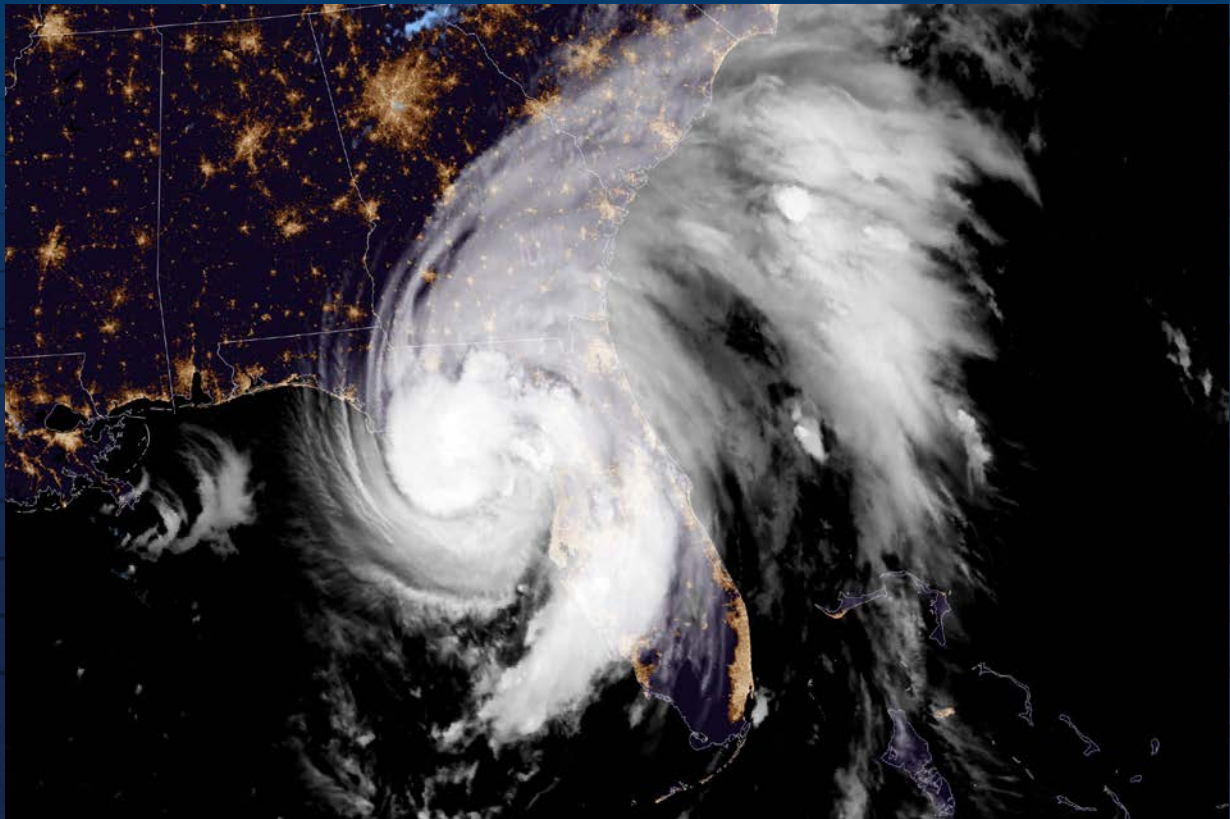


Preliminary Assessment of  
**AGRICULTURAL LOSSES  
AND DAMAGES**  
Resulting from  
**HURRICANE DEBBY**



*Image courtesy of NASA*

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# INTRODUCTION

The tropical system that would eventually become Hurricane Debby became a tropical depression on August 3, 2024 near Cuba, moving into the Gulf of Mexico and strengthening into a tropical storm later that same day. It gradually intensified, attaining Category 1 strength on August 4th prior to making landfall near Steinhatchee, FL (Taylor County) on August 5th. Hurricane Debby then moved northeast, impacting the southwestern peninsula and north central Florida before crossing into southeast Georgia as well as North and South Carolina and re-entering the Atlantic Ocean.

In general, tropical cyclones can impact production agriculture in many different ways. Producers can experience both losses (changes in economic flows) resulting from a change in the level or value of sales or a change in input costs and they can also experience damages (changes in economic stocks) that require repair or replacement. Agricultural losses might result from situations such as wind-damaged field and row crops, crop losses due to high winds in a pecan grove, water quality or mortality issues for shellfish aquaculture operations, lower milk production at a dairy farm due to stressed dairy cattle or the need to dump milk due to issues with cold storage during a power outage, or even a lower sales price for a beef cattle rancher that had cattle that were not able to get the appropriate nutrition due to stress or damaged grazing lands. Agricultural assets at risk for damages include fencing, irrigation systems, farm homes, farm buildings, greenhouse and nursery structures, machinery/equipment, other infrastructure, livestock animals, and perennial plantings such as pecan or citrus trees and vineyards.

## EVENT DATA

The wind swath of Hurricane Debby, as published by the National Oceanic and Atmospheric Administration (NOAA) National Hurricane Center (NHC), is shown in Figure 1. Hurricane conditions impacted four counties in Florida: Suwannee, Taylor, Lafayette, and Dixie. A larger swath of the Florida peninsula experienced tropical storm force winds, which extended as far south as Lee County.

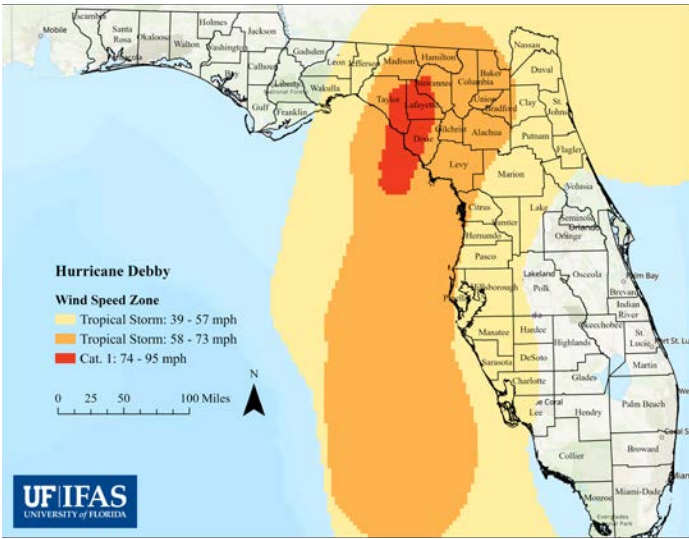
Data representing the 7-day cumulative precipitation amounts (08/02-08/08, 2024) are shown in Figure 2. The most intense rainfall, exceeding 15 inches, occurred in parts of northern Florida, especially Suwannee County. This region aligns with the path of the hurricane's center, where hurricane and tropical storm conditions were most severe. Another region that experienced significant rainfall includes

The University of Florida Institute of Food and Agricultural Sciences (UF/IFAS) Economic Impact Analysis Program (EIAP) began collecting information on agricultural losses and damages resulting from tropical cyclone events in 2016 in the wake of Hurricane Irma and has been improving databases and methods for these types of analyses ever since. On August 6th, 2024, the UF/IFAS EIAP distributed a survey titled "Assessment of Losses and Damages to Florida Agriculture from Hurricane Debby" to begin assessing losses and damages associated with Hurricane Debby. This survey instrument (ET00041674) was developed to assist Florida's Cooperative Extension System in collecting information on the impacts of natural disasters using the Qualtrics® survey system, which is a licensed survey platform recognized for its robust data security, analytics, and logical control programming features. The online survey instrument collects information directly from the owners/operators of farms, ranches, and other production agriculture operations, or via representatives of Florida Cooperative Extension and/or local, state, or federal government agencies, allowing for more timely and accurate reports on observed losses and damages.

This report summarizes the preliminary findings of the UF/IFAS EIAP's efforts to assess state-level losses for specific commodity groups due to Hurricane Debby. Data will continue to be collected via the Assessment of Losses and Damages to Florida Agriculture from Hazard/Disaster Events tool through marketing season 2024-2025 to be used in the final report for this event and for broader studies of the agricultural impacts of these types of events as well as to inform assessments of future events.

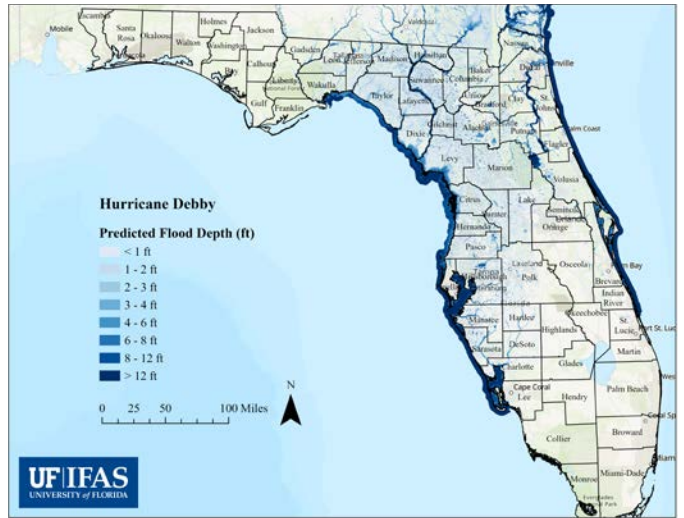
the Tampa Bay area and southwest Florida, particularly in Manatee and Sarasota counties.

Estimated flood inundation depths in Florida caused by Hurricane Debby are displayed in Figure 3. These data were retrieved from the Pacific Northwest National Laboratory's Rapid Infrastructure Flooding Tool, which simulated flood depth based on precipitation and storm surge estimates from August 5 to August 12. The results suggest that storm surge associated with Hurricane Debby might have exceeded 12 feet on the barrier islands and coastline of Florida. The most severe flooding was anticipated along the Gulf Coast, particularly in the Panhandle and west-central regions. Some areas experienced inland flooding in or downstream of areas with heavy precipitation.



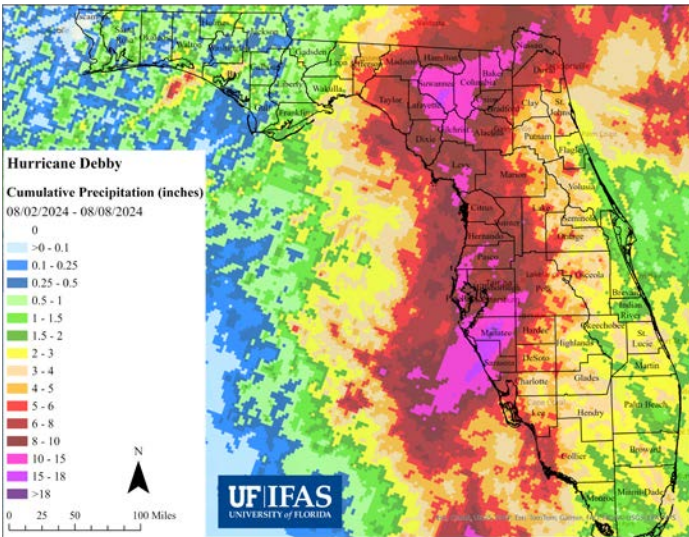
**Figure 1.** Wind swath pattern of Hurricane Debby as it impacted Florida.

Source: Geospatial data on the wind swath of Hurricane Debby are derived from NOAA NHC (<https://www.nhc.noaa.gov/gis/>).



**Figure 3.** Estimated flood inundation depth caused by Hurricane Debby in Florida.

Source: Estimated flood inundation data are retrieved from Pacific Northwest National Laboratory's Rapid Infrastructure Flooding Tool (<https://open-rift-pnnl.hub.arcgis.com/maps/Oa38c4d97a6b47369de20fb0c59231c6/about>).



**Figure 2.** Cumulative precipitation totals in Florida (08/02-08/08, 2024).

Source: Precipitation data are derived from NOAA National Weather Service (<https://water.weather.gov/precip/download.php>).

**Table 1.** Definition of intensity indices for wind, rainfall, and flooding associated with tropical cyclone events, which are components of the UF/IFAS EIAP's Hurricane Composite Intensity Index.

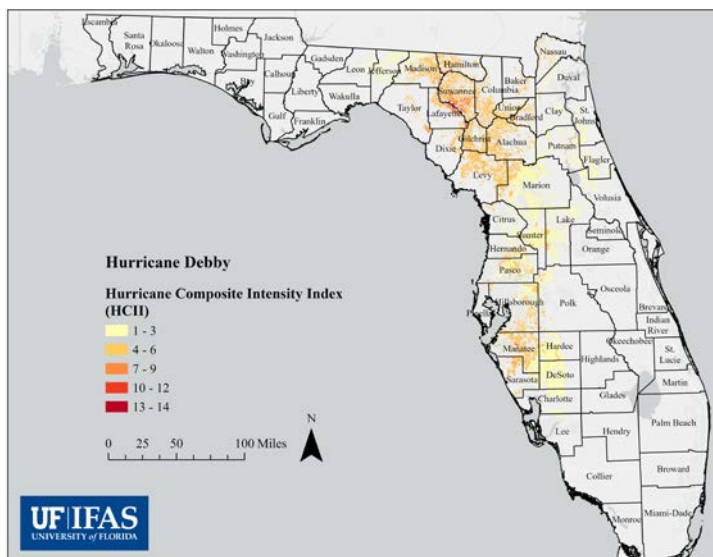
Intensity Index	Wind Speed (mph)	Precipitation (inches)	Flood Depth (ft)
1	TS1: 39-57	3-6	> 0-1
2	TS2: 58-73	6-9	1-2
3	Cat. 1: 74-95	9-12	2-4
4	Cat. 2: 96-110	12-15	4-6
5	Cat. 3: 111-129	15-18	6-8
6	Cat. 4 & up: > 130	> 18	> 8

To quantify the comprehensive impacts of Hurricane Debby in terms of wind, rainfall, and flooding, a Hurricane Composite Intensity Index (HCII) was derived. The HCII level is calculated as the sum of the intensity index of wind,

rainfall, and flooding, which are all classified into 6 levels based on wind speed (mph), cumulative precipitation (inches), and flood depth (ft), as shown in Table 1.

## IMPACTED AGRICULTURAL LANDS

Using geographic information systems (GIS) software (ArcGIS Pro), the hurricane wind swath, cumulative precipitation, and flood depth map shapefiles were overlaid on a geospatial database of agricultural lands in Florida to determine the wind, rainfall, and flooding intensity that each parcel of affected agricultural land experienced. The geospatial database of agricultural lands in Florida is the Florida Statewide Agricultural Irrigation Demand (FSAID) Agricultural Lands Geodatabase (ALG) developed by the Florida Department of Agriculture and Consumer Services (FDACS). The HCII level was calculated for each parcel of affected agricultural land, as shown in Figure 4. Table 2 summarizes the impacted acreage of agricultural lands by commodity group and HCII level in Florida.



**Figure 4.** Hurricane Composite Intensity Index (HCII) level for agricultural lands impacted by Hurricane Debby in Florida.

Source: The agricultural lands geospatial data are from the Florida Statewide Agricultural Irrigation Demand (FSAID) Agricultural Lands Geodatabase (ALG) developed by the Florida Department of Agriculture and Consumer Services (FDACS) (<https://www.fdacs.gov/Agriculture-Industry/Water/Agricultural-Water-Supply-Planning>).

**Table 2.** Estimated acreage of impacted agricultural lands by commodity group and HCII level for Hurricane Debby.

Commodity Group	Hurricane Composite Intensity Index (HCII)					Total
	1-3	4-6	7-9	10-12	13-15	
Animals and Animal Products <sup>1</sup>	753,151	723,041	149,318	27,262	1,025	<b>1,653,797</b>
Field and Row Crops <sup>2</sup>	71,532	225,241	67,709	16,125	1,324	<b>381,931</b>
Citrus <sup>3</sup>	64,938	25,074	3,100	375	5	<b>93,492</b>
Vegetables, Melons, and Potatoes	22,287	48,561	5,658	1,010	6	<b>77,522</b>
Greenhouse/Nursery	17,657	9,292	1,320	288	19	<b>28,576</b>
Fruit and Tree Nuts <sup>4</sup>	2,743	2,909	756	248	20	<b>6,675</b>
<b>Total</b>	<b>932,307</b>	<b>1,034,120</b>	<b>227,860</b>	<b>45,307</b>	<b>2,399</b>	<b>2,241,994</b>

Notes: <sup>1</sup> Animals and Animal Products acreage includes grazing land. <sup>2</sup> Field and Row Crops acreage includes field crops, hay, and sugarcane. The acreage of cotton is adjusted with the county level harvested acres of cotton from USDA 2022 Census data. <sup>3</sup> Citrus acreage includes non-bearing acreage and was adjusted to reflect the 2023 Commercial Citrus Inventory Preliminary Report from USDA NASS. <sup>4</sup> The acreage of pecan in the Fruit and Tree Nuts group is adjusted with the county level bearing and non-bearing acres of pecan from USDA 2022 Census data.

Over 2.2 million acres of agricultural lands were affected by Hurricane Debby, of which over 68% was grazing land. Across all commodity groups, around 41.6% of impacted acreage experienced low-intensity weather conditions

(HCII levels 1-3), 56.3% of impacted acreage experienced moderate-intensity weather conditions (HCII levels 4-9), and only 2.1% of impacted acreage experienced high-intensity weather conditions (HCII levels 10-15). The commodity

groups that were most affected (in terms of overall acreage impacted) by Hurricane Debby (not including grazing land) were Field and Row Crops (including hay and sugarcane, 381,931 acres), Citrus (93,492 acres), and Vegetables, Melons, and Potatoes (77,522 acres).

Table 3 shows the estimated annual value of production on the affected acreage areas by commodity group and HCII level. Data published by the United States Department of Agriculture National Agricultural Statistics Service (USDA-NASS) on price and yield were used to estimate value per acre in Florida for individual crops within commodity groups for the years 2019-2023 (converted to 2024 dollars using the GDP implicit price deflator, published by the St. Louis

Federal Reserve Bank), where available. When not available, value per acre was estimated using data on commodity-level price and yield at the national level or using the average value per acre of the relevant commodity group. The resulting five-year average of value per acre is used to estimate the value of production on affected acreage by commodity group and HCII level. For Greenhouse/Nursery and Animals and Animal Products, the shares of the agricultural area in each county affected by different HCII levels were used to allocate the sales revenues (five-year averages of 2018-2022 from IMPLAN, converted to 2024 dollars<sup>1</sup>) to estimate the value of production on impacted acreage.

**Table 3.** Estimated value of annual production (2024\$, Thousands) on impacted acreage by commodity group and HCII level.

Commodity Group	Hurricane Composite Intensity Index (HCII)					Total
	1-3	4-6	7-9	10-12	13-15	
Animals and Animal Products	\$327,434	\$547,002	\$164,094	\$48,904	\$3,185	<b>\$1,090,620</b>
Vegetables, Melons, and Potatoes	\$221,536	\$517,833	\$55,457	\$11,711	\$52	<b>\$806,589</b>
Greenhouse/Nursery	\$466,099	\$251,308	\$21,196	\$2,789	\$109	<b>\$741,502</b>
Field and Row Crops	\$52,176	\$166,374	\$50,174	\$12,000	\$1,028	<b>\$281,752</b>
Citrus	\$128,951	\$49,792	\$6,156	\$745	\$9	<b>\$185,653</b>
Fruit and Tree Nuts	\$27,809	\$30,118	\$7,827	\$2,568	\$202	<b>\$68,525</b>
<b>Total</b>	<b>\$1,224,007</b>	<b>\$1,562,426</b>	<b>\$304,905</b>	<b>\$78,717</b>	<b>\$4,586</b>	<b>\$3,174,641</b>

Hurricane Debby impacted agricultural lands that produce over \$3 billion dollars of agricultural products (crops, livestock, aquaculture, etc.) throughout a calendar or marketing year, some across multiple growing seasons (e.g., Vegetables and Melons) and others that might produce year-round (e.g., Greenhouse/Nursery, Animals and Animal Products). Considering impacts of all intensities, the commodity groups that were most affected in terms of “annual value at risk” by Hurricane Debby include Animals and Animal Products, Vegetables, Melons, and

Potatoes, and Greenhouse/Nursery. A majority, 97.4%, of the estimated value of annual production across all commodities, was impacted by low-intensity conditions (HCII levels 1-3) and moderate-intensity conditions (HCII levels 4-9). The annual value of agricultural products grown or raised in areas experiencing high intensity conditions (HCII levels 10-15) is estimated to be \$83.3 million, including Animals and Animal Products (\$52.1 million), Field and Row Crops (\$13.0 million), and Vegetables, Melons, and Potatoes (\$11.8 million).

## AGRICULTURAL LOSSES IN FLORIDA

On August 28, 2024, completed survey responses from both the English- and Spanish-language versions of the UF/IFAS Assessment of Losses and Damages to Florida Agriculture from Hurricane Debby were downloaded and prepared for analysis by investigators from the UF/IFAS EIAP.

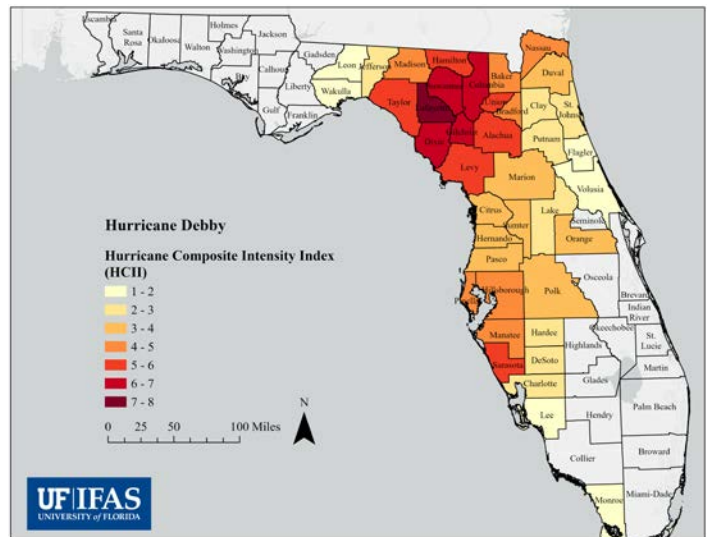
The survey tool collects information on county and Zip Code of the agricultural operation associated with each response but does not ask for an address or exact location. Also, a survey respondent can complete the survey by detailing impacts to one agricultural operation that spans multiple parcels, and in some cases, multiple counties.

<sup>1</sup> IMPLAN data for 2023 are not yet available.

Due to difficulties related to knowing the exact location of each survey respondents' operation, and in turn, the exact hurricane conditions that they experienced at their operation, the project team calculated an HCII level for each impacted county to relate respondents' reported damages and losses with a weighted average of hurricane conditions on agricultural parcels at the county level. The event data shapefiles (wind, precipitation, and flooding) were overlaid on the Florida county boundary shapefile from the U.S. Census Bureau. This process determined the wind, precipitation, and flooding index for each agricultural parcel, as well as the percentage of agricultural land in each county impacted by the different index categories. An area-weighted method was then applied to calculate the composite index for wind, precipitation, and flooding for each county, as shown in Figure 5.

The area-weighted HCII level of each affected county was used to connect with the results of the survey data analysis as well as observations from previously analyzed tropical cyclone events (Irma [2017], Michael [2018], Sally [2020], Ian [2022], and Idalia [2023]) to estimate a credible range on production losses (%) by commodity group for each HCII level by producing a "Low Scenario" and "High Scenario". These "Low" and "High" estimates of percentage production losses by commodity group and HCII level were then combined with available agricultural baseline data for the most recent year. Baseline data include information on acreage, value per acre, and season or growth stage for specific commodities. The baseline data are compiled from sources such as the USDA's 2022 Census of Agriculture, annual surveys by USDA-NASS, IMPLAN, Ask IFAS, as well as data published within the FDACS FSAID Geodatabase.

Table 4 displays the estimated annual production loss percentages (%) by commodity group and HCII level. Note that these estimates of production loss percentages are preliminary and might change as additional information specific to Hurricane Debby is collected. Production loss estimates (%) convey the percentage of annual production (calendar year 2024 or marketing year 2024-2025) that has been lost due to Hurricane Debby. Note that some producers have multiple growing seasons in Florida and others sell products year-round, which has been roughly accounted for in estimated loss percentage values. Additionally, adjustments have been made to estimated loss percentage values to account for planting and harvesting progress for some commodity groups but further adjustments might be made as information on early harvesting prior to the event, delayed planting in the face of Hurricane Debby, or the potential for growers to replant damaged or destroyed acreage is shared.



**Figure 5.** Area-weighted HCII levels of affected counties in Florida.

At this point in time, we are providing ranges on potential production losses as opposed to point estimates to reflect the uncertainty surrounding percentage production losses in the different areas that have been impacted by this event. The Low and High scenarios should be interpreted as low and high estimates of average losses for the relevant commodity group and HCII level combination and should not be interpreted as minimum and maximum values for individual producers or for commodity groups. Production losses that might occur in calendar year 2025, marketing year 2025-2026, or beyond as a result of the damages experienced by Hurricane Debby are not assessed and would be "in addition to" these estimates. Importantly, production loss estimates do not include the value of damages or destruction to stored inputs, stored harvested products, or infrastructure (including perennial plantings and lost/deceased animals). Finally, these estimates do not account for the fact that some crop losses might be eligible for or covered by crop insurance or other risk management tools available to producers.

Considering all of this information, the production losses for agricultural producers (crops, livestock/aquaculture, and animal products) resulting from Hurricane Debby are estimated to be between \$93.7 million and \$263.2 million. Estimated agricultural losses by commodity group and HCII level are displayed in Table 5.

**Table 4.** Estimated annual production loss by commodity group for Low and High scenarios based on preliminary analysis of survey data for Hurricane Debby along with observations from previously analyzed tropical cyclone events (Irma [2017], Michael [2018], Sally [2020], Ian [2022], and Idalia [2023]).

Commodity Group	Hurricane Composite Intensity Index (HCII)									
	1-3		4-6		7-9		10-12		13-15	
	Low Scenario	High Scenario	Low Scenario	High Scenario	Low Scenario	High Scenario	Low Scenario	High Scenario	Low Scenario	High Scenario
Animals and Animal Products	0%	5%	5%	10%	5%	10%	10%	20%	20%	40%
Citrus	0%	5%	5%	10%	5%	20%	20%	50%	40%	80%
Field and Row Crops	0%	10%	5%	15%	15%	30%	25%	60%	40%	70%
Fruit and Tree Nuts	0%	10%	5%	20%	10%	30%	25%	60%	40%	80%
Greenhouse/ Nursery	0%	5%	5%	10%	10%	20%	10%	30%	25%	40%
Vegetables, Melons, and Potatoes	0%	1%	2%	5%	2%	5%	5%	10%	5%	10%

Source: Authors' own calculations based on preliminary analysis of survey data for Hurricane Debby along with observations from previously analyzed tropical cyclone events (Irma [2017], Michael [2018], Sally [2020], Ian [2022], Idalia [2023]).

**Table 5.** Estimated potential range of agricultural losses due to Hurricane Debby by commodity group and wind speed zone (2024\$, Thousands).

Commodity Group	Hurricane Composite Intensity Index (HCII)										Total	
	1-3		4-6		7-9		10-12		13-15		Low	High
	Low Scenario	High Scenario	Low Scenario	High Scenario	Low Scenario	High Scenario	Low Scenario	High Scenario	Low Scenario	High Scenario	Low Scenario	High Scenario
Animals and Animal Products	\$0	\$16,372	\$27,350	\$54,700	\$8,205	\$16,409	\$4,890	\$9,781	\$637	\$1,274	\$41,082	\$98,536
Greenhouse/ Nursery	\$0	\$23,305	\$12,565	\$25,131	\$2,120	\$4,239	\$279	\$837	\$27	\$44	\$14,991	\$53,556
Field and Row Crops	\$0	\$5,218	\$8,319	\$24,956	\$7,526	\$15,052	\$3,000	\$7,200	\$411	\$720	\$19,256	\$53,146
Vegetables, Melons, and Potatoes	\$0	\$2,215	\$10,357	\$25,892	\$1,109	\$2,773	\$586	\$1,171	\$3	\$5	\$12,055	\$32,056
Citrus	\$0	\$6,448	\$2,490	\$4,979	\$616	\$1,231	\$149	\$372	\$4	\$7	\$3,259	\$13,037
Fruit and Tree Nuts	\$0	\$2,781	\$1,506	\$6,024	\$783	\$2,348	\$642	\$1,541	\$81	\$162	\$3,012	\$12,856
<b>Total</b>	<b>\$0</b>	<b>\$56,338</b>	<b>\$62,586</b>	<b>\$141,681</b>	<b>\$20,358</b>	<b>\$42,053</b>	<b>\$9,546</b>	<b>\$20,902</b>	<b>\$1,163</b>	<b>\$2,212</b>	<b>\$93,653</b>	<b>\$263,186</b>

Source: Authors' own calculations based on preliminary analysis of survey data for Hurricane Debby along with observations from previously analyzed tropical cyclone events (Irma [2017], Michael [2018], Sally [2020], Ian [2022], Idalia [2023]).

Production losses associated with animal operations (beef and dairy cattle, poultry, shellfish aquaculture, honey bee colonies, etc.) and producers of animal products (milk, eggs, honey) in the affected area (\$41.1 million - \$98.5 million) are expected as a result of damaged fencing, damaged livestock sheds (barns, poultry houses, etc.) and watering points, damaged aquaculture and apiculture structures, and widespread power outages and loss of feed. Beef and dairy cattle operations impacted by Hurricane Debby

reported stressed or injured cattle and shellfish aquaculture operations reported salinity issues, water quality issues, and closure of access to aquaculture lease areas during the hurricane.

Estimated production losses associated with Greenhouse/ Nursery operations in the affected area (\$15.0 million - \$53.6 million) are expected due to damaged hoop houses, greenhouse structures, and nursery infrastructure as well

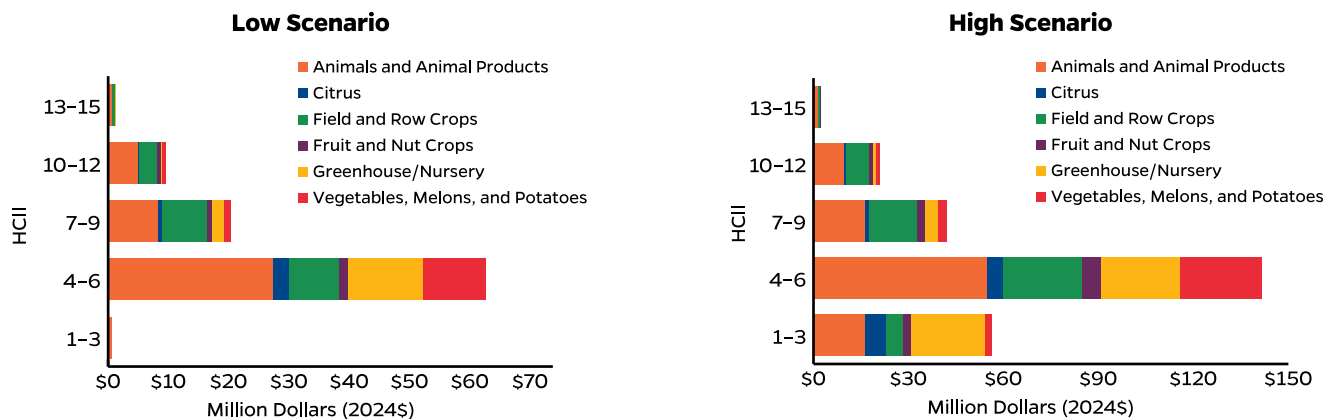
as loss of electricity, which is critically important for cooling and irrigation.

Production loss estimates for Field and Row Crops in the affected area (\$19.3 million - \$53.1 million) are expected, largely due to flooding, which can result in quality losses. There were also reports that heavy flooding, fallen trees, and debris associated with physical damages of Hurricane Debby impeded the ability of producers to tend or harvest some fields as scheduled.

Production losses estimated for Vegetables and Melons in the affected area (\$12.1 million - \$32.1 million) are heavily dependent on planting schedules as well as the ability (or inability) to harvest prior to the hurricane event or to replant damaged or destroyed crops after the event. Although 98.7% of Vegetables, Melons, and Potatoes crops experienced low or moderate hurricane conditions (HCII levels 1-9), reports on actual losses vary widely. Many growers of Vegetables, Melons, and Potatoes crops in regions impacted by Debby had not yet planted and those that had planted were impacted by only lower strength tropical storm conditions are reporting minimal to no losses; however, low levels of losses over large areas of high-value crops can be significant.

Estimated production losses for Fruit (non-citrus) and Tree Nuts in the affected area (\$3.0 million - \$12.9 million) are expected due to damages from flooding and wind. There were no reports of significant or widespread losses for citrus crops due to Hurricane Debby, but the result of low level production losses across a wide swath of citrus acreage that experienced tropical storm force winds and heavy rainfall/flooding conditions could reach up to \$13.0 million.

Results for production losses estimated by commodity group and HCII level are visualized in Figure 6, which highlights the fact that the Vegetables and Melons experienced the largest levels of losses. Both scenarios show that the majority of losses occur under moderate hurricane impacts (HCII 4-9). The large differences in the production losses experienced by all commodity groups within the regions that experienced weaker hurricane conditions are driving the large difference in total production losses estimated across the Low and High scenarios. This is due to the fact that many producers in this region are reporting minimal to no losses (hence, 0% losses modeled for the Low scenario) but even low-level losses for a large number of acres of high value crops can result in significant loss values.



**Figure 6.** Estimated Agricultural Production Losses in Florida due to Hurricane Debby by Commodity Group and HCII Level.

Source: Authors' own calculations based on preliminary analysis of survey data for Hurricane Debby along with observations from previously analyzed tropical cyclone events (Irma [2017], Michael [2018], Sally [2020], Ian [2022], Idalia [2023]).

## AGRICULTURAL DAMAGES IN FLORIDA

Agricultural damages include asset damages and production damages. Asset damages could include damages to agricultural structures, lost perennial plantings, lost/deceased animals, and damages to other infrastructure assets and equipment that will require repair or replacement. Production damages include damages to stored inputs such as fuel for farm equipment, fertilizer, and other agricultural chemicals, and previously harvested crops that were stored on-farm and not yet sold. Currently,

data limitations associated with baseline conditions (current number, location, type, and value) on agriculture-related infrastructure (buildings, fencing, machinery, and equipment) as well as stored inputs and harvested products cannot support an estimate of the exact (or close to exact) hurricane conditions experienced by each building, machine equipment, stored products, etc., preventing an accurate assessment on the caused agricultural damages.



The survey assessing the impacts of Hurricane Debby has questions on agricultural damages (agricultural infrastructure, stored inputs, and harvested products) as a supplementary section, which comes after collecting information on production losses. Respondents were asked to share additional information only if they affirmed their willingness to answer supplemental questions. Therefore, not all respondents provide information on damages to agricultural infrastructure, stored inputs or harvested outputs. The reported damages to infrastructure include homes, livestock sheds, barns, perennial plantings, conservation structures, fences, farm equipment, and aquaculture equipment (e.g., lost gear and bags). The reported damages to stored agricultural inputs include fertilizer, stored hay, and bird scratch/feed. Some respondents also reported seeds being blown off fields by strong winds and erosion of pastureland. The damages to stored harvested products from the survey include oysters, clams, hay, haylage, and silage.

### Agricultural Infrastructure

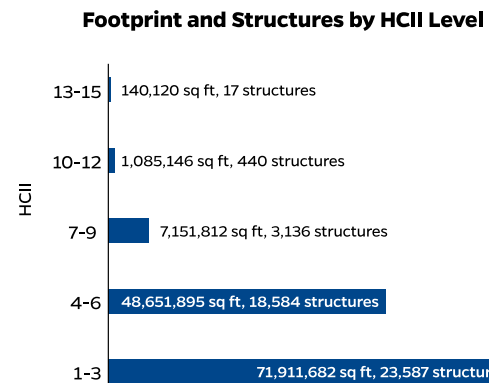
Data availability limit our ability to extrapolate to area-, county-, or state-wide estimates of the value of damaged/destroyed infrastructure or associated repair/replacement costs; however, some publicly available data do exist related to the quantity and potential value of agricultural infrastructure in Florida, which provide some level of understanding of the potential impacts to agricultural infrastructure due to Hurricane Debby.

### Structure Footprint Data

The Federal Emergency Management Agency’s (FEMA) USA Structures geospatial data, which includes an inventory of all structures with a footprint larger than 450 square feet, provides a data source for estimating the number and square footage of agricultural structure footprints within the path of Hurricane Debby. These data can provide an estimate of the square footage of structures “at risk” of damage or destruction during this event. A summary of the square footage of agricultural structure footprints by HCII level is provided in Figure 7. Note that the square footage represents only the structures’ footprints and does not account for square footage of floors above the first level in multi-story structures.

As many agricultural structures are single-story structures, we assume that the square footage of the agricultural structure footprints is a reasonable proxy for overall square footage of agricultural structures. The footprint of structures on the Florida agricultural lands impacted by moderate intensity conditions (HCII levels 4-9) and high-intensity conditions (HCII levels 10-15) is 55.8 million square feet and 1.2 million square feet, respectively. As a comparison, this 57 million square feet footprint of

agricultural structures in the path of Hurricane Debby is about 45 times larger than the footprint of The Pentagon in Arlington, VA, including the area encompassed by the central courtyard. Since there are many different types of structures on agricultural lands with a wide variety of values and the FEMA USA Structures geo-database does not provide information on the type of agricultural structure, it is not possible to accurately convert from area (square feet) to estimated current value (or to estimated repair/replacement costs).



**Figure 7.** Number of structures and footprint of structures on Florida agricultural lands by HCII level.

Note: Square footage represents the building footprint only and does not account for square footage on floors above the first level in multi-story structures. Structures with a footprint of less than 450 square feet are not included in the database.

Source: FEMA USA Structures geospatial data (<https://gis-fema.hub.arcgis.com/pages/usa-structures>).

### Data on Value of Agriculture-Related Buildings and Machinery/Equipment

The 2022 Census of Agriculture, published by the USDA, contains county- and state-level data on the current value (2022\$) of land and buildings, machinery, and equipment on farms as of 2022. The value of buildings was estimated using the average ratio of the value of improvements and lands in Florida, as detailed in the parcel tax database (2023) released by the Florida Department of Revenue. Combined with the event data of Hurricane Debby, these data can be used to estimate the value of buildings, machinery, and equipment that were at risk of damage/destruction in areas experiencing strong wind, heavy rainfall, or flooding. Importantly, this value is not an estimate of the value of damaged/destroyed buildings, machinery, and equipment nor is it an estimate of the repair/replacement costs for damaged/destroyed buildings.

In the areas of Florida impacted by Hurricane Debby, the estimated value of the buildings that were present in 2022 on the agricultural lands impacted by high intensity weather conditions (HCII level 10-15) was \$704.6 million (2022\$), which would be valued at \$744.7 million (2024\$)

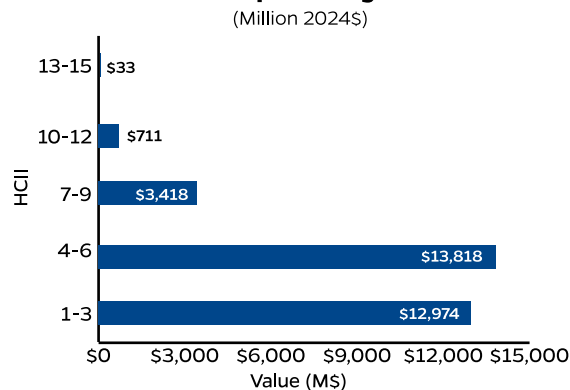
after adjusting for inflation (Figure 8). The estimated value of the machinery and equipment present in 2022 on the agricultural lands impacted by high intense weather conditions (HCII level 10-15) was \$61.3 million (2022\$), which would be \$64.8 million (2024\$) after adjusting for inflation (Figure 9). Similarly, the estimated value of the buildings that were present in 2022 on the agricultural lands impacted by moderately intense weather conditions (HCII level 4-9) was \$16.3 billion (expressed in 2022\$), which would be valued at over \$17.2 billion (2024\$) after adjusting for inflation. The estimated value of machinery and equipment present in 2022 on the lands impacted by moderately intense weather conditions (HCII level 4-9) was \$1.18 billion (2022\$), which would be \$1.25 billion (2024\$) after adjusting for inflation.

Note that these estimates do not capture the value of buildings, machinery, or equipment built or acquired after the 2022 Census of Agriculture was completed. These values are also not adjusted for buildings, machinery, or equipment that were demolished or are no longer present/used and they are not adjusted for depreciation over the period 2022-2024. It is also important to note that the accuracy of these values for 2022 might be influenced by the response rate on the 2022 Census of Agriculture.

## IRRIGATION EQUIPMENT

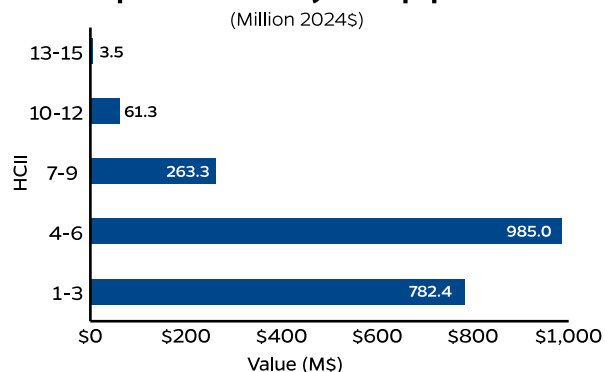
The Irrigated Lands Geodatabase (ILG) that is published within the FDACS FSAID Geodatabase provides information on irrigated agricultural lands in Florida as of 2021, including information on the type of irrigation system used. Over the agricultural land impacted by Hurricane Debby (approximately 2.2 million acres), there were over 575,000 acres of irrigated agricultural lands, shown in Table 6. The irrigation systems adopted in the impacted region have diverse vulnerabilities to strong wind, heavy rainfall, and flooding. For example, center pivot/lateral move and traveling guns are highly vulnerable to strong wind. On the other hand, micro spray, gravity systems, and drip are more resistant to wind but face a higher risk of damage from flooding.

**Estimated Value of Impacted Agricultural Buildings**



**Figure 8.** Estimated value of impacted agricultural buildings by HCII level.

**Estimated Value of Impacted Machinery and Equipment**



**Figure 9.** Estimated value of impacted agricultural machinery and equipment by HCII level.

This database suggests that there are over 43,000 acres of irrigated agricultural lands impacted by Category 1 hurricane conditions, over 95% of which employ center pivot/lateral move irrigation systems, which are vulnerable to wind damage. As irrigation systems come in different sizes and are used to irrigate a wide range of farm/field sizes, there is not a good method of converting from acreage irrigated by center pivot/lateral move systems to number of center pivots or lateral move systems or to further convert from number of systems impacted to the current value of those systems or an estimated value of damage to them (or repair/replacement costs associated with damage/destruction).

**Table 6.** Estimated impacted irrigated acreage by irrigation system by HCII level.

Irrigation System	Hurricane Composite Intensity Index (HCII)					Total
	1-3	4-6	7-9	10-12	13-15	
Center Pivot / Lateral Move	15,726	155,541	58,041	14,622	1,118	245,047
Micro Spray	100,424	18,116	854	56		119,450
Drip	25,106	67,197	5,518	570	37	98,427
Gravity Systems	54,004	13,590	798	23		68,415
Impact Sprinkler	15,385	3,288	324	30		19,028
Container Nursery	7,290	4,608	548	114	3	12,562
Traveling Gun	4,612	5,806	1,535	296	45	12,294
<b>Total</b>	<b>222,547</b>	<b>268,147</b>	<b>67,618</b>	<b>15,710</b>	<b>1,202</b>	<b>575,224</b>

## ADDITIONAL CONSIDERATIONS

This report focuses on a rapid assessment of statewide production losses for the current season (calendar year 2024 or marketing year 2024-2025) for agricultural operations in Florida due to Hurricane Debby. The value of the following categories of damages or losses are not included in these estimates and should be considered in addition to production losses suffered by impacted agricultural producers:

- Value of damages to agriculture-related infrastructure (including perennial plantings and lost/deceased animals that are used to produce animal products) that will need to be repaired or replaced.
- Value of stored inputs (seed, fertilizer, etc.) or stored harvested products that were damaged or destroyed.
- Expenses related to Hurricane Debby-specific preparations ahead of the storm and expenses related to clean-up after the storm.
- Value of production losses that might carry over into calendar year 2025, marketing season 2025-2026, or beyond due to damages to agriculture-related

infrastructure or other effects of the storm.

- Production losses for agricultural operations that specialize in post-harvest processing, packing, or distribution that might be impacted as a result of impacts to production agriculture operations (e.g., operations specializing in peanut drying, cotton ginning, seafood packaging and distribution, etc.).
- Value of timber- or forestry-related losses, which are assessed by the Florida Forest Service.
- Value of production losses to capture fisheries.

Production loss estimates in this report do include shellfish and finfish aquaculture as these operations are considered agriculture. Capture fisheries might be covered by surveys conducted by other organizations. It is also important to note that the estimates of production losses represent the estimated total value of agriculture-related production losses due to Hurricane Debby and do not account for the fact that some crop losses might be eligible for or covered by crop insurance or other risk management tools available to producers.

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