The Agricultural Economic Landscape in Hawai'i and the Potential for Future Economic Viability

JUNE 11, 2021

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EXECUTIVE SUMMARY

This brief summarizes key facts about Hawai'i's agricultural economy and what they may imply about its prospects for revival. Key findings include:

- Total agricultural sales have declined with the exit of sugarcane and pineapple plantations, but size of the decline looks different depending upon whether prices are discounted by the Consumer Price Index or the Producer Price Index.
- Because wholesale agricultural prices have increased less than consumer prices, the difference indicates that the economic value of Hawai'i's agricultural production has declined much more than the state's physical production of agricultural goods.
- While Hawai'i has soils and climates that are ideal for many crops, its productivity growth has lagged other states and countries.
- A key factor in stagnating productivity is Hawai'i's unusually high labor costs and associated low labor productivity. High labor costs stem from lack of mechanization relative to California and other highly-productive areas, not because wages are higher.
- Lack of mechanization can be traced to the relatively small scale and unique geography of Hawai'i's agricultural land, which is comprised of smaller and more fragmented fields that can be rockier and more steeply sloped.
- Agricultural production in Hawai'i is increasingly concentrated on smaller farms, a trend that departs from other parts of the country, and also one that likely contributes to the state's lower productivity growth.
- Hawai'i has more idle cropland than harvested cropland. This idle land represents an economic opportunity of one kind or another. Employing these resources in high-value crop production that is synergistic with current activities might increase productivity (output *relative to* inputs) in addition to scale.
- There may be prospects for growth in high-value crops that satisfy local demand for fresh produce and in niche crops that leverage Hawai'i's unique climate and soils.
- Emerging technology, including artificial intelligence and robotics, may favor smaller-scale mechanization thereby overcoming some of Hawai'i's past challenges.
- Data about Hawai'i agriculture is relatively lacking and prone to large sampling errors. Some standard metrics, like average farm size, can be especially misleading due to the way farms are defined, the manner in which data are collected, and how both definitions and sampling change over time. Some surveys exclude Hawai'i or have very small samples from the state. Thin data make it especially difficult to detect emerging trends in Hawai'i's agricultural sector.
- Improved data collection may shed clearer light on challenges and prospects for Hawai'i agriculture.

INTRODUCTION

In a recent UHERO policy brief, *Reviving Agriculture to Diversify Hawai‘i's Economy*, authors pointed to trends in Hawai‘i agriculture and state policies surrounding agricultural land management (La Croix & Mak, 2021). Hawai‘i's agricultural history has centered around the pineapple and sugar plantations and these are largely gone; the closing of Puna Sugar in 1982 was the inception of the decline and the last sugar producer shuttered on Maui in 2016 (Lyte, 2017; Melrose, Perroy, & Cares, 2016). Many small farms remain in Hawai‘i, but the vast majority have annual sales below $10,000 while the households that manage them derive income mainly from other sources (USDA-NASS, 2017; USTR, 2021). Much of the state's former agricultural land now sits fallow or unused.

Are there prospects for an agricultural revival in Hawai‘i?

Governor Ige set a goal of doubling local food production (Cocke, 2016; State of Hawai‘i, 2021) and many like to envision a Hawai‘i that is self-sufficient in food production, among other necessities (Caulfield, 2021a; Cheng, 2020; Hägg, 2019; Terrell, 2021). At the same time, concerns about excess tourism, the principal source of economic growth in the state over the decades of agricultural decline, leaves many looking for ways to grow Hawai‘i‘s economy while limiting tourism. The state's dependence on tourism has been thrown in sharp relief amid the COVID-19 pandemic, which has increased the state's unemployment rate from among the lowest in the nation to the highest. Some may hope for an agricultural revival to fill the tourism gap.

This policy brief aims to expand on La Croix and Mak (2021) by presenting data that may help increase understanding about the agricultural economic landscape in Hawai‘i and inform its future economic viability. We find that while farmland and the real value of agriculture sales are trending downwards, there are potential opportunities and examples of success. We also find that data are lacking to tell a comprehensive story about Hawai‘i's agricultural economy; an increased emphasis on data collection and analysis in the state would be valuable.

THE LIMITS OF AVAILABLE DATA

A challenge with assessing the state's agricultural economy is that the available data are thin. The standard government surveys that we can draw upon, such as the Current Population Survey and American Community Survey, have sample sizes that are much too small to assess this narrow slice of our relatively small economy. The best available data come from the Census of Agriculture, conducted by the U.S. Department of Agriculture's National Agricultural Statistical Service (USDA-NASS) every five years. The goal of the Census is to collect basic information about the *population* of farms, not just a sample. But the data actually collected fall far short of this aspiration. While the Census successfully collects data from the great majority of large farms (those with sales over $500,000), many smaller farms do not make it on the official list of farms that is maintained by the USDA. The USDA estimates the number of farms not on the list using a survey that samples farm areas. This survey is called the "June Area Survey." Farms identified in the sample of areas that are not on the official list are used to draw estimates of how many farms are undercounted in general, and how big the uncounted farms are. To account for these farms, the official statistics "weight" the responses that they do obtain to scale up farm counts, sales, and other metrics to estimate the true population total, inclusive of farms not on the official list (details of this procedure can be found here). As a result, the Census estimates are measured with error. USDA estimates the size of the error (an approximate +/- range), and it is fairly large for many statistics in Hawai‘i – it is based on the number of area samples that USDA conducts. The size of this error can be difficult to estimate, especially for the apparently small number of area samples conducted in Hawai‘i.

The methods and data sources used to create the official list of farms, estimate the number of "not-on-the-list" farms, and derive weights can change over time. A major revision in the sample frame in 2007 caused the count of small farms to increase substantially, but this was mainly attributable to the weights increasing (the estimated number of "not-on-the-list" farms) when the sample frame was changed. Some prominent news articles likely misattributed this increase as incipient change in the sector (see this article for example).

One reason for the large number "small farms" and "not-on-the-list" farms likely stems from USDA's generous definition of a farm. USDA defines a farm "as any place that produced and sold—or normally would have produced and sold—at least $1,000 of agricultural products during a given year" (Hoppe & MacDonald, 2013). This definition has been fixed since the 1970s, and since the value of a dollar has diminished over time, the definition of a farm has become more inclusive of smaller and smaller farms. It would not be surprising if many “farms” by USDA’s definition do not consider themselves farms. This fact might also help to explain modest growth in the number of small farms in recent years, as well as the relatively stable average farm size.

Of course, some small family farms with low sales may be attempting to grow into something larger and are surely mixed in with what USDA’s Economic Research Service calls “Residential/Lifestyle” family farms whose operators have primary occupations off farm. USDA-ERS’s farm typologies (Hoppe & MacDonald, 2013) provide a very useful way to better understand the heterogeneous structure of farms and how things are actually changing over time. But these statistics have not been broken out for the State of Hawaiʻi. Calculating these statistics (and approximate errors for them) would require access to the Census micro data.

Finally, some Census data are suppressed, usually to protect privacy if a particular operator could be identified. This results in some incomplete data in some cases, particularly in Hawaiʻi.

With this context and these caveats in mind, we focus on the data from 1982 to 2017, from around the time when plantation agriculture started declining to the most recent year of available data (Melrose, Perroy, & Cares, 2016).

AGRICULTURAL SALES IN HAWAIʻI ARE DECLINING, BUT BY HOW MUCH?

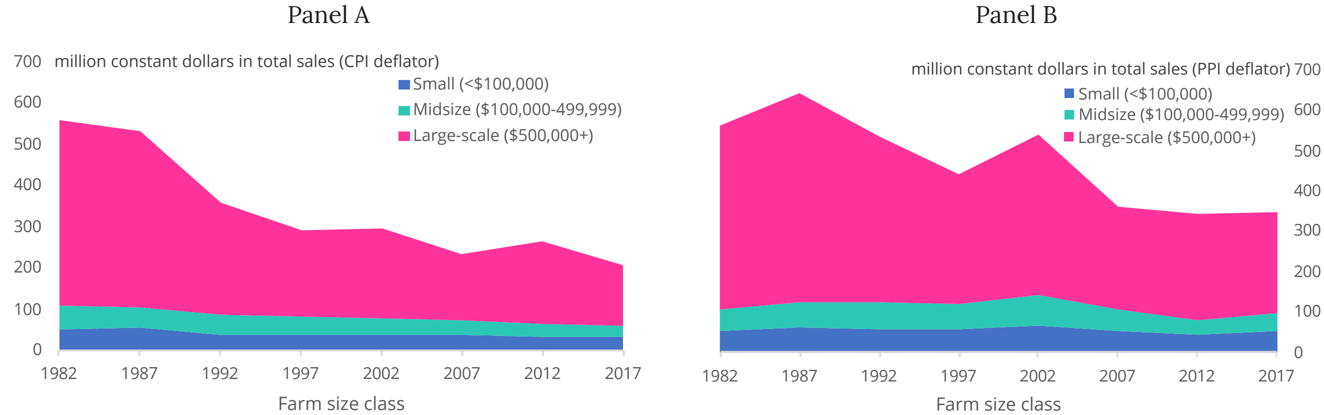
We first focus on the market value of agricultural sales in Hawaiʻi. Using a dollar metric is useful because it reduces heterogeneity such as crop yield when comparing acres or farm size when comparing number farms. Prices, however, change over time. Thus, in order to measure physical output or the real economic size of activity, we deflate nominal sales value to real sales value. We calculate inflation-adjusted value in two ways[1]. First, we follow, La Croix and Mak (2021) by deflating with the consumer price index (CPI) for all items in urban Hawaiʻi shown in Figure 1, Panel A (DOL-BLS, 2021b). The CPI measures the average price changes for a market basket of consumer goods and services paid (DOL-BLS, 2021a). The benefit of this deflator is that it is state-specific and the cost of living in Hawaiʻi is high; the average price for goods in the state is 11 percent higher than the national average (Inafuku & Fuleky, 2020).

Using the urban-Hawaiʻi CPI as a deflator is a good way to measure the *economic size* of farm output in the state, but it could be a poor measure of *physical production*, because the prices of farm products have experienced different changes over time than have prices of retail consumer products. As a result, USDA normally uses the producer price index (PPI) to deflate farm product sales which we show in Figure 1, Panel B. The PPI for farm products is an index like the CPI, but measures the prices paid to domestic producers for their output (MacDonald, Hoppe, & Newton, 2018; USDA-ERS, 2021b). The PPI has increased far less than the CPI, which is partly a testament to the broader sector’s productivity growth internationally.

A problem with using the PPI is that there are variations in the price changes for different agricultural commodities. For example, figure A.1 shows the PPI for three different farm products that are grown in Hawaiʻi: dry onions, tomatoes, and tree nuts. The price index varies substantially between these three commodities over time. And prices received by Hawaiʻi’s farmers may differ from those for the rest of the United States; for example, macadamia nuts, which are most prevalent here, comprise a tiny share of the national tree nut index. Farms may face different price inflation rates depending on the mix of commodities they produce (MacDonald, Hoppe, & Newton, 2018, p.4). Ideally, we would have a Hawaiʻi-specific PPI, but such an index is not available.

1 We did calculate inflation-adjusted value a third way, using a GDP deflator. We compared the results to the panels in Figure 1 and the results using a GDP deflator were similar to using CPI as a deflator.

Figure 1. Real value of agricultural sales in Hawaiʻi deflated using the consumer price index for all items in urban Hawaiʻi (Panel A) and using the producer price index for farm products (Panel B), 1982-2017.



Data source: USDA-NASS (2017).

Note: The CPI reference base is 1982-1984=100, not seasonally adjusted (DOL-BLS, 2021b) and the PPI reference base is 1982=100, not seasonally adjusted (DOL-BLS, 2021b).

Figure 1 demonstrates that there has been a substantial decline in agricultural value since 1982. We disaggregate the data into three economic size categories: small, midsize, and large-scale[2]. All farm size classes show substantial declines in value, measured in constant dollars. Shown in Figure 1, Panel A, the market value of agricultural sales generated by small farms decreased from $50.9 million in 1982 to $29.8 million in 2017, a decline of 41 percent ($1982). Midsize farms saw a real sales decline of 48 percent, from $54.6 million in 1982 to $28.3 million in 2017. The large-scale farms consistently contributed the most in sales value compared to the other farm size classes, yet declined by over two-thirds during this time period. Large-scale farms were associated with a market value of $427.5 million in 1982 and, as the sugar and pineapple plantations closed their operations, the value declined, ending at $149.1 million in constant dollars.

In Figure 1, Panel B, we deflate the sales series using the PPI for farm products (DOL-BLS, 2021c). The pattern is similar, but the decline is notably less dramatic than it is in Figure 1. And moreover, it seems to have stabilized over the last decade, despite the last sugarcane plantation shuttering. This graph also shows a modest uptick in production value from small and medium farms between 2012 and 2017, a change that is not visible when deflating by the CPI.

Between years considered, small farms maintained approximately the same sales value of approximately $50 million when adjusted for inflation in Figure 1, Panel B ($1982-84). Midsize farms saw a 13 percentage point change in sales value from $54.6 million in 1982 down to $47.6 million in 2017 in constant dollars. The value associated with large-scale farms declined the most, by 45 percent. Large-scale farms were producing a real value of $452.7 million and $250.6 million in 1982 and 2017, respectively.

Both panels in Figure 1 show the same shares; large-scale farms contributed 81 percent to total agricultural value in 1982, falling to 72 percent by 2017. Concentration has decreased in Hawaiʻi's agricultural sector, not because of a structural shift, rather because of the exit of sugar and pineapple. This trend diverges from national farm consolidation

2 The farm classification developed by the U.S. Department of Agriculture's Economic Research Service (USDA-ERS) uses similar categories, but not exactly the same categories. The agency defines small farms as having a gross cash farm income (GCFI) less than $350,000, midsize farms as having GCFI between $350,000 and $999,999, and large-scale farms with a GCFI of $1,000,000 or more. GCFI includes farm revenue, Government payments, and other farm-related income (Hoppe & MacDonald, 2013). Data on GCFI is not available for Hawaiʻi from the same data source that USDA-ERS uses in their farm classification, so we created the classifications in Figure 1 based on the market value of agricultural products sold in the Census of Agriculture data (USDA-NASS, 2017). The market value of agricultural products sold is gross farm sales without Government payments (Hoppe, MacDonald, & Korb, 2010). The benefit of this data series is that it is public, includes Hawaiʻi data, and is reported over time; however, less economic activity of the farm is captured compared to gross farm sales using this measurement (Hoppe, MacDonald, & Korb, 2010).

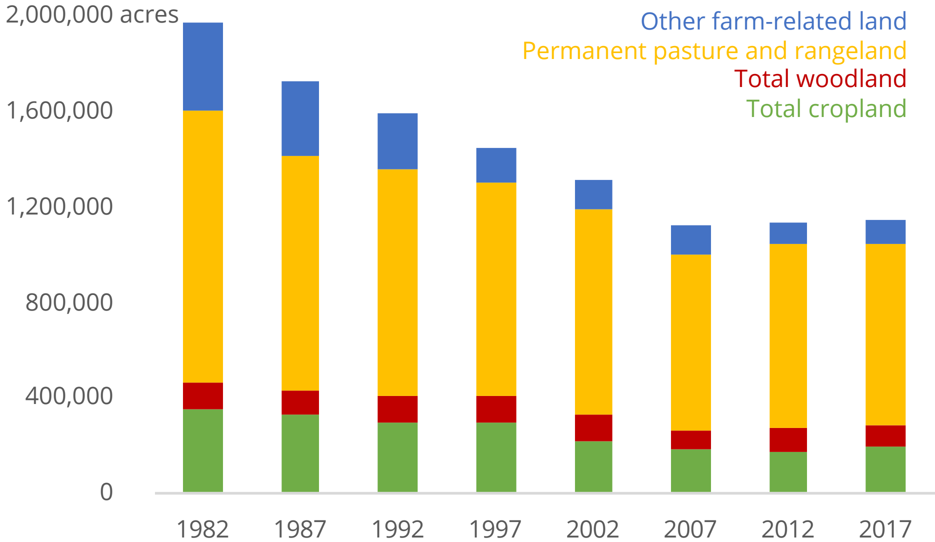
trends (MacDonald, 2018). In fact, MacDonald, Hoppe, and Newton (2018) find that Hawai'i and West Virginia are the only two states who have not seen agricultural industry consolidation in the past three decades.

This may seem to be a nuanced economist's exercise, but, in fact, we see substantial differences in the value deflating by CPI or PPI different series. The PPI values are about two-thirds greater than the CPI values by 2017. The differences may seem like a contradiction, but they are not. The CPI is growing at a much faster rate over time compared to the PPI which has also been more volatile (see figure A.2). Increasing prices for consumer goods, including housing, has outpaced stagnant farm commodity prices. Thus the differences simply indicate that the economic value of production has declined much more than physical production.

Both metrics are useful to consider. One reason for relatively stagnant farm commodity prices is broader agricultural productivity growth, which has pushed down the average cost of farm commodities in the United States (Fuglie, MacDonald, and Ball, 2007). Table A.2 provides the data behind Figure 1. Unfortunately, Hawai'i's agricultural productivity growth has not kept pace with the rest of the country, making production here less competitive, an issue that we address below.

AGRICULTURAL LAND USE IN HAWAI'I

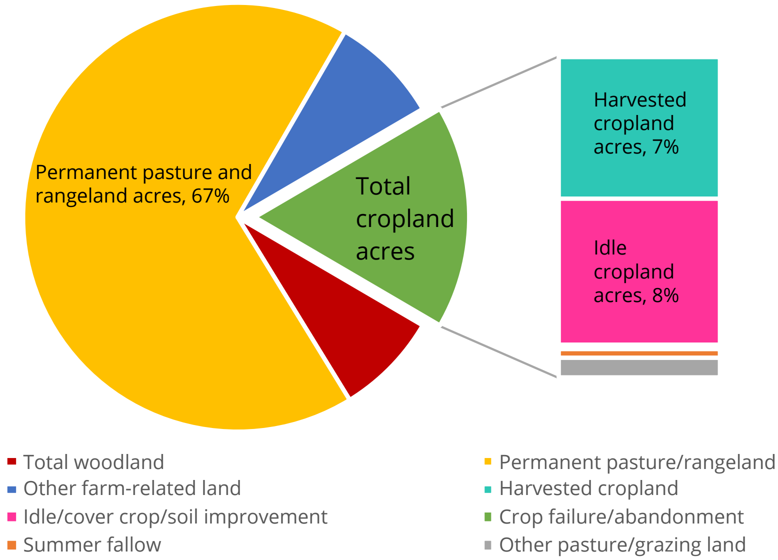
Figure 2. Farmland in Hawai'i, 1982-2017



Data source: USDA-NASS (2017).

The amount of farmland has been declining in Hawai'i over time. There were almost 2.0 million acres in farmland in 1982 which declined 42 percent to 1.1 million acres in 2017. This decline has been driven by total cropland and other farm-related land which is defined as land in farmsteads, homes, buildings, livestock facilities, ponds, roads, wasteland, etc. (USDA-NASS, 2017). Total cropland declined by 155,000 acres, or 45 percent, whereas other farm-related land declined by 268,000 acres, or 74 percent. As shown in figure 2, the majority of Hawai'i farmland has been in permanent pasture and rangeland, ranging from 58 percent in 1982 to 67 percent in 2017.

Figure 3. Farmland in Hawaiʻi with total cropland subcategories, 2017



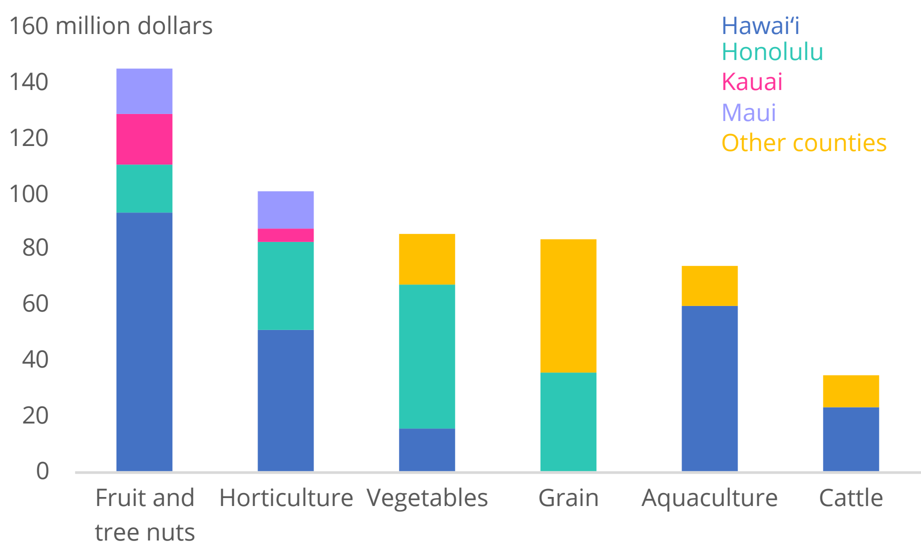
Data source: USDA-NASS (2017).

Shown in both Figure 2 and 3, over two-thirds of farmland in Hawaiʻi was permanent pasture and rangeland acres in 2017, a share that is higher than the 47 percent reported by the Census for California, but notably lower than California if leased public lands are taken into account. Total cropland acres in 2017 is further broken out in four categories in Figure 3: 1) harvested cropland, 2) cropland idle or used for cover crops or soil improvement, but not harvested and not pastured or grazed, 3) cropland on which all crops failed, 4) cropland in summer fallow, and 5) other pasture and grazing land that could have been used for crops without additional improvements. In 2017, only 7 percent of total farmland in Hawaiʻi was harvested cropland acres. The proportion of harvested cropland has consistently been between 7 to 9 percent of farmland between 1982 and 2017.

It is striking that Hawaiʻi has more idle cropland than harvested cropland. In contrast, 82 percent of California cropland is harvested while 81 percent U.S. cropland is harvested. It is unusual for so much productive cropland to sit idle if not in summer fallow, conservation, or otherwise in preparation for future use.

WHAT ARE THE TOP COMMODITIES AND WHERE ARE THEY PRODUCED?

Figure 4. Market value of top Hawaiʻi agricultural commodities sold ($2017), 2017



Data source: USDA-NASS (2017).

Note: Because of data suppressions, "other counties" was imputed by taking the state value minus all reported counties. This category represents all other counties in the state that are not already represented in the bar, except for grain where "other counties" represents Kauai and Maui only because there are no grain sales in Hawaiʻi County.

In 2017, the market value of all agricultural products sold was $563 million, in 2017 dollars. Over half of the value of agricultural commodities is generated in Hawai‘i County at $269 million. The largest sales come from fruit and tree nut commodities, predominantly macadamia nuts. Grain, representing seed corn grown in the state, and aquaculture are two industries that have developed in the recent past. Using the data points available from the Census, the sales value of seed corn grew from $19.4 million in 2007 to $80.1 million in 2017 (nominal dollars). Similarly, aquaculture showed strong growth with $14.0 million in sales in 2002 growing to $74.0 million in 2017 (nominal dollars).

There are differences when comparing the Census of Agriculture data to the top 20 commodities produced by the Hawai‘i State Department of Agriculture (HDOA) and USDA-NASS' Hawai‘i Field Office. Measuring value of production in 2017, the top three ranked commodities are: 1) seed crops, 2) macadamia nuts, and 3) cattle (HDOA & USDA-NASS, 2017). These differences arise due to different value measurement and different characterization and aggregation of crops. For example, the state reports macadamia nuts separately from other tree fruit crops, like papaya, mango, and bananas. Note that the main seed crops are grains (corn).

HAWAI‘I'S PRODUCTION CHALLENGES

Basic economic constraints are at odds with the growth of agricultural production in the state. Because of high input costs to production and smaller-scale farms, it is difficult for Hawai‘i to compete with production in other regions (Arita, Naomasa, & Leung, 2012). Input costs of agricultural production are 40 percent higher, farms generate half the sales, and farms are two-to-three times smaller in acreage compared to the U.S. mainland (Arita, Hemanchandra, and Leung (2014). Artia, Hemanchandra, and Leung (2014) find that local farms are adversely affected by imports (defined as international and mainland in-shipments) and small commercial farms are the most severely affected. Economies of scale, or the ability to produce additional units of output at a lower cost, is a means to remain competitive in the market and is mostly lacking in Hawai‘i.

Table 1. Farm production expenses for California and Hawai‘i, 2017

	California	Hawai‘i
	Percentage of total	
Variable Expenditures		
Fertilizer, lime, and soil conditions purchased	5%	5%
Chemicals purchased	6%	3%
Seeds, plants, vines, and trees purchased	4%	2%
Livestock and poultry purchased or leased	4%	1%
Feed purchased	13%	6%
Gasoline, fuels, and oils purchased	3%	4%
Utilities	5%	5%
Repairs, supplies, and maintenance costs	5%	7%
Hired farm labor	17%	37%
Contract labor	9%	4%
Customwork and custom hauling	4%	1%
Medical supplies, veterinary, and custom services for livestock	1%	0%
All other production expenses	7%	7%
Fixed Expenditures		
Cash rent for land, buildings, and grazing fees	4%	4%
Rent and lease expenses for machinery, equipment, and farm share of vehicles	1%	1%
Interest expense	3%	3%
Property taxes paid	3%	3%
Depreciation	7%	8%

Source: Authors' calculations using USDA-NASS data (2017).

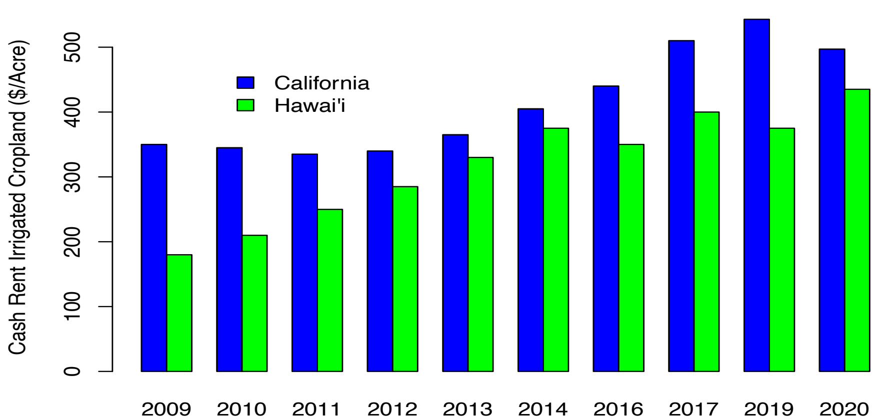
Table 1 shows the farm production expenses for the California and Hawaiʻi measured as a percentage the total. We calculate the percentage by dividing each expense by the total expenses; the higher the percentage, the more the input contributes to production cost. California is probably the best state for comparison to Hawaiʻi, even with their differences, given both states grow high-value, labor-intensive fruits, vegetables, and tree nuts and they are nearest each other geographically.

What stands out in this table is the share of hired farm labor at 37 percent of total farm production expenses for Hawaiʻi and 17 percent for California. Earlier articles have found labor costs to be an impediment to Hawaiʻi's competitiveness (Arita, Naomasa, & Leung, 2012; Parcon et al., 2011). Arita, Naomasa, & Leung (2012) suggest this is due to Hawaiʻi's geographically isolated location in the Pacific and competing industries such as tourism. While California's farm labor wages have typically been less than Hawaiʻi's, between 2017 and 2020, California field worker wages grew from $13 to $16.50, surpassing Hawai'i's field workers whose wages grew from $14 to $16 (USDA-NASS, 2021c). Thus, this labor cost difference derives mainly from Hawaiʻi's production being more labor intensive, not because labor is more expensive.

Thus, in addition to calculating labor's share of farm production expenses, we also calculate labor productivity in 2017. We divide gross receipts of farms which includes government payments (USDA-ERS, 2021a) by number of hired workers, based on available state-level data (USDA-NASS, 2017). We find that labor productivity, or output per worker, is about three times higher in California compared to Hawaiʻi, on average. To say this another way, more workers are needed in Hawaiʻi to produce the same amount of output, likely substituted for machinery on larger California farms. Mechanization in Hawaiʻi can be more difficult due to smaller, sometimes fragmented cropland fields, and its sloping, rocky, and volcanic geography.[3]

Parcon et al. (2011) find that Hawaiʻi farmers face higher costs of electricity, fertilizer, land, and transportation compared to competitors in the U.S. mainland and Japanese markets. In the data presented in Table 1, there are some differences, but not substantial differences in fuel or fertilizer between Hawaiʻi and California. As La Croix and Mak (2021) point out, land may not necessarily be a production constraint since agricultural land is available, but perhaps it is not accessible (Caulfield, 2021b). The 2020 Cash Rents Survey, also conducted by NASS, reports that Hawaiʻi had a cash rental rate of $435 per acre of irrigated cropland (USDA-NASS, 2021b). In 2020, California had the highest irrigated cropland cash rental rate in the nation at $497 per acre. Interestingly, Hawaiʻi's cash rental rates on irrigated land have grown closer to California levels in recent years (see Figure 5).

Figure 5. Cash rental rates for irrigated cropland in California and Hawaiʻi, 2009-2020



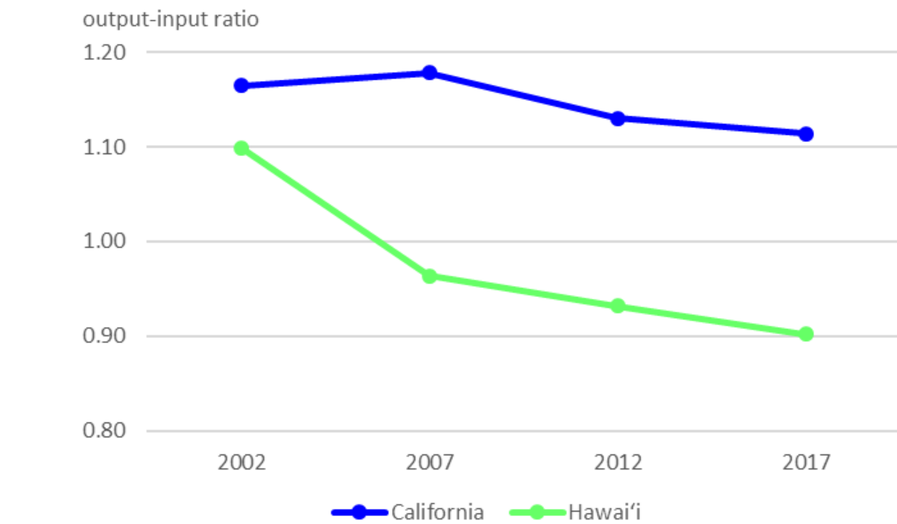
Data source: USDA-NASS (2021b).

3 An interesting article in Farm Progress from 2016 profiles Hawaiʻi's (and the nation's) largest macadamia nut farm. The article explains how their high labor costs stem from the farm's unique volcanic land. See https://www.farmprogress.com/tree-nuts/growing-macadamia-nuts-lava-hawaii-s-big-island.

Presented in Figure 6 are output-input ratios for the California and Hawaiʻi between the years of 2002 and 2017 in which depreciation expenses are published. An output-input ratio is a simple indicator of economic performance which has been used by others for earlier years of data (Arita, Hemanchandra, & Leung, 2014; Arita, Naomasa & Leung, 2012). Here, we divide the market value of agricultural sales by the sum of fixed and variable expenses. A higher output-input ratio indicates more sales per one dollar of expenditure.

Figure 6 shows Hawaiʻi's output-input ratio was 0.90 in 2017. This data point indicates that value of inputs is greater than the output value, or every dollar spent on inputs generates 90 cents in production value, on average. In 2017, Hawaiʻi's output-input ratio is lower than California's output-input ratio of 1.11. This measure of economic performance has been declining over time for both states, but more so in Hawaiʻi.

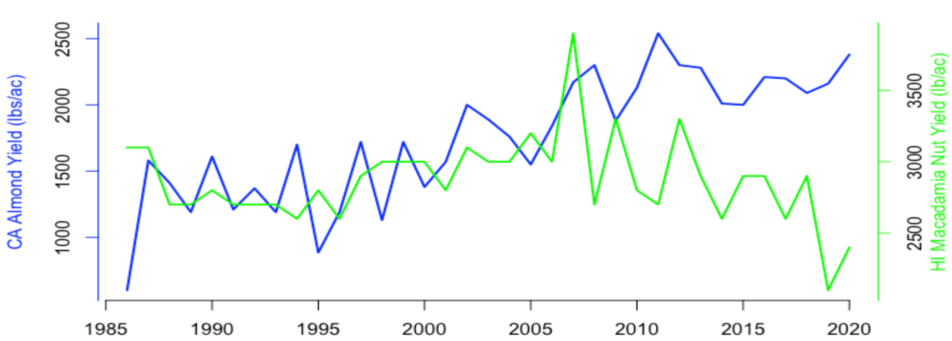
Figure 6. Output-input ratios for California and Hawaiʻi, 2002-2017



Data source: USDA-NASS (2017).

When comparing yields per acre, Hawaiʻi's crops can be very productive but have not trended up as much as they have in California and other US states. For example, the average yield of almonds, California's most valuable crop, has risen by more than a third since the late 1980s while Hawaiʻi's macadamia nuts have shown no sustained trend (Figure 7). Some of this particular difference might stem from Hawaiʻi's aging tree vintages. Lower yield trends may derive from biological factors such as the persistent pest and disease pressure in Hawaiʻi's tropical climate, or other technological or environmental factors. In a study comparing the technical efficiency of Hawaiʻi's aquaculture industry, Arita and Leung (2014) find that average technical efficiency across all farms was in decline from 1997 to 2007 and only 4 of 33 farms were efficient in 2007. The productivity data here indicate that Hawaiʻi faces steep challenges when competing with agriculture production elsewhere.

Figure 7. California Almond Yields and Hawaiʻi Macadamia Nut Yields, 1986-2020

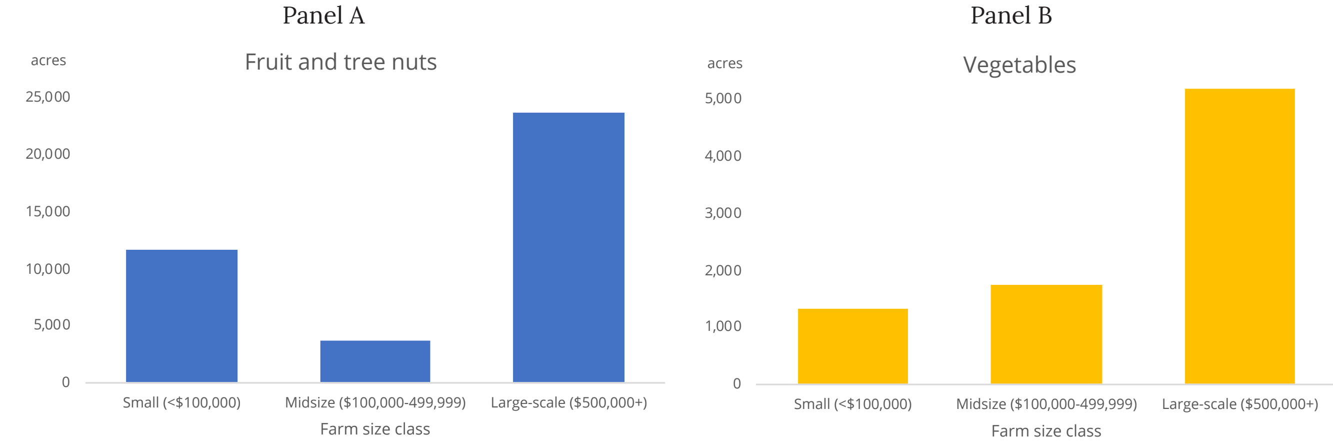


Data source: USDA NASS (2020a,b)

FUTURE ECONOMIC VIABILITY OF HAWAIʻI'S AGRICULTURAL SECTOR: ARE THERE OPPORTUNITIES?

As pointed out by La Croix and Mak (2021), agriculture represents a small share of Hawaiʻi's economy. The *agriculture, forestry, fishing, and hunting* industry's contribution to the state's gross domestic product (GDP)[4] has been declining over the last three decades to 0.43 percent in 2019 (La Croix & Mak, 2021). This is half of the industry's share of the U.S. economy; in 2019, *agriculture, forestry, fishing, and hunting* contributed 0.82 percent to U.S. GDP in 2019 (DOC-BEA, 2020).

Figure 8. Acres in specialty crops in Hawaiʻi, 2017



Data source: USDA-NASS (2017).

Figure 8 shows total acres in specialty crops by farm size class - fruit and tree nut acres in Panel A while vegetable acres are shown in Panel B. This figure was developed based on available data with an intent to show land distributions and shed light on potential opportunities. Even though there are far more small farms than large farms, larger farms comprise the vast majority of cropland. This is in line with U.S.-level farm economy trends as larger farms are able to capture economies of scale to reduce average production costs (MacDonald, Hoppe, & Newton, 2018). In Figure 8, Panel B, vegetable acreage is lowest for small farms whereas the lowest acreage for fruit and tree nuts (Panel A) is in the midsize farms. It makes sense to optimize land use across farm class, not just because it is good economics, but to make efficient use of limited natural resources. Productivity gains may be encouraged for farms in the smaller two size classes; productivity has been the main driver of economic growth in the U.S. farm sector over time (Wang et al., 2020). Expanded produce production has potential and there is a bill on Governor Ige's desk that would require 10 percent of state-bought agricultural products to be locally-produced, if passed (Associated Press, 2021).

Big Island Coffee Roasters and Maui Kuʻia Estate are examples of successful, vertically-integrated enterprises operating on small amounts of land (2 and 10 acres in production, respectively)[5]. They both grow some of the raw agricultural product (coffee cherry and cacao, respectively) and create value-added products (roasted coffee/espresso bits and premium chocolate, respectively) that are recognized as high-quality[6]. Maui Kuʻia Estate has also diversified to offer for-cost tours and chocolate tastings. Both businesses have online platforms to reach customers around the world (Big Island Coffee Roasters, 2021; Maui Kuʻia Estate, 2021). Other examples of profitable farmers are highlighted in a recent Honolulu Civil Beat article (Yerton, 2021).

4 GDP is a broad indicator of economic activity.

5 Big Island Coffee Roasters have 2 acres in production on a typical year (K. Stewart, personal communication, February 19, 2021). Maui Kuʻia Estate has 10 mature acres, 20 acres total planted, and 50 acres total planned (Maui Kuʻia Estate, 2020).

6 Big Island Coffee Roasters won the Grand Champion coffee in the state of Hawaiʻi in 2013, Forbes "Top 12 Roasters in the USA" in 2018, and Forbes "World's Best Hotel Coffee is at the Four Seasons Hualalai" in 2018 (Big Island Coffee Roasters, 2021). Maui Kuʻia Estate won a prestigious Cocoa of Excellence Award in 2019 at the Salon du Chocolate in Paris (Maui Kuʻia Estate, 2020) and a Silver Chocolate Alliance Award in the Made at Origin Chocolate Bar Class in 2020 (The Northwest Chocolate Festival, 2021). These are among other recognition received by each enterprise.

The large share of idle cropland, presumably land formerly dedicated to sugarcane and pineapple, represents an economic opportunity, whether for niche or high-value food crops, energy production (wind, solar, biofuel), housing or tourism development, or even habitat or cultural conservation. If all of this idle land were brought into agricultural production, and especially if it were in some way synergistic with existing production of fruit, tree, and vegetable crops, it might bring a scale of production that could narrow the productivity gap with California. The sector might then also benefit from larger and more efficient businesses specialized in wholesaling and distribution.

Other areas of opportunity may include agricultural products that promote Hawaiʻi's uniqueness and have few global competitors, have a high value per unit of farmland, are environmentally-friendly, are high-tech and less reliant on labor, or have a large potential market outside of the state.

Hawaiʻi branding has been an effective marketing strategy as used by Kona coffee growers. HDOA manages Hawaiʻi branding programs. They offer a Hawaiʻi Seal of Quality for Hawaiʻi-grown for Hawaiʻi-made premium products with over 51 percent of Hawaiʻi ingredients and a Made in Hawaiʻi with Aloha label for items with 51 percent or more of the cost incurred in the state (State of Hawaiʻi-Agricultural Development Division, 2020). HDOA also maintains a Hawaiʻi Agriculture and Food Products Directory to connect vendors to potential buyers (State of Hawaiʻi-Agricultural Development Division, 2020). Since the COVID-19 pandemic began, there have been additional marketing efforts of Hawaiʻi products such as the Buy Hawaiʻi, Give Aloha: One-Stop Site for Hawaiʻi Products (State of Hawaiʻi-DBEDT, 2020a). Finally, there always exists the potential for innovative ideas or new products.

This article focuses on economic value, but, certainly, there is nonmonetary value of land and agriculture which is more difficult to measure (Gómez-Baggethun et al., 2014). Bremer et al. (2018) study incorporating ecosystem services into land-use decisions, particularly cultural ecosystem services, or the "non-material benefits that people obtain from ecosystems." In the North Kona, Hawaiʻi community they study, participants describe a reciprocal relationship with the land centered on environmental kinship, responsibility, and stewardship (Bremer et al., 2018). The authors highlight the importance of incorporating a diverse set of values in land-use decision making. Gould et al. (2019) find that Hawaiian values resonate particularly with relational values[7], a concept that emphasizes reciprocal interactions and aims to facilitate decision making around sustainability. Hawaiʻi is distinct with respect to agriculture due to the heritage crops grown here (e.g., breadfruit and taro) and the ecological diversity of the islands allowing for a variety of commodities and alternative or indigenous production methods, especially in the face of climate change (Kurashima, Fortini, & Tickin, 2019). Broadening a definition of value may be a consideration for policymakers in the state (Fisher et al., 2008).

CONCLUSION

This policy brief summarizes the economic landscape of agriculture in Hawaiʻi and explores the potential of an agricultural revival in Hawaiʻi. The data show sales and land in farms are trending downwards, that agriculture is a small and decreasing share of state GDP, and Hawaiʻi faces some comparative disadvantages to remain competitive in increasingly global markets, particularly due to lack of mechanization and associated high labor costs. This is consistent with the findings of Arita, Hemanchandra, and Leung (2014) and La Croix and Mak (2021). However, we echo the concluding statement by La Croix and Mak (2021) that improving irrigation systems, promoting agriculture, supporting farmers navigating regulations, and working towards bringing goods to local and export markets could be worthwhile activities. We also point to potential opportunities in agriculture and provide examples of profitable ventures.

In the future, Hawaiʻi agriculture may benefit from adopting emerging precision technologies, artificial intelligence, and robots (Lowenberg-DeBoer, 2015). It is conceivable that these technologies will become more suited to small-scale operations focused on niche crops, like those of Hawaiʻi. Such a trend, however, would be a reversal from scale-favored mechanization of previous generations. While a less labor-intensive sector may not favor growth in on-farm jobs, it may be critical for keeping and growing the sector, and may provide greater benefits for Hawaiʻi's broader economy,

7 Gould et al. (2019) define relational values as those associated with relationships and that focus on the relational constitution of individuals and communities (human and beyond). Relational values came about as an alternative to intrinsic and instrumental values. Relational values and non-material values are not synonymous; "non-material values – as from cultural services or non-material contributions to people – can be relational and/or instrumental, and material benefits can have relational values" (Chan, Gould, & Pascual, 2018).

including jobs off farm. After all, a considerable amount of fertile cropland currently sits idle and ready to employ such technologies.

Another key finding is that limited data cloud the story of Hawaiʻi agriculture. As a result, some statistics should be interpreted with caution. As we presented in the context of agricultural sales over time, it matters which index is used to deflate nominal dollars. We see important differences in the magnitude of sales when using the CPI or PPI to adjust for inflation and a more substantial decline when deflating by the CPI. While some of these differences tell an important part of the underlying economic story, measurement is still obscured by a PPI that likely does a poor job of reflecting prices of Hawaiʻi's specific agricultural products. As is true of U.S. agriculture, simple measures of average farm size such as the mean or median derive from the antiquated definition of a farm and take poor account of the highly skewed distribution of agricultural production (MacDonald, Hoppe, & Newton, 2018). If one only considers the growth in number of Hawaiʻi farms, this trend excludes the production distribution, the exit of the large plantations, and, ultimately, the evidence of a declining agricultural economy.

As we point out, there are large sample errors in the estimates as well, leading to uncertainty. The Census intends to measure the *population*, but coverage, non-response, and misclassification adjustments are made to the estimates which affect the reliability of the dataset. In 2017, number of farms, land in farms, and sales in Hawaiʻi were adjusted by 47.4, 6.3, and 10.3 percent, respectively (USDA-NASS, 2017).[8]

More detailed data that are collected consistently over time and across the same metrics would enable better analysis. For example, Hawaiʻi is excluded from the Agricultural Resource Management Survey (ARMS) which "the U.S. Department of Agriculture's primary source of information on the production practices, resource use, and economic well-being of America's farms and ranches. The results of this survey give farmers, ranchers, and many others factual insights into many aspects of farming, ranching, and conditions in agricultural communities" (USDA-ERS, 2020). Furthermore, the *Statistics of Hawaiʻi Agriculture* books have not been published since 2011 (USDA-NASS, 2019) and there is no longer a NASS data lab in Hawaiʻi in which the Census micro data can be accessed securely. Other data such as state-specific prices could facilitate demand analysis and improved productivity measures. An investment in a Hawaiʻi-specific data collection and research effort may lead to additional quantitative insights into Hawaiʻi's agricultural economy. An effort to collect more or better data is likely an achievable short-term goal to better understanding the agricultural economic landscape in Hawaiʻi and where future opportunities may lie.

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8 Standard errors for the data series used in this brief are presented in Table A.1.

APPENDIX

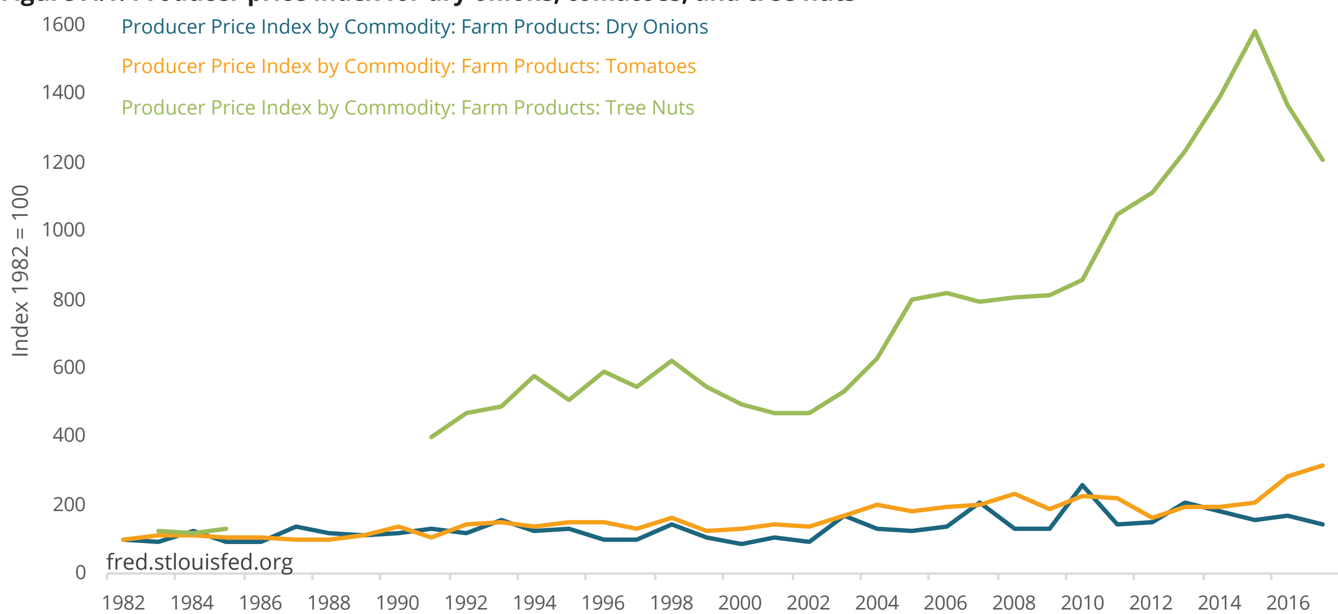
Table A.1 Estimates of reliability for Hawaiʻi, 1982-2017

	All farms		Land in farms		Sales	
Year	Total (number)	Relative standard error of estimate (percent)	Total (acres)	Relative standard error of estimate (percent)	Total ($1,000)	Relative standard error of estimate (percent)
2017	7,328	7.6	1,135,352	3.8	563,803	17.1
2012	7,000	11.4	1,129,317	4.0	661,347	4.1
2007	7,521	3.3	1,121,329	1.9	513,626	2.0
2002	5,398	0.5	1,300,499	0.2	533,423	0.2
1997	5,473	0.7	1,439,071	0.1	496,935	0.1
1992	5,336	1.5	1,588,843	0.1	522,054	0.2
1987	4,870	0.5	1,721,521	0.1	609,740	0.1
1982	4,595	0.7	1,957,501	2.2	558,608	0.2

Source: USDA-NASS (2021a). Census of Agriculture Appendix A (1982, 2007, 2012, 2017) and Appendix C (1987, 1992, 1997, 2002).

Note. The relative standard error of the estimate was reported as a percentage in years 1982-1997 and as a value in 2012-2017 so these were converted to a percentage. There were standard errors of the estimate reported for total farm production expenses in 1997 and 1992 and for selected farm production expenses in 1982 and 1987, but not for 2017 which is the year of data reported in Table 1.

Figure A.1. Producer price index for dry onions, tomatoes, and tree nuts



Note. A macadamia nut producer price index is available, but is not consistent with the time period or index as the other crops. Therefore, we use the tree nuts PPI instead.

Figure A.2. Consumer price index for all items in urban Hawai'i and producer price index for farm products, 1982-2017

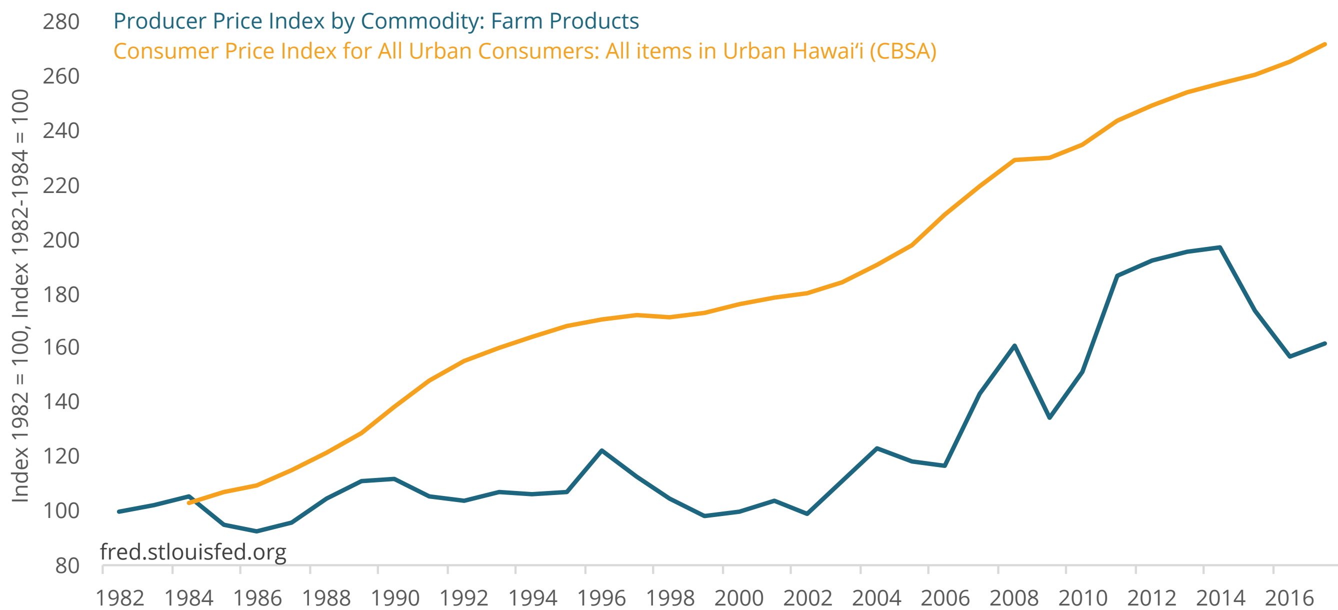


Table A.2. Comparison of real agricultural sales data using a consumer price index (CPI) and producer price index to deflate nominal dollars, 1982-2017

			1982	1987	1992	1997	2002	2007	2012	2017	1982-2017
Farm size class	**Deflator**	**Index year**	**Million dollars in sales**								**Percentage change**
Small (<$100,000)	CPI: All Items in Urban Hawai'i	1982-84	50.9	52.0	37.7	38.0	36.2	33.7	31.7	29.8	-41%
Midsize ($100,00-499,999)	CPI: All Items in Urban Hawai'i	1982-84	54.6	51.1	45.8	41.1	41.0	35.8	30.2	28.3	-48%
Large-scale ($500,000+)	CPI: All Items in Urban Hawai'i	1982-84	452.7	427.5	272.4	210.1	218.7	164.5	203.1	149.1	-67%
Small (<$100,000)	PPI: Farm Products	1982	50.9	62.6	56.5	57.8	65.9	51.5	41.1	50.2	-2%
Midsize ($100,00-499,999)	PPI: Farm Products	1982	54.6	61.5	68.5	62.5	74.7	54.8	39.2	47.6	-13%
Large-scale ($500,000+)	PPI: Farm Products	1982	452.7	514.4	407.9	319.8	398.3	251.9	263.3	250.6	-45%

Source: Authors' calculations using USDA-NASS (2017), DOL-BLS (2021b), and DOL-BLS (2021c).

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