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Comparison of Cost Structure and Economic Performance of Hawai'i and U.S. Mainland Farms

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Introduction

Hawai'i's agricultural industry is in the midst of change and revitalization. Formerly a highly concentrated plantation economy dominated by sugarcane and pineapple, today it continues to shift production towards diversified agriculture for its local and export markets. With much of the food consumed in Hawai'i produced elsewhere, there is growing concern about the state's high dependency upon outside sources. While interest in local food production is growing, Hawai'i farmers face keen competition from imports abroad. Today the vast majority of the food consumed in the Islands is supplied by the U.S. Mainland, which is Hawai'i's chief source of competition.[1]

The goal of this publication is to compare the economic performance and cost structure of Hawai'i producers to those of U.S. Mainland producers. Direct comparison between these two regions is important because it will generate needed economic assessment of where Hawai'i stands in relation to its most important competitor. U.S. Mainland farms apply competitive pressure on Hawai'i farms through cheaper imported agricultural products. Even though transportation costs may provide a slight buffer of protection between Hawai'i farm-gate prices and U.S. Mainland farm-gate prices (Yu and Leung 2010, Parcon et al. 2010), intense import competition leads to squeezed profit margins for Hawai'i farms and potential contraction of local production.

For Hawai'i farmers who face imports from a much larger, cost-efficient agricultural producer, the competitive challenges are steep. Geographically isolated from sources of cheap labor, Hawai'i faces higher labor costs. High residential and commercial land values also lead to constraints on further expansion. Hawai'i farmers must compete against a more vibrant tourism sector, which offers significant competition for these inputs. Furthermore, Hawai'i's smaller farm scale (on average, less than half the size of the average U.S. Mainland farm) further aggravates these cost disadvantages.

Using aggregate data from the U.S. Census of Agriculture, we assess the differences between Hawai'i and U.S. Mainland farms for the census cohort years 2002 and 2007. By analyzing the data closely we attempt to assess its overall economic viability and the direction in which Hawai'i's agricultural production is heading. This publication is organized as follows: First it summarizes the primary differences between the average Hawai'i and U.S. farms. Then it evaluates their economic performances and then compares the cost structure in detail between Hawai'i and U.S. Mainland farms. Finally it offers a conclusion.

Summary Statistics

Table 1 presents agricultural production summary statistics for Hawai'i and U.S. Mainland[2] farms. In 2007, Hawai'i's agricultural sector produced over $500 million in sales (farm-gate value) by farming over 1 million acres of land. Several interesting facts are revealed: First, the summary statistics reflect noticeable size differences for

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Table 1: Hawai'i vs. U.S. Mainland Farms: Summary Statistics (2007)

	Hawai'i	U.S.
Number of Farms	7,521	2,204,792
Land		
Total Acres	1,121,329	922,095,840
Average Size of Farm (Acres)	149	418
Value of Production Sales		
Total Sales ($Thousand)	513,626	297,220,491
Sales per Farm	$68,290	$134,810
Sales per Acre	$458	$322
Sales per Asset	6%	17%
Farm Production Expenses		
Total Expenses ($Thousand)	486,648	241,113,666
Average Expenses per Farm	$64,710	$109,360
Estimated Market Value of Assets		
Total ($Thousand)	8,620,668	1,744,294,733
Average per Farm ($Thousand)	1,146	791
Average per Acre	$7,688	$1,892

Hawai'i farms in terms of acreage used for operations. The average farm in Hawai'i is 149 acres, 2–3 times smaller than the average U.S. Mainland farm.[3] Second, Hawai'i's average farm generates $68,000 worth of sales, approximately half the U.S. Mainland value. Lastly, despite the smaller size of farms, the average Hawai'i farm's asset value (including market value of land, buildings, and equipment) is far greater than the average U.S. Mainland farm's ($1.14 million vs. $0.79 million), largely owing to the higher value of agricultural real estate in Hawai'i.

Table 2 reports summary statistics by farm sector. We include the following subsectors in this analysis: vegetables/melon, fruit/tree nuts, nursery/floriculture/greenhouse, beef cattle, poultry/eggs, and animal aquaculture/other animals (a more detailed description of these sectors is provided in the appendix).[4] We notice that relative to the U.S. Mainland, Hawai'i has a higher proportion of fruit and vegetable farms. While fruit and vegetable farms make up over 55% of all Hawai'i farms, the figure is less than 6% for the U.S. Mainland.

Table 3 presents summary statistics by farm size. Farm size can be broken down according to total sales or total acreage used for production. Due to the varying quality of farmland, as well as the different levels of production intensity and the variety of commodities produced, the literature has generally favored defining farm size according to sales (Hoppe et al. 2010). Following this approach, we determine farm size by total sales generated from production, excluding government payments. We categorize farms according to their total sales as follows: very large commercial farms ($1,000,000 or more), large commercial farms ($250,000 to $999,999), small commercial farms ($10,000 to $249,999), and non-commercial farms (less than $10,000). Assessing the distribution of farms by sales size, we can see that the U.S. Mainland has a larger share of large commercial farms and a lower share of non-commercial and small farms.

Economic Performance: Hawai'i vs. U.S. Mainland

We first compare Hawai'i's economic performance to that of the U.S. Mainland in terms of various economic and financial measures. We calculate output–input ratio and return on asset (ROA) as efficiency measures.[5] Net profit per acre and gross profit per acre are calculated as profitability indicators.

Definitions of these four indicators are summarized below:

Output–input ratio: total sales / (variable cash expenditures + fixed cash expenditures + depreciation)

ROA: 100* (net profit + total interest paid) / (value of land and buildings + value of machinery and equipment)

Net profit/acre: (total sales – variable cash expenditures – fixed cash expenditures – depreciation) / farm acreage

Gross profit/acre: (total sales – variable cash expenditures) / farm acreage

Table 2: Summary Statistics by Farm Sector*, 2007

	% of Farms	% of Total Sales	Average Acreage per Farm
Total			
Hawai'i			149
U.S.			418
Vegetable, Melon (1112)**			
Hawai'i	8%	12%	26
U.S.	2%	5%	228
Fruit, Tree Nut (1113)			
Hawai'i	47%	30%	25
U.S.	4%	6%	124
Nursery, Floriculture, Greenhouse (1114)			
Hawai'i	19%	23%	43
U.S.	2%	6%	72
Beef Cattle (112111)			
Hawai'i	11%	9%	891
U.S.	30%	9%	573
Poultry, Egg (1123)			
Hawai'i	1%	1%	16
U.S.	3%	13%	109
Animal Aquaculture, Other Animals (1125, 1129)			
Hawai'i	5%	4%	63
U.S.	11%	2%	268

Notes. *Sector defined by North American Industry Classification System (NAICS) codes.
** NAICS codes.
Selected sectors cover 91% of total farms in Hawai'i and 53% of total farms in the U.S. These sectors produce 79% of Hawai'i total sales and 41% of U.S. total sales.

Variable cash expenditures include fertilizer, chemicals, seeds, breeding, feed, gasoline, utilities, repairs, paid labor, custom work, and other miscellaneous expenses. Fixed cash expenditures include rent expense for land, buildings, and machinery;[6] interest paid; and property taxes.

Output–input ratio indicates the level of sales a farm can yield from one dollar of expenditure. This indicator controls for the size effect by normalizing output according to its expenditure levels and is used as a measure of efficiency. As a separate indicator of economic efficiency we also use the ROA. The ROA indicates the dollar return the owner receives from each dollar of invested assets, which include the total market value of land, buildings, and equipment. As interest expenses are considered part of the costs of borrowing capital, these expenses are added back into net profits to calculate the total return (Hoppe and Banker 2010).

Net profit per acre accounts for the profit that accrues after covering for total expenses (including variable and fixed cash expenditures as well as depreciation). If net profits are negative, a farm may continue operating at a loss; however, long-term lack of profitability would likely lead to the farm's closure. We also include gross profit by calculating the difference between total sales and variable cash expenditures. Variable cash expenses reflect the sales required to operate in the short term. Commercial farms should only operate if they can meet their variable expenses; however, non-commercial farms driven by non-profit motives may wish to continue operating under short-run losses. Additionally, government subsidies may also support farms suffering losses.

The summary statistics in Table 1 reveal that Hawai'i farms are smaller, produce less output, and have a different level of engagement across agriculture subsectors. Such systematic differences confound strict economic comparisons between an average Hawai'i and an average U.S. farm. To compare the farms more appropriately, we analyze farms along two dimensions. First, we compare farms within the same subsector. Comparing relative performance across sectors allows some degree of differentiation between farm types, though there still remains a significant degree of variation within the sectors. For example, farms producing the same types of crops may be different in terms of

Table 3: Summary Statistics by Farm Size, 2007

	% of Farms	% of Total Sales	Average Acreage per Farm
Very Large Commercial ($1,000,000 or more)			
Hawai'i	1%	61%	5,053
U.S.	3%	58%	2,593
Large Commercial ($250,000 to $999,999)			
Hawai'i	2%	17%	1,610
U.S.	7%	26%	1,688
Small Commercial ($10,000 to $249,999)			
Hawai'i	31%	20%	139
U.S.	31%	15%	520
Noncommercial (Less than $10,000)			
Hawai'i	66%	3%	26
U.S.	60%	1%	126

productivity and size, while even within the same subsector farms produce a diverse variety of crops with different cost structures. To augment our performance analysis across subsectors, we also decompose farms according to farm size (in sales).

Economic Performance Across Agricultural Sectors

Table 4 presents how Hawai'i farms perform relative to the U.S. Mainland along our various economic performance measures by agricultural subsectors. For 2007, the overall output–input ratio for Hawai'i was relatively poor, generating on average less in sales than the value of their inputs.[7] Overall Hawai'i's farms' output–input ratio was approximately 17% lower than the U.S. Mainland. One dollar of farm inputs generated $0.96 worth of production, whereas the average U.S. Mainland farm generated $1.14. With the exception of animal aquaculture/other animal and vegetable/melon farms, Hawai'i's economic performance trails that of the U.S. Mainland, with the fruit/tree nut and poultry/egg sectors performing the furthest behind.

We also find that Hawai'i's ROA is significantly less than the U.S. Mainland's. For 2007, the ROA was 2.4% for the Mainland, while it was -0.1% for Hawai'i. The lower levels of returns found under this measure reflect both the under-performance of Hawai'i farms and the higher overall asset values in Hawai'i, especially of land. With the average Hawai'i farm's asset value (market value of land, buildings, and equipment) 4 times greater per acre than on the U.S. Mainland, Hawai'i farms' overall rates of return are significantly reduced for a given level of income.

Next we examine profitability measures. Hawai'i farms generally under-perform relative to U.S. Mainland farms. The average Hawai'i farm suffers a net loss of $20 per acre. This compares with a net profit of $40 per acre in the United States. With the exception of the vegetable/melon sector, all other Hawai'i farms have lower levels of net profit per acre than U.S. Mainland farms. Across sectors in Hawai'i, we find that only vegetable/melon and nursery/floriculture/greenhouse farms achieve positive net profits, while all other sectors suffer net losses. The relatively higher level of returns to the Hawai'i vegetable/melon farms may be partially explained by higher cultivation intensity of Hawai'i's farms and the year-round growing conditions that are possible in Hawai'i's environment.

Hawai'i's gross profit also under-performs U.S. Mainland gross profit. While most sectors on average are able to cover their short-term expenses, poultry/egg and animal aquaculture/other animals suffer short-run net losses. The continued operation of these farms suggests that many of the farms in these two sectors must either rely heavily on government payment support or are being driven by non-profit motives.

In Appendix 2, we also compare indicators over time. We found that over the past five years, Hawai'i's relative economic performance compared to that of the U.S. Mainland has worsened. Output–input efficiency, ROA, and net profit per acre for Hawai'i farms have been on the decline, while the U.S. Mainland's economic performance has been more stable across these years (see Appendix 2 for more details).

Table 4: Economic Performance of Hawai'i vs. U.S. Farms Across Sectors for Year 2007

	Total	Vegetable, Melon (1112) *	Fruit, Tree Nut (1113)	Nursery, Floriculture, Greenhouse (1114)	Beef Cattle (112111)	Poultry, Egg (1123)	Animal Aquaculture, Other Animals (1125, 1129)
Hawai'i							
Output–Input Ratio	0.96	1.30	0.99	1.19	0.88	0.83	0.87
Return on Asset	-0.1%	3.3%	0.1%	2.1%	-0.1%	-1.4%	-0.5%
Net Profit per Acre	-$17	$956	-$26	$313	-$8	-$925	-$137
Gross Profit per Acre	$67	$1,382	$330	$562	$11	-$409	-$13
U.S.							
Output–Input Ratio	1.14	1.30	1.18	1.29	0.90	1.24	0.66
Return on Asset	2.4%	7.5%	2.9%	9.7%	-0.3%	17.4%	-2.2%
Net Profit per Acre	$39	$371	$232	$954	-$8	$1,051	-$49
Gross Profit per Acre	$95	$588	$489	$1,376	$13	$1,331	-$13

Note. *NAICS codes.

Economic Performance by Farm Sale Size

Table 5 assesses economic performance measures according to different economic classes in terms of sales. Once again, Hawai'i farms are generally found to underperform U.S. Mainland farms in terms of efficiency and profitability. However, we find that after controlling for farm size, the level of under-performance is smaller than what was found in our sector level analysis. Very large Hawai'i commercial farms ($1,000,000 or more) still significantly under-perform Mainland farms by approximately 19% in terms of output–input efficiency. However, small to large commercial farms ($10,000–$1,000,000) are relatively comparable in performance to similar-sized U.S. Mainland farms. Output–input ratios and net profits are surprisingly very similar for these farms. While large U.S. Mainland commercial farms have an output–input ratio of 1.22, a comparable large-sized Hawai'i commercial farm on average trails closely behind, at 1.21. For net profit per acre, small to large commercial farms share an almost identical average return. Hawai'i's ROA still trails significantly behind that of U.S. Mainland farms, but this is partially explained by the high value of agricultural real estate. We can see that for both Hawai'i and U.S. Mainland, non-commercial farms significantly under-perform commercial farms.

The similar performance patterns found in Table 5 suggest that farm size is an important factor in explaining economic performance. Table 5 reveals that both Hawai'i and U.S. farms strongly exhibit economies of scale in agricultural production. The only exception is very large Hawai'i commercial farms ($1,000,000 or more), which under-perform Hawai'i large commercial farms ($250,000–$1,000,000) by approximately 16%. However, for all other size groups for both Hawai'i and U.S. farms, output–input ratio, ROA, and net profit all increase with increased farm sales. While the average Hawai'i small commercial farm produces approximately $1.01 for a dollar's worth of inputs, a large commercial farm generates approximately $1.21 worth of sales. We notice that non-commercial farms (less than $10,000) are particularly inefficient and unprofitable. These farms suffer heavy net losses and operate under very poor efficiency both in Hawai'i and on the Mainland.

The data's confirmation of economies of scale is critical because of the significant size disadvantages of Hawai'i farms. In 2007, fewer than 4% of Hawai'i farms

generated over $250K, whereas for the U.S. Mainland, $250K+ farms accounted for more than 9% of all farms. Small farms tend to have disadvantages in input costs, marketing, and transportation costs, and they are unable to take advantage of potential technologies that may lead to improved efficiency. With Hawai'i farms averaging less than half the size of U.S. Mainland farms, the lack of economies of scale may contribute to relative under-performance in aggregate productivity and profitability. Lack of economies of scale may also explain some of the under-performance found in the cross-sector comparison of Hawai'i and U.S. farms.

Hawai'i vs. U.S. Mainland Cost Structure

Our economic performance analysis reveals that Hawai'i farms under-perform relative to U.S. Mainland farms. We now analyze the underlying cost structure and attempt to detect any evidence of Hawai'i factor cost disadvantages.

Higher Labor and Energy Costs but Lower Levels of Other Purchased Input Expenditures

We first compare Hawai'i and the U.S. Mainland's cost structure by examining input expenditures and net profits as a percentage share of total sales. We aggregate input expenditures into the following four factors:

Paid labor: Expense for hired labor[8] and contract labor
Utilities, gasoline: Expense for utilities, gasoline
Purchased inputs: Expense for fertilizers, chemicals, seeds, livestock, feed
Others: Expense for supplies and custom work, rent for land & buildings, rent for machinery and equipment, interest expense, property taxes, all other expenses, and depreciation

The percentage shares indicate how much factor expense is necessary to produce one dollar of sales. For farms that suffer net losses, the total expenditure shares will be larger than 100% of sales. Table 6 presents the cost structure by the selected agriculture subsectors. The table reveals that labor is the largest factor input for Hawai'i farms and its overall share is significantly higher than U.S. Mainland farms in the same sector. While the average Hawai'i farm requires hired farm labor inputs amounting to approximately 38% of total sales,[9] for the U.S. Mainland the level is considerably less, at 9%. Since

Table 5: Economic Performance of Hawai'i vs. U.S. Farms by Sale Size for Year 2007

	Very Large Commercial $1,000,000 or more	Large Commercial $250,000 to $999,999	Small Commercial $10,000 to $249,999	Non-Commercial Less than $10,000
Hawai'i				
Output–Input Ratio	1.03	1.21	1.01	0.23
Return on Asset	0.8%	1.9%	0.2%	-1.1%
Net Profit per Acre	$20	$52	$3	-$332
Gross Profit per Acre	$131	$92	$74	-$190
U.S.				
Output–Input Ratio	1.24	1.22	1.02	0.18
Return on Asset	10.4%	3.5%	0.5%	-2.2%
Net Profit per Acre	$234	$53	$2	-$73
Gross Profit per Acre	$359	$112	$38	-$38

the labor expenses used in our analysis only include the reported paid expenses and do not fully account for unpaid labor and/or management, total labor expenses are underestimated. In Appendix 3 we estimate unpaid operator labor expenses and find higher levels of required labor input for both Hawai'i and U.S. Mainland farms.

Purchased inputs comprise a relatively smaller share of Hawai'i's factor expenditures. While purchased inputs expenditures is approximately 17% of the average Hawai'i farm, the level of expenditures is significantly larger for the U.S. Mainland farm, which averages about 43%. Across all sectors, we find that Hawai'i farms on average expend less on purchased inputs to produce a dollar of sales. The lower cost share of purchased inputs suggests its smaller role in overall production costs for Hawai'i farms. In contrast, Hawai'i farms face significantly higher energy costs. While the average U.S. Mainland farm requires a utilities/gasoline expenditure equal to approximately 6% of sales, Hawai'i farms expend 10%.[10]

Table 7 reports input expenditures and net profit as a percentage of sales by economic size. The table once again confirms that labor comprises a significantly higher

Table 6: Percent of Input Expenditures, Net Profit to Total Sales Across Sectors for Year 2007

	Paid Labor	Utilities, Gasoline	Purchased Inputs	Others	Net Profit
Total					
Hawai'i	38%	10%	18%	38%	-4%
U.S.	9%	6%	43%	30%	12%
Vegetable, Melon (1112)*					
Hawai'i	32%	8%	14%	23%	23%
U.S.	21%	7%	22%	28%	23%
Fruit, Tree Nut (1113)					
Hawai'i	39%	9%	13%	41%	-1%
U.S.	30%	7%	14%	34%	15%
Nursery, Floriculture, Greenhouse (1114)					
Hawai'i	34%	6%	17%	27%	16%
U.S.	29%	6%	16%	25%	22%
Beef Cattle (112111)					
Hawai'i	18%	9%	31%	56%	-14%
U.S.	6%	9%	52%	44%	-12%
Poultry, Egg (1123)					
Hawai'i	20%	5%	81%	15%	-21%
U.S.	3%	3%	61%	14%	20%
Animal Aquaculture, Other Animals (1125, 1129)					
Hawai'i	49%	16%	15%	36%	-16%
U.S.	19%	14%	46%	72%	-51%

Note. *NAICS codes

Table 7: Percent of Input Expenditures, Net Profit to Total Sales by Sales Size for Year 2007

	Paid Labor	Utilities, Gasoline	Purchased Inputs	Others	Net Profit
Very Large Commercial ($1,000,000 or more)					
Hawai'i	40%	8%	16%	34%	3%
U.S.	10%	4%	46%	20%	19%
Large Commercial ($250,000 to $999,999)					
Hawai'i	31%	7%	16%	28%	17%
U.S.	7%	7%	36%	32%	18%
Small Commercial ($10,000 to $249,999)					
Hawai'i	29%	12%	20%	39%	1%
U.S.	7%	10%	35%	46%	2%
Non-Commercial (Less than $10,000)					
Hawai'i	88%	52%	76%	216%	-332%
U.S.	30%	56%	121%	330%	-451%

level of expense for Hawai'i farms compared to U.S. farms, while purchased inputs comprise a relatively lower level. The large differences in labor costs are partially driven by the greater percentage of labor-intensive fruit/tree nut and vegetable/melon farms in Hawai'i. Similar to the results found in our economic performance analysis, we can see that the level of net profit as a percentage of total output is increasing in economic size.

The finding of lower shares of purchased inputs for Hawai'i farms is rather surprising, given that most of these inputs are imported from abroad and require additional transportation costs. Indeed, Hawai'i farmers have voiced concerns over the cost disadvantages of imported inputs. The lower levels of expenditures found in our analysis could be attributed to lower input intensity required to produce a dollar of sales for the crop mix in Hawai'i. Due to transportation costs passed on to products, quality differences, or possible preferences for local produce, Hawai'i farmers generally receive higher farm-gate prices. Given higher prices, a farm would require less farm input usage in order to generate $1 worth of agricultural sales. Nonetheless, the fact that we did not detect any evidence of higher levels of expenditures on inputs in similar-sized farms, nor through the expenditures shares across industries, suggests that the potentially higher costs for imported inputs may not have significantly disadvantaged Hawai'i farms. Furthermore, any cost disadvantage due to these input expenditures would be dwarfed by labor cost disadvantages.

Labor Costs Analysis

The previous section reveals that labor expenditure is both the most significant factor cost and accounts for a dramatically larger share of costs for Hawai'i farms relative to the U.S. Mainland. As mentioned, the higher level of labor expenditure could be attributed to Hawai'i farms producing more labor-intensive crops. For example, Hawai'i's lack of wheat and other large mechanized farms, and its relatively higher level of truck farms, would reflect different labor intensity patterns. To see

whether Hawai‘i farm’s higher labor expenditures are due to higher labor costs or more labor-intensive farm operations, we compare labor wage rates and labor-capital ratios.

Table 8 shows effective wage levels, which are calculated by dividing the total hired labor expenses by the number of full-time-equivalent[11] hired workers. Unlike standard wage rate measures, these numbers reflect direct wage payment as well as health, benefit, and transaction costs. We find that Hawai‘i wages are significantly higher, paying on average over 43% more for similar levels of labor work-time. With the exception of the nursery/floriculture/greenhouse sector, the wage premium exists across all farms sectors. Hawai‘i’s higher labor costs are not surprising, given the state’s lack of access to cheaper migrant workers.

Overall Hawai‘i farms have a higher number of workers per dollar of capital, as well as higher levels of labor expense. Analyzing labor–capital ratios, we can also assess how Hawai‘i farms compare in relative usage of labor inputs in real labor input rather than nominal labor expenses. Hawai‘i farms on average employ 3.2 workers per $100,000 worth of machinery and equipment compared to U.S. Mainland farms, which average 1.1 workers per $100,000 worth of machinery and equipment.[12] These higher labor intensity ratios may be driven by Hawai‘i’s greater share of labor-intensive fruit/tree nut farms. Controlling for sector differences, we find that the labor–capital ratios are generally lower across the majority of Hawai‘i’s agricultural sectors. In all sectors but beef cattle and animal aquaculture/other animals, Hawai‘i has a lower labor–capital ratio. The vegetable/melon and fruit/tree nut farms in particular are significantly less labor intensive than the U.S. Mainland farms, while their labor expense/machinery expenses are more similar in magnitude.

In theory, high labor costs should provide incentives for farms to substitute capital for labor or encourage the adoption of technology that may require less labor inputs. We find that Hawai‘i’s vegetable/melon and fruit/tree nut employ approximately 64% and 42% the amount of workers per $100,000 worth of equipment compared to U.S. Mainland farms, suggesting that some farms may be substituting labor for capital. Nevertheless, we also find that in the beef, poultry, and animal aquaculture sectors, Hawai‘i farms are relatively more labor intensive despite the higher wages they pay. Thus, the data suggests there may be some operational difficulties in substituting the high costs of labor for capital.

The above comparisons together substantiate evidence that Hawai‘i’s farmers face significant cost disadvantages in labor. The labor–capital ratios suggest that higher wages and not labor intensity are driving the higher labor expenditures found in major agricultural sectors in Hawai‘i. This can be most clearly seen in the vegetable/melon sector, where we find that even with lower labor intensity, Hawai‘i farms have a higher overall labor expense. Hawai‘i farms pay higher wages and expend a significantly higher share of total expense on labor across the majority of the state’s agricultural sectors. Since labor is the chief factor input, our analysis confirms it is the primary source of cost disadvantage for Hawai‘i farms.

Land Value and Rental Expense Analysis

High land cost is often seen as a significant constraint on Hawai‘i’s agricultural development. In Hawai‘i, approximately 50% of the total acres farmed are owned by the farm operator, with the remaining half operated on rented property. To assess this issue in detail, Figure 1 breaks down land value and rental rate per acre across different farm sizes in terms of acreage. The data reveals that the value of Hawai‘i agricultural real estate is significantly higher than for U.S. Mainland farms across all farm sizes. The differences between land rental rates are much smaller. We find that while Hawai‘i’s rental rates are significantly higher for smaller-sized farms with 1–9 acres ($375/acre vs. $256/acre for U.S. Mainland), for larger-sized farms with 2,000-plus acres they are actually lower ($22/acre vs. $28/acre). Averaging across all rented agricultural land, the rental rates for Hawai‘i and U.S. are approximately the same: $37.4/acre for Hawai‘i vs. $37.3 acre for the U.S. Mainland (note that this is the result of the much larger share of land that is rented by the 1,000-plus-acreage farms). Not counting the smaller-sized farms, the similar land rental rates found for Hawai‘i are rather surprising, given the significantly higher value ascribed.[13] It suggests that land may not be a significant cost constraint for Hawai‘i farmers. However, if cheap rental rates are not accessible to new farmers or

Table 8: Estimated Annual Wage, Labor–Capital Ratio Across Sectors for Year 2007

	Estimated Annual Wage per Paid Worker	Labor–Capital Ratio	
		Number of Paid Workers/ Machinery	Labor Expense/ Machinery
Total			
Hawai'i	$19,685	3.2	0.63
U.S.	$12,333	1.1	0.14
Vegetable, Melon (1112)*			
Hawai'i	$22,052	2.9	0.63
U.S.	$12,917	4.5	0.59
Fruit, Tree Nut (1113)			
Hawai'i	$16,426	3.7	0.61
U.S.	$9,216	8.9	0.82
Nursery, Floriculture, Greenhouse (1114)			
Hawai'i	$14,512	4.7	0.68
U.S.	$17,668	6.2	1.09
Beef Cattle (112111)			
Hawai'i	$19,785	0.9	0.17
U.S.	$6,967	0.6	0.04
Poultry, Egg (1123)			
Hawai'i	$20,552	1.2	0.25
U.S.	$15,824	1.2	0.18
Animal Aquaculture, Other Animals (1125, 1129)			
Hawai'i	$27,614	1.9	0.51
U.S.	$11,658	0.9	0.11

Notes. *NAICS codes
Estimated annual wage per hired worker = labor expense for hired labor/number of hired farm laborers
Number of paid labor = number of hired farm laborers (adjusted) + contract laborers
We derived the number of contract labor by "expense for contract labor/estimated annual wage per hired worker."
Labor expense = expense for hired labor and contract labor in $100,000
Machinery = value of machinery and equipment in $100,000

others wishing to expand, the costs may not comprehensively reflect the relative differences.

Discussion

Comparing Hawai'i farms and U.S. Mainland farms, our analysis revealed several significant findings. First, the analysis revealed that Hawai'i farms under-performed U.S. Mainland farms in terms of output–input efficiency, ROA, net profit per acre, and gross profit per acre. Assessing farms across both sectors and economic size, we found that Hawai'i farms trailed behind comparable U.S. Mainland farms. The superior economic performance found in larger farms in both Hawai'i and the U.S. Mainland suggests that Hawai'i's size disadvantages may serve as an impediment to competing with U.S. Mainland farms.

Second, we detected noticeable differences in cost structure between the average Hawai'i and U.S. Mainland farm. Hawai'i farms incur a significantly higher level of expenditures on labor, primarily due to higher wage rates, on average 43% higher than the U.S. Mainland. Hawai'i's labor–capital ratios (controlling for sector differences) were found to be slightly lower in magnitude than U.S. Mainland farms, suggesting that Hawai'i farms may be substituting higher-cost labor inputs for other factors. However, these substitutions appear to be minimal, insofar as Hawai'i farms were found to have significantly larger labor expense-to-machinery ratios, indicating the severe constraint high labor cost has on Hawai'i agricultural production.

While energy and utility expenditures were found to be higher, expenditures on other farm inputs were found to be fairly comparable with U.S. Mainland farms. This suggests that the additional transportation cost required for these predominantly imported farm inputs does not have a significant impact on farm profitability. Lastly, we found that land rental expenses on average were not significantly different than the U.S. Mainland's.

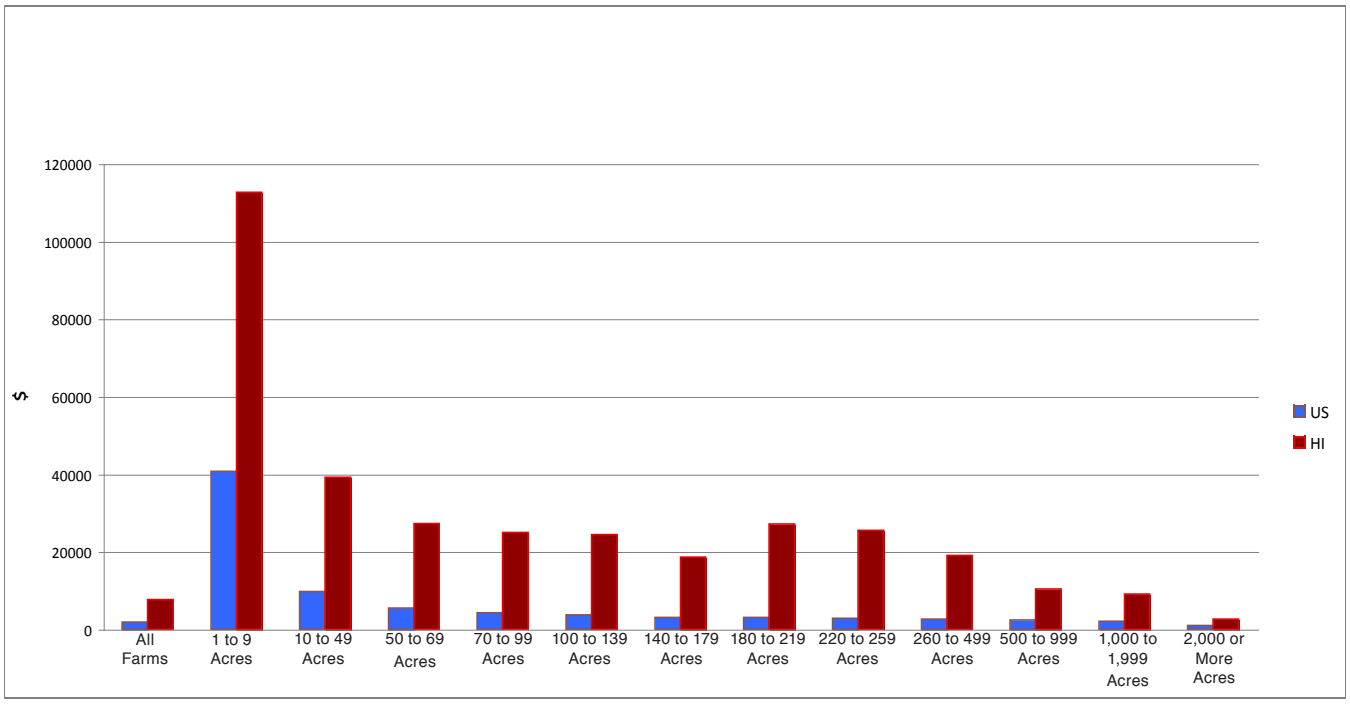
Can Hawai'i Farms Be Economically Viable?

Overall the levels of under-performance are primarily attributed to the higher labor costs faced by Hawai'i farms or the difficulty in exploiting economies of scale. These cost disadvantages suggest that Hawai'i's farmers

may be challenged in sectors where they face high import competition. The future of Hawai'i's agricultural industry may depend upon focusing on the subsectors with high import costs. Products characterized by low value per shipping weight and high perishability (Parcon et al. 2010) may be more promising sectors to compete in. One such sector is the vegetable/melon sector. Compared to other sectors, we found that Hawai'i's vegetable/melon farms performed relatively strongly, operating at a similar output–input efficiency as the U.S. Mainland. Over the last decade, while all other sectors seem to be trailing further behind the U.S. Mainland, the vegetable sector has improved its relative performance. Nonetheless, high labor costs can still place substantial cost pressure on this sector's competitiveness.

Considering the difficulties of competing in the global markets, the future of Hawai'i's agricultural sector may depend on cultivating the demand preferences of local consumers. Food localization has been receiving a great deal of attention from consumers, farmers, and policymakers. Economic viability in Hawai'i may depend on the ability to cultivate the preferences for local foods through increased education and marketing campaigns. Some of these efforts are already underway. The state's Hawai'i Department of Agriculture (HDOA) actively promotes farmers' markets with its "Buy Fresh, Buy Local" call-to-action program and its "Seal of Quality" program, which is designed to raise awareness of the benefits of locally grown foods. Hawai'i Regional Cuisine, a culinary coalition of the Islands' top chefs, supports local farmers by increasing demand for locally produced foods in higher-end markets. Increased partnerships with Hawai'i chefs may not only increase demand for local foods directly but may also foster further marketing benefits in shaping local foods as higher-quality products. Lastly, grassroots non-profit community groups have also been involved in promoting food localization through educational outreach and technical support. These efforts could improve the future viability of Hawai'i's agricultural production.

Figure 1a. Agricultural Real Estate Value per Acre in $ by Land Size for 2007

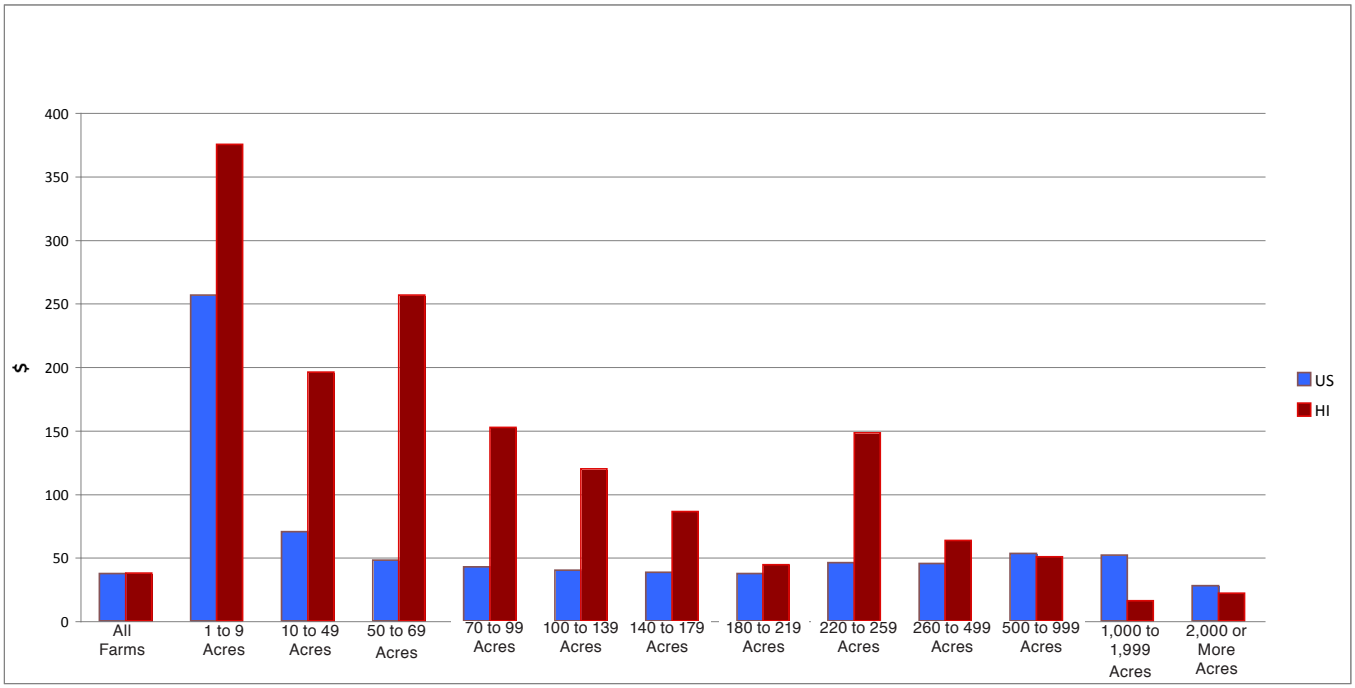


Appendix 1: Description of Agricultural Sectors

- *Vegetable, Melon (11121):* Comprised of establishments primarily engaged in one or more of the following: (1) growing vegetables and/or melon crops, (2) producing vegetable and melon seeds, and (3) growing vegetable and/or melon bedding plants.
- *Fruit, Tree Nut (1113):* Comprised of establishments primarily engaged in growing fruit and/or tree nut crops. These crops are generally not grown from seeds and have a perennial life cycle.
- *Nursery, Floriculture, Greenhouse (1114)*: Comprised of establishments primarily engaged in growing crops of any kind under cover and/or growing nursery stock and flowers. ''Under cover'' is generally defined as in greenhouses, cold frames, cloth houses, and lath houses. Crops grown are removed at various stages of maturity and may have annual or perennial life cycles. The category includes short-rotation woody crops and Christmas trees with a growing and harvesting cycle of 10 years or less.
- *Beef Cattle (112111):* Comprised of establishments primarily engaged in raising cattle (including cattle for dairy herd replacements).
- *Poultry and Egg (1123):* Comprised of establishments primarily engaged in breeding, hatching, and raising poultry for meat or egg production.
- *Animal Aquaculture, Other Animals (1125):* Comprised of establishments primarily engaged in the farm raising of finfish or shellfish, or any other kind of animal aquaculture. These establishments use some form of intervention in the rearing process to enhance production, such as holding in captivity, regular stocking, feeding, and protecting from predators.

Note: Source: National Agricultural Statistics Service, 2007 Census of Agriculture; NAICS codes in parentheses.

Figure 1b. Rent per Acre in $ by Land Size for 2007



Notes. Agricultural real estate value per acre = value of land and buildings/farm acreage
Rent per acre = rent expense for land and buildings/farm acreage

Appendix 2: Economic Performance Across Time

Comparing our 2007 economic performance indicators to the 2002 census data, we can observe how Hawai'i's efficiency and profitability have changed over time. We find that output–input efficiency, ROA, and net profit per acre for Hawai'i farms have been on the decline. While Hawai'i farms suffered negative net profits in 2007, they averaged a small net gain in 2002, with an ROA of 1.9% and a net profit per acre of $37. We see that these declining levels of performance are found across the majority of the sectors. The vegetable/melon sector is one of the few exceptions, where output–input efficiency and net profits improved.

Hawai'i's overall declining trend contrasts with the U.S. Mainland's economic performance, which has been more stable over time. While the average U.S. Mainland ROA declined from 2.9% to 2.4%, output–input ratio and net profit/acre both grew. Thus over the past five years, Hawai'i's relative economic performance compared to the U.S. Mainland has worsened.

Appendix 3: Inclusion of Unpaid Operator Labor

In the Census of Agriculture data, some farmers include operator input as part of hired labor expenses, while others leave this input unreported. Since the labor ex-

Appendix Table 2a: Economic Performance Over Time Across Sectors

	Year	Total	Vegetable, Melon (1112)*	Fruit, Tree Nut (1113)	Nursery, Floriculture, Greenhouse (1114)	Beef Cattle (112111)	Poultry, Egg (1123)	Animal Aquaculture, Other Animals (1125, 1129)
Hawai'i								
Output–Input Ratio	2002	1.10	1.24	1.16	1.46	0.69	1.00	0.93
	2007	0.96	1.30	0.99	1.19	0.88	0.83	0.87
Return on Asset	2002	1.9%	5.2%	3.1%	6.8%	-0.5%	0.8%	0.0%
	2007	-0.1%	3.3%	0.1%	2.1%	-0.1%	-1.4%	-0.5%
Net Profit per Acre	2002	$37	$770	$275	D	D	-$76	-$57
	2007	-$17	$956	-$26	$313	-$8	-$925	-$137
Gross Profit per Acre	2002	$93	$1,354	$522	D	D	$1,316	$58
	2007	$67	$1,382	$330	$562	$11	-$409	-$13
U.S.								
Output–Input Ratio	2002	1.06	1.34	1.16	1.35	0.88	1.32	0.68
	2007	1.14	1.30	1.18	1.29	0.90	1.24	0.66
Return on Asset	2002	2.9%	12.3%	4.9%	15.5%	0.4%	28.2%	-1.2%
	2007	2.4%	7.5%	2.9%	9.7%	-0.3%	17.4%	-2.2%
Net Profit per Acre	2002	$13	$297	$159	$807	-$6	$973	-$46
	2007	$39	$371	$232	$954	-$8	$1,051	-$49
Gross Profit per Acre	2002	$56	$468	$379	$1,104	$8	$1,207	-$6
	2007	$95	$588	$489	$1,376	$13	$1,331	-$13

Notes. *NAICS codes
D=Incomputable because land acreage is not disclosed in the census book.
Gross profit = total sales – variable cash expenditures
Net profit = total sales – variable cash expenditures – fixed cash expenditures – depreciation
ROA = 100* {net profit + total interest paid}/{value of owned land and buildings + value of machinery and equipment}
Output-input ratio = total sales / {variable cash expenditures + fixed cash expenditures + depreciation}

Figure 2a: Economic Performance Over Time Across Sectors: Output–Input Ratio

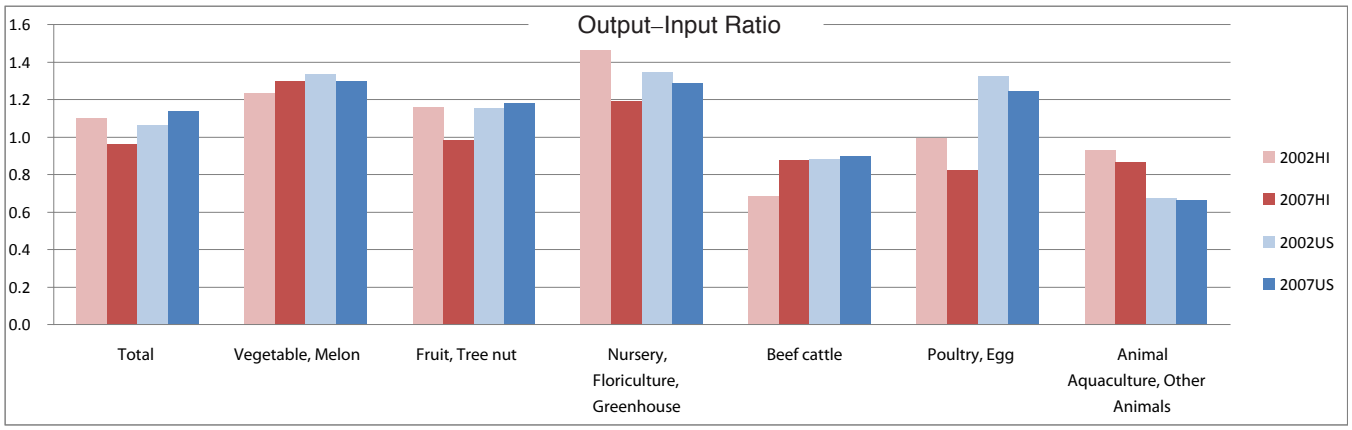
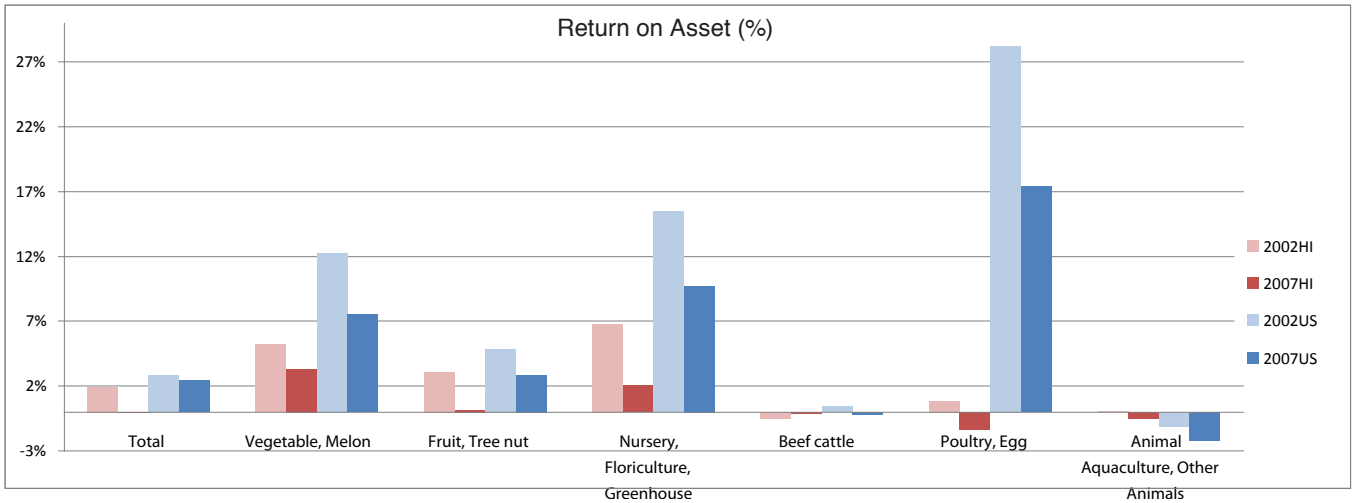


Figure 2b: Economic Performance Over Time Across Sectors: Return on Asset (%)



penses used in our analysis only relied on the reported paid expenses and do not fully account for unpaid labor and/or management by the farm operator(s), total labor expenses are underestimated. In this section, we report the economic performance measures and cost structure estimates including estimated unpaid labor and/or management inputs provided by the operators.

To estimate the unpaid labor and/or management expenses we apply the following procedure. First, we estimate the number of unpaid operators by multiplying the total number of operators by the ratio of the number of farms with non-hired managers to the total number of farms. For this calculation, we referred to the number of farms with hired managers from the census book, assuming that a non-hired manager is the unpaid operator. Second, part-time operator inputs were adjusted to their

Figure 2c: Economic Performance Over Time Across Sectors: Net Profit per Acre in $Thousand

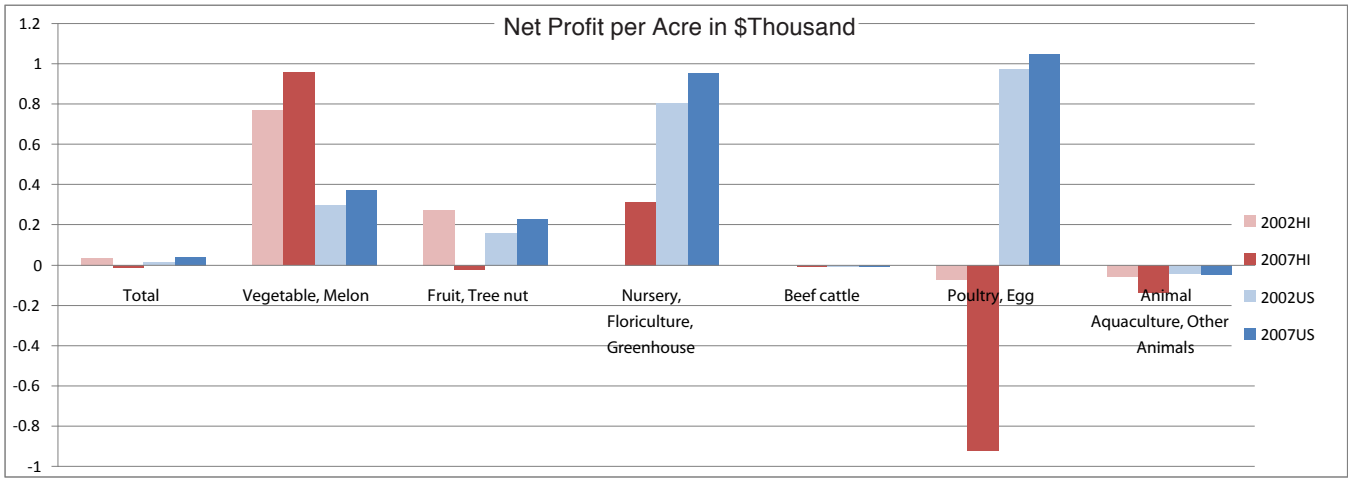
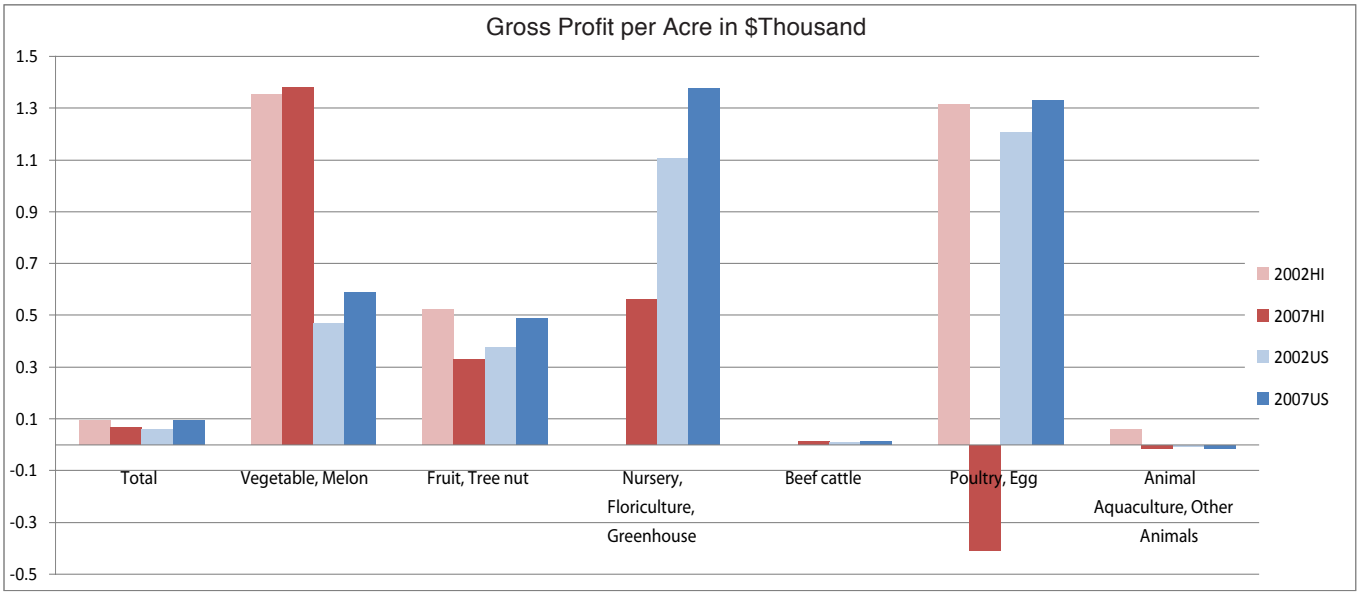


Figure 2d: Economic Performance Over Time Across Sectors: Gross Profit per Acre in $Thousand



full-time equivalent based on the number of operator days worked. Finally, we estimated the unpaid operator labor expenses by multiplying the total unpaid labor input by estimated annual wages, using the average hired worker wage as a proxy for operator wages.

Appendix Table 3a shows the adjusted relative performances of Hawai'i and U.S. Mainland farms. The inclusion of these additional expenses reduces both efficiency and profitability across all farms. The average ROA reduces to -1.5% for Hawai'i farms and falls to 1.0% for U.S. Mainland farms. The reduction in output–input efficiency and net profit is significant. While gross profit

Appendix Table 3a: Economic Performance of Hawai'i vs. U.S. Farms Across Sectors for Year 2007 Including Unpaid Operator Labor Expenses

	Total	Vegetable, Melon (1112)	Fruit, Tree Nut (1113)	Nursery, Floriculture, Greenhouse (1114)	Beef Cattle (112111)	Poultry, Egg (1123)	Animal Aquaculture, Other Animals (1125, 1129)
Hawai'i							
Output–Input Ratio	0.77	1.05	0.74	1.00	0.69	0.67	0.62
Return on Asset	-1.5%	0.7%	-2.0%	0.3%	-0.6%	-4.1%	-2.4%
Net Profit per Acre	-$135	$186	-$616	$4	-$27	-$2,154	-$533
Gross Profit per Acre	-$51	$612	-$260	$253	-$7	-$1,638	-$409
U.S.							
Output–Input Ratio	1.03	1.24	1.12	1.20	0.78	1.20	0.51
Return on Asset	1.0%	6.4%	2.2%	7.4%	-1.2%	14.9%	-4.6%
Net Profit per Acre	$10	$311	$161	$705	-$20	$891	-$93
Gross Profit per Acre	$66	$528	$418	$1,128	$1	$1,171	-$57

Notes. Unpaid operator labor = estimated expense for unpaid labor and/or management provided by the operator
Paid labor = expense for hired labor, contract labor
Utilities, gasoline = expense for utilities, gasoline
Purchased inputs = expense for fertilizers, chemicals, seeds, livestock, feed
Others = expense for supplies and custom work, rent for land & buildings, rent for machinery and equipment, interest expense, property taxes, all other expenses, and depreciation
Net profit = total sales – variable cash expenditures – fixed cash expenditures – depreciation – unpaid operator labor

is positive for Hawai'i farms without including unpaid labor, it is negative including this additional expense.

Importantly, we find that with the inclusion of unpaid operator labor expenses, the relative under-performance of Hawai'i's farms increases. Appendix Table 3b shows the breakdown by farm size. Compared to Table 4, we find that profitability and efficiency are reduced disproportionately more for smaller farms, which rely more heavily on operator input. Since Hawai'i farms are on average smaller, the inclusion of operator labor input decreases their efficiency and profitability relative to those of the U.S. Mainland. Thus while Hawai'i vegetable/melon farms appeared to perform relatively in line with U.S. Mainland farms without unpaid labor, the inclusion of this labor expenses finds that they under-perform.

Appendix Table 3c reports the cost structure accounting for unpaid operators and/or management across sectors. We find that unpaid operator labor expenses are significantly higher for Hawai'i farms relative to U.S. Mainland farms. The average Hawai'i farm requires an input level of 20% of total sales compared to 9% for the U.S. Mainland, with the relatively higher levels fairly constant across sectors. Appendix Table 3d reports that unpaid labor decreases in inverse proportion to farm size. This further confirms that Hawai'i's significantly larger share of unpaid operator labor may be attributed to its greater share of smaller-sized farms, where Hawai'i farms still have a relatively larger share of operator labor input compared to similar-sized U.S. Mainland farms.

Lastly, Appendix Table 3e shows labor–capital ratios, including operator inputs, as part of labor expenses. While Table 6 indicated that Hawai'i had a lower labor–capital expense for fruit/tree nut sectors compared to U.S. Mainland farms, we find that after we account for unpaid operator

Appendix Table 3b: Economic Performance of Hawai'i vs. U.S. Farms by Sales Size for Year 2007 Including Unpaid Operator Labor Expenses

	Very Large Commercial $1,000,000 or more	Large Commercial $250,000 to $999,999	Small Commercial $10,000 to $249,999	Non-Commercial Less than $10,000
Hawai'i				
Output–Input Ratio	1.01	1.15	0.87	0.15
Return on Asset	0.5%	1.5%	-0.3%	-2.0%
Net Profit per Acre	$11	$40	-$46	-$572
Gross Profit per Acre	$33	$26	$3	-$430
U.S.				
Output–Input Ratio	1.23	1.19	0.96	0.15
Return on Asset	10.0%	3.2%	0.1%	-3.0%
Net Profit per Acre	$226	$47	-$5	-$95
Gross Profit per Acre	$350	$106	$31	-$60

labor expenses, Hawai'i has a higher labor–capital expense ratio. Under these estimates, we find that the majority of Hawai'i farms use fewer labor inputs but pay a significantly higher level of total labor expenses. These numbers further confirm high wage costs as being the primary driver of the higher labor expenditures.

Endnotes

1. The exact percentage of food products imported is unknown. However, the number is estimated to be around 85% (Rocky Mountain Institute, 2007, Island of Hawaii Whole System Project Phase I Report). Ken Meter of the Crossroads Resource Center argues that the correct figure is over 90% (as cited in Halweil 2004).

2. The term "U.S. Mainland farms" reflects statistics from all U.S. farms including Hawai'i. Since Hawai'i farms make up less than 0.4% of all the farms in the U.S., the differences between including and excluding Hawai'i from these numbers are negligible.

3. The largest 1% of farms (greater than 2,000 acres) skews the overall average, insofar as 90% of farms are less than 50 acres. This is comparably less than U.S. Mainland farms, where only 40% are less than 50 acres.

4. Due to disclosure issues, we do not present agricultural sectors that have small levels of Hawai'i production. Cattle feedlots, dairy, hog and pig, and sheep are some sectors in the U.S. Census data that were excluded.

5. These measures are adapted from Hoppe et al. (2010).

6. The terms "machinery" and "equipment" are used interchangeably in this publication.

7. Total sales does not include government payments.

8. Hired labor includes hired farm workers and paid family members. In the Census of Agriculture data, some farmers include operator input as part of hired labor expenses, while others leave this input unreported.

9. This is equivalent to saying that for every dollar of sales, 38 cents of hired farm labor is required.

10. Parcon et al. (2011) find that relative to their export competitors, Hawai'i's farmers face higher energy costs.

Appendix Table 3c: Percent of Input Expenditures With Unpaid Labor, Net Profit to Total Sales Across Sectors

	Unpaid Operator Labor	Paid Labor	Utilities, Gasoline	Purchased Inputs	Others	Net Profit
Total						
Hawai'i	26%	38%	10%	18%	38%	-30%
U.S.	9%	9%	6%	43%	30%	3%
Vegetable, Melon (1112)						
Hawai'i	19%	32%	8%	14%	23%	4%
U.S.	4%	21%	7%	22%	28%	19%
Fruit, Tree Nut (1113)						
Hawai'i	33%	39%	9%	13%	41%	-34%
U.S.	5%	30%	7%	14%	34%	11%
Nursery, Floriculture, Greenhouse (1114)						
Hawai'i	16%	34%	6%	17%	27%	0%
U.S.	6%	29%	6%	16%	25%	17%
Beef Cattle (112111)						
Hawai'i	32%	18%	9%	31%	56%	-46%
U.S.	16%	6%	9%	52%	44%	-28%
Poultry, Egg (1123)						
Hawai'i	28%	20%	5%	81%	15%	-49%
U.S.	3%	3%	3%	61%	14%	17%
Animal Aquaculture, Other Animals (1125, 1129)						
Hawai'i	45%	49%	16%	15%	36%	-60%
U.S.	46%	19%	14%	46%	72%	-97%

Notes. Unpaid operator labor = estimated expense for unpaid labor and/or management provided by the operator
Paid labor = expense for hired labor, contract labor
Utilities, gasoline = expense for utilities, gasoline
Purchased inputs = expense for fertilizers, chemicals, seeds, livestock, feed
Others = expense for supplies and custom work, rent for land & buildings, rent for machinery and equipment, interest expense, property taxes, all other expenses, and depreciation
Net profit = total sales – variable cash expenditures – fixed cash expenditures – depreciation – unpaid operator labor

11. Half-time workers (those working fewer than 150 days) are adjusted into full-time-equivalent inputs by dividing their number by 2.

12. It should be noted that the lower average U.S. ratio can be attributed to the relatively more capital-intensive grain and cereal sector, which constitutes a fair amount of the total U.S. agricultural production.

13. Hawai'i's high real estate value makes agricultural land a very lucrative element in the game of investment and land speculation. Given the scarcity of land, Hawai'i's state government has heavily regulated land use and the designation of property. Current agricultural land rates and real estate value may be heavily undervalued compared to the value that could be obtained if they were converted to commercial or residential zoned property.

Appendix Table 3d: Percent of Input Expenditures With Unpaid Labor, Net Profit to Total Sales by Sales Size for Year 2007

	Unpaid Operator Labor	Paid Labor	Utilities, Gasoline	Purchased Inputs	Others	Net Profit
Very Large Commercial ($1,000,000 or more)						
Hawai'i	1%	40%	8%	16%	34%	1%
U.S.	1%	10%	4%	46%	20%	19%
Large Commercial ($250,000 to $999,999)						
Hawai'i	4%	31%	7%	16%	28%	13%
U.S.	2%	7%	7%	36%	32%	16%
Small Commercial ($10,000 to $249,999)						
Hawai'i	15%	29%	12%	20%	39%	-15%
U.S.	6%	7%	10%	35%	46%	-4%
Non-Commercial (less than $10,000)						
Hawai'i	240%	88%	52%	76%	216%	-572%
U.S.	133%	30%	56%	121%	330%	-584%

Notes. Unpaid operator labor = estimated expense for unpaid labor and/or management provided by the operator
Paid labor = expense for hired labor, contract labor
Utilities, gasoline = expense for utilities, gasoline
Purchased inputs = expense for fertilizers, chemicals, seeds, livestock, feed
Others = expense for supplies and custom work, rent for land & buildings, rent for machinery and equipment, interest expense, property taxes, all other expenses, and depreciation
Net profit = total sales – variable cash expenditures – fixed cash expenditures – depreciation – unpaid operator labor

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Appendix Table 3e: Labor–Capital Ratio by Sector for Year 2007 With Unpaid Labor

	Labor–Capital Ratio	
	Number of Paid Workers/ Machinery	Labor Expense/ Machinery
Total		
Hawai‘i	5.4	1.07
U.S.	2.2	0.27
Vegetable, Melon (1112)*		
Hawai‘i	4.5	1.00
U.S.	5.4	0.69
Fruit, Tree Nut (1113)		
Hawai‘i	6.8	1.12
U.S.	10.3	0.95
Nursery, Floriculture, Greenhouse (1114)		
Hawai‘i	6.9	1.00
U.S.	7.4	1.31
Beef Cattle (112111)		
Hawai‘i	2.3	0.46
U.S.	2.2	0.15
Poultry, Egg (1123)		
Hawai‘i	2.9	0.60
U.S.	2.4	0.37
Animal Aquaculture, Other Animals (1125, 1129)		
Hawai‘i	3.6	0.98
U.S.	3.1	0.36

Notes. *NAICS codes
Number of labor = number of operators (adjusted) + hired farm labor (adjusted) + contract labor
We derived the number of contract labor by dividing expense for contract labor by estimated annual wage per hired worker."
Labor expense = expense for hired labor, contract labor, and unpaid operator labor (imputed) per $100,000
Machinery = value of machinery and equipment per $100,000

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