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Puerto Rico's Agricultural Economy in the Aftermath of Hurricanes Irma and Maria: A Brief Overview

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Xuan Pham, Angel Terán, and James Kaufman





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Puerto Rico's Agricultural Economy in the Aftermath of Hurricanes Irma and Maria: A Brief Overview

Bart Kenner, Dylan Russell, Constanza Valdes, Andrew Sowell, Xuan Pham, Angel Terán, and James Kaufman

Abstract

This study provides a broad overview of Puerto Rico's agricultural sector, with an emphasis on observable changes between 2012 and 2018. In 2017, Hurricanes Irma and Maria caused severe damage in Puerto Rico, particularly affecting smaller farms with sales under \$20,000 per year. Subsequently, the number of farms smaller than 10 acres decreased by more than 50 percent, and the number of farms with 10–49 acres fell by almost one-third. Crop sales in Puerto Rico decreased by \$82 million from 2012 to 2018, with decreases occurring most notably for plantains (-\$54 million), coffee (-\$30 million), vegetables and melons (-\$23 million), and fruits and coconuts (-\$19 million).

Keywords: Puerto Rico, farm income, agricultural trade, trade, export, import, coffee, dairy, risk management, recovery, hurricane

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Contents

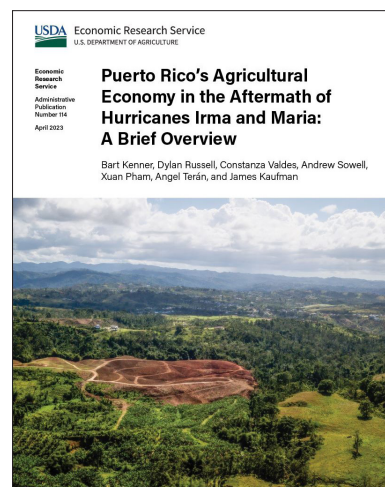
Summary	iii
Introduction	1
Overview of the Puerto Rico Agricultural Sector	2
Hurricane Maria’s Significant Impact on Puerto Rico’s Agricultural Sector	5
Cash Receipts and Farm Income, 2012 and 2018.	6
Gross Cash Income	8
Cash Receipts from Crop Sales	9
Cash Receipts from Livestock, Poultry, and Related Products	10
Cash Farm-Related Income	11
Cash Farm Expenses	12
Net Cash Farm Income	13
Dairy Industry in Puerto Rico	15
Puerto Rico’s Agriculture and Related Exports	16
Consumer-Oriented Products	17
Intermediate Agricultural Products	21
Agricultural-Related Products	22
Bulk Exports	23
Imports	23
Puerto Rico’s Coffee Sector	25
USDA’s Shade-Grown Coffee Initiative	27
Conclusion	28
References	28

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What Is the Issue?

Relative to its other economic sectors, the agricultural sector of Puerto Rico—a U.S. territory—is comparatively small, making up only a fraction of 1 percent of the island's gross domestic product (GDP) in 2020. In the past, Puerto Rico's agricultural industry had more economic significance, surpassing 40 percent of the island's GDP in the mid-1930s. A limited amount of Puerto Rico's agricultural production is exported, with the European Union (EU) and Canada receiving the most exports. Since the early 2000s, the agricultural sector has received boosts from policy initiatives to decrease the island's reliance on food imports. Even with incentives to increase production, agriculture generally provides a small share of farm household income, and few Puerto Rican households are fully reliant on farming. In September 2017, Hurricanes Irma and Maria caused major disruptions, destroying Puerto Rico's agricultural harvest and infrastructure, with long-lasting effects on the makeup of its agricultural sector. This report examines the resulting changes in Puerto Rico's agricultural sector between 2012 and 2018, based on statistics collected under the 2017 *Census of Agriculture, Puerto Rico (2018)*.



What Did the Study Find?

Puerto Rico's agricultural sector is adjusting to the devastation left by Hurricanes Irma and Maria in 2017 through production and business decisions consistent with the options and resources available to individuals and firms, including Government support.

Hurricane damages are reflected in the difference between 2012 and 2018 agricultural census data:

- Between 2012 and 2018, total farm sales fell \$170 million (26 percent), from \$655 million to \$485 million (adjusted for inflation), with large declines in bananas, coconuts and other fruits, coffee, and poultry.
- Crop sales decreased by \$82 million, falling in 8 of the 10 commodity groups for which crop sales are recorded.

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- Poultry and poultry products suffered the greatest percentage decline in sales among livestock, poultry, and animal products (58 percent). The inflation-adjusted dollar value of reduced sales in poultry and poultry products was \$28 million.
- Sales of milk and other dairy products declined 24 percent to \$54 million (adjusted for inflation).
- Despite the decline in sales, net cash farm income increased from \$15 million in 2012 to \$21 million in 2018. However, much of the gain was due to increased Federal Government payments for participation in farm programs. Payments more than doubled, from \$42 million in 2012 to \$86 million in 2018.

Overall, between agricultural census years 2012 and 2018, the number of farms declined by 37.5 percent and acreage under cultivation by 16.6 percent, a loss of 4,929 farms and 97,213 acres. The losses were particularly felt by smaller farms of less than 10 acres, whose numbers decreased by more than half.

Agricultural exports were also affected. Traditionally, the bulk of Puerto Rico's agricultural exports are concentrated in a small group of high-value products. The most significant include food preparations, distilled spirits, and essential oils.

- Agricultural and related exports dropped in value from a high of \$352 million in 2016 to just \$191 million in 2020.
- The largest destination markets have been the European Union and Canada. The value of exports to Canada fell by 60 percent from 2011–20, while shipments to the European Union (EU-27) rose 66 percent.
- Tobacco exports, which had accounted for more than 85 percent of bulk exports fell by 99 percent from 2017 to 2018 and remained low in the years since.
- Exports of processed fruit nearly doubled (up 98 percent) from 2011–20.

Among more resilient crops, coffee farming has remained a dominant land use and an important source of economic activity for thousands of farmers in the central highlands of the island, providing employment to thousands of hired workers.

- Despite hurricane damage, coffee cultivation continued partly because it is mostly grown in the center of the island and was relatively less affected by the hurricanes. More important, however, is its transformation from shade-grown cultivation to sun-grown coffee.

Medium-sized farms accounted for the bulk of total coffee sales (41 percent) in 2018, while small-farm share of the value of coffee sales was 35 percent—up from 14 percent in the early 1980s.

How Was the Study Conducted?

The primary source of detailed agricultural production data in Puerto Rico is the U.S. Department of Agriculture, National Agricultural Statistics Service (NASS), Census of Agriculture, conducted every 5 years. The Puerto Rico Department of Agriculture and NASS collect survey data directly from farmers. At the time this analysis was conducted, the most recent census data available was taken in 2018, delayed a year because of hurricane disruptions in 2017. Trade data for Puerto Rico was collected from the U.S. Department of Commerce, Bureau of the Census' State Data Series. Vital information providing historical and regional context was provided by members of Puerto Rico's Government and academic and private research institutions.

Puerto Rico's Agricultural Economy in the Aftermath of Hurricanes Irma and Maria: A Brief Overview

Introduction

Relative to other economic sectors, the agricultural sector of Puerto Rico—a U.S. territory—is comparatively small. Agriculture, combined with forestry and fishing, accounted for 0.6 percent of the island's gross domestic product (GDP) in 2020 (World Bank, 2022). As of 2017, Puerto Rico's agriculture sector was producing approximately 15 percent of the island's total food needs, with the other 85 percent supplied by imports (Bond et al., 2020).

A limited amount of Puerto Rico's agricultural production is exported, with a value reaching \$180 million in 2020, reported by the U.S. Department of Commerce, Bureau of the Census' (Census) State Data Series. Historically, Canada has been the largest purchaser of Puerto Rico's international agricultural exports. However, Canada was surpassed by the European Union in 2020 as exports to Canada declined significantly. Trade with the United States is conducted between the ports of Jacksonville, Florida, and the island's main port in San Juan. Both ports are exposed to hurricane risk, presenting seasonal exposure to negative shocks.

In the past, Puerto Rico's agricultural industry had more economic significance, reaching a peak of 45 percent of the island's GDP in 1934 (Bond et al., 2020). When the Industrial Incentives Act of 1947 was passed by the legislature of Puerto Rico, a portion of the legislation known as "Operation Bootstrap" provided tax-free benefits for industrial investment. These benefits, along with other financial backing for rapid industrial development, resulted in major economic shifts. As a result of changing investment and economic opportunities, the value of agricultural production fell to 1 percent of GDP by 2000, and the bulk of Puerto Rican exports comprised industrial materials and pharmaceuticals.

Pivoting Puerto Rico's economy away from agricultural dependence and toward more integrated and balanced industrialization was the core aim of Operation Bootstrap. This legislation was a key contributor to the following decline in the sugar industry, which had been the largest export sector on the island. Sugar production in Puerto Rico peaked in 1952 and declined throughout the 1960s. Another barrier to agricultural development in Puerto Rico is the Jones Act of 1920. This legislation requires shipping from points in the United States to be conducted through a shipping company owned by U.S. citizens, on a ship that was constructed in the United States, and operated with at least 75 percent U.S. citizen crewmembers (Bond et al., 2020).

Beginning in the new century, Puerto Rico's agricultural sector has received boosts from policy initiatives to decrease the island's reliance on food imports. Even with incentives to increase production, however, agriculture generally provides a small share of Puerto Rican farm household income, and few households are fully reliant on farming. In 2012, only 16.7 percent of farmers received 75 percent or more of their income from farming. That figure remained nearly unchanged in the 2018 census, which reported 16.9 percent of farmers receiving 75 percent or more of their income from farming.

In September 2017, Hurricanes Irma and Maria caused major disruptions, destroying Puerto Rico's agricultural harvest, operations, and infrastructure, with long-lasting effects on the makeup of the territory's agricultural sector. The destruction of crops led to an exodus of farmworkers, which hampered the sector's ability to recover to its previous levels. Those who continued the work of agricultural production were left to reconsider—and often to change—the types of products they could produce with the resources that remained.

The lower levels of agricultural exports in 2018 and 2019 compared to previous years can be largely attributed to lingering damages from Hurricanes Irma and Maria. The destruction of crops and exodus of farm workers from the profession has hampered the ability of the agricultural sector to recover. This report examines and highlights the observable changes to Puerto Rico’s agricultural sector in the aftermath of the 2017 hurricanes.

Overview of the Puerto Rico Agricultural Sector

The primary source of detailed agricultural production data in Puerto Rico is the USDA, National Agricultural Statistics Service (NASS), *Census of Agriculture*, conducted every 5 years. The census collects data directly from farmers by the Puerto Rico Department of Agriculture and NASS. At the time this analysis was conducted, the most recent census data available was taken in 2018, delayed by a year because of hurricane disruptions in 2017. The most disaggregated level of reporting in the census is the agricultural region, which is made up of municipios (municipalities). Figure 1 shows the municipios grouped by agricultural region for 2018.

Figure 1
Puerto Rico's agricultural regions



Note: Agricultural regions determined by representations from the Puerto Rico Department of Agriculture and municipio boundaries from U.S. Census.

Source: USDA, Economic Research Service using USDA, National Agricultural Statistics Service, 2017 *Census of Agriculture: Puerto Rico (2018) Island and Regional Data*.

The value of Puerto Rico’s agricultural production in 2018 was \$485 million, measured by farm cash receipts from the sale of crops, livestock, and animal products (U.S. Department of Agriculture, 2018). The regions of Arecibo and Ponce accounted for over half of all agricultural production in Puerto Rico in 2018. Figure 2 shows farm cash receipts by agricultural regions for 2018. The majority of crop sales are clearly attributed to the Ponce region, which has the most effective irrigation infrastructure and desirable soil for crop production.

Figure 2
Total farm receipts for Puerto Rico, 2018



Note: Agricultural regions determined by representations from Puerto Rico Department of Agriculture and municipio boundaries from U.S. Census.

Source: USDA, Economic Research Service using USDA, National Agricultural Statistics Service, 2017 *Census of Agriculture: Puerto Rico (2018) Island and Regional Data*.

The total value of agricultural sales in 2018 was divided almost equally between crops and livestock. Figures 3 and 4 show farm receipts for both sectors. Milk, primarily produced in the Arcibo region, was the main agricultural product in Puerto Rico in 2018, with \$172.2 million in sales, followed by grains and other field crops (\$74.4 million) and bananas (\$42.3 million). About half (50.8 percent) of the sales value of all agricultural products sold in 2018 originated from milk, grains, and other field crops.

Figure 3
Total farm receipts for crop sales, 2018



Note: Agricultural regions determined by representations from Puerto Rico Department of Agriculture and municipio boundaries from U.S. Census.

Source: USDA, Economic Research Service using USDA, National Agricultural Statistics Service, 2017 *Census of Agriculture: Puerto Rico (2018) Island and Regional Data*.

Figure 4
Total farm receipts for livestock sales, 2018



Note: Agricultural regions are determined by representations from the Puerto Rico Department of Agriculture and municipio boundaries shown in the map from U.S. Census.

Source: USDA, Economic Research Service using USDA, National Agricultural Statistics Service, 2017 *Census of Agriculture: Puerto Rico (2018) Island and Regional Data*.

In 2018, Puerto Rico had 8,230 farms operating on 487,775 acres of agricultural land, or about 21.6 percent of the island's total land area. Approximately 75 percent of farms in Puerto Rico were under 50 acres, and half of the farms reported agricultural sales of less than \$5,000 per year; only about 1,000 farms had \$60,000 or more per year in agricultural sales.

A wave of efforts over the last decade aimed to improve the infrastructure and profitability for small farms in Puerto Rico. Those farms are likely vital to the resurgence of Puerto Rican agricultural production, with farms under 100 cuerdas¹ making up 85 percent of the farms and one-third of the farmland area in the territory (U.S. Department of Agriculture, 2018). Programs are underway to improve the ability of farms to report key statistics necessary to apply for grants and other programs. Other programs are targeted at revitalizing specific commodity production such as coffee and plantains (Acevedo, 2021).

Hurricane Maria's Significant Impact on Puerto Rico's Agricultural Sector

Puerto Rico sustained direct hits from Hurricanes Irma and Maria in September 2017. Maria's impact was especially catastrophic. In total, it is estimated that the hurricane destroyed over 80 percent of Puerto Rico's 2017 agricultural crop value—an estimated \$780 million in total losses. Plantain, banana, and coffee harvests were most affected. Twelve days before Hurricane Maria made landfall, Puerto Rico was hit by Hurricane Irma, resulting in cumulative storm damages. The back-to-back hurricanes caused lasting devastation and claimed over 2,975 lives in Puerto Rico and the U.S. Virgin Islands. Maria was the strongest storm to hit Puerto Rico since 1928. After the devastation of the 2017 hurricanes, Puerto Rico sustained further catastrophic damage from numerous severe earthquakes in January 2020. The effects of the earthquakes are not covered in this report as sufficient data are not available to evaluate their impact on the agricultural sector.

Damages of the hurricanes are reflected in the difference between 2012 and 2018 agricultural census data (delayed from 2017 due to severe damage to the infrastructure and communications network on the island). Prior to the hurricanes, agriculture in Puerto Rico was growing on a year-over-year basis. Between 2012 and 2018, however, total farm sales fell \$170 million (26 percent), from \$655 million to \$485 million (adjusted for inflation), with large declines in the sales of bananas, coconuts and other fruits, coffee, and poultry. The number of farms declined by 37.5 percent, a loss of 4,929 farms, and total acres in agriculture declined by 16.6 percent, a loss of 97,213 acres. Hurricane losses particularly affected smaller farms with sales under \$20,000 per year. The number of farms under 10 acres decreased by more than half, and the number of farms with 10–49 acres fell by almost a third.

The severe losses because of back-to-back hurricanes intensified concerns about the increased frequency and severity of tropical storms due to climate change. As a result, calls for hurricane resilience have been elevated in recovery planning. Ideas on specific implementations have been proposed, such as *Opportunities and Challenges for Hurricane Resilience on Agricultural and Forest Land in the U.S. Southeast and Caribbean* (Wiener et al., 2020).

Resilience planning suggests that Puerto Rican farmers can diversify crops and seek additional investment in insurance to mitigate financial risks. In addition, rapid response and efficient support plans ready for activation in the wake of the next major hurricane could bring faster relief and mitigate long-lasting damages made worse by delays. In rural areas, obstacles to taking full advantage of such programs resulted from farmers' lack of resources for detailed recordkeeping, grant and application submission, and carrying out appeals. Recent increases in extension workshops and seminars may help to address some of these issues.

¹ In Puerto Rico, a cuerda is a traditional unit of land area. The term "Spanish acre" has sometimes been used; a cuerda and an acre are often treated as equal because they are nearly the same size. 1 cuerda = 0.971 acre.

Cash Receipts and Farm Income, 2012 and 2018

Hurricane impacts are also apparent in producer gross cash income data (table 1). Gross cash income for Puerto Rico's farms comprises cash receipts from the sale of agricultural commodities, cash from farm-related income, and participation in Government farm programs. From 2012 to 2018, gross cash income fell 19 percent in inflation-adjusted dollars from \$718 million to \$585 million, but the number of farms reporting gross cash income dropped by 37 percent. As a result, the average net cash income of farms increased by 36 percent between 2012 and 2018. Some of that increase is due to participation in Government programs. The \$170 million decline in commodity receipts and \$6 million decline in farm-related income were countered by a doubling of Government payments from \$42 million to \$86 million. However, the number of farms reporting Government payments due to losses from Hurricanes Irma and Maria increased by only 3 percent in 2018. Government payments from the Wildfire and Hurricane Indemnity Program (WHIP), one of several programs included in the \$86 million stated in the 2017 *Census of Agriculture*, were largely made in 2019, with only \$20 million of the cumulative \$201 million paid in 2018 (U.S. Department of Agriculture, Farm Service Agency, 2021).

Table 1

Gross cash receipts, expenses, and net farm income for Puerto Rico, 2012 and 2018

	2012		2018		Percent change 2012–18	
	Dollars	Farms	Dollars	Farms	Dollars	Farms
Gross cash receipts	717,895,958	13,159	585,011,156	8,230	-19	-37
All commodity receipts	655,180,286	13,159	485,053,483	8,230	-26	-37
Crops sold	324,606,049	9,367	242,419,442	3,877	-25	-59
Coffee	35,022,336	4,478	4,772,608	1,363	-86	-70
Pineapples	2,280,022	42	2,976,971	90	31	114
Plantains	96,315,925	3,628	42,271,955	1,353	-56	-63
Bananas	14,483,912	1,474	10,829,957	801	-25	-46
Grains or field crops ¹	10,216,159	781	74,399,421	317	628	-59
Root crops or tubers	9,800,834	1,242	8,705,814	770	-11	-38
Fruits and coconuts	37,735,732	1,926	18,594,300	858	-51	-55
Vegetables and melons, including hydroponic crops	56,392,087	1,528	33,533,195	750	-41	-51
Hydroponic crops	12,552,425	213	8,701,107	219	-31	3
Nursery and greenhouse crops, floriculture, and sod	44,905,274	657	34,853,304	303	-22	-54
Grasses, except lawn grass	17,453,768	532	11,481,917	282	-34	-47
Livestock, poultry, and their products	330,574,237	4,119	242,634,041	3,074	-27	-25
Cattle and calves	40,205,514	2,911	37,689,466	2,305	-6	-21
Poultry and poultry products	48,305,367	706	20,094,625	409	-58	-42
Milk and other dairy products from cows	226,627,327	318	172,208,134	281	-24	-12
Hogs and pigs	9,594,187	532	6,215,392	423	-35	-20
Aquaculture	823,091	51	136,396	37	-83	-27
Other livestock and livestock products	5,018,750	630	6,290,028	490	25	-22
Cash farm-related income	20,420,938	2,955	14,209,647	2,840	-30	-4
Customwork	13,505,587	464	2,685,707	232	-80	-50
Renting of farmland	2,879,479	216	3,349,759	315	16	46
Sale of farm by-products or waste	731,427	43	615,434	37	-16	-14

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Table 1

Gross cash receipts, expenses, and net farm income for Puerto Rico, 2012 and 2018

	2012		2018		Percent change 2012–18	
	Dollars	Farms	Dollars	Farms	Dollars	Farms
Agritourism and recreational services	99,661	11	230,843	26	132	136
Other farm-related income	3,204,784	248	7,327,904	249	129	0
Government payments	42,294,734	2,241	85,748,026	2,299	103	3
Cash expenses	594,059,398	10,983	499,733,946	7,140	-16	-35
Livestock, poultry, and fish purchased	29,320,304	2,168	28,366,752	1,866	-3	-14
Feed purchased for livestock, poultry, and fish	128,615,410	4,418	95,969,743	3,217	-25	-27
Medicines and drugs purchased for livestock and poultry	9,602,550	3,887	7,277,951	2,939	-24	-24
Veterinarian services	2,736,502	1,336	2,268,590	1,213	-17	-9
Professional services	6,908,720	2,708	5,114,395	2,622	-26	-3
Seeds, bulbs, plants, and trees purchased	13,759,036	4,636	10,330,620	2,434	-25	-47
Commercial fertilizer purchased	21,327,604	7,696	11,602,168	4,123	-46	-46
Gasoline and other fuel and oil products purchased	30,173,882	10,983	19,061,938	7,140	-37	-35
Wages and salaries paid to employees or hired farm workers	201,166,148	8,337	132,535,383	5,857	-34	-30
Contract labor	3,412,489	657	10,888,723	514	219	-22
Machine hire and customwork	10,826,795	2,979	6,228,016	1,965	-42	-34
Agricultural chemicals purchased	19,572,366	6,999	13,174,040	3,572	-33	-49
Machinery and equipment repair and maintenance	15,174,392	3,034	11,766,572	2,274	-22	-25
Building repair and maintenance	7,185,527	1,185	16,487,336	1,184	129	0
Water	2,724,698	2,241	2,408,768	1,617	-12	-28
Electricity	16,932,511	4,750	9,888,009	2,412	-42	-49
Interest	19,880,988	4,712	10,804,855	1,901	-46	-60
Depreciation	N/A	N/A	42,246,664	2,783	N/A	N/A
All other expenses	54,739,476	8,954	63,313,423	4,630	16	-48
Net cash farm income	15,495,292	10,983	21,035,880	7,140	36	-35

Note: 2012 values are adjusted for inflation with base year of 2018. Farms is the number of farms reported. Where number of farms were not reported for category totals, the largest number of farms reported for a subcategory was used. Net farm income is calculated by adjusting the gross cash income to be comparable to the number of farms reporting expenses before subtracting expenses from gross farm income.

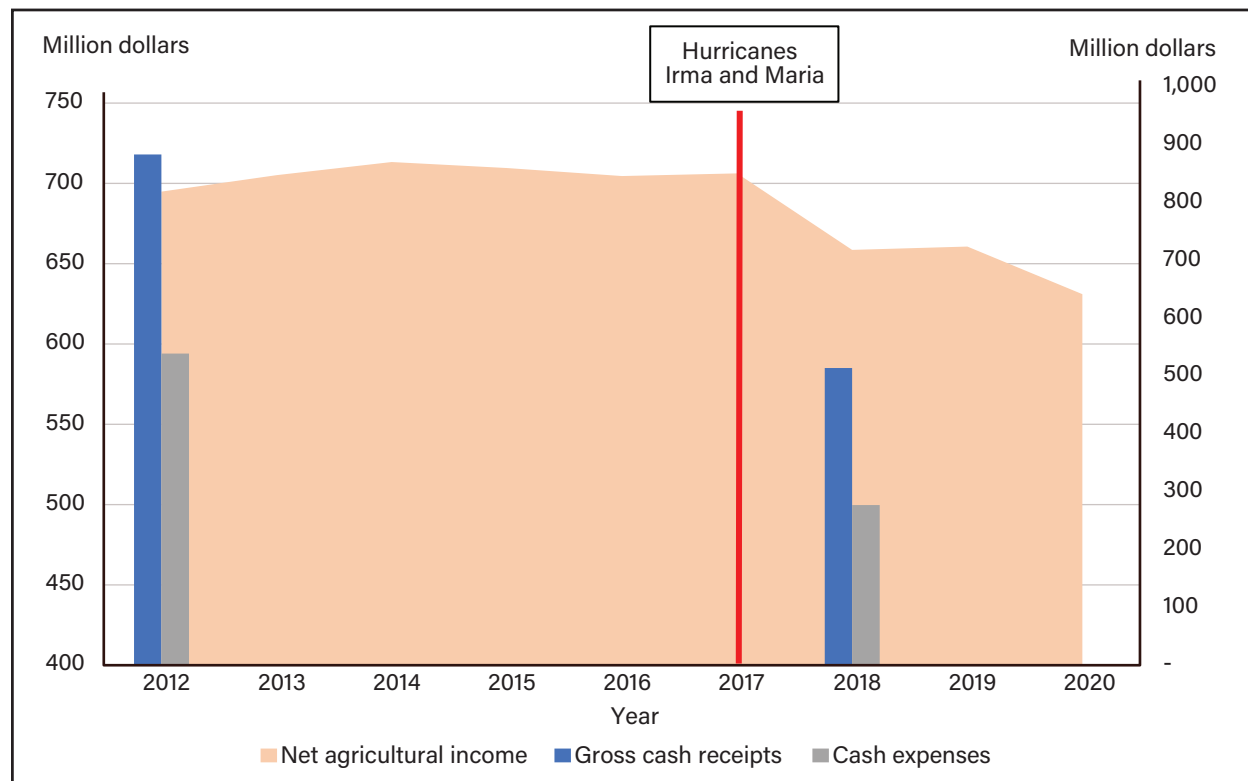
¹"Grains or field crops" consists of pigeon peas, dry beans, green beans, corn for seed, soybeans, cotton for seed, rice and rice seeds, sugarcane for sugar, sunflower seeds, wheat for grain or seed, and other field crops.

Source: USDA, Economic Research Service compilation and calculation using USDA, National Agricultural Statistical Service, 2017 *Census of Agriculture: Puerto Rico (2018) Island and Regional Data* and United States Department of Labor, Bureau of Labor Statistics, *Producer Price Indexes*.

Cash expenses for Puerto Rican farms decreased between 2012 and 2018 by 16 percent, from \$594 million to \$500 million. After adjusting gross cash income values downward to be comparable to cash expense values in terms of the number of reporting farms, calculated net farm income reflects the rise in revenues and decline in cash expenses, increasing from \$15.5 million in 2012 to \$21.0 million in 2018. That is, net farm income rose 36 percent because of both the decrease in the number of farms reporting and the increase in Government payments.

To depict how farm revenues—and therefore gross cash farm income—may have fluctuated in the years between *Census of Agriculture* reports, figure 5 combines data sources to show net agricultural income for 2012 through 2018. The \$101 million decline in net income indicated by the solid area spanning from 2012 to 2020 in figure 5 reflects the net agricultural income reported by the Puerto Rico Planning Board. It shows a less dramatic decrease than the \$133 million decline in farm cash receipts (blue bars), based on USDA, NASS survey data collected for the *Census of Agriculture*.

Figure 5
Gross cash receipts and expenses, 2012 and 2018 (left axis), and net agricultural income (right axis), 2012 through 2020, for Puerto Rico



Note: Gross cash receipts and cash expenses for 2012 are adjusted for inflation with base year of 2018. Net agricultural income has not been adjusted for inflation.

Source: USDA, Economic Research Service compilation and calculation using USDA, National Agricultural Statistics Service, 2017 *Census of Agriculture, Puerto Rico (2018) Island and Regional Data*; U.S. Department of Labor, Bureau of Labor Statistics, *Producer Price Indexes*; Puerto Rico Planning Board, *Economic Report to the Governor 2020*.

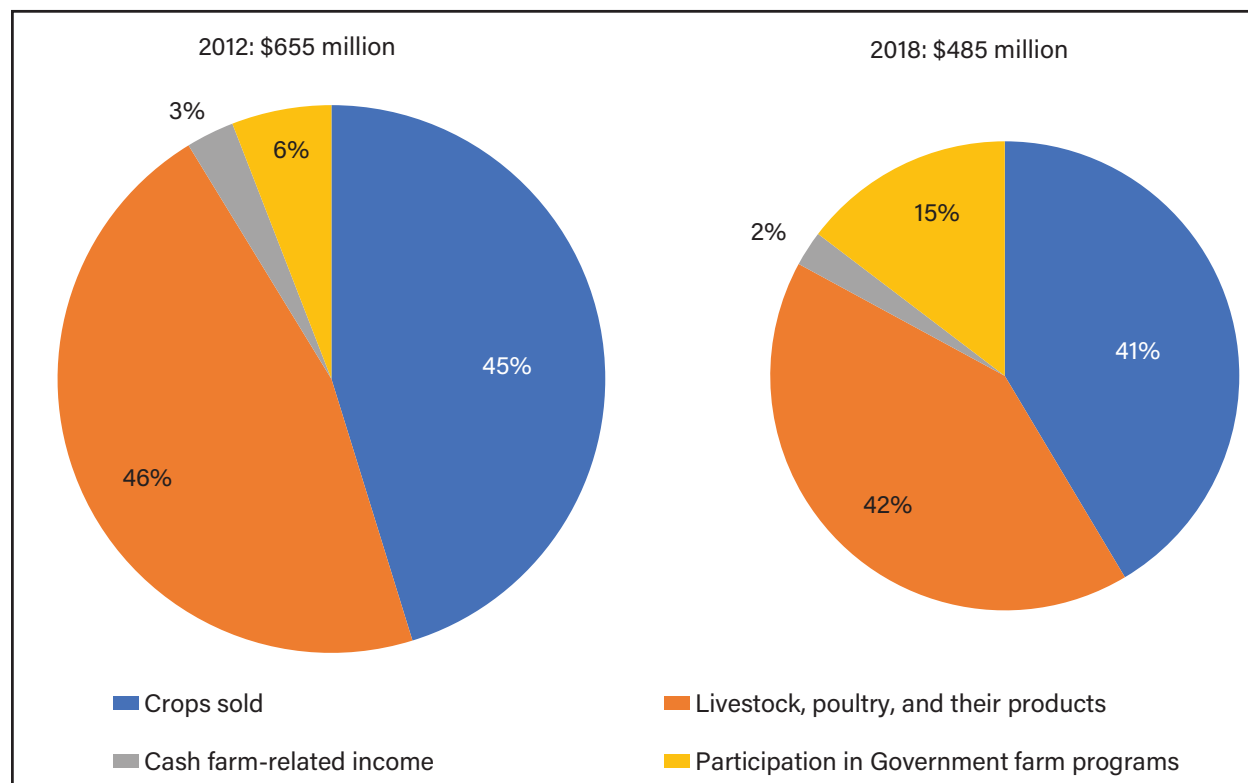
Simply subtracting total expenses from total gross income would overstate net farm income as more farms reported cash receipts than reported expenses in each of the *Census of Agriculture* reports. The additional farms reporting income likely had non-zero-value expenses as well. To correct for the difference in total number of farms reporting income versus farms reporting expenses, the difference in farms reporting expenses and cash receipts was multiplied by the average cash receipts, and that amount was subtracted from cash receipts before totaling gross farm income and subtracting expenses.

Gross Cash Income

Cash receipts from the sale of crops and livestock, poultry, and their products contributed similarly to make up 91 percent of gross cash farm income in 2012 and 82 percent in 2018. The main difference in the elements

of gross cash income over that period is the \$43 million growth in revenue from participation in Government farm programs, which increased that revenue stream's share of the gross cash income from 6 percent to 15 percent during the period.

Figure 6
Gross cash farm income for Puerto Rico, 2012 and 2018



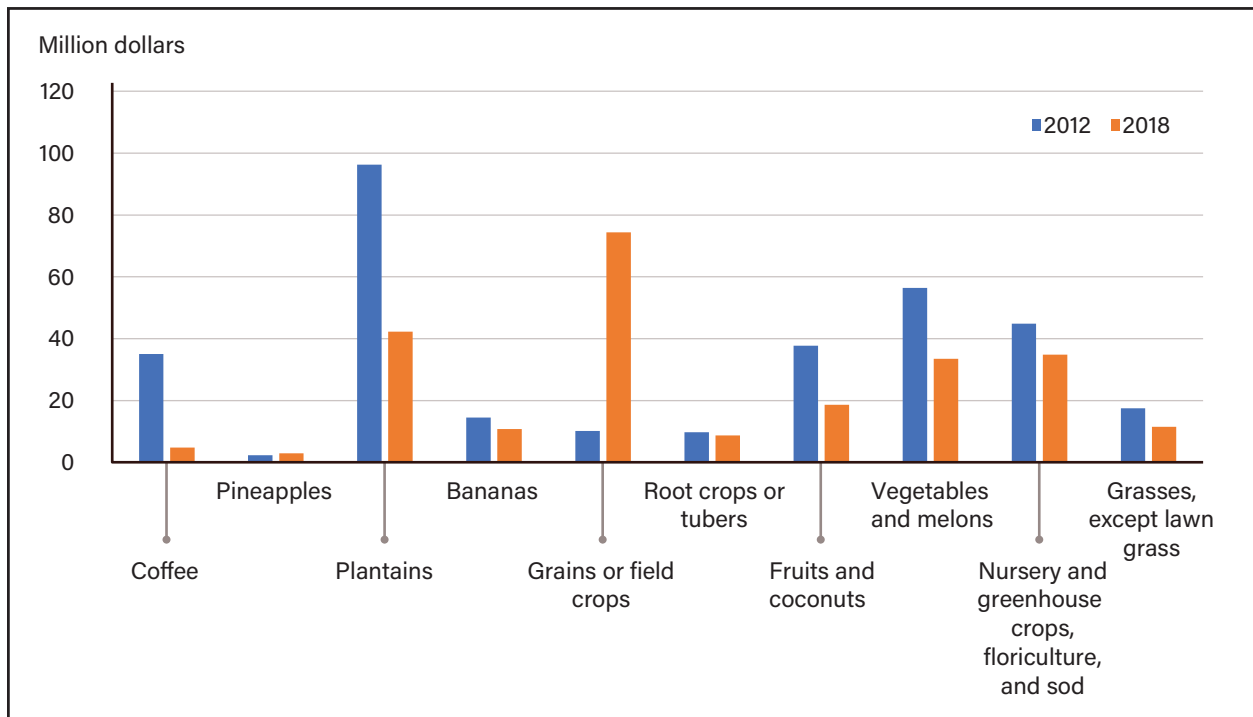
Note: 2012 values are adjusted for inflation with base year of 2018.

Source: USDA, Economic Research Service compilation and calculation using USDA, National Agricultural Statistics Service, 2017 Census of Agriculture, *Puerto Rico (2018) Island and Regional Data*, and U.S. Department of Labor, Bureau of Labor Statistics, *Producer Price Indexes*.

Cash Receipts from Crop Sales

Crop sales in Puerto Rico decreased by \$82 million from 2012 to 2018, with 8 of the 10 commodity groups decreasing (see figure 7 and table 1). The most notable decreases were for plantains (-\$54 million), coffee (-\$30 million), vegetables and melons (-\$23 million), and fruits and coconuts (-\$19 million). Notably, the most negatively affected commodities were tree crops, which require some years to return to profitable yields; destruction of these long-term agricultural investments was a substantial impact of the hurricanes. Only two crop-commodity groups increased in sales from 2012 to 2018. Pineapples, the crop least affected by the hurricanes, increased by \$0.7 million, and grains or field crops gained \$64 million, or 628 percent, in sales. The grains and field crops industry in Puerto Rico experienced high consolidation during the period, with 59 percent fewer farms reporting sales of any grains or field crops.

Figure 7
Cash receipts from crops sold in Puerto Rico, 2012 and 2018



Note: 2012 values are adjusted for inflation with base year of 2018.

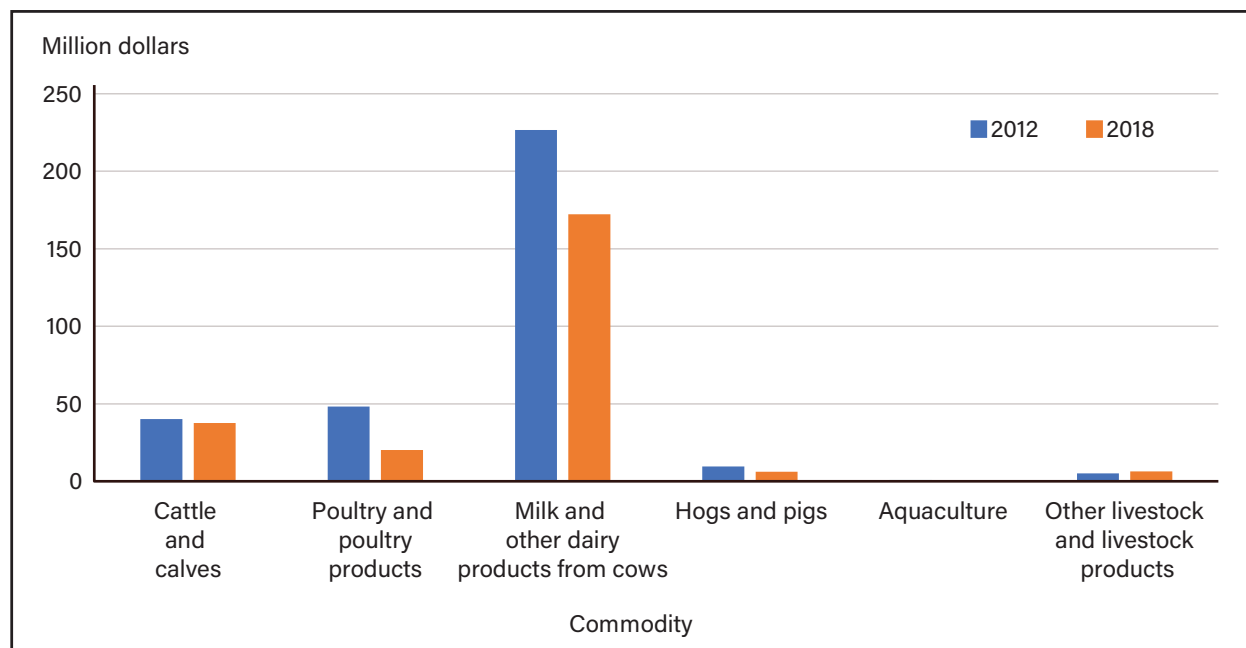
Source: USDA, Economic Research Service compilation and calculation using USDA, National Agricultural Statistics Service, 2017 Census of Agriculture, *Puerto Rico (2018) Island and Regional Data*, and U.S. Department of Labor, Bureau of Labor Statistics, *Producer Price Indexes*.

Cash Receipts from Livestock, Poultry, and Related Products

While poultry and poultry products suffered the greatest percentage decline in sales among livestock, poultry, and animal products (58 percent), the inflation-adjusted dollar value of the reduced sales of these products was only \$28 million, about half the \$54 million (24 percent) decline in milk and other dairy product sales.

Figure 8

Gross cash income from livestock and animal products sold in Puerto Rico, 2012 and 2018



Note: 2012 values are adjusted for inflation with base year of 2018.

Source: USDA, Economic Research Service compilation and calculation using USDA, National Agricultural Statistics Service, 2017 Census of Agriculture, *Puerto Rico (2018) Island and Regional Data*, and U.S. Department of Labor, Bureau of Labor Statistics, *Producer Price Indexes*.

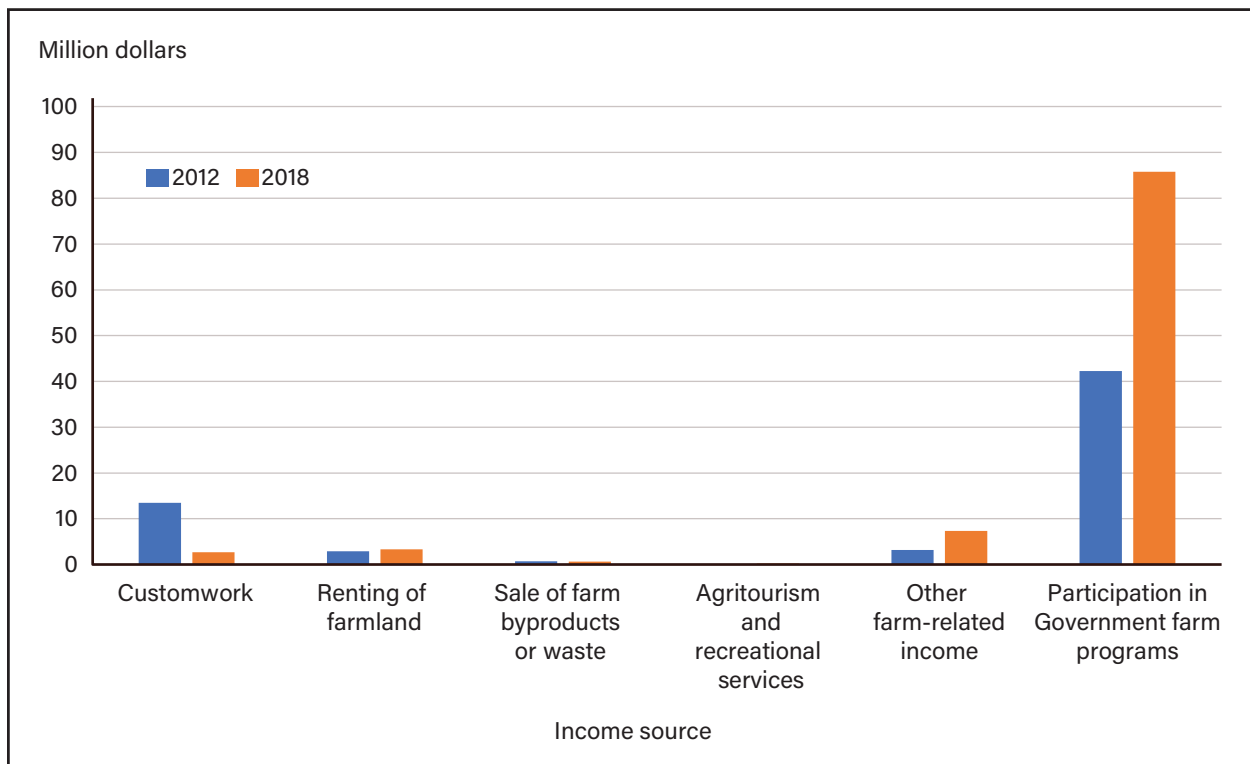
Despite the large decline in dairy sales, the dairy industry lost the smallest share of farms (12 percent) among the livestock, poultry, and animal product category in Puerto Rico. The territory has historically been less reliant on imports for dairy products than any other agricultural products, making the dairy industry particularly important to the island’s agricultural sector.

Poultry and poultry product farm numbers declined by the largest percentage (42 percent), and the rest of the livestock and animal product groups had reductions in farm numbers ranging from 20 percent to 27 percent.

Cash Farm-Related Income

Based on cash receipts, in 2012, Government payments for participation in farm programs (\$42 million) provided more than three times the amount of income than the next highest source—farm-related custom work (such as providing planting, plowing, spraying, and harvesting services for others). By 2018, after the damage sustained from Hurricanes Irma and Maria, Government payments more than doubled to \$86 million, while custom work revenues fell by 80 percent to \$3 million. Though much smaller, revenues from renting farmland and agritourism increased from \$2.8 million and \$0.1 million to \$3.3 million and \$0.2 million, respectively, and other farm-related income increased from \$3.2 million to \$7.3 million.

Figure 9
Gross cash farm-related income in Puerto Rico, 2012 and 2018



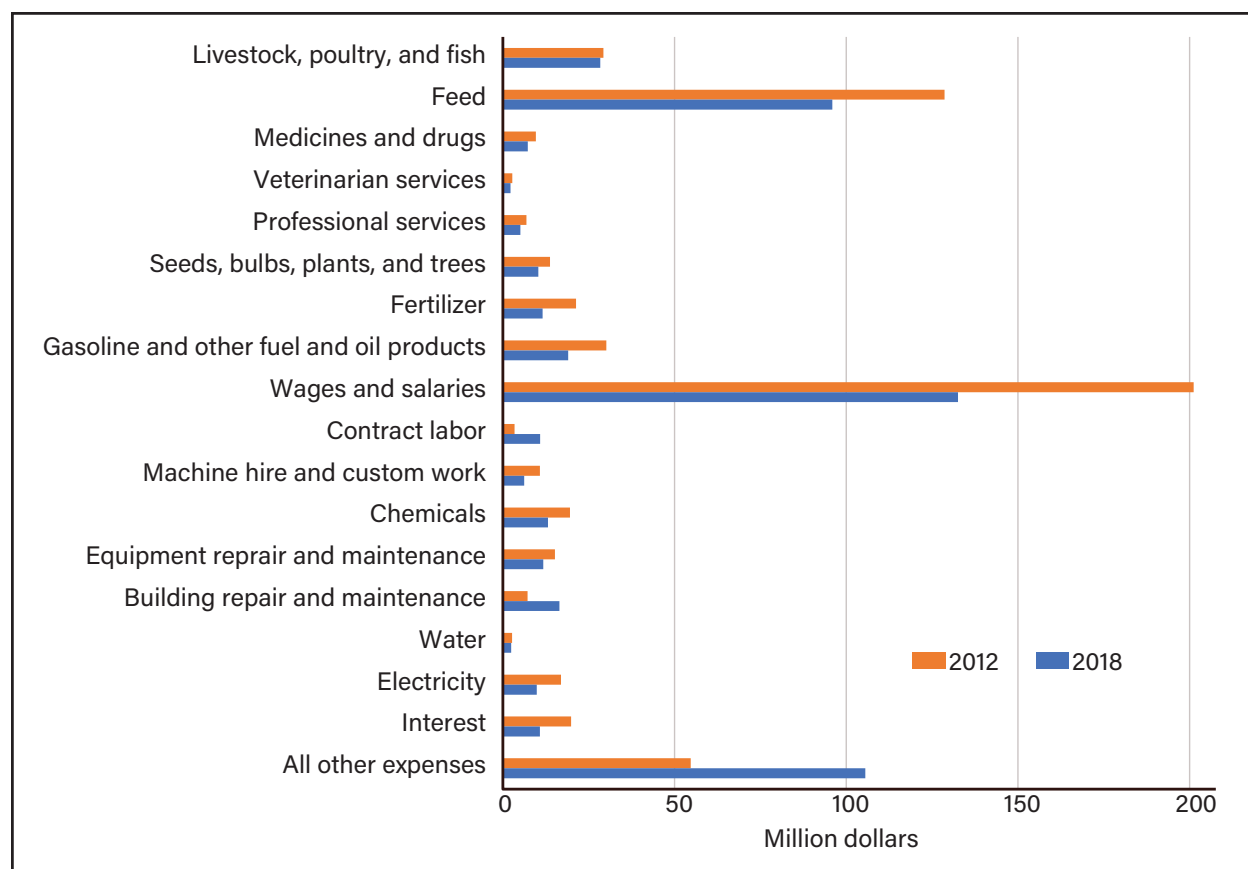
Note: 2012 values are adjusted for inflation with base year of 2018.

Source: USDA, Economic Research Service compilation and calculation using USDA, National Agricultural Statistics Service, 2017 Census of Agriculture, *Puerto Rico (2018) Island and Regional Data*, and U.S. Department of Labor, Bureau of Labor Statistics, *Producer Price Indexes*.

Cash Farm Expenses

In total, farm expenses in Puerto Rico dropped by \$94 million between 2012 and 2018 (figure 10). Almost every category of expenses decreased, with the largest declines recorded for wages and salaries (-\$69 million), feed costs (-\$33 million), and fuel costs (-\$11 million). In contrast, contract labor, such as for seasonal harvesting, increased from \$3 million to \$11 million (219 percent), though this increase was not enough to offset the total decline in wages and salaries, leaving overall labor expenses down by over \$60 million. Building repair and maintenance, the other category of cash expenses that increased, rose from \$7 million to \$16 million (129 percent), directly associated with hurricane recovery.

Figure 10
Farm expenses in Puerto Rico, 2012 and 2018



Note: 2012 values are adjusted for inflation with base year of 2018. Depreciation expense is included in all other expenses.

Source: USDA, Economic Research Service compilation and calculation using USDA, National Agricultural Statistics Service, 2017 Census of Agriculture, *Puerto Rico (2018) Island and Regional Data*, and U.S. Department of Labor, Bureau of Labor Statistics, *Producer Price Indexes*.

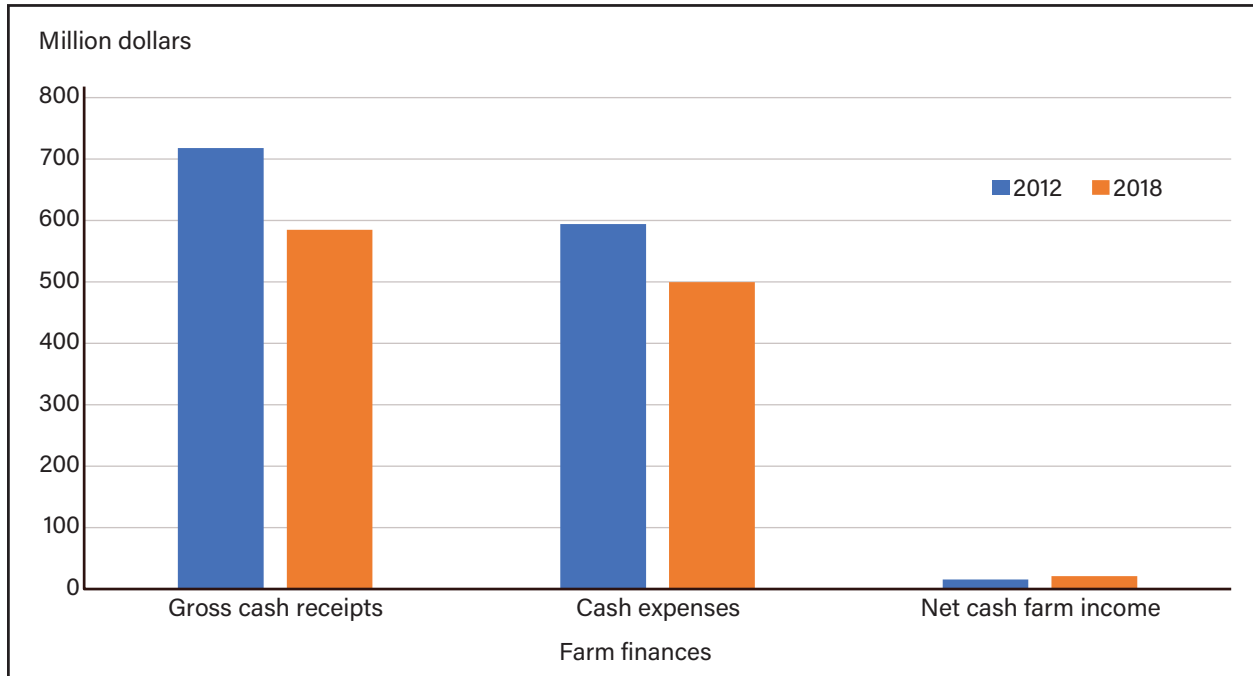
Net Cash Farm Income

Net cash farm income increased from \$15 million in 2012 to \$21 million in 2018 (figure 11). Net cash farm income is calculated by subtracting cash expenses from gross cash income. But because of the difference in the number of farms reporting cash receipts and the number reporting cash expenses in the *Census of Agriculture* reports, simply subtracting total cash expenses from gross cash farm income would overstate net farm income. To correct for this, the average cash receipt amount is multiplied by the difference in the number of farms reporting cash receipts and cash expenses, and that amount is subtracted from cash receipts before totaling gross cash farm income. Ideally, net cash farm income would be calculated for each individual farm. However, to protect the privacy of survey participants, all identifying information is unavailable, leaving no way to match individual farm income with expenses. Therefore, it is possible that this method may over- or understate total or average net income values.

Another limitation of the available data from the *Census of Agriculture* is the inclusion of depreciation as a specified production expense for farms in 2018, but not for 2012. With the extensive damage caused by hurricanes Irma and Maria, depreciation was a considerable expense in 2018 accounting for more than 8 percent of total production expenses. To omit such expense from this analysis would not clearly represent the finan-

cial situation of Puerto Rico’s farms at that time. Therefore, depreciation, which is not typically included in the calculation of net farm cash income was included in the 2018 production expenses used to calculate net farm cash income. Though not listed separately in the 2012 *Census of Agriculture*, depreciation expenses were likely reported as purchases of machinery or buildings, or as other expenses by respondents that year.

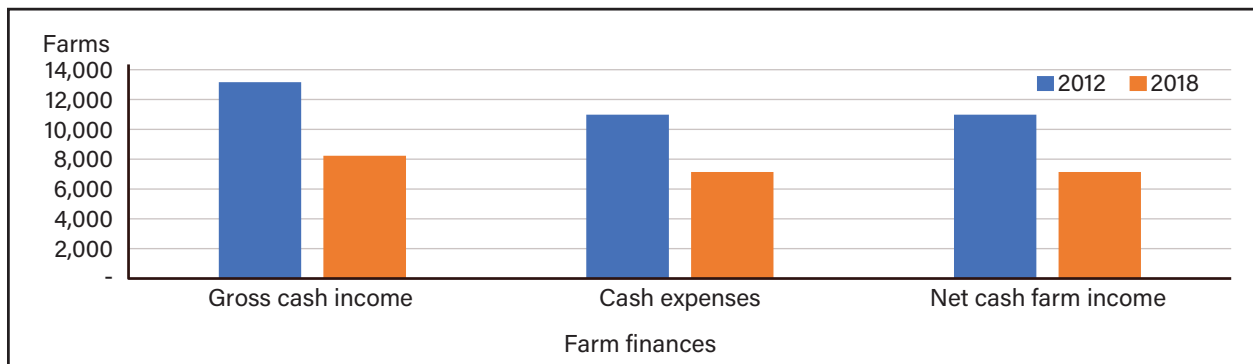
Figure 11
Net farm income in Puerto Rico, 2012 and 2018



Note: 2012 values are adjusted for inflation with base year of 2018.

Source: USDA, Economic Research Service compilation and calculation using USDA, National Agricultural Statistics Service, 2017 Census of Agriculture, *Puerto Rico (2018) Island and Regional Data*, and U.S. Department of Labor, Bureau of Labor Statistics, *Producer Price Indexes*.

Figure 12
Farms reporting net farm income in Puerto Rico, 2012 and 2018



Note: 2012 values are adjusted for inflation with base year of 2018. Farms is the number of farms reported.

Source: USDA, Economic Research Service compilation and calculation using USDA, National Agricultural Statistics Service, 2017 Census of Agriculture, *Puerto Rico (2018) Island and Regional Data*, and U.S. Department of Labor, Bureau of Labor Statistics, *Producer Price Indexes*.

Dairy Industry in Puerto Rico

The dairy industry is the principal agriculture business in Puerto Rico, representing 23 percent of the total agricultural gross cash income in 2018. Milk and other dairy products from cows provide the highest gross cash income by commodity at \$172.2 million, more than twice as much as the next highest commodity category (see table 1). This is a slight decline from 2012 when gross cash income from milk and other dairy products was \$226.6 million and represented 32 percent of gross cash farm income.

The data indicate the substantial contribution made by dairy to Puerto Rico's agricultural sector. According to the Puerto Rico Department of Agriculture, the total value of domestic fluid milk sales during fiscal year 2021 was 184 million cuartillos (1 cuartillo = 2.3 gallons) (see table 2). The dairy industry also generated about 16,000 direct and indirect jobs. Around 250 dairy farms were operating in fiscal years 2020 and 2021 with 57,980 cows (including productive and dry cows). Those farms used an area of 46,191 "cuerdas" (1 cuerda = 0.9711 acre). The principal dairy farm region was Arecibo, located in the northwest area of the island. The average yield per milking cow was 14.44 cuartillos of milk per day. There are three bottling plants: Suiza Dairy Corp. and Vaqueria Tres Monjitas, Inc., located in the San Juan metropolitan area, and Borinquen Dairy in Aguadilla (west coast of the island). There was also one balancing plant, Indulac, that processed milk not used for bottled milk to make dairy products, including UHT (Ultra High Temperature) milk, UHT milk with flavor, UHT milk without lactose; butter, white cheese, and evaporated milk. Unlike other countries and States, Puerto Rico did not process dry products like NDM (nonfat dry milk), whey, WPC (whey protein concentrate), and others.

Table 2
Total milk sales for fiscal years 2020-21

Type of milk	Sales (Cuartillos)		
	2020	2021	Difference
Regular fresh milk	93,777,995	87,171,739	(6,606,256)
Fresh milk for schools	5,619,673	3,133,567	(2,486,106)
Low fat fresh milk	31,373,160	37,253,245	5,880,085
Flavored fresh milk	577,141	479,970	(97,171)
Essential fresh milk	10,023	–	(10,023)
Total fresh milk	131,357,991	128,038,521	(3,319,471)
Total MST (Vaqueria Tres Monjitas, Inc.)	3,923,940	3,487,672	(436,268)
Total UHT (Planta VIDA Suiza Dairy Corp.)	13,883,337	21,098,087	7,214,750
Total UHT milk (Indulac)	36,314,193	30,709,101	(5,605,092)
Total UHT local	50,197,530	51,807,188	1,609,658
Total ESL (Planta VIDA Suiza Dairy)	378,795	940,941	562,146
Total sales (local fluid milk)	185,858,256	184,274,321	(1,583,935)

Note: One cuartillo is equivalent to 17.04 fluid ounces or 0.482 liquid (U.S.) quarts. The following are different methods of processing milk to reduce spoilage and disease-causing microbes: MST = Millisecond Technology, UHT = Ultra High Temperature, and ESL = Extended Shelf-Life. Essential fresh milk is a non-fat, calcium added brand of milk.

Source: USDA, Economic Research Service calculations using data from the Puerto Rico Department of Agriculture.

Puerto Rico's Agriculture and Related Exports

The bulk of Puerto Rico's agricultural exports are concentrated in a small set of high-value products such as food preparations,² distilled spirits, and essential oils. Following Hurricanes Irma and Maria, agricultural and related exports dropped in value from a high of \$352 million in 2016 to just \$191 million in 2020.

Table 3
Summary of Puerto Rico's agriculture and related exports

Calendar year	Value in 1,000 U.S. dollars											10-year percent change
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
Consumer oriented agricultural total	168,443	158,573	167,050	162,949	154,779	169,183	167,027	151,544	152,551	133,446	120,877	-28
Intermediate agricultural total	88,297	113,228	118,858	121,797	127,282	142,955	157,131	96,601	80,405	86,542	56,124	-36
Agricultural related product total	14,590	12,488	11,582	14,094	13,460	11,486	9,649	12,736	18,979	12,277	10,797	-26
Bulk agricultural total	15,427	16,838	13,298	17,691	15,966	20,143	18,567	13,239	1,484	2,456	3,033	-80
Grand total	286,757	301,127	310,788	316,531	311,487	343,767	352,374	274,120	253,419	234,721	190,831	-33

Source: U.S. Department of Commerce, Bureau of the Census Trade Data, U.S. State Export Data, accessed via USDA, Foreign Agricultural Service, Global Agricultural Trade System (GATS) database. The product groupings used are BICO (Bulk, Intermediate, and Consumer Oriented).

Consumer-oriented products³ made up the largest category by value of Puerto Rico's agricultural and related exports over the last decade, followed by intermediate agricultural products. From 2010–17, bulk agricultural products held third place ahead of agricultural-related products. Beginning in 2018, however, bulk agricultural products exports declined dramatically, dropping well below agricultural-related product exports, where they have remained (tables 3 and 4). The limited availability of farmland and Puerto Rico's long-term trend toward increased emphasis on industrial products has supported the importance of value-added products in Puerto Rico's agricultural exports. While the value of exports in all four categories was lower in 2020 than in 2010, bulk agricultural products exhibited the most significant decline in percentage terms, but much of this drop occurred from 2017 to 2018.

While exports of all four broad categories of goods declined from 2010 to 2020, there is substantial volatility to that trend. This particularly pertains to intermediate and agricultural-related goods, as exports of both categories had some periods of growth during the past decade even though the overall direction of change was downward.

² Food preparations is a broad category that includes many products. The majority in this case are derived from dried dairy and mixed with other ingredients such as sugar and are used mainly in the production of soups and beverages.

³ Throughout this section, the product groupings referenced are those used in the BICO (Bulk, Intermediate, and Consumer Oriented) reports, available on the USDA, Foreign Agricultural Service (FAS) website through the Global Agricultural Trade System (GATS). State-level export data, including for Puerto Rico, are available through this data source. In most cases, this data needs to be "transformed" to account for State-to-State trade to give a more accurate representation of trade originating in the State. In the case of Puerto Rico, this transformation process is not necessary since Puerto Rico does not directly border any State, so State-level export data already represent the flow of goods originating from the island.

Table 4

Puerto Rico's total agricultural and related exports, by destination

Country	Value in 1,000 U.S. dollars											10-year percent change
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
EU-27	31,067	43,527	50,225	38,942	44,451	54,966	51,210	51,307	59,570	53,774	51,716	66
Canada	121,214	128,627	117,028	69,852	66,647	89,836	108,068	75,919	75,364	77,267	48,841	-60
Leeward-Windward Islands	14,394	12,033	11,814	12,854	14,096	13,579	13,446	15,781	20,762	16,847	15,021	4
Dominican Republic	34,894	29,219	23,020	29,170	28,134	35,538	32,172	23,163	14,715	16,678	14,930	-57
Mexico	1,923	1,297	3,609	6,756	11,376	9,960	8,958	10,789	16,815	15,794	13,961	626
Others	83,265	86,424	105,092	158,957	146,783	139,888	138,520	97,161	66,193	54,361	46,362	-44
Total	286,757	301,127	310,788	316,531	311,487	343,767	352,374	274,120	253,419	234,721	190,831	-33

Source: U.S. Department of Commerce, Bureau of the Census Trade Data, U.S. State Export Data, accessed via USDA, Foreign Agricultural Service, Global Agricultural Trade System (GATS) database. The product groupings used are BICO (Bulk, Intermediate, and Consumer Oriented).

The largest markets for Puerto Rico's agricultural and related exports since 2011 have been the European Union and Canada, although the value of exports to Canada fell by 60 percent from 2010 to 2020, while shipments to the European Union (EU-27⁴) rose 66 percent during the same period. In 2020, the EU-27 passed Canada as Puerto Rico's leading export market (table 4).

Consumer-Oriented Products

Consumer-oriented products accounted for more than half (63 percent) of overall agricultural and related exports by value in 2020. Within that category, distilled spirits was the largest export category, accounting for about a third (34 percent) of Puerto Rico's total consumer-oriented exports in that year. Rum, which also includes tafia (a rum distilled from molasses), accounts for nearly all of Puerto Rico's distilled spirit exports. From 2010 to 2020, exports of distilled spirits declined in value by 32 percent, and exports of the second largest product category, soup and other preparations, decreased by 55 percent. In contrast, exports of the third largest category, processed fruit, nearly doubled (up 98 percent) over the last decade (table 5).

⁴ EU-27 refers to the 27-member European Union and does not include the United Kingdom which left the EU Customs Union as of January 1, 2021.

Table 5
Summary of Puerto Rico's consumer-oriented exports

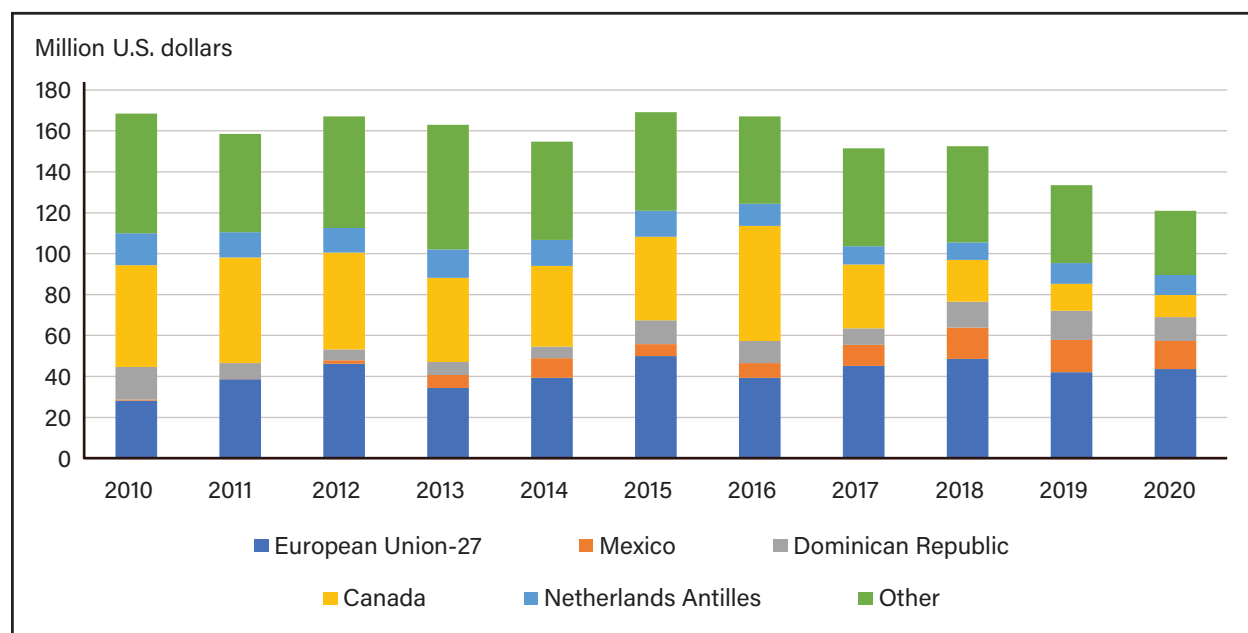
Calendar year	Value in 1,000 U.S. dollars											10-year percent change
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
Distilled spirits	59,577	61,455	65,759	53,034	53,356	63,223	41,594	33,985	53,994	41,399	40,571	-32
Soup and other food preparations	47,436	36,335	37,057	43,485	35,145	43,956	55,550	55,264	37,569	25,018	21,421	-55
Processed fruit	6,101	9,125	8,990	11,075	12,500	5,127	15,721	9,259	7,417	8,221	12,059	98
Non-alcoholic bev. (ex. juices, coffee, tea)	8,591	6,489	10,606	12,320	11,440	11,649	6,366	8,796	9,371	9,794	9,834	14
Dairy products	6,455	7,046	10,385	14,660	13,337	17,022	13,615	12,342	12,398	16,008	9,753	51
Bakery goods, cereals, and pasta	8,780	8,440	7,681	8,516	7,916	7,677	9,460	6,543	5,362	6,852	6,869	-22
Fresh fruit	3,560	6,574	5,915	8,702	8,558	7,434	8,250	8,140	7,135	7,654	4,804	35
Condiments and sauces	1,152	2,038	1,221	1,139	1,485	1,604	1,389	2,030	2,069	2,157	3,187	177
Others	26,791	21,071	19,436	10,018	11,042	11,491	15,082	15,185	17,236	16,343	12,379	-54
Total	168,443	158,573	167,050	162,949	154,779	169,183	167,027	151,544	152,551	133,446	120,877	-28

Source: U.S. Department of Commerce, Bureau of the Census Trade Data, U.S. State Export Data, accessed via USDA, Foreign Agricultural Service, Global Agricultural Trade System (GATS) database. The product groupings used are BICO (Bulk, Intermediate, and Consumer Oriented).

As table 5 shows, soup and other food preparations are the second-largest export product category. These food preparations are largely destined for Canada and Mexico, but a significant share also go to countries proximate to Puerto Rico.

The EU-27 became the leading export destination for Puerto Rico's consumer-oriented exports in 2020 in a gradual shift from Canada over the previous decade. Mexico also grew in importance as an export destination in the last decade, with shipments rising in value from less than \$500,000 in 2010 to nearly \$14 million in 2020 (figure 13).

Figure 13
Puerto Rico's consumer-oriented exports by destination

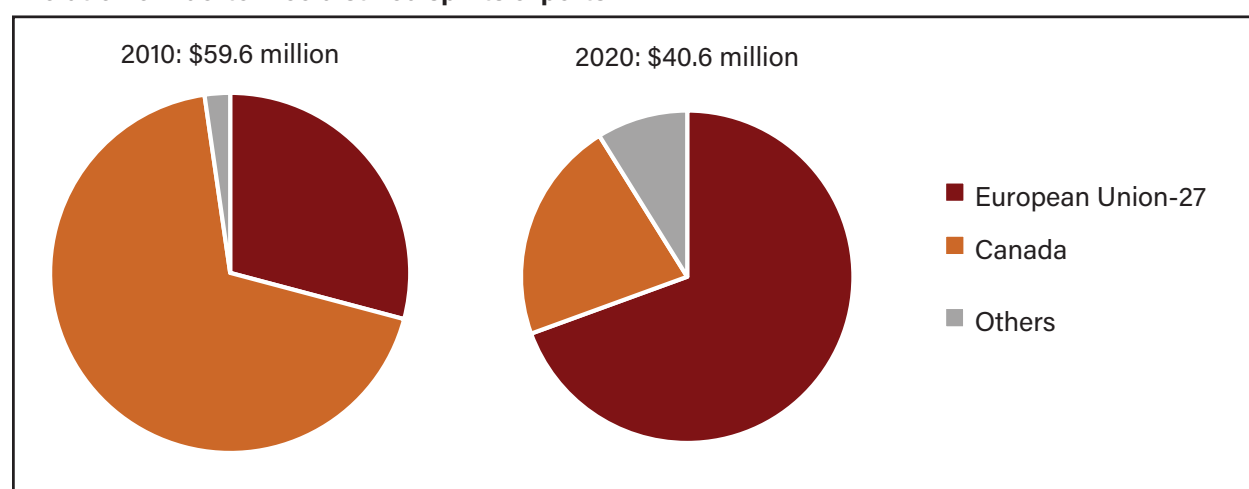


Source: USDA, Economic Research Service using U.S. Department of Commerce, Bureau of the Census Trade Data, U.S. State Export Data—accessed via USDA, Foreign Agricultural Service, Global Agricultural Trade System (GATS) database. The product groupings used are BICO (Bulk, Intermediate, and Consumer Oriented).

As figure 14 shows, distilled spirits are a major driver of the overall shift between Canada and the EU-27 as the top destination for Puerto Rico's agricultural exports. As noted, distilled spirits make up a relatively large share of agricultural exports, with rum dominating the category. Rum exports to Canada gradually declined over the last 10 years, while gradually increasing to the EU-27 over the same period. In contrast, rum exports from other regions of the United States increased to both Canada and the EU-27 over the period. Rum exports to Canada from the U.S. South (mainly Florida), Northeast, and Midwest have expanded rapidly since 2017, as have rum exports from the Midwest to the EU-27, because those regions compensated for sharp drops in the exports from Puerto Rico following the hurricanes (table 6).⁵

⁵ The composition of States in the regional definitions discussed in this section can be found on the GATS webpage on the USDA, FAS website. Unlike for Puerto Rico, most State-level export data requires further estimation to account for State-to-State movement of commodities and compensate for exports that may be allocated to States recorded as the origin of products as they are en route to or at the port. The regional export statistics referenced here have not been transformed; thus, there is a possibility that some of the commodities noted as being exported from one region of the country could have been produced in another area.

Figure 14

Evolution of Puerto Rico distilled spirits exports

Source: USDA, Economic Research Service using U.S. Department of Commerce, Bureau of the Census Trade Data, U.S. State Export Data, accessed via USDA, Foreign Agricultural Service, Global Agricultural Trade System (GATS) database. The product groupings used are BICO (Bulk, Intermediate, and Consumer Oriented).

Table 6

U.S. State-level exports of rum and tafia to Canada and the EU-27

Value in 1,000 U.S. dollars												10-year percent change
Exports to Canada	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
Puerto Rico	40,846	39,923	37,507	30,670	30,229	21,634	21,145	1,361	8,085	7,764	8,799	-78
South ¹	6,304	10,129	11,544	10,134	5,059	5,663	6,060	21,044	25,381	28,686	31,013	392
Northeast ²	3,999	5,710	6,207	7,292	8,740	8,896	8,762	8,280	9,008	9,537	12,035	201
Midwest ³	1,119	2,172	6,038	9,344	9,973	8,963	8,883	8,813	9,788	10,952	11,504	928
Others	525	1,054	1,173	1,698	1,846	1,857	1,898	1,866	1,816	1,200	1,380	163
Total	52,793	58,988	62,469	59,138	55,847	47,013	46,748	41,364	54,078	58,139	64,731	23
Exports to the EU-27	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	percent change
Puerto Rico	17,277	19,877	22,045	21,343	22,574	40,913	18,620	30,559	36,880	27,725	28,172	63
South	5,781	8,708	10,082	5,823	5,950	6,866	4,281	5,582	12,444	15,252	10,506	82
Northeast	315	77	32	0	169	0	92	210	132	480	291	-8
Midwest	3	0	224	356	225	466	461	1,073	863	648	149	4867
Others	17	706	400	84	18	53	45	402	634	365	883	5094
Total	23,393	29,368	32,783	27,606	28,936	48,298	23,499	37,826	50,953	44,470	40,001	71

Note: Rum and tafia are defined in this table by the Harmonized Tariff System (HS) code 220840 as defined by the World Customs Organization. EU-27 refers to the 27-member European Union and does not include the United Kingdom which left the EU Customs Union as of January 1, 2021.

¹ Alabama, Arkansas, District of Columbia, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Tennessee, Texas, Virginia, and West Virginia.

² Connecticut, Massachusetts, Maine, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.

³ Iowa, Illinois, Indiana, Kansas, Michigan, Minnesota, Missouri, North Dakota, Nebraska, Ohio, South Dakota, and Wisconsin.

Source: USDA, Economic Research Service using U.S. Department of Commerce, Bureau of the Census Trade Data, U.S. State Export Data, accessed via USDA, Foreign Agricultural Service, Global Agricultural Trade System (GATS) database.

Intermediate Agricultural Products

Table 7 shows that essential oils accounted for 70 percent of Puerto Rico's 2020 exports of intermediate agricultural products. Exports of this product category rose between 2010 and 2016 and then declined in recent years. Puerto Rico's other major exports in this product grouping include vegetable saps (such as aloes and manna) and extracts, as well as milled grains and products. Exports of vegetable saps and extracts grew substantially in the last decade, in part aided by the island's expanded cultivation of hemp, from which cannabis plant extracts can be obtained. Also, the hurricanes, earthquakes, and pandemic lockdowns stopped the growth of other commodities that had been strong leading up to 2017, resulting in a drop of more than \$60 million in total intermediate product exports from 2016 to 2017 and a further decrease of almost \$40 million through 2020.

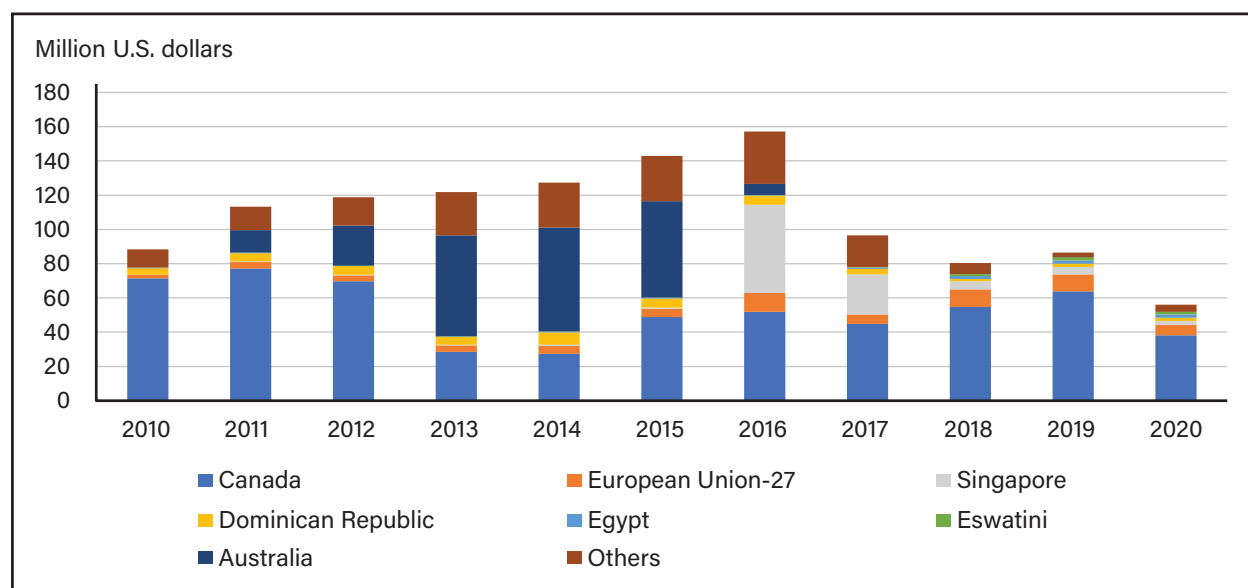
Table 7
Summary of Puerto Rico's intermediate product exports

Product	Value in 1,000 U.S. dollars											10-year percent change
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
Essential oils	73,649	95,815	101,248	105,387	110,052	130,325	142,998	83,913	59,707	64,318	39,254	-47
Vegetable saps	459	715	1,327	877	1,088	810	2,008	4,365	12,799	14,997	11,109	2,320
Milled grains and products	2,341	2,748	3,357	3,595	3,491	2,553	3,189	2,308	2,039	2,575	2,520	8
Others	11,848	13,950	12,926	11,938	12,651	9,267	8,936	6,015	5,860	4,652	3,241	-73
Total	88,297	113,228	118,858	121,797	127,282	142,955	157,131	96,601	80,405	86,542	56,124	-36

Source: USDA, Economic Research Service using U.S. Department of Commerce, Bureau of the Census Trade Data, U.S. State Export Data, accessed via USDA, Foreign Agricultural Service, Global Agricultural Trade System (GATS) database. The product groupings used are BICO (Bulk, Intermediate, and Consumer Oriented).

Nearly all of Puerto Rico's essential oil exports are destined for Canada, but Canada accounts for very little trade in the other intermediate agricultural products. Figure 15 shows that the EU-27 is the second-largest market (after Canada) for Puerto Rico's intermediate agricultural products.

Figure 15

Puerto Rico's intermediate agricultural exports by destination

Note: Data presented are total intermediate agricultural products as defined by the BICO (Bulk, Intermediate, and Consumer Oriented) trade product grouping system defined in USDA, Foreign Agricultural Service's Global Agricultural Trade System (GATS).

Source: USDA, Economic Research Service using U.S. Department of Commerce, Bureau of the Census Trade Data, U.S. State Export Data, accessed via USDA, Foreign Agricultural Service, Global Agricultural Trade System (GATS) database.

Agricultural-Related Products

Puerto Rico's exports of agricultural-related products declined substantially in recent years after peaking in 2018. More than 90 percent of this category is forest products, with seafood products accounting for the remainder. As table 8 shows, the majority of Puerto Rico's exports of agricultural-related products are destined for nearby Caribbean markets, particularly Leeward-Windward Islands and the Netherlands Antilles.

Table 8

Puerto Rico's total agricultural related product exports, by destination

Country	Value in 1,000 U.S. dollars											10-year percent change
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
Leeward-Windward Islands	5,707	4,620	4,540	5,647	6,142	6,157	5,413	8,229	12,670	7,953	7,332	28
Netherlands Antilles	1,897	1,700	1,841	2,124	2,313	2,341	933	1,810	2,302	1,905	1,469	-23
Dominican Republic	1,523	1,839	1,420	1,991	838	383	504	191	554	332	711	-53
French West Indies	448	531	522	521	466	567	354	632	848	468	425	-5
European Union-27	588	738	555	626	493	276	574	639	732	714	328	-44
Others	4,427	3,060	2,704	3,185	3,208	1,762	1,871	1,235	1,873	905	532	-88
Total	14,590	12,488	11,582	14,094	13,460	11,486	9,649	12,736	18,979	12,277	10,797	-26

Source: USDA, Economic Research Service using U.S. Department of Commerce, Bureau of the Census Trade Data, U.S. State Export Data, accessed via USDA, Foreign Agricultural Service, Global Agricultural Trade System (GATS) database. The product groupings used are BICO (Bulk, Intermediate, and Consumer Oriented).

Bulk Exports

Bulk exports represented a relatively small portion (2 percent) of Puerto Rico's total agricultural and related product exports in 2020. Table 9 shows this category shifted significantly since 2018 when tobacco exports fell by 99 percent in 1 year and have remained low since. Conversely, exports of coffee (unroasted) surged from 2018 to 2020 in the strong recovery of that industry from the decreased sales immediately following hurricanes Irma and Maria. Unroasted coffee is the leading bulk export commodity for Puerto Rico, although only about 1 percent of total U.S. coffee exports.

Table 9
Summary of Puerto Rico's bulk agricultural exports

Calendar year	Value in 1,000 U.S. dollars											10-year percent change
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
Coffee, unroasted	34	0	0	3	47	215	4	14	0	1,200	1,629	4,691
Tobacco	13,649	14,448	11,023	15,190	14,123	18,122	16,046	11,634	165	212	508	-96
Rice	1,239	1,486	1,533	2,041	1,425	1,321	1,398	1,142	689	620	408	-67
Others	505	904	742	457	371	485	1,119	449	630	424	488	-3
Total	15,427	16,838	13,298	17,691	15,966	20,143	18,567	13,239	1,484	2,456	3,033	-80

Source: USDA, Economic Research Service using U.S. Department of Commerce, Bureau of the Census Trade Data, U.S. State Export Data, accessed via USDA, Foreign Agricultural Service, Global Agricultural Trade System (GATS) database. The product groupings used are BICO (Bulk, Intermediate, and Consumer Oriented).

Imports

Puerto Rico imports a larger value of agricultural products than it exports. However, there are several similarities in the composition of these in-and-out trade flows. Agricultural imports from outside the United States into the U.S. customs district of San Juan, Puerto Rico, are approximately 75 percent consumer-oriented products. These products are largely associated with meat and meat products (beef, pork, and poultry), alcoholic beverages (distilled spirits, beer, and wine), along with processed fruit and vegetables, sugars and sweeteners, bakery goods, cereals, and pasta, among others.

The largest source of Puerto Rican imports from outside the United States is the European Union, which mostly consists of alcoholic beverages (wine, beer, and distilled spirits). Pork, processed vegetables, bakery goods, cereals and pasta, and dairy products are also significant. Canada is the second-largest source of imports, supplying pork, processed vegetables, fresh vegetables, and wheat. The third-largest import source is the Dominican Republic, which supplies bakery goods, cereals and pasta, and sugars and sweeteners. Mexico and Chile are the fourth and fifth-largest import sources.

Imports to the San Juan customs district from outside the United States gradually declined since 2015, although that trend turned upward in 2020. Much of the decrease in imports is associated with the European Union, especially after 2017.

Table 10
Agricultural import value into the U.S. customs district of San Juan, Puerto Rico by source country

	Value in 1,000 U.S. dollars											10-year percent change	
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	
European Union-27	349,683	368,229	358,023	370,484	394,806	438,762	411,964	368,856	204,649	185,113	198,093	261,902	-25
Canada	130,418	165,458	132,621	136,670	135,260	170,365	148,560	146,607	168,570	142,892	145,663	163,763	26
Dominican Republic	69,358	74,300	100,951	90,830	91,300	90,974	99,736	104,372	117,293	111,068	116,967	140,551	103
Mexico	86,981	124,821	84,836	105,445	97,499	115,395	116,229	89,475	91,955	99,416	93,483	121,348	40
Chile	35,815	36,346	42,796	49,849	52,417	61,760	60,880	53,408	71,985	64,351	79,939	88,870	148
Brazil	43,284	72,558	59,778	55,839	23,595	32,590	30,149	50,374	57,407	53,712	52,243	66,239	53
Nicaragua	47,511	44,717	33,144	29,582	51,838	40,034	39,738	48,691	59,477	73,243	60,308	63,622	34
Argentina	33,617	27,331	39,636	48,764	31,450	29,898	30,101	31,714	22,976	26,842	26,010	56,435	68
Colombia	23,853	21,689	20,676	21,256	26,567	27,204	33,946	39,109	49,887	39,130	41,326	52,274	119
World total	1,007,996	1,155,863	1,113,617	1,155,154	1,131,611	1,253,176	1,203,623	1,172,774	1,134,997	1,039,644	1,094,525	1,325,053	31

Source: USDA, Economic Research Service using U.S. Department of Commerce, Bureau of the Census Trade Data, U.S. Customs Districts Import Data, accessed via USDA, Foreign Agricultural Service, Global Agricultural Trade System (GATS) database.

Puerto Rico's Coffee Sector

In the United States, coffee is grown commercially in the State of Hawaii and the territory of Puerto Rico. The 2018 *Census of Agriculture* reports that coffee in Puerto Rico is grown on 2,445 farms and harvested from 12,900 acres. Those numbers are significantly higher than the 1,477 coffee farms in Hawaii with 9,000 coffee acres but lower than in the years preceding Hurricanes Irma and Maria in 2017. Coffee farms in Puerto Rico account for half of all commercial farms and 16 percent of harvested cropland (U.S. Department of Agriculture, 2018).

Puerto Rico's coffee-growing areas are located at elevations of 4,300 feet above sea level, under a mean annual temperature of 75 degrees Fahrenheit, on the mountain slopes of the Central West highlands. In this area, coffee production spreads across 28 municipalities grouped geographically into four regions: Utuado, Arcibo, Lares, and San German. More than 90 percent of Puerto Rico's coffee and the income from coffee sales come from these four regions.

The main variety of coffee grown in Puerto Rico is Arabica, marketed as "Mild Washed Arabica," but the island also produces small quantities of Robusta. Puerto Rico's harvest season for coffee is July–June (U.S. Department of Agriculture, 2018).

Puerto Rico has a long history of coffee cultivation, dating to when the island became a U.S. territory in 1917. At that time, coffee began to replace sugarcane and tobacco as the dominant crop. The importance of coffee to Puerto Rico's economy has varied over the years in response to hurricanes, slumps in international coffee prices, and changes in agronomic conditions, Government assistance, agricultural practices, and land use. While coffee has been replaced in economic importance by plantains, grains, and horticultural crops, coffee farming remains a dominant land use and an important source of economic activity for thousands of farmers in the central highlands, employing thousands of hired farm workers.

Coffee cultivation increased during 1978–92 with the expansion of the agricultural frontier and coffee's substitution for sugarcane area and pastureland (Grau et al., 2003). By 1992, coffee production boomed to become Puerto Rico's single most important crop. The number of coffee farms peaked at 13,150, harvested on nearly 80,000 acres, a production of over 20,000 tons. The value of coffee sales in that same year reached \$57 million—equivalent to 30 percent of agricultural sales (U.S. Department of Agriculture, 1994).

This situation changed radically in 1998 when Hurricane George destroyed one-quarter of the coffee trees on the island (U.S. Department of Agriculture, 2018; Gladkikh, 2020). Subsequent efforts to reconstruct the coffee sector were hampered by the economic recession and fiscal crises affecting Puerto Rico's economy during 2005–17. In September 2017, Hurricanes Irma and Maria destroyed 80 percent of the coffee trees and 85 percent of the coffee production expected that year (U.S. Department of Agriculture, 2018; PRDA, 2019). Since then, the amount of land dedicated to coffee production was drastically reduced to 12,900 acres from the 20,000 acres under cultivation before the damage. Coffee trees often take 3–4 years to begin bearing fruit, further contributing to the replacement of coffee production on farmland by other crops and the number of coffee farms continuing to decline (figure 16) (National Coffee Association, 2015).

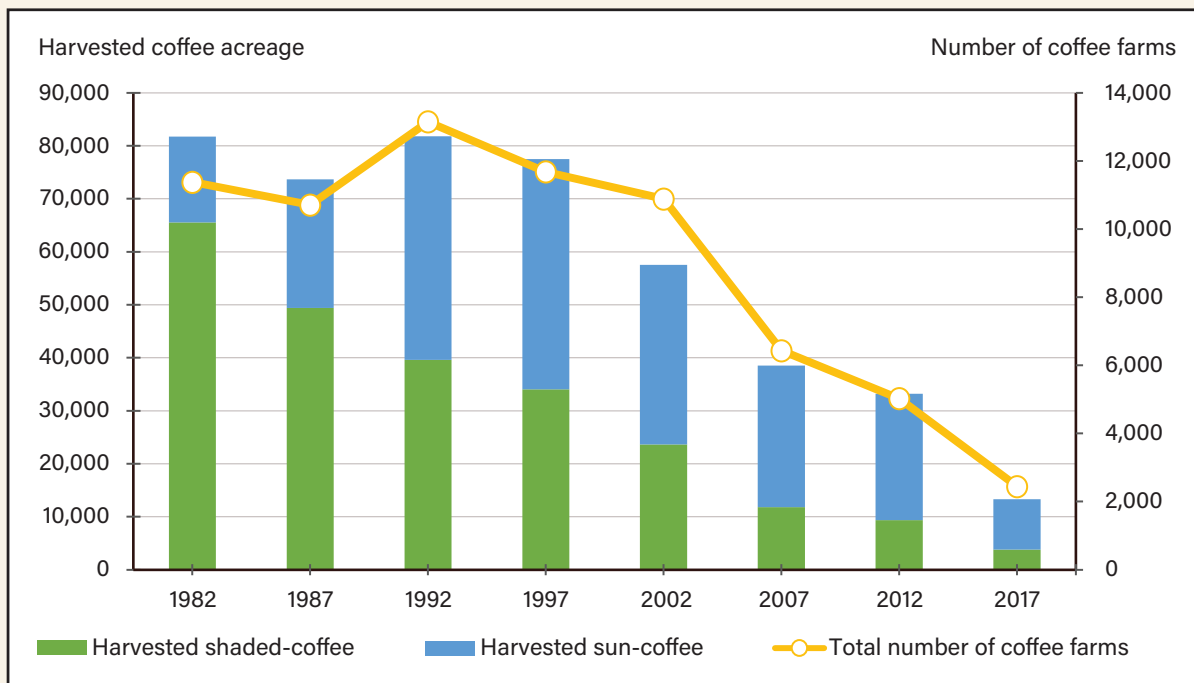
Despite the damage caused by the hurricanes, coffee cultivation has continued, partly due to the best region for growing coffee located in the center of the island and relatively less affected by the hurricanes. More directly responsible for this resiliency, however, is the transformation from shade-grown cultivation to sun-grown coffee. Coffee was traditionally grown under a canopy of shade trees in regions where pastures were gradually abandoned.

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Beginning in the 1980s, Puerto Rico (and various Latin American countries) began a transformation process to convert to commercial coffee plantations with little or no shade (commonly referred to as sun coffee). This program, supported by the Puerto Rico Department of Agriculture (PRDA), sought to increase yields and reduce the incidence of coffee leaf-rust, a potentially devastating disease for coffee trees. As a result, sun-coffee farms, which represented 9 percent of coffee farms in Puerto Rico in the early 1980s, currently account for more than two-thirds of coffee farms on the island. Sun-coffee acreage expanded from 5 percent of coffee acres in the late 1970s to 71 percent in 2018 (Census, 1978, 2018).

The extent of conversion from shade- to sun-grown cultivation varied across farm size, with larger scale farms (97 to 253 acres) accounting for the higher rate of acreage conversion to sun-coffee farming. The conversion from shade coffee to sun-grown coffee also altered the distribution of farms between the small-farm category (less than 18.5 acres) and the other farm groups. The share of coffee farms classified as small increased by 19 percentage points—from 44 percent to 63 percent—during the period of conversion from shade to sun coffee. In contrast, the share of production on farms in the medium-farm category (19.4 acres to 96 acres) increased only slightly, from 40 percent in the early 1980s to 43 percent in 2018 (U.S. Department of Agriculture, 1982, 2018).

Figure 16
Coffee production in Puerto Rico



Source: USDA, Economic Research Service using data from USDA, National Agricultural Statistics Service, *2017 Census of Agriculture*.

USDA's Shade-Grown Coffee Initiative

The success of the conversion from shade to sun farming and the resulting increases in yields and total production are reflected in changes in the share of production accounted for by medium-sized and small farms. Medium-sized farms accounted for the bulk of coffee sales (41 percent of total sales) in 2018, while the small-farm share of the value of coffee sales increased from 14 percent to 35 percent over the same period. Both medium-sized and small farms improved yields and overall production through sun farming techniques, but medium-sized farms were able to adopt more expensive technologies. Medium-sized farms accounted for half of all coffee husk removers and mechanical coffee dryers and a third of all mechanical coffee washers, while small farms relied more on cheaper solar coffee dryers (U.S. Department of Agriculture, 1982, 2018).

Given the relative importance of coffee to farmers' incomes and the recent changes in the attitudes toward the conservation of wildlife, USDA's Natural Resources Conservation Service (NRCS) is actively promoting the expanded cultivation of shade-grown coffee. Shade-grown coffee is expected to support biodiversity conservation, as well as provide improved economic outcomes for growers. Fifteen years ago, as deforestation of coffee agroforests coincided with declining bird populations, the issue of biodiversity decline because of agricultural intensification was brought to the forefront of discussions of coffee farming sustainability in Puerto Rico (U.S. Department of Agriculture, 2020).

Since 2006, NRCS has provided technical assistance to Puerto Rico's farmers to convert sun-grown coffee plantations to shade-grown plantations. Puerto Rico's Shade-Grown Coffee Initiative is a partnership project between NRCS, the U.S. Fish and Wildlife Service (FWS), and EnviroSurvey, Inc., a non-governmental organization. The main objective of the initiative is to protect, enhance, and conserve wildlife habitats. To accomplish this, NRCS designated a Shade-Grown Coffee priority area extending 5 miles around the perimeter of the Mariaco State Forest located in the Utuado and Lares regions and in the municipalities of Maricao, Mayagüez, Las Marías, San Sebastián, San Germán, and Yauco.

The Shade-Grown Coffee Initiative promotes shading of up to 30 percent of the acreage on coffee plantations. The program consists of using mainly five native tree species. Between 2007 and 2020, the NRCS project distributed 90,000 shade trees to farmers for planting. In addition, NRCS contributed more than \$400,000 to improve 979 acres of coffee plantations, with the objective of reducing pesticide and fertilizer use on coffee crops, reducing soil erosion, lowering temperatures, providing pollinator habitat, improving coffee and bean quality, extending tree production lifetime, and protecting biodiversity.

Shade farming, however, is associated with lower yields. To encourage shade farming and compensate farmers for lower yields and production levels, the U.S. Government, environmental organizations, and multinationals implemented numerous incentives, including price premiums for shade coffee and payments for ecosystem services (Gladkikh et al., 2020). After the devastation from Hurricanes Irma and Maria, Puerto Rico's coffee production is just 20 percent of domestic demand (PRDA, 2019). PRDA implemented six programs to speed the reconstruction of Puerto Rico's coffee supply chain—from coffee production to processing and the commercialization of export markets. The latest initiative seeks to market the island's coffee under the "Puerto Rico Single Origin" and the "Puerto Rico Biodiversity Shade Coffee" labels. Puerto Rican coffee marketed under these labels is expected to fetch a 15–20 percent premium export price in international markets (PRDA, 2019).

Conclusion

Puerto Rico's agricultural sector is adjusting to the impacts of the natural disasters of the past 5 years through production and business decisions consistent with the options and resources available to individuals and firms and with the influx of Government support. The hurricane damages are reflected in the difference between the 2012 and 2018 Census of Agriculture data. Between 2012 and 2018, total farm sales fell \$170 million (26 percent), from \$655 million to \$485 million (adjusted for inflation), with large declines in the sales of bananas, coconuts and other fruits, coffee, and poultry. Overall, between these two census years, the number of farms declined by 37.5 percent and acreage under cultivation by 16.6 percent, a loss of 4,929 farms and 97,213 acres, respectively. The losses were particularly felt by smaller farms of less than 10 acres, whose numbers decreased by more than half. Agricultural exports were also affected. Traditionally, the bulk of Puerto Rico's agricultural exports are concentrated in a small set of high-value products. The most significant of these products include food preparations, distilled spirits, and essential oils. Severe losses from the two hurricanes intensified concerns about the likelihood of increased frequency and severity of future tropical storms in the region due to climate change. As a result, calls for hurricane resilience have been elevated in recovery planning.

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