% decline).

The downward trend in Hawai‘i’s sugarcane industry was largely due to increased competition from the mainland due to (1) the development of high-fructose corn syrup and (2) higher yields from sugar beets. Because of the increased competition, the Federal government maintained low price supports for sugar in order to avoid over production by U.S. growers. The resulting Federal price supports for sugar were too low to allow profitable operations by Hawai‘i sugar growers.

For pineapple, the downward trend was due largely to competition from lower-cost foreign producers, including competition from firms that have or had plantations in Hawai‘i.

**b. Crop Acreage Trends, Statewide: Diversified Crops**

As shown in Figure 1 and repeated in Figure 2, diversified farming acreage increased from the mid-1960s to the late 1990s, but has been flat or has declined since that time. Part of the rapid growth in the early 1980s and the temporary bump in diversified-crop acreage in the late 1990s reflects the fact that some former sugarcane fields were newly planted with grasses for future cattle grazing. After cattle began grazing on this land, it was re-categorized from crop land to grazing land.

Macadamia nut acreage grew rapidly from the late 1970s to about 1986 when tax-shelter advantages were terminated. Most of the macadamia nut orchards are on the Big Island. Coffee acreage increased by about 4,600 acres from 1988 to 1991 because a portion of the McBryde Sugar Company lands on Kaua‘i were converted to coffee. For most of the major diversified crops—vegetables and melons, fruits, macadamia nuts, coffee, and “other” crops—acreage has grown little or has declined since the early 1990s. The major exception has
been seed crops: acreage has grown from about 850 acres in 1990 to about 6,630 acres in 2009, or an average growth of over 300 acres per year. Much of the seed acreage is on O‘ahu.

Figures 1 and 2 reveal that the growth of diversified-crop acreage has slowed over time even though ample land was available following the contraction of plantation agriculture. The slower growth is explained by the fact that the most promising opportunities for diversified farming were explored early. Also, Hawai‘i lost much of its agricultural expertise after the plantations closed.

c. Crop Acreage Trends, O‘ahu: All Crops

Figure 3 shows acreage trends for O‘ahu for all crops, plantation crops, and other crops. From 1960 to 2008, the amount of land in crop declined by 72,200 acres, from 83,200 acres in 1960 to 11,000 acres in 2008 (a decline of 87%). The decline since 1980—the year that corresponds to the planted acreage shown in Map 8—was 36,900 acres, from 47,900 acres in 1980 to 11,000 acres in 2008 (a 77% decline).

The downward trend up to the early 1990s was due to the contraction of the pineapple industry, the closure of Kahuku Plantation (sugar) and, for O‘ahu Sugar Company, volunteer fallowing of about 4,600 acres and some urbanization. *Mauka* fields in Waiawa and Kunia were fallowed because of high pumping cost, and fields near the ocean in ‘Ewa were fallowed due to poor soils, low yields, and long trucking distances to the mill. The slow decline in plantation agriculture was followed by the closures of O‘ahu Sugar Company in 1995, Waialua Sugar Company in 1996, and Del Monte in 2006. Also, Dole reduced pineapple acreage in recent years. Since 2005, pineapple acreage has not been shown separately in “Statistics of Hawai‘i Agriculture.”

As mentioned previously, the temporary bump in diversified-crop acreage that occurred in the late 1990s reflects the fact that some former sugarcane fields were planted with grasses for future cattle grazing, but were subsequently re-categorized as grazing land when cattle were placed on the land. Nevertheless, diversified cropland increased by about 3,700 acres from 1996 to 2000, largely as a result of the increased availability of farmland on O‘ahu.

Since 2006, the 3,900-acre increase in total cropland on O‘ahu is mostly due to the growth of seed crops. Some of this growth was new, but some reflects the relocation of production from Kaua‘i to O‘ahu due to seasonal disease problems on Kaua‘i.
d. **Crop Acreage Trends, Statewide, O‘ahu and Neighbor Islands: Selected Crops**

Figure 4 shows acreage in vegetable and melon crops for the state, O‘ahu and the Neighbor Islands. For O‘ahu, acreage increased significantly from 1994 to 1999, declined in 2000, then increased slowly until 2006. Some of the increase in acreage on O‘ahu occurred because production shifted from the Neighbor Islands due to the greater availability of land on O‘ahu following the contraction and closure of three plantations. After 2006, acres for vegetables and melons that are grown on O‘ahu and statewide are not shown because of non-disclosure requirements—acreages of vegetables and melons for some O‘ahu farms are now listed under Other Crops.

Figure 5 shows acreage in fruit crops other than pineapple for the state, O‘ahu and the Neighbor Islands. The large increase in acreage on O‘ahu in the late 1990s, followed by a decline, is partially due to large-scale papaya plantings on the North Shore on former sugarcane lands. As indicated by the subsequent decline, this endeavor was unprofitable. Nevertheless, acreage in fruit increased on O‘ahu by about 300 acres from 1995 to 2005. As with vegetables and melons, some of this O‘ahu increase occurred because production shifted from the Neighbor Islands due to the increased availability of land on O‘ahu.

e. **Water Use Trends, O‘ahu**

From 1980 to 2008, the amount of water used to irrigate crops on O‘ahu declined by about 208 mgd (about 88%), from 237 mgd in 1980 (excluding water reuse) to about 29 mgd in 2008 (Table 1, Section 1.b). For perspective, this decrease exceeds the 146.3 mgd of drinking water delivered by the Honolulu Board of Water Supply in 2008.

The substantial decline in water requirements is explained by (1) a 77% decline in the amount of land in crop, (2) diversified crops use less water than did sugarcane, and (3) for land that is farmed, more of it is fallowed between crops.

Compared to an acre in drip-irrigated sugarcane, seed corn uses about 12.5% as much water for land that is farmed and—depending upon the amount of fallowing—most other diversified crops use about 17% to 50% as much water. Compared to pineapple with 80% kept in crop, seed corn used about 63% as much water and—depending upon the amount of fallowing—diversified crops used about 83% to 2.5 times as much water as pineapple.

f. **Livestock Trends, O‘ahu**

Figures 6 and 7 show trends for O‘ahu livestock. Since 1980, there has been a dramatic decrease in the number of pigs, beef cattle (including calves), dairy cattle (including calves),
layer chickens, and non-layer chickens.

The sharp decline in the number of beef cattle in the early 1990s reflects the 1991 closure of the large feedlot at Campbell Industrial Park and the related slaughterhouse. Since 1995, the number of cattle on O‘ahu ranches has fluctuated around 5,000 head.

Regarding dairies, the last one on O‘ahu closed in 2008, although a small boutique dairy with 20 cows began operations in 2009. In the state as a whole, two large dairies remain on the Big Island, and a third is proposed.

The number of poultry farms on O‘ahu has declined to such a small number that, since 2005, data on their operations are no longer disclosed.

The decline in the number of livestock in Hawai‘i is due largely to the fact that importing meat, milk and eggs has become cheaper than importing feed. For cattle, about 7 pounds of grain are required to produce about 1 pound of meat.

g. Agricultural Employment Trends, Statewide, O‘ahu and Neighbor Islands

Figure 8 shows agricultural employment trends for the state, O‘ahu, and the Neighbor Islands for 1980 to 2008. The statewide figures also show plantation employment and diversified agricultural employment. Employment figures include wage jobs, self-employed farmers, and unpaid family farm workers. Gaps in the employment data after 2002 reflect the fact that the number of self-employed farmers and unpaid family farm workers were not reported.

For the 1981-to-2008 period, statewide agricultural employment changed as follows:

— Plantation employment declined by 6,550 jobs (86%), from 7,650 jobs in 1981 to 1,100 jobs in 2008.

— Diversified agricultural employment increased by 1,350 jobs (18%), from 7,950 jobs in 1981 to 9,300 jobs in 2008. Diversified agricultural employment has changed little since 2000.

— Total statewide agricultural employment declined by 5,200 jobs (33%), from 15,600 jobs in 1981 to 10,400 jobs in 2008. Total agricultural employment has changed little since 1995 because growth in diversified employment offset declines in plantation employment.

For the above period, the percentage decline in total statewide agricultural employment (33%) was much less than the decline in farm acreage (68% derived from Figure 1) because diversified agriculture, which increased in acreage, employs more workers per 100 acres than does plantation agriculture.
On O‘ahu, total agricultural employment declined from 3,925 jobs in 1982 to 2,700 jobs in 2002, for a net loss of 1,125 jobs (31%). The Neighbor Islands had a larger decline in the number of jobs, but a smaller percentage decline: from 11,275 jobs in 1982 to 8,300 jobs in 2002, for a net loss of 2,975 jobs (26%). From about 1995 to 2002, agricultural employment changed little for both O‘ahu and the Neighbor Islands.
5. FACTORS AFFECTING FARMING

Factors favoring and limiting agriculture in Hawai‘i are reviewed below, along with characteristics of successful crops.

a. Factors Favoring the Growth of Farming

O‘ahu has favorable conditions for growing many different types of crops. These favorable conditions include:

— A large supply of good farmland with favorable agronomic conditions (good soils, high solar radiation, flat or gentle slopes, a range of elevations and microclimates, etc.).
— A subtropical climate which allows many crops to be grown year-round, including during the winter months when most areas in the mainland U.S. become unproductive.
— An ample supply of water for irrigating crops and a developed distribution system, although repairs are needed.
— Good infrastructure (roads for transporting commodities to the large Honolulu market and to shipping and airline terminals for export, two harbors, an international airport, reliable power, etc.).
— Good support services (suppliers of farm equipment and services, education and extension service support from the University of Hawai‘i, research support from the University and from the Agricultural Research Center and other organizations, etc.).
— Fields that are a short trucking distance to the large Honolulu market and to shipping terminals.
— A labor force which includes farmers skilled in growing a wide variety of crops and animals (see Table 1), specialists (extension agents, water systems, equipment sales and maintenance, pest control), laborers, etc.
— A legal system which protects property rights and investments.
— Duty-free access to the large U.S. market.

b. Factors Limiting the Growth of Farming

Even though O‘ahu has favorable conditions for agriculture, there have been downward trends for many commodities due to changing economic conditions which caused many
agricultural operations to become unprofitable. Some diversified crops have grown in acreage but, with the exception of seed corn, this growth has been modest for most crops. Also, few crops can be grown profitably at a large scale that require more than a few hundred acres. The primary factors that have limited the growth of diversified agriculture on O‘ahu and throughout Hawai‘i are given below.

— Hawai‘i’s subtropical climate is not well-suited to the commercial production of major crops that grow better in temperate mainland climates (e.g., apples).

— For certain crops, special hybrids adapted to Hawai‘i’s subtropical climate are yet to be developed.

— Crop pests are more prevalent and more expensive to control in Hawai‘i than they are on the mainland where the cold winters kill many pests.

— Fruit-fly infestations prevent exports of many crops, or require expensive treatment.

— Most soils in Hawai‘i have low nutrient levels and therefore require high expenditures for fertilizer.

— Hawai‘i has high farm-labor costs, largely because the agriculture industry must compete against the visitor industry, construction industry, and other industries for workers (see below).

— Compared to many other farm areas that supply U.S. markets, the cost of shipping agricultural supplies and equipment to Hawai‘i is high, as is the cost of exporting produce from Hawai‘i to mainland markets. High shipping costs are a result of Hawai‘i’s remote location and Federal law that requires using American-built ships and U.S. crews between U.S. ports.

— For a number of crops, consumption volumes in Hawai‘i are too small to support large, efficient farms (that is, the volumes are too small to realize economies of scale).

— Grocery chains that purchase from large sellers who can consistently and cheaply provide a wide variety of foods that are certified as safe.

— Hawai‘i farmers must compete against highly efficient mainland and foreign farms which, in a number of cases, can deliver produce to Hawai‘i more cheaply than it can be produced locally. This is due to economies
of scale and, in comparison to Hawai‘i, low costs for land, labor, supplies, fertilizer, pest control, equipment, etc.

Regarding Hawai‘i’s farm wages, they reflect what most farms can pay while maintaining profitable operations in competition with overseas producers. Compared to farm wages of other countries that supply food to the U.S. and international markets, Hawai‘i’s farm wages are high as mentioned above. But compared to wages paid by other industries in Hawai‘i, Hawai‘i farm wages are low which makes it difficult to attract local farm labor (see Subsection 3.c). To address their labor requirements, a number of plantations and large farms have a long history of employing immigrant workers at wages that are regarded as low. However, these workers benefit in terms of higher wages than they would have earned in their native countries; many are provided a path to U.S. citizenship; and their children receive a quality education.

c. Characteristics of Successful Crops

For the local market, successful crops tend to be those that (1) grow well in the winter when produce prices tend to be higher; (2) have short shelf-lives and/or incur high handling and transportation costs from overseas, and (3) do not require economies of scale to be competitive.

For the export market, successful crops generally have some competitive advantage. Examples include:

— Sugar: high yields, corresponding low costs, duty-free access to the U.S. market, and Federal protection from low-cost imports.

— Pineapple: first to develop the canned, fresh, and fresh-chill markets.

— Macadamia nuts: first to develop the market, and tax shelter advantages (which ended in 1986).

— Coffee: high quality, branded niche markets.

— Seed corn: three crops per year and a favorable legal environment.

Some of these advantages lasted for many decades, but eventually were lost to competition. In the case of sugar, the competition came primarily from U.S. mainland producers of high-fructose corn syrup, and mainland producers of sugar from sugar beets. In the case of pineapple and macadamia nuts, the competition came from foreign producers.
6. **Availability of Farmland**

This section provides information on the supply of farmland available for additional crop production, the location of available lands, and limitations on crop production.

a. **Supply of Available Farmland**

   As discussed in Subsections 4.a and 4.c, and as shown in Figures 1 and 3, the contraction and closure of sugarcane and pineapple plantations since the 1960s resulted in a major decline in the amount of land in crop for both the state and O‘ahu. For the entire state, land in crop declined from about 327,500 acres in 1968 to about 81,500 acres in 2009, for a total loss of about 246,000 acres (75%). For O‘ahu, land in crop declined from about 83,200 acres in 1960 to about 11,000 acres in 2008, for a total loss of about 72,200 acres (88%).

   Although some of the land freed from farming has been urbanized and, on the Big Island and Kaua‘i, converted to commercial forest, most of it is now pasture land used for grazing cattle. For the entire state, the amount of good farmland that remains available for diversified farming is estimated at about 177,000 acres ±5,000 acres (2010 estimate).

   On O‘ahu, much of the land freed by the demise of plantations was replanted in diversified crops, including most of the land in Kunia, much of the land on the North Shore, and some land in Kahuku. However, considerable land remains available for crop farming—land that is now fallow or used for grazing cattle.

   As discussed in Subsection 2.k and shown in Map 2, O‘ahu has about 42,620 acres of high-quality farmland outside the City’s Community Growth Boundaries. This accounting excludes land that is under military control and is not available for farming (Lualualei, Schofield Barracks and Waipio Peninsula), and land near Kahuku that is scheduled to become a wildlife refuge. As mentioned above, about 11,000 acres on O‘ahu were in crop in 2008. With the recent expansion of the seed industry on O‘ahu following their purchases of land, the 2010 estimate for the total amount of land farmed on O‘ahu is about 12,000 acres. This estimate includes about 2,425 acres farmed in ‘Ewa and Central O‘ahu that are within the City’s Community Growth Boundaries (see Subsection 7.a), and about 9,575 acres outside the Growth Boundaries. Assuming that the farms within the Growth Boundaries eventually will relocate to land outside the Growth Boundaries, over 30,000 acres of good farmland on O‘ahu will remain available for growing additional crops (42,620 acres – 12,000 acres).
b. Locations of Available Farmland

The largest concentrations of good farmland that are not farmed are in upper Kunia, the North Shore, and Kahuku. Smaller amounts are scattered throughout windward O‘ahu and Wai‘anae. The available land in upper Kunia is former pineapple land, of which about 2,500 acres are arable. Including non-arable land, about 560 acres are owned by the State, and about 2,519 acres abutting Schofield Barracks are owned by an organization affiliated with the U.S. Army.

On the North Shore, about 19,000 acres were in sugarcane and pineapple in the mid-1990s, of which about 17,000 acres were irrigated. Currently, about 6,000 acres are used for diversified crops and 2,500 acres for pineapple, for a total of about 8,500 acres. Thus, about 8,500 acres of the irrigated land are now fallow or used for grazing cattle, and remain available for crop farming (17,000 acres, less 8,500 acres in crop). Most of the available fields on the North Shore are owned by Kamehameha Schools, including: (1) mid-elevation fields at Kawaiola (400 feet to 650 feet), (2) upper-elevation fields at Kawaiola (650 feet to 800 feet), and (3) mid-elevation fields at Waimea (400 feet to 600 feet). Available Dole lands include (1) about 1,500 acres of Helemano Ridge just north of Kamehameha Highway (elevations range from 20 to 1,160 feet), and (2) scattered fields. Another 2,000 acres are former pineapple lands near Lake Wilson, most of which are still owned by the George Galbraith Trust.

Near Kahuku, over 2,700 acres of former sugarcane lands mauka of Kamehameha Highway remain available for crop farming.

c. Potential for Increased Production from Existing Farms

The effective supply of available farmland also includes some land that is already farmed, but which can be farmed more intensely. For example, some major farmers on O‘ahu only keep about one-third of their land in crop, and fallow the remaining two-thirds. Also, Dole reports that they fallow a higher percentage of their pineapple fields than they did in the past. The large amount of fallowing reflects best farm practices when land is abundant and land rents are relatively low. Fallowing increases soil fertility and helps control unwanted volunteer plants, weeds, insects and disease. When demand for farmland is strong and rents are high in response to a strong demand for agricultural products, then more intensive farming of the land may be warranted even if this increases farmers’ costs for soil additives, pest control, etc.
For many crops, the potential for higher crop production from the existing land supply is substantial:

— Some vegetable and melon farms could increase yields by farming more of their land (over 50% instead of about 33%), and planting more crops per year (6 or more crops instead of 1 or 2).

— More land could be used for intercropping. For example, the seed companies grow their crops in patches to prevent cross-fertilization. Some of the remaining land is used to grow other short-term crops and, provided that there is no conflict with growing seed crops, intercropping could be increased.

— Trellises could be used to grow plants vertically to increase yields per acre.

— Green houses could be used to increase yields via better agronomic conditions (temperatures, nutrients, water, pest control, etc.).

— Hydroponics in greenhouses could increase yields even more. As explained in Subsection 10.j, the VertiCrop technology could increase per-acre yields about 20 times those of conventional field farming while using no high-quality farmland and about 5% as much water.

These and other approaches to increase crop production would be warranted if and when the demand for Hawai‘i crops increases substantially and, as a result, the land supply on O‘ahu and the Neighbor Islands becomes a limiting factor to production using existing approaches to farming.

d. **Limitations on Types of Crops**

Some of the available farmlands have limitations that preclude growing certain types of diversified crops. Some of these limitations are short term, but some are permanent. In particular, fields at the higher elevations in Kunia and on the North Shore have lower solar radiation compared to fields at lower elevations (see Map 5). While higher-elevation fields are suitable for certain crops, they are not suitable for crops that grow best at lower elevations—e.g., melons near sea level, and seed corn up to about 400 to 500 feet. Also, some fields at the higher elevations incur higher pumping costs for water.

On the North Shore, lower elevation fields are generally irrigated with groundwater, but many mid- and high-elevation fields are irrigated with water from the Wahiawa Irrigation System. As discussed in Subsection 2.g, various repairs and upgrades to the system may be needed in order to keep up with the demand for water.
Also, the types of crops on fields irrigated with water from this system will be restricted as long as partially-treated wastewater is discharged into Lake Wilson during heavy rainstorms. Water from the lake can be used to irrigate tree crops (e.g., papaya and coffee), and crops that are processed sufficiently to kill pathogens. But the water cannot be used to irrigate unprocessed leafy vegetable crops. As discussed in Subsection 2.g, upgrades to the Wahiawa Wastewater Treatment Plant are scheduled for 2011, after which partially treated wastewater will no longer be discharged into Lake Wilson, and the discharge will be rated R-1. Water with this rating can be used to irrigate any crop using any type of irrigation system.
7. **Potential Land Requirements for Crops**

This section provides information on the amount of farmland on O‘ahu required to relocate existing farms from areas scheduled for development, and the amount of land required to accommodate the future increase in crop farming.

**a. Farm Displacement and Relocation**

Planned and proposed urban development eventually will displace existing farms in ‘Ewa and Central O‘ahu. Major planned projects affecting existing farms include (1) the UH–West O‘ahu and (2) residential and commercial development by the Department of Hawaiian Home Lands. Both of these projects are in ‘Ewa. Major proposed projects that would affect existing farms include (1) Ho‘opili in ‘Ewa and (2) Koa Ridge Makai in Central O‘ahu. All four of these projects are located within the City’s Community Growth Boundaries.

The affected farms and the acreage that could be lost to development are:

- Aloun Farms (vegetables and melons): about 1,500 acres in ‘Ewa and 325 acres in Central O‘ahu
- Sugarland Farms (vegetables and melons): about 300 acres in ‘Ewa
- Syngenta (seed crops): about 200 acres in ‘Ewa
- Fat Law’s Farm (herbs and vegetables): about 100 acres in ‘Ewa

The decline in farming acreage in ‘Ewa will be gradual and could span decades. To offset the loss of 325 acres farmed at Koa Ridge, the developer (Castle & Cooke) worked with Dole to provide about 670 acres available on the North Shore near Whitmore Village—more than twice the amount of land needed to offset the land lost to Koa Ridge. While suitable for higher-elevation crops, the replacement land is too high for most of the low-elevation crops grown in ‘Ewa. Sugarland Farms, which is part of the largest group of related vegetable and melon farms in the state, has secured replacement land on the North Shore. Syngenta has secured replacement land in Kunia. And Fat Law’s Farm has secured sufficient replacement land in Kunia to achieve a four-fold expansion in production.

The only farm in need of additional replacement land due to future urbanization is Aloun Farms. To offset their losses in ‘Ewa, they would need about 1,500 acres of low-elevation land on the North Shore or in some other area on O‘ahu or the Neighbor Islands. As indicated earlier, unlike other major farms on O‘ahu, Aloun Farms chose to locate most of its farm within the City’s Community Growth Boundaries and, as a result, is more vulnerable to displacement.
Unrelated to past or future urban development, the seed companies Pioneer Hi-Bred, Monsanto, and Syngenta purchased land in lower Kunia from the James Campbell Estate in 2006, 2007 and 2008 respectively. The 2007 purchase by Monsanto displaced the lessee Syngenta, which then purchased replacement land in 2008. The purchases by Pioneer and Monsanto displaced over 400 acres farmed by Sugarland Farms.

b. Continuation of Trends

With one exception, recent trends suggest modest future growth in acreage for diversified crops statewide and on O‘ahu (see Subsections 4.b. to 4.d, and Figures 1 to 5). Since the early 1990s for the state and since the late 1990s for O‘ahu, there has been little growth and some decline in acreages for vegetables and melons, fruits, macadamia nuts, coffee, and “other” crops. During the mid-1990s, O‘ahu benefited when some Neighbor Islands production shifted to O‘ahu.

As previously noted, the major exception has been acreage for seed corn and other seed crops. Since 1990, statewide growth has averaged over 300 acres per year. Assuming continuation of this trend with about half the acreage on O‘ahu, land in seed crops could grow by about 3,000 acres on O‘ahu by 2030. However, two of the three major seed companies on O‘ahu report that their land requirements have stabilized or will grow slowly.

c. Crops to Replace Imports of Fresh Produce

In 2008, about 5,900 acres statewide were used to grow fruits other than pineapple, and about 5,500 acres were used for vegetables and melons (Table 1). Adding the current estimate of 3,500 acres for pineapple (which is now grown mostly for the local market), at most a total of about 15,000 acres statewide are used to supply Hawai‘i’s produce markets.

Corresponding figures for O‘ahu are about 900 acres for fruits other than pineapple, about 3,900 acres for vegetables and melons, and about 2,500 acres for pineapple, for a total of about 7,300 acres.

Statewide, Hawai‘i is 32% self-sufficient in fruits, and about 34% self-sufficient in vegetables and melons. This suggests that Hawai‘i could be self-sufficient in fresh fruits, vegetables and melons if it had about 30,000 additional acres in crop (3 x 15,000 acres less the existing 15,000 acres). Assuming no inter-island shipping, the corresponding figure for O‘ahu is about 23,000 additional acres needed for 100% self-sufficiency in fresh produce (3 x 15,000 acres x 67% of the state’s de facto population less the existing 7,300 acres). More intensive farming of the land than is currently the case would greatly reduce land require-
ments for self-sufficiency (see Subsections 6.c and 10.j). Utilizing capital-intensive farming approaches that provide far higher yields than current farming approaches in Hawai‘i, 100% self-sufficiency could be achieved for many crops with little or no increase in the amount of land farmed.

Realistically, Hawai‘i and O‘ahu farmers are competitive with only a subset of crops due to the factors discussed in Subsection 5.b. Even for crops that are grown profitably in Hawai‘i, market shares for Hawai‘i growers are limited by the following factors: (1) local varieties are not perfect substitutes for all imports (e.g., premium-priced sweet Maui onions versus inexpensive storage onions); (2) some crops cannot be produced profitably in the summer due to competition from low-cost imports of fruits and vegetables from California, other states, and Mexico; and (3) farmers must avoid over-production in order to maintain profitable price levels.

A major increase in acreage for crops grown for the local market would require a major change in economic conditions, such as a disruption in shipping that would limit or prevent both imports and exports.

d. Export Crops

The potential market for export crops is far larger than the Hawai‘i market. In 2009, the U.S. population was about 307 million, compared to Hawai‘i’s resident-plus-visitor population of less than 1.5 million. To take advantage of this large potential, Hawai‘i farmers and landowners have explored a great many export crops over many decades. Crop exploration was intense from the 1970s through the 1990s when plantation agriculture was phasing out. The plantations possessed considerable agricultural resources, including individuals with expertise in growing crops, abundant land, ample irrigation water, ample farm labor, farm equipment, etc. The objective was to find one or more replacement crops to take advantage of the resources available at the time and maintain a healthy economy.

In terms of acreage, the greatest success occurred with macadamia nut orchards on the Big Island in the late 1970s and early 1980s, coffee on Kaua‘i in the late 1980s, and seed corn since the early 1990s. The success with macadamia nuts was driven largely by market development by C. Brewer and by tax-shelter advantages which ended in 1986. In 1987, A&B planted about 4,850 acres in coffee on Kaua‘i, which was subsequently reduced to about 3,100 acres due to orchard losses caused by Hurricane ‘Iniki in 1992. The operation has reported losses in most years. Flowers and nursery products showed promise in the past, but acreage has declined in recent years due to competition from lower-cost foreign producers.
The only export-crop category that continues to show significant growth is seed crops. But as previously mentioned, two of the three major seed companies on O‘ahu report that their land requirements have stabilized or will grow slowly. The seed companies are very large multi-national firms which choose Hawai‘i to conduct much of their research because the year-round growing conditions allow three crops per year instead of just one as in most other areas, and Hawai‘i and the U.S. provide a supportive legal environment. The seeds derived from research in Hawai‘i are distributed throughout the world, and contribute to feeding billions of people. In Hawai‘i, the seed operations generally are the highest bidders for land, labor and other agricultural resources on O‘ahu, Kaua‘i, Moloka‘i and Maui. On O‘ahu, they own a few thousand acres in Kunia, and own or lease a few thousand acres on the North Shore.

Over the next 20+ years, explorations of export markets by Hawai‘i farmers may lead to one or more additional crops becoming a major export crop(s). However, the above history of agricultural efforts in Hawai‘i reveals that the successful development of major new export crops requiring large amounts of land is difficult and infrequent. For example, the intense explorations of export crops over the past 40 years in Hawai‘i resulted in just one diversified crop that requires more than 10,000 acres (macadamia nuts at 17,000 acres in 2008); two additional crops that require more than 5,000 acres (coffee at 7,800 acres and seed crops at 5,990 acres); and only one additional crop category that requires more than 1,000 acres (flowers/nursery products at 3,240 acres).

Most export crops that require an extensive amount of land are located on the Neighbor Islands because of (1) cheaper farmland than on O‘ahu, and (2) the common shipping rate charge by Matson, regardless of the island.

e. Feed Crops

If feed crops could be grown in Hawai‘i and priced competitively against mainland imports, they could replace some of the grains and hay that are now being imported to the state. Also, the production of local feed could stimulate livestock production in Hawai‘i. Unfortunately, a number of commercial attempts to grow feed in Hawai‘i have been unsuccessful. For example, in the 1980s corn was grown near Kahuku to supply feed to Meadow Gold Dairy near Hale‘iwa, but the venture was unprofitable. After Waialua Sugar Company closed in 1996, Dole planted grass for hay on 1,000 acres, planted feed corn and sorghum on another 800 acres, and had plans to plant alfalfa on 1,000 to 1,500 acres in Mokulē‘ia, lower Kemo‘o, and fields near the old mill. All were unprofitable.
The major problems have been (1) pests, particularly birds that eat the grains before they are harvested; (2) humidity that is too high to dry hay properly; and (3) high production costs when compared to mainland farms.

In spite of the past difficulties, attempts to grow feed crops on O‘ahu and the Neighbor Islands have continued, but with limited commercial success. For example, on the Big Island, Island Dairy has begun growing corn to feed its cow. Although similar to the Kahuku feed-corn operations, its chances for success are higher because Big Island land rents are lower than on O‘ahu, and mainland feed prices have increased in recent years.

f. Biofuel Crops

Biomass to Fuel a Boiler

Crops can be grown to produce biomass to fuel a boiler or as feedstock to produce fuels. Regarding biomass to fuel a boiler, the common practice in Hawai‘i has been to produce biomass as a byproduct of some principal crop. For example, at HC&S on Maui, the sugarcane by-product bagasse is burned to help fuel its power plant. With the closure of all the Hawai‘i sugar plantations but one, the amount of electrical energy produced from bagasse has plunged.

Biomass as Feedstock for Fuel, Existing Technologies

Regarding biomass as a feedstock to produce fuels, sugarcane, corn, or sorghum can be grown to produce ethanol. In turn, the ethanol is used to produce E-10 gasohol (90% gasoline and 10% ethanol). Also, algae, palm oil, soybean, sunflower, kukui nut, avocado, coconut, neem, and other crops can be grown to produce biodiesel fuel.

Since the late 1990s, a number of organizations have explored and some have proposed biofuel plantations and ethanol plants in Hawai‘i. These explorations are in response to high energy prices, anticipated oil shortages and even higher prices, Federal and State subsidies, and a State mandate to use non-oil energy sources. To comply with the mandate, ethanol currently is imported in order to produce gasohol. In spite of these incentives, no major biofuel plantations or ethanol plants have been developed in Hawai‘i. Difficulties in developing one or more biofuel plantations on O‘ahu using existing technology include the following:

— Land

On O‘ahu, the available fields are scattered, so assembling the land for a new plantation could be difficult. Also, it could be difficult to lease
the large amount of land required for a biofuel plantation at low lease rents for the 30 or so years required to capitalize the investment. Over time, other farmers and other users of land are likely to make higher offers to landowners to lease or purchase much of the available land. In view of this potential for landowners, the current market value of available farmlands is likely to be higher if landowners do not commit long-term to rents that are low enough to be affordable to a biofuel plantation.

— Capital

Substantial investment capital will be required to cover the cost of improvements and equipment such as: a mill to extract the juice from a biofuel crop; a generating plant to provide power; improvements and upgrades to irrigation systems; trucks and equipment to harvest and haul harvested plants to the mill, and to haul the extracted juice to an ethanol plant or the vegetable oil to a refinery, etc.

— Short-term Profitability

Annual revenues from selling the ethanol plus direct State and Federal subsidies are estimated by the consultant at about $3,600 per acre (based on an estimated 1,200 gallons per acre per year of ethanol at about $3 per gallon). Even with the government subsidies, these revenues are low compared to the $15,000 per acre average from other crops on O‘ahu (Table 2, Section 2.c). Per-acre returns from biodiesel crops are even lower, with the exception of algae. As with many other crops in Hawai‘i, the cost of importing molasses or palm oil for feedstock, or importing ethanol may prove to be less expensive than growing a biofuel crop in Hawai‘i.

— Long-term Profitability

Over the long term, there is a risk that the combined Federal and State subsidies for ethanol could be reduced, thereby compromising the profitability of a biofuel crop. Furthermore, emerging technologies show promise of cheaper sources of feedstock for ethanol and biodiesel fuels than does growing a biofuel crop on a plantation (see the following paragraphs).

The above difficulties and risks suggest that the probability of successfully developing and sustaining a biofuel plantation on O‘ahu using existing technology is low.
Cellulosic Sources of Feedstock

Two new biofuel approaches show promise over the long-term, neither of which would require a large supply of good farmland and water. The first, would be to produce ethanol from sugar derived from “cellulosic” sources instead of from conventional sources like molasses, sugarcane, grains, fruits, etc. Sugar that is locked in the complex carbohydrates of plants would be separated into fermentable sugars using new technology that is in the early stages of commercialization. Feedstock could include the large supply of yard clippings and agricultural waste that are already collected by the City, private waste-disposal companies, the military, and farmers, then hauled to ‘Ewa for composting by Hawaiian Earth Products (Menahune MAGIC).

This new technology promises much higher ethanol yields per ton of biomass because the entire plant can be used as feedstock. Also, using green waste would eliminate the need for a biofuel plantation to grow the feedstock. There would be no cost for land, water, labor, fertilizer, farm equipment, etc. Also, the biofuel operator would not have to pay to have the feedstock hauled to the conversion plant since the hauling costs would be paid by others. Finally, the operator could receive a tipping fee to dispose of the green waste.

This new technology is being explored by various companies throughout the world, including companies in Hawai‘i.

Algae as Feedstock

The second promising approach for biofuel would be to produce biodiesel from algae. One of the advantages of algae is its high yield of vegetable oil (about 5,000 gallons to 15,000 gallons per acre per year), and the corresponding high returns per acre. Also, good farmland is not required since algae is grown in open or covered ponds. The water source can include wastewater, brackish water, or even seawater. High yields are achieved in areas having (1) high solar radiation, (2) access to a source of nutrients, and (3) access to carbon dioxide to stimulate growth.

For a small operation, a possible location on O‘ahu could be within the Kalaeloa Community Development District (the former Barbers Point Naval Air Station), which would take advantage of the high solar radiation in ‘Ewa, use wastewater from the Honouliuli Wastewater Treatment plant, and use carbon dioxide from power plants and refineries in Campbell Industrial Park. However, O‘ahu would be a poor location for a large-scale operation involving thousands or even tens of thousands of acres to replace much or all of Hawai‘i’s liquid fuels. The reason for this is that O‘ahu does not have an abundant supply of
inexpensive non-farmland in leeward coastal areas—that is, areas having high solar radiation and access to abundant supplies of inexpensive seawater and/or wastewater. A better location might be in West Hawai‘i on lands having high solar radiation, but which are poorly located for urban development and are unsuitable for farming due to the poor soils (primarily lava).

Various organizations throughout the world are exploring the possibility of using algae to produce biofuels. In Hawai‘i, Royal Dutch Shell, Alexander and Baldwin, Hawaiian Electric Company, and other companies are involved with various research and demonstration ventures on O‘ahu, Maui, and the Big Island.

g. Aquaculture

Aquaculture expanded significantly on O‘ahu in the 1970s, especially in the Kahuku area following the closure of Kahuku Plantation Co. in 1971. However, land-based aquaculture on O‘ahu has not grown significantly in recent decades. Aquaponics (hydroponics utilizing fish to provide nutrients) has grown, but the amount of land needed is small and good farmland is not required. Most large-scale aquaculture in recent years has been open-ocean cage aquaculture which requires no land rent and no water costs. Land for support operations can be located in industrial parks. Algae as a potential feedstock for biofuel is addressed in the previous subsection.

Regarding the existing aquaculture operations in Kahuku, the U.S. Fish and Wildlife Service has acquired land to expand the James Campbell National Wildlife Refuge, and has approval to acquire more land, including 314 acres of nearby land currently being used for aquaculture. By 2023, the leases for these operations will expire, at which time the aquaculture operations must vacate the property. These operations are unlikely to relocate elsewhere on O‘ahu because of the high cost of renting or buying suitable coastal land, high development costs (most of the ponds were acquired at discounted prices following bankruptcies of former companies) and—for fresh-water aquaculture—very high water requirements (about 27,000 gallons per acre per day).

In about 2024, the anticipated employment loss will be about 110 jobs, including about 70 direct jobs and about 40 indirect jobs.

h. Commercial Forests

Although commercial timber is not categorized as a crop, it can be grown on farmland as well as on grazing land. On the Big Island, Prudential Timber has more than 20,000 acres planted in eucalyptus trees on former sugarcane and ranch lands. The timber is to be used for
veneer, paper pulp, and as a biofuel. On Kaua‘i, Hawaiian Mahogany grows eucalyptus and albizia trees for high-end furniture and landscape timber. Commercial forests are located in high-rainfall areas where irrigation is not required.

A commercial forest requires a major investment and a long-term commitment (25 years or more) before significant returns are realized. It is also a risky investment given the uncertainty about future lumber prices and potential losses to fire. Over time, projected returns from forests are greater than returns from grazing, but less than returns from crop farming. A commercial forest is best suited as an alternative to grazing when there is a high probability that the land will not be needed for a higher-value use (such as crop farming) for a period of 25 years or more.

On O‘ahu, commercial forests may be appropriate as windbreaks which would provide supplemental income to crop farming. Also, small stands of high-value timber species such as koa may be appropriate in the foothills on non-irrigated lands. However, large commercial forests are more appropriate for the Big Island where far more land is available and a commitment has already been made to develop a timber industry.

i. **Support Facilities**

Farms also need land for support facilities, including parking areas for trucks and equipment, cooling facilities, packing plants, processing facilities, offices, etc. However, the amount of land required for support facilities is usually a small percentage of a farm, and processing facilities are often located in industrial areas. Because the land requirements are small, they are not estimated in this report.

j. **Future Demand for Farmland versus Supply**

As discussed in Subsection 6.a, after farms in ‘Ewa and Central O‘ahu eventually are relocated to accommodate planned urbanization, over 30,000 acres of good farmland outside of the City’s Community Growth Boundaries will remain available for cultivating additional crops.

Assuming that the necessary water improvements are made, this supply of good farmland appears to be more than sufficient to accommodate demand in the foreseeable future. Continuation of past crop acreage trends suggests only modest growth for most crops over the next 20 or so years, with the exception of seed crops which could grow by a few thousand acres on O‘ahu. Also, the land supply appears more than sufficient to accommo-
date realistic increases in (1) self-sufficiency (i.e., import substitution of fresh fruits, vegetables and melons), and (2) new export crops. As discussed above, development of large feed-crop farms, biofuel plantations, and commercial forests are not anticipated on O‘ahu.

The supply of farmland does not appear to be the limiting factor to the growth of agriculture. Instead, the limiting factor is the size of the market that can be supplied profitably by Hawai‘i farmers.
8. Cattle Industry

Information on the Oahu cattle industry is provided below.

a. Cattle Grazing and Its Contributions

As mentioned previously, O‘ahu has about 122,927 acres in the State Agricultural District, of which about 11,000 acres were farmed in 2008. Much of the remaining land is used for grazing about 5,000 head of cattle—a figure which has changed little since the feed lot at Campbell Industrial Park closed in the early 1990s (see Figure 6).

Compared to other agricultural activities, cattle grazing is a low-value use of land. Depending on rainfall and the resulting growth of grass for feed, about 3 to 10 acres are required to support a cow-and-calf unit. Gross revenues generally are about $400 per calf, or about $60 per acre per year assuming a yield of 75% of the number of cows and 5 acres per unit. The industry standard for rents is $30 per year per cow-and-calf unit although, in practice, rents can be higher or lower. Assuming a carrying capacity of 5 acres per unit, the rent would be about $6 per acre per year. More than a 1,000 acres may be required to provide employment for a single cowboy.

Even with very low rents or even no rents, grazing provides value to the landowner in terms of (1) reduced fire hazards because the grass is kept short, (2) land management to help prevent trespassing and illegal dumping, and (3) reduced property taxes (see Subsection 10.k). Grazing is also an appropriate use of farmland until the land is needed for farming (i.e., land banking). For the rancher, cattle grazing provides employment, income, and an attractive lifestyle. For the community, ranching preserves undeveloped open space.

b. Finishing, Slaughtering and Processing Operations

Cattle ranches in Hawai‘i are cow-and-calf operations wherein most of the weaned calves are shipped to the mainland at about 6 months of age where they are finished, slaughtered, and processed. However, some animals are finished on range grass, then slaughtered locally at about age 2. Hawai‘i slaughterhouses are small, low-volume operations that process surplus and inferior animals, but also serve specialized clientele who may prefer locally grown range-fed beef. O‘ahu’s last slaughterhouse closed in 2008.

Having cattle operations in Hawai‘i and exporting the calves to the mainland can be explained by a number of factors. In Hawai‘i, ranges are productive year around, while on the mainland, range productivity falls in the winter due to wet or snowy conditions, thereby
requiring semi-confined feeding, and higher costs for feed and labor. But it is less expensive to finish cattle in mainland feedlots because the feed is less expensive than it is in Hawai‘i. Also, importing meat to Hawai‘i is cheaper than importing feed inasmuch as about 7 pounds of grain are required to produce about 1 pound of meat.

Furthermore, slaughtering and processing costs are substantially lower on the mainland because of enormous economies of scale—just four companies account for nearly 90% of the industry. Also, by-products provide a significant return to mainland companies, while Hawaii companies incur additional costs to dispose of these same products. The economic advantage of processing on the mainland, less the cost of shipping a calf to the mainland, is about $200 ± $50 per animal.
9. **State and City Agricultural Policies**

State and City policies related to agricultural land are summarized below.

a. **Assured Availability of Agricultural Land and Water**

   The *Hawaii State Constitution*, the *Hawaii State Plan*, the *State Agriculture Functional Plan*, and the *General Plan of the City and County of Honolulu* call directly or implicitly for preserving the economic viability of plantation agriculture and promoting the growth of diversified crops. To accomplish this, an adequate supply of agriculturally suitable lands and water must be assured.

   With regard to plantation agriculture, the only plantation remaining on O‘ahu is Dole’s pineapple operation. However, at about 2,500 acres, it should now be considered a farm instead of a plantation.

   With regard to diversified crops, more than sufficient agricultural land remains available on O‘ahu and outside the Community Growth Boundaries to accommodate the anticipated growth of diversified farming. This is due to the enormous supply of agricultural land that is available following the contraction of plantation agriculture (see Figures 1 and 2).

b. **Conservation of Agricultural Lands**

   In addition to the above, State policies call for conserving and protecting prime agricultural lands, including protecting agricultural lands from urban development. These policies were written before the major contraction of plantation agriculture, and implicitly assume that profitable agricultural activities eventually will be available to utilize the available agricultural lands. This has proven to be a questionable assumption in view of the enormous amount of acreage released by the contraction of plantation agriculture, and the slow growth in the amount of land being utilized for diversified agriculture.

   Regardless of the policy to conserve and protect prime agricultural lands, discussions in the “Agriculture” portion of the *State Functional Plan* recognize that redesignation of lands from Agricultural to Urban should be allowed “…upon a demonstrated change in economic or social conditions, and where the requested redesignation will provide greater benefits to the general public than its retention in …agriculture;” that is, when an “overriding public interest exists.”
c. The City’s Urban and Agricultural Growth Policies

The City’s General Plan as well as the regional development plans and sustainable communities plans are intended to provide a balance on O‘ahu between urban development and preserving agricultural lands. A major component of the regional plans are Urban and Rural Community Growth Boundaries that limit future urban development, thereby protecting farmlands from development (see Map 2).

As envisioned in these plans, planned redevelopment to higher densities will be directed to the Primary Urban Center, and most new development will be directed to ‘Ewa and, to a lesser extent, to Central O‘ahu. The vision is for compact development at medium and high densities rather than scattered development at low densities.

Farm areas to be protected include Kunia, the North Shore, and other rural areas on O‘ahu—i.e., farm areas in Waimānalo, Wai‘anae, and Windward O‘ahu north of Kahalu‘u. As mentioned in Subsection 2.k, most of the farmlands in Kunia and the North Shore are among the best agricultural lands in Hawai‘i.

The plans allow for urban and suburban lifestyles in urban areas, while preserving rural lifestyles in outlying areas. As such, they are consistent with the slogan, “Keep the country country.”
10. AGRICULTURAL ISSUES

Discussed below are selected agricultural issues that could affect the supply or demand of agricultural land on O‘ahu.

a. Trade, Self-sufficiency and Food Security

Benefits of Specialization and Trade

As noted in Subsections 3.b and 3.c and Table 1, Hawai‘i’s agriculture is dominated by exports (about 85% of sales in 2008), while most of the food is imported (about 66% of the fresh fruits and vegetables consumed in Hawai‘i). In 2008, less than 15,000 acres statewide were used to supply food to Hawai‘i markets, or about 16% of the 91,500 acres farmed (see Subsection 7.c).

Such extensive trade in food and other agricultural products is possible because of (1) past and ongoing advances in transportation (faster and cheaper shipping, improved communication which allows for better coordination of supply and demand, refrigeration and packaging that extends the shelf-lives of produce, etc.); (2) free trade among states; and (3) international trade agreements that open markets for both exports and imports. Shipping costs are about 10 cents per pound for food imported from California, a fraction of which is for the cost of fuel.

The resulting lower shipping costs and open markets favor specialization and trade. For some farmers, growing crops in large volumes for many markets is often more profitable than growing in small volumes for a local market where farmers must compete with low-cost imports. Nevertheless, some Hawai‘i farmers compete in terms of quality and freshness by selling at premium prices in small volumes to local niche markets. Consumers benefit by having more choices, lower prices for most foods and, correspondingly, higher standards of living. Generally speaking, supermarkets supply variety, big-box stores supply food at lower costs, health food stores serve the high-quality niche markets, and farmers’ markets supply fresh produce at attractive prices albeit in settings that may be inconvenient to many shoppers.

Given the large release of farmland from plantation agriculture, land has not been a limiting factor for Hawai‘i agriculture for decades, nor is land expected to be a limiting factor in the foreseeable future. Consequently, the use of farmland for export crops has not and, for the foreseeable future, is not expected to affect significantly the amount of food produced in Hawai‘i for local consumption, or the prices of locally grown food.
Risks to Food Security

Even though trade benefits consumers, relying on imports creates a risk to Hawai‘i’s food security. An interruption in shipping services—for whatever reason—could result in difficulties in importing fresh fruits and vegetables, canned goods, fish, meats, milk, eggs, etc. At the same time, it would also be difficult for Hawaii to export crops, thereby freeing about 65,000 acres statewide (2010 estimate) for replanting to supply local markets. This is in addition to the 177,000 ±10,000 acres of farmland that is fallow or used for grazing cattle. If an interruption in shipping results from a catastrophic event, there would be little time to increase local food production, and food shortages could result. But if the interruption in shipping occurs slowly—possibly due to rising fuel costs—there would be time to replant.

Although increased self-sufficiency could increase food security related to a possible interruption in shipping, it could decrease food security in the event of widespread crop failures—such as that which occurred when Hurricane ‘Iniki devastated crops on Kaua‘i in 1992.

Economic Benefits of Increased Self-sufficiency

If increased food self-sufficiency were to occur then, instead of sending dollars out of state for imported foods, more money would be spent in Hawai‘i, thereby increasing jobs and incomes in Hawai‘i. Because of these economic benefits, increased self-sufficiency has been advocated by all State administrations for at least the past 50 years.

Using 2005 data, agricultural economists with the UH College of Tropical Agriculture and Human Resources estimated that increasing local production of fresh fruits and vegetables to 100% self-sufficiency would generate about $160 million in farm sales, and about 4,430 direct and indirect jobs (about 2,950 farm jobs and about 1,480 indirect jobs, assuming a 1.5 employment multiplier). Corresponding figures for livestock (beef, pork, eggs and milk), are about $420 million in farm sales, and about 10,200 direct and indirect jobs (about 6,380 farm jobs and about 3,820 indirect jobs, assuming a 1.6 employment multiplier). These numbers illustrate the potential economic benefits (but not costs) of increased food self-sufficiency. The UH analysis assumes that increased food self-sufficiency would not change food prices significantly, and it would not occur at the expense of agricultural exports which, as mentioned above, dominate Hawai‘i’s agriculture industry.

The authors of the UH study also note that “…even though Hawai‘i can conceivably grow anything that we consume, the quest to achieve 100% food self-sufficiency is impractical, unattainable and perhaps impossible, as it imposes too high a cost for society.” As a result, “…Hawai‘i will probably continue to import most of its food supply …”
The benefits of increased food self-sufficiency merit government support for farming in terms of farm education and training, extension services, State Ag parks, improvements to irrigation systems, marketing local produce, research, favorable taxes for farms and farming activities, etc. But large subsidies for agriculture could result in higher taxes, while restrictions on food imports (assuming that they would be legal) and/or onerous mandates to purchase local foods could result in higher food prices and less variety in foods if competition from low-cost imports were to be reduced. Also, any addition to agricultural employment due to increased food self-sufficiency could be offset by job losses elsewhere in the economy due to the diversion of resources and expenditures. Whether or not there would be a net benefit to Hawai‘i residents would depend upon the circumstances. The same arguments apply to biofuel crops.

Land for Increased Self-sufficiency and Food Security

From a land-use perspective, the issue of increased self-sufficiency/food security suggests the following question: To what extent should agricultural land be preserved in the event that it might be needed in the future to supply more food to the Hawai‘i market?

As discussed in Section 7.c, 100% self-sufficiency in fresh fruit and vegetables would require about 30,000 additional acres statewide (an increase from 15,000 acres to 45,000 acres). This figure for additional acreage is high in that (1) 100% self-sufficiency is unrealistic, and (2) more intensive farming than is currently the case would greatly reduce the amount of land required (see Subsection 6.c). Nevertheless, the additional land required is small compared to the estimated 177,000 acres ±10,000 acres of good farmland that is available statewide, plus the 65,000 acres (2010 estimate) that could come available if exporting crops is no longer feasible.

For O‘ahu, about 23,000 additional acres would be required for 100% self-sufficiency in fresh produce assuming no inter-island shipping. Again this estimate is high. This compares to over 30,000 acres of good farmland that is available on O‘ahu outside the Community Growth Boundaries, plus about 4,700 acres used for export and non-food crops that could become available if needed. Regarding possible Neighbor Island production to supply the Honolulu market, this is clearly viable as illustrated by Figures 4 and 5. Shipping costs to O‘ahu are partially offset by lower rents for farmland on the Neighbor Islands.

For the foreseeable future, both O‘ahu and the state appear to have sufficient farmland for (1) realistic (and unrealistic) levels of self-sufficiency in fresh produce crops, (2) export crops, and (3) realistic levels of animal feed crops and energy crops (see Section 7). Thus,
any additional land preserved for future food security—such as not urbanizing land within the City’s Community Growth Boundaries—might never be needed for this purpose.

b. Increased Beef Self-Sufficiency

Hawai‘i’s cattle industry is another example of specialization and trade. Calves are produced in Hawai‘i because of the year-round growing conditions for grasses; most calves are then shipped to the mainland where feed for finishing is cheaper; they are slaughtered and processed on the mainland because of the cost advantages provided by economies of scale; and meat is imported from the mainland to Hawai‘i.

Instead of exporting calves to the mainland and importing meat, more cattle could be finished and slaughtered in Hawai‘i (i.e., increased self-sufficiency). Significant changes would have to be made and challenges overcome in order for this approach to be more profitable in volume than the current practice. If the cattle are finished on rangeland grass then, assuming that the land is being grazed at its carrying capacity, the number of cows would have to be reduced by about a third since the calves would graze the land for an additional 1-1/2 years or so. If finished in a feedlot, then feed would have to be grown locally. As discussed in Subsection 7.e, many attempts to grow feed in Hawai‘i have been unsuccessful, although Island Dairy on the Big Island has begun growing corn to feed its cows. Also, Hawai‘i’s cattle industry is too small to achieve the economies of scale of mainland slaughterhouses. If a cost-competitive slaughterhouse could be built in Hawai‘i, the logical location would be on the Big Island, not on O‘ahu. The Big Island accounts for more than 75% of the beef cows in Hawai‘i, while O‘ahu has less than 3%. Also, shipping meat between islands is less expensive than shipping cattle.

c. Agricultural Subdivisions, Farm Use

Even though considerable farmland is available on O‘ahu, some small farmers report that they have problems finding affordable land to lease. This is especially true of farmers who want property where a farmhouse is allowed. Living on a farm is more convenient than commuting, and it provides security against theft and vandalism of crops and farm equipment.

Some of the available parcels on O‘ahu are over 1,000 acres, which is too much land for most small farmers. Landowners report that it is unprofitable to subdivide large parcels into small lots for lease to farmers who want to live in a house on the property. Typical agricultural rents received by the landowners are too low to finance the City requirements of paved
roads, underground water, electrical power, wastewater disposal, etc. However, for leased land, State law (Chapter 205, Section 4.5) exempts an agricultural subdivision from County subdivision standards provided that (1) the principal use of the land is for agriculture, (2) no temporary or permanent dwelling is built on the property, and (3) the term for the lease is the greater of 5 years or the property-tax agricultural dedication period. The resulting agricultural lot may have gravel roads, surface water pipes, and no electrical power.

A common alternative for subdividing agricultural land for farming is to license small, unsubdivided lots to farmers. The major difference between a lease and a license is that a lease can be mortgaged to obtain a farm loan, while a license cannot. Also, a farm dwelling would not be allowed.

On O‘ahu, a less common alternative for making land available to small farmers is condominium ownership of agricultural lots, possibly combined with cluster development of farm dwellings that would reduce the cost of providing roads, drinking water, electricity, waste disposal, etc.

Another alternative for subdividing agricultural land that is under consideration by the City is to develop rural infrastructure standards that would allow farm dwellings to be served by less expensive infrastructure, provided that controls are in place to ensure agricultural use of the property.

d. Agricultural Subdivisions, Residential Use

In addition to subdividing agricultural land for farming, occasionally agricultural lots on O‘ahu have been subdivided for large-lot homes. They conform to the zoning code provided that agricultural activity takes place on the property, even if the agricultural activity is minimal. Minimum lot sizes are 5 acres and 2 acres for land zoned AG-1 and AG-2, respectively. And, at most, 5,000 square feet of the lot can be used for a farm dwelling, garage, and other accessory structures. Farm dwellings, which are not clearly defined in the zoning code, can range from very small modest homes to very large expensive homes. Agricultural subdivisions with expensive homes are commonly referred to as gentleman farms or gentleman estates.

Even though limited agriculture may take place on these types of agricultural subdivisions, for the most part they are tantamount to scattered large-lot residential development outside the City’s Community Growth Boundaries. Such development is a concern because of the loss of good farmland, the impact on agricultural land prices, and the cost to government to provide infrastructure and services. Agricultural subdivisions for large-lot homes are
more common on the Neighbor Islands, but they can also be found on O‘ahu. Examples include Pūpūkea on the North Shore (a development that is at least 40 years old and which was rezoned Country in 1986), development along old Kalaniana‘ole Highway near Waimānalo, and Poamoho Estates on the North Shore.

On O‘ahu, agricultural subdivisions for large-lot homes are often considered and are occasionally proposed by landowners and developers because of the potential of high returns provided by development. While some potential projects would affect farming, others would not because (1) the land has poor soils that are unsuitable for growing crops, or (2) the project would amount to minor infill of an existing development where commercial farming may no longer take place.

The City opposes agricultural subdivisions for large-lot homes, especially those that would be located on high-quality farmland, or which would be far from existing communities. However, by law, an agricultural subdivision must be approved by the City if all standards are met, including an agricultural feasibility study and specified infrastructure.

Even though agricultural subdivision for large-lot homes are often considered, and the law requires approval if all standards are met, very few agricultural subdivisions have been developed on O‘ahu in recent years—either because approvals were not granted or, if they were granted, satisfying the City’s infrastructure requirements would have been too expensive. If the State Department of Agriculture informs the City that a developer’s agricultural feasibility study is acceptable then, in order to obtain subdivision approval, the City will require the developer to provide paved roads that are built to City standards, all utility connections, a source of drinking water, wastewater disposal, etc.\(^3\) Such infrastructure requirements, which exceed those of the Neighbor Islands, can be very expensive when shared among a small number of homes that are far from existing infrastructure.

The major exception to the above is Poamoho Estates. Located on the North Shore, this 85-acre subdivision was approved in the mid-1990s before the City became more strict with their agricultural subdivision requirements. This project is located on high-quality former sugarcane land, is far from other residential communities, and is surrounded by fields that are in diversified crops or are fallow. It has 15 lots averaging 5.7 acres. Poamoho Estates proceeded to actual development: the land was subdivided; infrastructure was built; lots were sold; and some homes have been built. Most of the lots are used for large homes, with varying amounts of farming on the remaining portions of the lots. The City has inspected the

3. Under existing subdivision rules, the City can allow an agricultural subdivision to have less expensive streets with grass shoulders instead of sidewalks, and overhead utilities lines instead of underground lines.
project and found that sufficient agricultural activity takes place to conform with the zoning code. The surrounding land is owned by Dole, but the land for Poamoho Estates was not Dole land as is commonly assumed.

e. Planned Urbanization of Agricultural Land

Urban development of high-quality agricultural land is a major concern. A common perception in Hawai‘i is that urban sprawl onto O‘ahu’s limited supply of farmland is rampant; developer proposals are nearly always granted; and there is little control of urban sprawl by the City or State.

In practice, however, nearly all developments on O‘ahu are within the City’s Community Growth Boundaries. Landowners and developers occasionally explore urban development of agricultural land outside the Growth Boundaries because urban uses provide far greater economic returns than does agriculture (e.g., rents of less than $300 per acre per year for large-scale farming versus over $300 per square yard per year for retail space). But urban development outside the Community Growth Boundaries is rarely proposed due to (1) the high costs associated with seeking development approvals from the State and City and (2) the low probability of obtaining development approvals for projects that do not conform to the City’s land-use plans. Costly items include community outreach, land surveys, land-use plans, a market study, engineering studies, a financial feasibility study, impact studies, petition filings, expert witness testimony, etc.

For over two decades, most urban development of agricultural land on O‘ahu has occurred in ‘Ewa consistent with the City’s plan to develop the Second City of Kapolei. This plan was first proposed in 1959 by Campbell Estate. It was debated intensely for decades along with other alternatives for urban development on the island; incorporated in the City’s 1977 General Plan; and ultimately, in 1994, the City proposed the Urban Community Growth Boundaries and adopted it by ordinance in 1997. The State has supported this plan by (1) redistricting land from the Agricultural District to the Urban District for a number of urban projects, including projects by the State; (2) developing the Villages of Kapolei in the late 1980s; (3) developing the UH–West O‘ahu campus; (4) providing land to the Department of Hawaiian Home Lands for their ongoing urban development in ‘Ewa; (5) building State offices in Kapolei; (6) building freeway interchanges, the Kualaka‘i Parkway (North-South Road), and additional lanes to widen Ft. Weaver Road; (7) increasing the State excise tax to help fund a rapid transit system to ‘Ewa; etc. Regarding density, most new residential projects in ‘Ewa and Central O‘ahu are comprised of small-lot, single-family homes mixed with multi-family homes. Most lots for single-family homes range from 3,500 to 5,000
square feet, or about half the size of lots in many older neighborhoods on Oʻahu. This development pattern reduces the amount of land required for new communities.

The option of developing coastal communities around the island, which would have preserved the good farmland in ‘Ewa and Central Oʻahu, was proposed in the 1964 County General Plan. Eventually, this option was rejected because of (1) strong community opposition (“Keep the country country.”), (2) the high infrastructure costs associated with scattered development, and (3) sufficient land in ‘Ewa and Central Oʻahu to accommodate projected growth. Over time, the opposition to urban development in rural communities has increased.

For many decades City policy has included redeveloping Honolulu’s urban core to higher densities so as to reduce the pressure to build on agricultural lands, and to reduce infrastructure costs. Nevertheless, City plans also favor developing ‘Ewa and Central Oʻahu because redevelopment in Honolulu is likely to accommodate only a portion of Oʻahu’s economic and population growth. For example, mainland studies show that transit-oriented development (TOD) meets only about 25% of the demand for new homes. Also, redevelopment can be costly because of the difficulty of assembling land; the cost of buying and disposing of buildings that still have value; relocating businesses and families; upgrading infrastructure to accommodate higher densities; building under constraints to minimize problems to neighbors; etc. Finally, many families strongly prefer single-family homes over multi-family homes. This demand is accommodated with small-lot single-family homes that reduce the amount of land needed for each home.

If the City or State were to change development plans to preserve the prime agricultural lands in ‘Ewa and Central Oʻahu that are within the Community Growth Boundaries—i.e. the lands that are planned for eventual development—then urban development to accommodate Oʻahu’s economic and population growth would be diverted to other parts of the island. This would eventually increase the economic pressure to redraw the Growth Boundaries to allow development of other lands on Oʻahu, such as on agricultural lands in Kunia, the North Shore, and in rural areas.

f. Reconfiguring and Relocating Farms

Ongoing, planned, and proposed urban development in ‘Ewa and proposed development in Central Oʻahu will continue to force affected farmers to gradually reduce the size of their farms, and eventually to relocate their operations (see Subsection 7.a). This transition could last 20 more years or longer as the lands are gradually urbanized. The affected farmers
leased the lands after plantations ceased operations, and after the City designated the lands for urban development. Because of the planned development, lease rents for farmland in ‘Ewa and Central O‘ahu are discounted from normal market rents.

Reconfiguring and relocating farms is common and appropriate when farmers lease land in the path of the planned urban expansion of a growing city. For diversified-crop farmers who supply nearby markets, locating their farms on the edge of town may be ideal for them because of the lower trucking costs. And until the lands are urbanized then—from the perspectives of farmers, landowners and the community—the best “temporary” use of these lands is often farming. This temporary use may last for decades. But when urbanization does occur, the farmers incur the expense and disruption of relocating their farms to other areas. This, however, is offset by the decades of below-market rents they paid for the temporary use of the land.

Because of the eventual displacement of farms in ‘Ewa and Central O‘ahu, landowners on the North Shore and elsewhere should anticipate that these farms could be relocating to their areas. This may require upgrades and repairs to the Wahiawa Irrigation System, possibly with government assistance (see Subsection 2.g). Also, the City will have to complete its scheduled upgrade of the Wahiawa Wastewater Treatment Plant so that its discharged water into Lake Wilson will be rated R-1 and can be used to irrigate vegetable and melon crops.

g. **Intensive Livestock Farms**

Intensive livestock farms (dairies, pig farms and poultry farms) require little land compared to crop farming or ranching. Even a dairy with 3,000 milking cows only requires about 50 acres. Also, the land does not have to be good farmland. Nevertheless, finding land on O‘ahu for intensive livestock operations can be a challenge because such farms generally are located in coastal areas. This is because the State Department of Health guidelines for livestock waste management favor locating livestock facilities and related waste systems *makai* of the Underground Injection Control Line—i.e., in coastal areas. The purpose of the guidelines is to reduce the risk of contaminating aquifers used for drinking water, which are located *mauka* of the line.

Locating intensive livestock farms on coastal land presents two problems to farmers. First, the land may be unaffordable for livestock operations, especially if it is composed of small parcels that allow farmhouses to be built on the lots, and the lots provide ocean views (i.e., competition with high-value residential use).
The second problem is that communities are located along many coastal areas of O‘ahu, and residents of these communities will complain if a nearby livestock operation emits odors, generates considerable noise, and is a source of flies. If a livestock operation is new to an area, the farmer will not be protected by Hawai‘i’s Right-to-Farm Act (see the following).

h. Nuisance Issues

Nuisances arising from agricultural operations can become an issue for both residents and farmers. Residents who live close to and downwind from agricultural operations may complain about noise, dust, chemical spraying, odors, etc.

The Hawai‘i Right-to-Farm Act gives farmers who were in operation before neighboring properties were developed the right to farm even if they cause a nuisance, provided that the farm activity does not threaten public health or safety. Nevertheless, farmers may have to change their operations in order to address complaints. Such changes may include building high berms and planting vegetation to screen their operations, providing a buffer of fallow fields near homes, restricting their hours of operation, restricting plowing and chemicals on windy days, etc. If a large residential community is nearby, farmers may suffer from increased theft and vandalism, or may have to pay for increased security. In some cases, fencing has increased yields by 25%.

For these reasons, farming and residential developments should be separated to the extent possible. But this may not always be possible.

Rural residents are generally more tolerant of nearby farming activities, accepting them as part of the ambiance of living in the country. But nuisance issues are more of a challenge for growing urban areas such as ‘Ewa. To reduce possible complaints, developers and sales agents commonly inform buyers of lots and homes that they will be living near operating farms. This point is highlighted in promotional brochures and spelled out in sales contracts. With such notice, new residents are more likely to tolerate nearby farm operations.

i. Agricultural Land Values and Rents

A concern that is sometimes expressed is whether the development of agricultural land in ‘Ewa and Central O‘ahu will cause a general increase in agricultural land values and/or rents which, in turn, could cause some farmers to be displaced because they are unable to afford the higher land costs.
Agricultural Land Values

On O‘ahu, the value of agricultural land largely reflects its development potential. If farmland is within the City’s Urban Community and Rural Growth Boundaries and development is likely to start within a few years, then the land value can exceed $50,000 per acre. But if the land is outside the Growth Boundaries and unlikely to be developed in the foreseeable future, then the value may be less than $20,000 per acre.

Development of the agricultural lands in ‘Ewa and Central O‘ahu that are within the Community Growth Boundaries reduces the development pressures on other farmlands on O‘ahu and delay their possible development. This would include the high-quality farmlands in Kunia and portions of the North Shore. Reduced development pressure on these farmlands should result in slightly lower agricultural land values than would otherwise be the case.

Agricultural Land Rents

Agricultural land rents are based on the supply and demand of land for farming, and on what farmers can afford to pay while still remaining profitable. Agricultural rents are not based on the value of the land. If they were, high rents would preclude farming in ‘Ewa. Yet, ‘Ewa farmlands are leased at rents that are affordable for farming.

Development in ‘Ewa and Central O‘ahu will decrease the supply of farmland on O‘ahu which, in turn, could cause farm rents to be bid up. Any increase in rents is expected to be small in view of (1) the acreage of the farms to be relocated (about 2,425 acres), and (2) the supply of good farmland that will remain available outside of the City’s Community Growth Boundaries after these farms are relocated (over 30,000 acres)—see Subsections 6.a and 7.a).

j. New Technologies

In 2010, the Launch Organization4 identified ten water-related innovative technologies that show great promise in making tangible progress and impacting society. Two of these technologies could affect the long-term requirements for farmland and irrigation water in Hawai‘i.

4. The mission of the Launch Organization is to identify, showcase and support innovative approaches to global challenges. Founder and water-resource partners include the National Aeronautics and Space Administration (NASA), Sandia National Laboratories, The Earth Institute of Columbia University, U. S. Agency for International Development (USAID), the U.S. Department of State, the Pacific Institute (research on development, environmental, and security issues), IDEO (a design and innovative consultancy), and NIKE (sportswear and equipment).
VertiCrop

Developed over several years by Valcent Americas, VertiCrop is a commercial system that combines vertically stacked hydroponics trays and a greenhouse to facilitate high-density production of vegetables and other suitable crops in a controlled environment. Plants are grown in multi-level trays 10 to 20-feet high. The trays are suspended from an overhead conveyor system which moves the plants to provide equal exposure to light and airflow. Also, the plants pass through a station which provides water and nutrients, and recaptures the run-off for recycling. Sophisticated controls provide optimum growth performance using correct misting; a correct mixture of nutrients; an accurate balancing of pH; and the appropriate amount of heat, light and water. Ultraviolet light and filter systems eliminate the necessity for herbicides and pesticides.

The VertiCrop system is reported to provide per-acre yields that are about 20 times those of conventional field farming but use about 5% as much water. Stacking the trays vertically allows for more efficient utilization of building space. Growing plants in a greenhouse allows for greater security and reduced theft of produce and equipment. Locating the greenhouse near an urban market reduces shipping costs and delivery times, and increases food security.

Since the plants are grown hydroponically, a VertiCrop greenhouse can be located in an industrial area or some other suitable place without having to use high-quality farmland, although agricultural land would be less expensive than industrial land. The greenhouse could even be located on the roof of a building, with the ground floor containing (1) agricultural support facilities (refrigerators, packing facilities, offices, retail space, etc.), and/or (2) facilities and activities unrelated to agriculture. (e.g., a big box store)

If the VertiCrop system is commercially successful, it will eventually reduce the amount of land and water required to grow vegetables and other suitable crops. Depending on the capital and operating costs, the VertiCrop system and other similar systems may not be competitive on O‘ahu until (and if) the demand for Hawai‘i crops increases substantially and, as a result, the land supply on O‘ahu and the Neighbor Islands becomes a limiting factor to production using more conventional approaches to farming.

Subsurface Vapor Transfer Irrigation System

In certain parts of O‘ahu and the Neighbor Islands irrigation water is unavailable or, in the future, may be unavailable, insufficient (possibly due to a prolonged drought), too expensive to develop or deliver, too brackish, or too polluted. One of the more promising
technologies for overcoming water shortages is the Dutyion Root Hydration System (dRHS), also known as the Subsurface Vapor Transfer Irrigation System. This system has been under development for more than a decade by the British company Design Technology & Irrigation Ltd. (DTI-r) in cooperation with DuPont.

The dRHS system delivers water vapor to plant roots via buried hoses made from a special material. The hoses—which are filled with brackish water, seawater, or wastewater under low pressure—allow water vapor but not salts to pass through the hose material to irrigate plants. No expensive desalination plant is required and, as a result, no high-pressure pumps or high-pressure pumping, no fine filtering, and no water purification are required. Once water is supplied to the holding tank, the only moving part is the water powered by gravity alone. And since the water is supplied continuously, there is no need for scheduled irrigation events. The farmer will have to flush the pipes occasionally to clean out salt crystals and dirt.

Advantages of the dRHS are its simplicity and the corresponding low capital and operating costs. The system has been proven by a number of field trials throughout the world and with many different types of crops.

If the system is commercially successful, it could eventually reduce the amount of potable groundwater and surface water required to cultivate many crops, and open up new areas for farming.

In addition to being recognized by Launch Organization in 2010, the dHRS system won the Global Water Technology Award in 2009. In late 2010, DTI-r granted a global exclusive license of its technology to DuPont, which is expected to speed the development and introduction of the technology.

k. Property Taxes

The 2010 property tax rate for agricultural land and buildings was $5.70 per $1,000 of assessed value. Buildings are assessed at their market values. The assessed value of the land depends on the agricultural use and the period of the agricultural dedication, if any. Assuming that the market value of the land is $20,000 per acre, then the assessed value of the land and the property taxes are as follows:

— Agricultural land, no dedication: $20,000 per acre assessed value (100% of market value), property taxes of $114 per acre per year.

— Crop land, 1-year dedication: $1,000 per acre assessed value (5% of market value), property taxes of $5.70 per acre per year.
— Crop land, 5-year dedication: $600 per acre assessed value (3% of market value), property taxes of $3.42 per acre per year.
— Crop land, 10-year dedication: $200 per acre assessed value (1% of market value), property taxes of $1.14 per acre per year.
— Pasture land, 1-year dedication or longer: $200 per acre assessed value (1% of market value), property taxes of $1.14 per acre per year.

As indicated, dedicating land for an agricultural use results in substantially reduced property taxes. Occasionally, governments reduce or waive property taxes in order to provide an incentive to property owners to use the land for something considered by the government to be desirable. In the case of dedicated agricultural lands, such incentives would be negligible since the property taxes are already very low.

Regarding capital-intensive farming approaches such as VertiCrop, the land could be dedicated for agriculture even if the zoning is industrial or commercial. For example, improved industrial land valued at $1.5 million per acre would be assessed at $15,000 (1%), assuming a 10-year agricultural dedication. Annual property taxes on the land would be $186 per acre based on an industrial tax rate of $12.40 per $1,000 of assessed value. However, for a property that has mixed use (such as a greenhouse on the roof of an industrial building that houses non-agricultural activities), the agricultural portion of a property may not qualify for an agricultural dedication. Also, a greenhouse or other agriculture-related building would not qualify for reduced property taxes. For example, a greenhouse valued at $1.5 million (e.g., 30,000 sq. ft. structure valued at $50 per sq. ft.) and located on industrial land would be subject to property taxes of about $18,600 per year for the building ($1.5 million x $12.40 per $1,000 of assessed value).

To foster fair competition between capital-intensive farming approaches and field farming, modifications to the property tax system may be warranted to (1) split the land value between agricultural and non-agricultural uses for land that is zoned industrial or commercial, (2) allow an agricultural dedication for the agricultural portion of the land, and (3) provide reduced property taxes for agricultural buildings and related improvements.
11. PRIMARY REFERENCES

City and County of Honolulu, Department of Planning and Permitting. “Development Plans” and “Sustainable Community Plans.”

These plans provide information on the City’s agricultural policies and the Community Growth Boundaries.

City and County of Honolulu, Department of Planning and Permitting. “General Plan of the City and County of Honolulu.” 1997.

This plans provides information on the City’s agricultural policies and where future economic and population growth should occur.


These reports provide information on the situation and outlook for agriculture on O‘ahu for the years shown.


This report provides information on the aquaculture operations that will be impacted by the expansion of the James Campbell National Wildlife Refuge.

Discussions with farmers, major landowners, agricultural extension agents, government officials, energy specialists, and others. 1980s to 2010.

These personal discussions provided information on the operations and plans of farms and landowners, portions of which were placed in the public domain through various reports and testimony.

Google Earth Pro. 2010.

Google Earth Pro provides recent satellite photos of farm areas, and facilitates acreage calculations.


This report provides soil ratings along with aerial photos of agricultural activity on O‘ahu in the early 1970s.


News articles provided information on farm and landowner operations and plans.

This book provides historic information on a number of subjects, including agricultural activity in Hawai‘i.


These annual documents are the primary source of detailed information on Hawai‘i agriculture.


This document provides State policies on agriculture.


This report provides economic multipliers that are used to estimate direct and indirect economic impacts.


These annual documents provide information on a number of subjects, including agricultural activity in Hawai‘i.

State of Hawai‘i, Hawai‘i Revised Statutes, Chapter 205.

This Chapter provides State laws for land-use districting, permitted uses within the agricultural districts, and policies related to Important Agricultural Lands.


The State Office of Planning provides a number of resource maps relevant to agriculture.


This document provides information on the State’s agricultural policies.

State of Hawai‘i. *Hawai‘i State Constitution*.

The State Constitution includes policies related to agriculture.

This census provides detailed information on farming and livestock operations in Hawai‘i in 2007, along with comparisons to 2002.


This report provides soil ratings along with aerial photos of agricultural activity in the early 1970s.
MAPS
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<td>Specialty Crops</td>
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<td>Sugarcane</td>
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<td>39,700</td>
<td>- acres in crop</td>
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<td>17,000</td>
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<tr>
<td>Coffee</td>
<td>1,900</td>
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<td>Pineapples</td>
<td>43,000</td>
<td>11,500</td>
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<td>3,240</td>
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<td>Floriculture and Nursery Products</td>
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<td>44%</td>
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<td>3,420</td>
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<td>Feed Crops</td>
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<td>dnd</td>
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<td>Herbs</td>
<td>dnd</td>
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<td>dnd</td>
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<td>dnd</td>
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<tr>
<td>Ginger Root</td>
<td>40</td>
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<td>50</td>
<td>dnd</td>
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<td>Other and Adjustment for dnd</td>
<td>4,203</td>
<td>1,026</td>
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<td>8,720</td>
<td>7,901</td>
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<td>Adj. for Vegetable and Melon Crops</td>
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<td></td>
<td></td>
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<td>Papayas</td>
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<td>1,380</td>
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<td>47%</td>
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<td>Avocados</td>
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<td>34%</td>
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<tr>
<td>Guavas</td>
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<td>dnd</td>
<td></td>
<td>180</td>
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<tr>
<td>Passion Fruit</td>
<td>75</td>
<td>dnd</td>
<td>dnd</td>
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<tr>
<td>Oranges</td>
<td>30</td>
<td>dnd</td>
<td>dnd</td>
<td></td>
<td>dnd</td>
<td>dnd</td>
<td></td>
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<tr>
<td>Tangerines</td>
<td>28</td>
<td>dnd</td>
<td>dnd</td>
<td></td>
<td>dnd</td>
<td>dnd</td>
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<tr>
<td>Other</td>
<td>1,062</td>
<td>dnd</td>
<td>dnd</td>
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<td>1,160</td>
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<td>Total Fruits</td>
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<td>5,900</td>
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<td>(Self-sufficiency includes pineapple)</td>
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<td>Vegetables and Melons</td>
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<tr>
<td>Potatoes, Sweet</td>
<td>100</td>
<td>45</td>
<td>83%</td>
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<td>470</td>
<td>dnd</td>
<td>harvested acres</td>
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<td>Cabbage, Head</td>
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<td>80%</td>
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<td>410</td>
<td>dnd</td>
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<tr>
<td>Corn, Sweet</td>
<td>250</td>
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<td>78%</td>
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<td>400</td>
<td>dnd</td>
<td></td>
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<tr>
<td>Taro</td>
<td>320</td>
<td>dnd</td>
<td>30%</td>
<td></td>
<td>390</td>
<td>dnd</td>
<td>acres in crop</td>
<td></td>
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<td>Cucumbers</td>
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<td>Romaine</td>
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<td>Total Vegetables and Melons</td>
<td>3,900</td>
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<td>306</td>
<td>29</td>
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### 1.c. LIVESTOCK

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<td>Chickens, Egg Production</td>
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<td>11,600</td>
<td>10.0%</td>
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<td>Hogs and Pigs</td>
<td>57,000</td>
<td>35,400</td>
<td>3.9%</td>
<td>13,000</td>
<td>9,400</td>
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<td>Honey and Beeswax</td>
<td>7,000</td>
<td>dnd</td>
<td>dnd</td>
<td>10,000</td>
<td>dnd</td>
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<td>9,200</td>
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<td>dnd</td>
<td>6,500</td>
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<td>Sheep and Lambs</td>
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Table 1. Crop Acreage, Livestock and Farms: 1980 and 2008
(Continued)

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<th>1980</th>
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<td>1d. Farms and Livestock Operations</td>
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<td>Farms</td>
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<tr>
<td>Sugarcane</td>
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<td>Pineapple (including specialty)</td>
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<td>Flowers and Nursery Products</td>
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<td>Fruits (excluding pineapple)</td>
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<td>Vegetables and Melons</td>
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<td>Taro</td>
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<td>Macadamia Nuts</td>
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<td>Other Operations Less Duplications</td>
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<td>(133)</td>
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<td>7,500</td>
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dna: data not available
dnd: data not disclosed

Sources
*Statistics of Hawaiian Agriculture.*
*Economic Impacts of Increasing Hawaii's Food Self-Sufficiency.*
## Table 2. Economic Contributions of Agriculture, Oahu: 2007 and 2008

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<td><strong>2.a. MARKET: POPULATION AND HOUSEHOLDS: 2008</strong></td>
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<tr>
<td>Residents</td>
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<td>Residents and Visitors (de facto population)</td>
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<tr>
<td>Households</td>
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<td><strong>2.b. FOOD EXPENDITURES: 2008</strong></td>
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<tr>
<td><strong>Per Household</strong></td>
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<td>In 2004-2005</td>
<td></td>
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<tr>
<td>All Foods</td>
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<td>Fruits and Vegetables</td>
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<td>In 2008</td>
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<td>All Foods</td>
<td>1.18 CPI Adjustment</td>
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<td>Fruits and Vegetables (fresh, frozen and canned)</td>
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<td><strong>Total Food Expenditures, Oahu</strong></td>
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<td>All Foods</td>
<td>$ 9,545 per household</td>
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<td><strong>2.c. SALES: 2008</strong></td>
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<td>Other (pineapple, coffee, mac nuts, taro and seeds)</td>
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<td>Cattle</td>
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<td>Other (milk, eggs and aquaculture)</td>
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<td><strong>Theft, Vandalism and Security</strong></td>
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<td>Share of Total Value of Farm and Livestock Production</td>
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<td><strong>Annual Revenues per Acre, Farms</strong></td>
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Table 2. Economic Contributions of Agriculture, Oahu: 2007 and 2008
(continued)

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<td>Total Ag Employees</td>
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<td>1,535</td>
<td>jobs</td>
</tr>
<tr>
<td>Self-employed and Unpaid Family Workers</td>
<td>68%</td>
<td>1,044</td>
<td>*</td>
</tr>
<tr>
<td>Total Farm Employment</td>
<td></td>
<td>2,579</td>
<td>jobs</td>
</tr>
<tr>
<td>Indirect Jobs</td>
<td>0.5 x direct jobs</td>
<td>1,290</td>
<td>*</td>
</tr>
<tr>
<td>Total Farm-related Employment</td>
<td></td>
<td>3,869</td>
<td>jobs</td>
</tr>
<tr>
<td>Share of Total Oahu Jobs (456,950 jobs)</td>
<td></td>
<td>0.8%</td>
<td></td>
</tr>
<tr>
<td>Farm Jobs per 100 Acres</td>
<td></td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>2.e. WAGES AND PAYROLL: 2007</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Wages</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Agriculture</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop Farming</td>
<td>DLIR</td>
<td>$ 25,192</td>
<td></td>
</tr>
<tr>
<td>Livestock</td>
<td>&quot;</td>
<td>$ 27,033</td>
<td></td>
</tr>
<tr>
<td>Support Activities</td>
<td>&quot;</td>
<td>$ 28,503</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>&quot;</td>
<td>$ 25,720</td>
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<tr>
<td>Indirect Workers</td>
<td>&quot;</td>
<td>$ 40,784</td>
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<tr>
<td>Payroll</td>
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<tr>
<td>Crop Farming</td>
<td></td>
<td>$ 30,759,432</td>
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<tr>
<td>Livestock</td>
<td></td>
<td>$ 4,217,148</td>
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</tr>
<tr>
<td>Support Activities</td>
<td></td>
<td>$ 4,503,474</td>
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</tr>
<tr>
<td>Total Payroll, Direct Jobs</td>
<td></td>
<td>$ 39,480,054</td>
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</tr>
<tr>
<td>Indirect Workers</td>
<td></td>
<td>$ 42,578,496</td>
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<tr>
<td>Total Payroll</td>
<td></td>
<td>$ 82,058,550</td>
<td></td>
</tr>
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Sources
"Statistics of Hawaiian Agriculture."
"Employment and Payrolls in Hawaii."
"The State of Hawaii Data Book."
Figure 1. Crop Acreage, Statewide: All Crops
Figure 2. Crop Acreage, Statewide: Diversified Crops
Fig. 3. Crop Acreage, Oahu: All Crops
Fig. 4. Crop Acreage, Statewide, Oahu and Neighbor Islands: Vegetables and Melons
Fig. 5. Crop Acreage, Statewide, Oahu and Neighbor Islands: Fruits (excluding pineapple)
Fig. 6. Cattle and Pigs, Oahu
Fig. 7. Chickens, Oahu

- Chickens, Egg Production
- Chickens, Other
Fig. 8. Agricultural Employment, Statewide, Oahu and Neighbor Islands
(including self-employed and unpaid family farm workers)