2026

Florida Statewide Agricultural Irrigation Demand

Appendix E – Technical Information

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Appendix E – Technical Information

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FSAID Methodology

As required by Florida Statute, metered and reported observations of irrigation water use form the basis for the FSAID estimates of spatially distributed irrigation demand. Water use data is collected each year from the water management districts. Historical water use data extends from 2007 to 2024. For FSAID XIII, the sample size of metered data increased by 5,278 field-level data points with the incorporation of 2024 calendar year permit-level water use data.

New permits are identified and added to the GIS spatial dataset, using updated permit boundary shapefiles supplied by the districts. Modified CUP permit data is similarly reviewed and GIS values updated as appropriate. Parameter values needed for estimating water demand are assigned to the newly added irrigated fields, including rainfall (assigned by latitude/longitude using a 4 km gridded dataset), evapotranspiration (ET; also assigned by latitude/longitude on a 2km grid), crop, irrigation system, and irrigated acres. Where metered data within a permit reflects multiple fields with multiple crops, water use is apportioned using mean AFSIRS inches/acre by crop. This process does not use the actual irrigation depth values from AFSIRS, rather it uses the ratios of irrigation depths among crops to divide the permit-level water volume totals to fields with different crops within a permit.

Quality control processes are completed before exporting GIS data in tabular format for analytical modeling. The model specification is estimated using Ordinary Least Squares regression analysis to generate coefficients from the actual water use for each field-level variable. Variables include rainfall (assigned by Latitude/Longitude on a 4km grid), ET (assigned by Latitude/Longitude on a 2km grid), the log of net price (crop-specific average farmgate prices less UF-IFAS or UGA average chemical costs from enterprise budgets), crop choice (Citrus, Field Crops, Vegetables, Non-Citrus Fruits, Greenhouse/Nursery, Potatoes, Sod, and Sugarcane), irrigation system type (gravity/seepage, microspray/microjet, center pivot, traveling gun, drip, container/nursery and impact sprinkler) and location attributes including Water Management District dummies; all input variables are scaled by field-specific irrigated acres. In the current model, about 88,500 water use records throughout the state were used to estimate the effects of these variables on irrigation volumes. The R^2 or statistical "fit" of the model output to actual data is 0.78.

After the model is run on the metered input dataset, the output coefficients are applied to each irrigated field in the ILG (approximately 21,000 fields). The current year irrigation water use estimate is based on rainfall and ET from the year matching the most recent water use data (in this case, 2024).

For projection years, the field level variables are updated to reflect changes in five-year increments based on county-level declines or expansions in agricultural acreage, and crop changes indicated by long-run worldwide agricultural price forecasts. Average rain and evapotranspiration (2005-2024) values are used for projections and assigned to each field. If a crop change is indicated in a given period, a new net price is assigned to match the updated crop type. If the crop type does not change, the net price is simply updated to the new period's value. To simulate future conditions, the coefficients are applied to the updated field level values and aggregated. Water use is then calculated for each irrigated field.

If the water use for a given irrigated field exceeds the prior period's water use, a portion of the water is retained for assignment to newly added acreage in future periods. In counties with declining acreage, irrigated fields are selected for deletion based on spatial decision rules, removing the associated acreage and water use from the model.

Model Comparison to Prior Years

Updated field-level metered/reported water usage data from all five Districts was combined into the statistical model. The variables in the prior year model included:

- Water Management District – an indicator value (1 or 0 for each District)
- Rain (annual inches reported for the 2km grid of the field centroid)
- Rain/ET (ET annual inches reported for the field location multiplied by rain annual inches; this treatment allows for estimate of marginal impact of ET when holding rainfall constant)
- Crop indicator and acres of field – Crop categories include:
    - Citrus
    - Field Crops
    - Vegetables (Fresh Market)
    - Fruit (Non-citrus)
    - Greenhouse/Nursery
    - Hay
    - Potatoes
    - Sod
    - Sugarcane
- Crop price, in log form multiplied by the field acres – categories match the crop indicator above. Price is calculated as farm gate price less chemical costs, both on a per acre basis.
- Irrigation system indicator – categories include:
    - Center Pivot (represents 11% of observations)
    - Container nursery (6% of observations)
    - Drip irrigation (19%)
    - Gravity systems (21%)
    - Impact sprinklers (6%)
    - Microspray (36%)
    - Traveling gun (1%)

The updated model includes current year data, but all model function and form are identical to last year. Coefficients reflect a very slight change in statistical fit. R^2 improved from .77512 to .77839. The South Florida dummy variable, which denotes the origin of 25% of the observations, is not statistically significant with a p-value of 0.32, but is an improvement from the previous model. Analysis in prior years has found that the irrigation behaviour of SFMWD is very similar to that of SWFWMD irrigation, which covers 48% of the observations, and as such the SFWMD indicator variable adds only minor explanatory value. The p-value for SJRWMD was 0.23 for 15% of records. The SRWMD and SWFWMD indicators both remain strong with significance at the 0.00 level.

All other variables are significant to the 1% level, with the exception of the Center Pivot indicator variable and the natural log of the price of sugarcane. Given that the model fit is strong and no surprising results emerged, the model was used without modification to its functional form for the 2026 update.

Model Input Data and Equation Details

The following tables (**Tables E-1 to E-3**) provide information about the FSAID input data and model details.

Table E- 1. Statewide Metered Data Records Statistics by Crop

Year	Measure	Citrus	Field Crops	Fruit (Non-citrus)	Greenhouse/Nursery	Hay	Potatoes	Sod	Sugarcane	Vegetables (Fresh Market)	All Crops (n)
2007	**Count**	529	29	87	155	16	10	27	8	141	1,002
2007	**in/yr**	13.04	9.30	31.64	30.10	7.22	12.46	15.30	33.42	15.96	14.19
2008	**Count**	2,194	207	129	1,070	248	122	266	95	1,241	5,572
2008	**in/yr**	11.14	9.40	30.09	31.79	8.99	15.34	11.17	17.09	18.89	13.08
2009	**Count**	2,283	180	117	1,064	280	133	224	128	1,361	5,770
2009	**in/yr**	12.53	8.19	23.57	31.85	9.08	16.20	13.80	19.32	19.00	14.30
2010	**Count**	675	103	102	154	36	25	29	7	354	1,485
2010	**in/yr**	13.53	11.07	28.58	30.35	6.91	18.06	16.05	26.84	19.80	15.56
2011	**Count**	2,372	225	209	1,127	228	144	189	147	1,315	5,956
2011	**in/yr**	11.58	10.79	25.27	28.79	9.13	13.94	14.31	15.93	17.45	13.25
2012	**Count**	2,719	284	239	859	243	127	208	223	1,376	6,278
2012	**in/yr**	12.23	9.54	25.59	28.29	9.67	15.24	12.35	16.06	18.70	13.81
2013	**Count**	2,543	70	211	698	181	119	155	167	1,162	5,306
2013	**in/yr**	12.01	7.17	27.29	25.87	9.68	11.21	17.48	17.41	16.77	13.47
2014	**Count**	2,311	259	177	687	236	66	174	196	1,369	5,475
2014	**in/yr**	10.32	10.93	27.81	27.55	11.15	13.47	10.90	18.17	15.38	12.68
2015	**Count**	2,059	474	243	730	248	115	168	362	966	5,365
2015	**in/yr**	10.28	10.95	29.10	25.48	10.51	11.46	13.01	18.50	15.22	13.15
2016	**Count**	2,599	367	381	702	236	146	170	309	1,450	6,360
2016	**in/yr**	11.04	10.91	27.86	30.90	11.65	13.57	10.86	16.60	18.16	13.61
2017	**Count**	2,956	727	491	792	416	136	223	397	1,427	7,565
2017	**in/yr**	11.70	11.54	29.07	30.79	11.22	15.13	12.88	20.71	19.90	14.75
2018	**Count**	2,387	819	851	771	219	174	150	406	1,262	7,039
2018	**in/yr**	11.61	10.57	27.65	27.06	9.43	13.90	10.25	16.75	16.96	13.52
2019	**Count**	2,270	859	729	656	278	153	207	393	1,015	6,560
2019	**in/yr**	11.65	11.81	27.26	30.84	10.48	14.52	12.14	17.68	17.60	14.12
2020	**Count**	1,957	782	721	635	274	140	189	324	982	6,004
2020	**in/yr**	10.66	11.15	28.63	29.16	9.66	13.91	12.49	13.90	16.49	12.81
2021	**Count**	1,986	688	709	704	290	167	187	342	1,275	6,348
2021	**in/yr**	11.78	11.58	27.95	29.22	10.74	13.81	15.65	15.18	17.64	14.12
2022	**Count**	1,599	776	756	574	301	147	133	237	1,261	5,784
2022	**in/yr**	10.84	12.52	29.71	29.28	11.85	11.63	15.75	17.49	17.67	14.27
2023	**Count**	1,466	785	775	637	271	213	212	248	1,104	5,711
2023	**in/yr**	11.69	11.15	32.24	29.91	10.23	12.23	14.21	15.66	17.59	14.06
2024	**Count**	1,019	793	684	738	311	185	187	401	1,141	5,459
2024	**in/yr**	10.77	11.70	29.96	26.45	12.03	14.26	16.89	19.46	15.98	15.12
All Years	**Count**	**35,924**	**8,427**	**7,611**	**12,753**	**4,312**	**2,322**	**3,098**	**4,390**	**20,202**	**99,039**

Table E- 2. Metered Data Records Statistics by District

WMD	Primary Crop	Total Acres	Total MGD	IN/YR
NWFWMD	Citrus	79	0	8.11
NWFWMD	Field Crops	163,027	112	9.22
NWFWMD	Fruit (Non-citrus)	33	0	19.94
NWFWMD	Greenhouse/Nursery	12,685	34	36.25
NWFWMD	Hay	8,832	5	7.02
NWFWMD	Potatoes	2,349	4	21.33
NWFWMD	Sod	18,040	16	11.73
NWFWMD	Vegetables (Fresh Market)	8,843	8	11.70
SFWMD	Citrus	1,706,837	1,464	11.53
SFWMD	Field Crops	14,796	11	10.42
SFWMD	Fruit (Non-citrus)	6,932	13	24.51
SFWMD	Greenhouse/Nursery	40,128	95	31.80
SFWMD	Hay	517,240	397	10.31
SFWMD	Potatoes	31,847	34	14.33
SFWMD	Sod	172,689	160	12.44
SFWMD	Sugarcane	1,199,251	1,549	17.37
SFWMD	Vegetables (Fresh Market)	807,818	1,121	18.65
SJRWMD	Citrus	127,280	106	11.24
SJRWMD	Field Crops	29,017	25	11.59
SJRWMD	Fruit (Non-citrus)	14,712	32	29.21
SJRWMD	Greenhouse/Nursery	73,384	152	27.77
SJRWMD	Hay	153,421	134	11.70
SJRWMD	Potatoes	131,118	130	13.30
SJRWMD	Sod	83,143	92	14.93
SJRWMD	Vegetables (Fresh Market)	84,039	105	16.82
SRWMD	Citrus	80	0	11.33
SRWMD	Field Crops	467,314	420	12.09
SRWMD	Fruit (Non-citrus)	5,556	13	30.72
SRWMD	Greenhouse/Nursery	7,439	15	26.72
SRWMD	Hay	62,107	44	9.59
SRWMD	Potatoes	4,806	6	17.54
SRWMD	Sod	1,106	1	17.84
SRWMD	Vegetables (Fresh Market)	62,394	72	15.51
SWFWMD	Citrus	1,860,925	1,587	11.46
SWFWMD	Field Crops	40,546	24	7.96
SWFWMD	Fruit (Non-citrus)	86,206	182	28.43
SWFWMD	Greenhouse/Nursery	30,215	58	25.85
SWFWMD	Hay	39,963	24	8.14
SWFWMD	Potatoes	18,470	20	14.50
SWFWMD	Sod	69,421	74	14.26
SWFWMD	Vegetables (Fresh Market)	418,018	498	16.00
Total		**8,582,105**	**8,836**	**13.84**

Table E- 3. Statistical Output and Coefficients of Analytical Model

Ordinary least squares regression ....
LHS=INYRAC Mean = 1199.26737
Standard deviation = 2192.19793
No. of observations = 99039 DegFreedom Mean square
Regression Sum of Squares = .370506E+12 30 .12350E+11
Residual Sum of Squares = .105444E+12 99008 1065005.74503
Total Sum of Squares = .475950E+12 99038 4805731.74766
Standard error of e = 1031.99116 Root MSE 1031.82963
Fit R-squared = .77846 R-bar squared .77839
Model test F[30, 99008] = 11596.36849 Prob F > F* .00000

Variable	Coefficient	Standard Error	P[|Z|>z]	Mean of X
Constant	(278.65)	65.69	-	
SFWMD	(26.28)	26.53	0.32	0.25
SJRWMD	(30.57)	25.47	0.23	0.15
SRWMD	137.35	21.64	-	0.08
SWFWMD	(88.51)	25.65	0.00	0.48
RAIN	(17.59)	1.38	-	55.33
RAINET	0.32	0.02	-	3,006.83
CITAC	11.45	0.04	-	37.31
FIEAC	11.29	0.18	-	7.22
FRSAC	17.86	0.07	-	13.95
FRUAC	24.06	0.42	-	1.15
GREAC	30.08	0.65	-	1.65
HAYAC	8.24	0.05	-	7.89
POTAC	12.66	0.23	-	1.90
SODAC	13.11	0.14	-	3.48
SUGAC	17.38	0.06	-	12.11
LNPCIT	16.42	5.47	0.00	2.63
LNPFIE	47.58	7.72	-	0.57
LNPFRS	14.94	4.79	0.00	1.90
LNPFRU	31.81	4.73	-	0.73
LNPGRE	14.26	4.06	0.00	1.44
LNPHAY	100.83	8.69	-	0.24
LNPPOT	32.47	5.94	-	0.21
LNPSOD	27.53	6.05	-	0.26
LNPSUG	6.13	6.34	0.33	0.36
CPIVOT	(34.55)	36.39	0.34	0.11
CONTNUR	197.78	43.17	-	0.06
GRAVSYS	229.56	35.57	-	0.21
IMPSPRK	197.38	41.22	-	0.06
DRIP	145.20	37.44	0.00	0.19
MICROS	233.34	41.49	-	0.36

The econometric model is used to generate coefficients from the metered data records. The coefficients are used to estimate water use for the remaining Florida farms that do not have metered data. The following example is provided to demonstrate the process.

Assume a Citrus farm in DeSoto County in the Southwest Florida Water Management District, with an irrigated area of 52.16 acres. The farm has Microspray irrigation, the recorded average annual rainfall was 52.08 inches, and the recorded average annual ET was 56.13. The estimated net price was $321 in 2024. A summary of the GIS attribute values for the specified farm are provided in **Figure E- 1**. Applying the coefficients from FSAID XIII to this specific farm's GIS attributes produces an estimated 10.88 inches per acre per year.

Figure E- 1. Application of Analytical Model

GIS Attribute Value for Demonstration Farm

Name	Variable (all values are for demonstration farm)	Value
ID	Field ID	DeSo_17079
SWFWMD	Indicator of 1 if field is in SWFWMD	1.00
RAIN	Rainfall (in inches, average annual, per nearest rain station)	**52.08**
RAINET	RainET interaction term (rain times ET)	**2,923.01**
CITAC	Indicator of 1 if field is citrus, times acres	**52.16**
LNPCIT	Indicator of 1 if field is citrus, times the log of citrus Net Price	**5.77**
MICROS	Indicator of 1 if field irrigation type is Micro Spray	1.00

Calculation of Farm-level Estimated Water use for GIS assignment

Name	Field-Specific Value	Coefficient	Product
CONSTANT	NA	(278.65)	(278.65)
SWFWMD	1.00	(88.51)	(88.51)
RAIN	52.08	(17.59)	(915.97)
RAINET	2,923.01	0.32	924.90
CITAC	52.16	11.45	597.47
LNPCIT	5.77	16.42	94.77
MICROS	1.00	233.34	233.34
		ACREIN (Total in Acre Inches per Year)	**567.35**
		GALMIL (Total in Millions of Gallons per Year)	**15.41**
		Estimated Inches/Acre/Year (GALMIL/365/52.16 acres*13441.7)	**10.88**

Table E- 4. Projected Crop Prices and Costs

Primary Crop	Unit	2024	2025	2030	2035	2040	2045	2050
Citrus	Crop Price	$1,942	$2,367	$2,842	$3,048	$3,067	$3,084	$3,098
	Chem. Cost	$1,621	$1,664	$1,862	$1,957	$2,057	$2,162	$2,272
Field Crops	Crop Price	$846	$790	$888	$951	$821	$781	$741
	Chem. Cost	$215	$222	$252	$265	$279	$293	$308
Fruit (Non-citrus)	Crop Price	$10,259	$10,431	$10,070	$9,382	$10,309	$10,346	$10,383
	Chem. Cost	$1,585	$1,930	$2,179	$2,290	$2,407	$2,529	$2,658
Greenhouse/Nursery	Crop Price	$110,28	$113,15	$123,571	$120,813	$126,976	$133,453	$140,260
	Chem. Cost	$3,048	$3,170	$2,663	$2,799	$2,942	$3,092	$3,250
Hay	Crop Price	$423	$402	$411	$408	$428	$424	$420
	Chem. Cost	$196	$182	$206	$217	$228	$240	$252
Potatoes	Crop Price	$5,872	$5,740	$5,868	$5,744	$6,180	$6,346	$6,513
	Chem. Cost	$314	$323	$367	$386	$406	$427	$448
Sod	Crop Price	$7,126	$7,404	$8,343	$8,942	$9,398	$9,877	$10,381
	Chem. Cost	$1,243	$1,280	$1,455	$1,529	$1,607	$1,689	$1,776
Sugarcane	Crop Price	$3,507	$3,488	$3,399	$3,312	$3,227	$3,144	$3,064
	Chem. Cost	$272	$207	$235	$247	$260	$273	$287
Vegetables (Fresh Market)	Crop Price	$6,788	$8,665	$9,124	$9,425	$9,261	$9,509	$9,732
	Chem. Cost	$2,124	$1,579	$1,819	$1,912	$2,010	$2,112	$2,220

County Acreage Trends

Table E- 5. County Historical Irrigated Acres and Trend Type for Future Projections

The table below shows historical irrigated acres from FSAID data annual updates and the selected best fit trend type used in future area estimates. Note: counties in which 500 acres or less of future irrigated area change is projected were set to no future change, given the uncertainty around future estimates. Manual changes – different from the selected trend type – were made in Glades County to account for surface water projects (acres removed) and to account for the Brighton Land plans for increased palm nursery (irrigated acres added in future). Also, Osceola County has future irrigated acreage increases to align with the North Ranch Sector Plan irrigated acres increases.

	2015	2017	2018	2019	2020	2021	2022	2023	2024		
County	**FSAID 4**	**FSAID 6**	**FSAID 7**	**FSAID 8**	**FSAID 9**	**FSAID 10**	**FSAID 11**	**FSAID 12**	**FSAID 13**	**Selected Trend**	**Trend Set to 0 or Manual Change**
Alachua	11,687	11,851	11,983	12,552	12,508	12,489	12,612	12,431	12,427	Natural Log	0
Baker	208	208	208	209	209	209	209	209	211	Power	0
Bay	1,101	1,096	1,095	1,098	1,103	1,103	1,103	1,104	1,100	Exponential	0
Bradford	1,636	1,505	1,499	1,514	1,514	1,514	618	904	885	Power	0
Brevard	21,449	20,423	17,895	18,200	16,795	16,291	15,211	13,872	25,534	Power	
Broward	1,430	1,421	1,288	1,230	1,239	1,164	1,166	1,143	1,140	Power	0
Calhoun	3,841	3,713	3,225	3,234	3,617	3,660	3,318	3,897	4,290	Natural Log	0
Charlotte	30,617	30,769	30,925	30,250	29,588	26,998	24,343	23,453	14,227	Power	
Citrus	1,345	1,604	1,598	1,598	1,499	1,173	1,034	1,126	1,088	Power	0
Clay	727	715	715	708	640	544	497	483	483	Power	0
Collier	77,822	72,536	72,450	71,591	69,961	68,697	66,470	63,423	50,198	Power	
Columbia	3,881	4,082	3,965	4,141	4,297	4,346	4,274	4,400	4,557	Linear	
DeSoto	81,395	79,891	79,451	78,323	79,301	77,923	73,689	72,070	52,225	Exponential	
Dixie	6,195	6,731	6,862	7,146	7,146	7,273	7,273	7,246	7,276	Exponential	
Duval	1,286	1,287	1,287	1,292	1,292	1,277	1,278	1,277	1,277	Natural Log	0
Escambia	2,997	2,971	2,997	2,990	3,469	3,470	3,428	3,365	3,365	Exponential	
Flagler	9,504	9,875	9,644	10,348	10,458	10,313	10,010	9,872	9,797	Power	
Franklin	-	-	-	-	-	-	-	-	-	NA	0
Gadsden	4,723	4,712	4,703	4,659	4,169	4,114	4,227	4,359	3,218	Natural Log	0
Gilchrist	15,559	18,471	19,717	21,189	21,413	21,451	21,851	23,022	23,774	Natural Log	
Glades	82,085	78,020	77,794	76,371	76,313	75,905	74,740	79,411	76,931	Power	manual change – surface water and land use plan
Gulf	47	47	21	23	23	21	21	21	-	NA	0
Hamilton	13,692	13,885	13,792	13,917	13,983	14,155	14,184	14,562	15,214	Natural Log	
Hardee	59,088	56,833	57,365	55,426	54,955	52,102	47,382	45,786	34,527	Power	
Hendry	252,482	251,407	257,620	251,710	246,035	235,811	223,969	212,180	191,672	Power	
Hernando	2,241	2,046	1,125	1,128	1,051	995	967	1,043	929	Power	0
Highlands	115,567	107,713	107,713	106,084	95,114	88,164	88,027	87,686	82,092	Natural Log	
Hillsborough	32,196	26,565	26,064	24,023	22,957	21,397	20,458	19,489	18,372	Power	
Holmes	682	771	646	646	615	586	586	639	639	Natural Log	0
Indian River	47,328	46,103	45,008	46,871	34,902	28,467	26,871	23,062	18,968	Power	
Jackson	34,022	35,476	36,539	36,229	36,329	36,340	36,183	37,529	37,677	Natural Log	
Jefferson	3,168	3,388	3,148	2,908	2,961	2,980	3,214	3,215	3,179	Linear	0

	2015	2017	2018	2019	2020	2021	2022	2023	2024		
County	**FSAID 4**	**FSAID 6**	**FSAID 7**	**FSAID 8**	**FSAID 9**	**FSAID 10**	**FSAID 11**	**FSAID 12**	**FSAID 13**	**Selected Trend**	**Trend Set to 0 or Manual Change**
Lafayette	9,324	10,606	11,246	11,898	12,042	12,099	12,332	12,453	12,723	Linear	
Lake	17,899	17,256	15,928	14,874	13,391	12,939	11,021	9,800	9,378	Natural Log	
Lee	23,523	20,313	20,302	19,473	16,575	15,458	15,076	13,362	7,684	Natural Log	
Leon	469	447	491	494	450	407	407	407	388	Natural Log	0
Levy	22,634	23,469	23,808	28,233	27,884	28,083	28,601	28,511	27,821	Linear	
Liberty	31	31	24	24	33	33	33	33	33	Power	0
Madison	18,912	22,807	24,157	25,129	25,032	25,232	25,908	25,112	25,204	Natural Log	
Manatee	62,464	57,812	57,979	56,539	55,187	47,848	44,338	39,120	33,099	Power	
Marion	11,585	10,899	10,866	10,511	9,930	9,416	8,805	9,880	9,852	Natural Log	
Martin	52,600	52,892	52,790	52,750	51,921	50,973	48,223	50,214	45,602	Natural Log	
Miami Dade	36,770	36,223	37,248	37,729	37,849	38,349	37,656	37,175	37,064	Power	0
Monroe	-	-	-	5	5	-	-	-	-	NA	0
Nassau	824	821	821	690	140	140	753	753	753	Power	0
Okaloosa	364	362	354	354	345	349	482	482	474	Natural Log	0
Okeechobee	31,845	25,885	25,622	24,970	23,933	23,481	21,017	20,363	17,680	Natural Log	
Orange	5,169	4,811	4,252	3,804	3,482	3,175	2,920	2,711	2,411	Natural Log	
Osceola	28,637	32,689	32,263	31,458	30,590	29,232	27,985	27,648	26,784	Natural Log	manual change – North Ranch Sector Plan
Palm Beach	430,718	430,728	429,933	428,921	429,003	420,771	419,977	408,806	408,253	Power	0
Pasco	9,253	6,623	2,857	2,687	2,366	2,184	2,050	1,786	1,748	Power	
Pinellas	17	15	3	3	-	-	9	9	9	NA	0
Polk	90,581	87,629	85,663	83,759	79,476	71,765	68,529	67,754	49,226	Natural Log	
Putnam	11,148	11,291	10,548	10,332	10,406	10,249	9,828	9,142	9,033	Power	0
Santa Rosa	875	868	838	1,069	1,099	966	990	1,135	1,129	Exponential	
Sarasota	4,427	4,330	4,454	4,104	4,016	3,834	3,414	3,424	3,168	Natural Log	0
Seminole	1,732	1,600	1,567	1,585	1,507	1,047	1,035	1,002	987	Exponential	
St Johns	22,044	21,884	21,584	21,505	20,870	20,398	20,067	20,081	20,075	Power	
St Lucie	55,296	51,249	50,897	50,995	50,660	47,868	46,179	39,952	35,558	Natural Log	
Sumter	4,385	3,837	3,845	3,694	3,667	3,625	3,633	3,190	3,093	Natural Log	0
Suwannee	28,001	31,955	36,175	37,198	37,458	37,747	38,506	38,405	38,757	Natural Log	
Taylor	476	476	515	539	572	581	577	626	161	Power	0
Union	754	819	824	821	821	821	821	710	613	Power	0
Volusia	9,671	9,784	9,271	8,781	8,367	8,055	7,723	7,387	6,874	Natural Log	
Wakulla	123	193	138	74	59	48	48	47	33	Exponential	0
Walton	330	327	378	380	437	654	1,011	1,187	1,171	Natural Log	0
Washington	692	811	635	748	655	655	655	690	690	Natural Log	0
Total	**1,913,573**	**1,877,858**	**1,876,617**	**1,863,742**	**1,815,684**	**1,749,417**	**1,699,826**	**1,655,634**	**1,534,799**		

Sensitivity Analysis

Metered Water Use

Metered or reported water use data was obtained from each Water Management District. Data was cleaned using a number of checks prior to use in the final dataset. Tukey inter-quartile range (IQR) analysis, measurement of the standard deviation from the mean, and tercile analysis were processes used to discover outliers. Tukey analysis uses 1.5 times the IQR from the first and third quartiles to determine the range. The standard deviation methodology uses two standard deviations from the mean to identify potential outliers. In reviewing the reasonableness of irrigation intensities by crop, it was determined that the 25th percentile for the lower bound and the 90th percentile for the upper bound were appropriate to identify thresholds for including metered data for model development. These thresholds reflect the right skewness of the water use data (more 0 and small values; mean greater than median).

These ranges (**Table E- 6**) were applied to crop irrigation intensity measures of inches/year for metered measurements of water use and acreage. These variables were chosen over total water use, since outliers for this variable would depend heavily on farm size.

Table E- 6. Crop-specific Irrigation in/yr Thresholds for Including Metered Data for Model Calibration

FSAID crop type	25th percentile (in/yr)	90th percentile (in/yr)
Citrus	5.9	21.0
Field Crops	4.1	22.1
Fruit (Non-citrus)	14.8	51.9
Greenhouse/Nursery	8.8	61.3
Hay	2.6	23.3
Potatoes	6.7	27.1
Sod	4.4	38.7
Sugarcane	5.8	35.2
Vegetables (Fresh Market)	7.0	34.6

Rainfall

Because rainfall replaces irrigation water, it is an important component of water demand. Rain gage data was used in the initial FSAID I estimates. However, in some districts, this resulted in very few location-specific measures of precipitation. Starting with FSAID II, NOAA's Advanced Hydrologic Prediction Service (AHPS) data has been used instead. This set of data is provided in the form of daily point shapefiles for the entire continental USA and Puerto Rico. Within Florida, there are over 12,600 points spaced approximately 3.5 to 4 km apart (point spacing decreases from north to south). The available period of record is from 2005 to 2024.

Crop Changes

Newly irrigated areas in future projection periods in FSAID are assigned crop types based partly on future predicted net prices and the modelled water demands associated with each crop type. There may be instances of currently irrigated areas on which a crop change would be suggested based on changing net prices in the future. The actual occurrence of crop changes of course depends on producer preference, costs of equipment changes, labor requirements for cultivation and harvest, and other factors. Crop changes were imposed for several thousand acres of irrigated pasture in Glades County. These fields were switched to Palm Nursery to align with Seminole lands acreage projections. The irrigated areas by crop group within Counties or planning regions do change in future periods as irrigated areas are added or removed based on Counties with declining and increasing irrigated area.

Global Agriculture Market Changes and Scenario Analysis

The current economics conditions of highly elevated input costs and low crop prices are bringing significant challenges to producers throughout the U.S. Without an improvement in crop prices and some reduction in fertilizer costs and fuel costs, there could be substantial acreage declines in Florida. The duration of the conflict in Iran is resulting in unusually high costs and uncertainty in future costs and prices. Florida producers are working to achieve trade improvements through updates to the USMCA (United States–Mexico–Canada Agreement). Changes to the USMCA that would benefit Florida producers include: Seasonal tariff-rate quotas (TRQs) – which would limit duty-free Mexican imports during Florida's peak growing season and stronger anti-dumping enforcement – which some Florida growers indicate that Mexican producers sell produce below market cost ("dumping"). An overview of recent trade and relevant policy changes is summarized in **Table E- 7**.

Table E- 7. 2025 Market Changes Summary

Crop	Summary	Upside	Downside
Citrus	Possible $200M in state funding to support re-planting (this was funded in 2025 and as of this writing there is proposed legislation to make this an annual commitment)	Could fund re-planting of citrus trees on over 20,000 acres depending on how much funding is targeted for re-planting	If annual funding is not sustained, there would be expected to be more decline in citrus acreage.
All crops	Labor cost inflation for workers with H-2A visas is expected to slow with the adjustments to the Adverse Effect Wage Rate Methodology	Could lower labor costs for FL producers under new H-2A contracts, making production more profitable in some systems.	NA
All crops	Extremely high input costs: particularly fuel and fertilizer – resulting from the spring 2026 conflict in Iran	NA	Possible increase in farmland conversion to non-agricultural uses; possible temporary acreage contractions.

Four alternative scenarios were developed based on national and global changes that are occurring or could occur in key agricultural areas. These possible future outcomes relate to recent market changes or potential future policy or production shifts. These four scenarios include: 1) western U.S. to eastern U.S. agricultural migration, 2) trade adjustments that might improve prices for Florida berry and vegetable producers, 3) potential citrus greening solutions, and 4) increased land use change to non-agricultural uses. Data sources used to quantify potential Florida irrigation demand changes are described in the following sections. These four scenarios are not exhaustive of the range of global or regional changes that could influence Florida irrigation demands, but they serve to demonstrate some of the uncertainty in future irrigation water demands for agriculture.

Scenario 1 (West to East irrigation transition): The increased frequency and severity of drought in the western U.S. might accelerate some of the west to east shift in irrigated agriculture that has occurred in recent decades (Hrozencik et al. 2021). There has been long term drought in the Colorado River Basin, and it seems likely that water withdrawals from the river will be cut by around 25% (Berggren 2024), and as municipal water use has fewer options to switch sources of water – it is likely that agricultural irrigation will be reduced the most in order to achieve those reductions (Richter et al. 2024). A recent example of this (not in the Colorado River Basin), is the 2023/2024 drought in the main sugarcane growing area of Texas (Rio Grande Valley). This drought resulted in the loss of over 20,000 acres of irrigated sugarcane production in the region. While that sugarcane production will likely not transition to Florida, it is emblematic of western U.S. droughts resulting in irrigated acreage declines in the western U.S.

Scenario 1 irrigated acreage changes in Florida were estimated based on the predicted Colorado River Basin states reductions in irrigated agriculture. There are about 2.8 million acres of irrigated agriculture in the Colorado River basin in the seven states of AZ, CA, CO, NV, NM, UT, and WY. If we assume that the 25% estimated water use reductions translate to a similar irrigated area reduction; that is about 700,000 acres of irrigated area loss. It was then assumed that 2% of that loss would translate to increased irrigated area in Florida - based on expert judgement of realistic, potential acreage change. This might happen either through direct shifts in operations from western states or through increased market opportunities that provide price incentives that allow Florida-based operations to increase irrigated areas. These potential acreage increases in Florida were estimated to be equally divided between vegetables and field crops (about 7,000 irrigated acres increased for each of those crop groups).

Scenario 2 (Trade adjustments and market improvements for Fruit Non-citrus): In recent years, Florida producers face tough competition from imports to the U.S. of berries and vegetables from other countries with substantially lower production costs. This makes it difficult for Florida producers to sell produce above their production costs. Also, as a result of the pandemic and global wars, there is growing support for more domestic production to improve supply chain resilience. This includes manufacturing and agriculture. For Florida agriculture, there is possibly a higher likelihood that trade adjustments including market timing restrictions (imports capped or reduced during certain times of year) could be approved. Efforts to implement trade adjustments that would support Florida (and other southeast region) producers have been ongoing, but there is now wider national support for domestic supply resilience. Irrigation demand impacts from this scenario were estimated with "Scenario 2: Trade adjustments and market improvements - Fruit (Non-citrus) increase." This was estimated using the historical growth trend in Florida strawberry and blueberry combined acreage for 2008-2020. This was roughly a 1.8% annual increase during a time period in which there was growth in those crops in Florida, and foreign imports slowed growth starting around 2012. That historical growth rate was used here for Scenario 2 to represent a time period in which there was some downward pressure on Florida crops but moderate growth was still observable. That acreage increase rate was applied for the 2025-2035 period only, with the expectation that markets and acreage would stabilize by 2035.

Scenario 3 (Citrus Greening solutions): Citrus acreage has continued to decline in Florida, largely due to citrus greening disease (Huanglongbing: HLB), and lingering impacts of recent hurricanes (water logging and wind damage). Substantial state and federal investments in solutions for citrus greening are likely to lead to some improvement in the coming decade. There has recently been increased optimism among citrus producers related to oxytetracycline injections for HLB management. This involves trunk injections of an antibiotic that significantly reduces fruit drop and increases yield and fruit quality. Typical costs are around $1.30 to $2.70 per tree (based on data from UF-IFAS Southwest Florida Research and Education Center). A recent survey from Citrus Industry magazine (Jan 2024) found that 84% of survey respondents in Florida had treated their groves with oxytetracycline injections. The other main management solution – development of HLB resistant or tolerant trees – has been progressing. This year, in early 2024, CRISPR-developed (genetic editing technology) citrus trees are being tested in the field for HLB resistance (Citrus Industry magazine - Feb 2024). While new varieties take years to develop, CRISPR gene editing tools can drastically reduce the time required to develop and test new varieties.

A scenario was modeled here to represent a potential citrus recovery if there are affordable solutions for greening, and/or replanting with new varieties can be achieved. Irrigation demand impacts from this scenario were estimated with "Scenario 3: Citrus greening solution - Citrus increase," using recent historical citrus acreage increases as guidance. The 1988 to 1996 acreage increase for citrus, following a major freeze event around 1988/1989, was approximately a 14% 5-year growth rate. Based on changes in markets and other land use demands, it was determined that about a tenth of that rate could realistically be achieved in the present conditions. A 1.4% 5-year growth rate was used from 2030 onward (as the assumed year in which substantial citrus re-planting initiates) to estimate an alternative scenario for citrus acreage increases.

Scenario 4 (Increased conversion of irrigated lands to non-agricultural uses): A final scenario was modeled to estimate impacts from potentially increased rates of conversion of irrigated lands to non-agricultural uses – likely this would be mostly residential lands and possibly some water storage projects. To estimate a possible outcome for this scenario, the FSAID-projected declines in irrigated areas in SFWMD, SJRWMD, and SWFWMD were increased by 50% through 2050, as these are the Districts with the most recent historical and projected declines in irrigated area due to population growth. This was labelled "Scenario 4: Increased conversion of irrigated lands to non-agricultural uses."

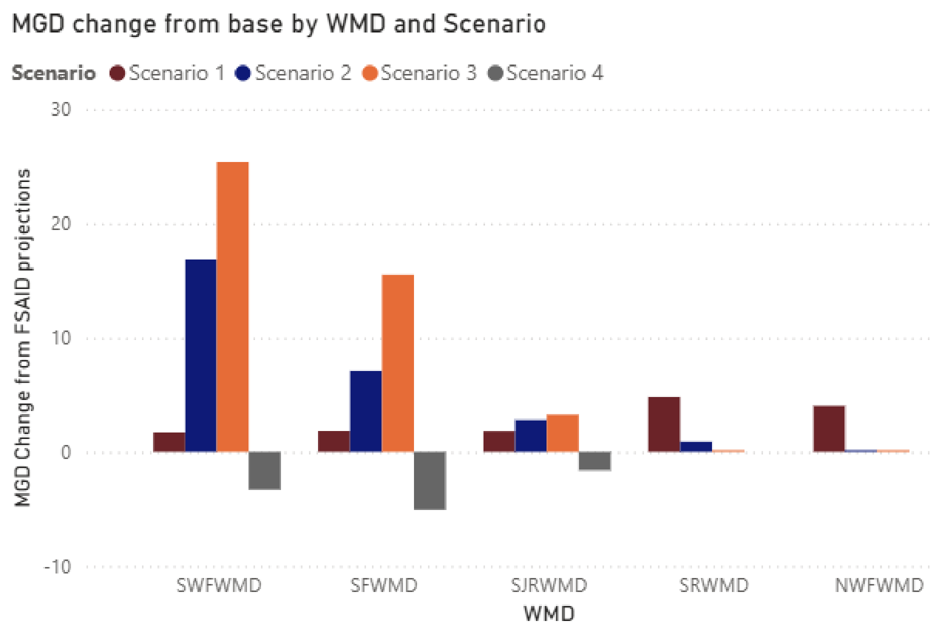
The water demand outcomes of those four scenarios are summarized in the table below (**Table E- 8**) and in **Figure E- 2**. The results are presented as changes from the FSAID 2050 projections (62k acre decrease in irrigated area and 50 MGD drop in irrigation demand). For example, Scenario 3 shows an estimated 44

MGD increase above the 50 MGD decrease, a net change of a 6 MGD decrease (rather than the projected 2050: 50 MGD decrease) in total for that scenario.

Table E- 8. Scenario Summary: Acreage and MGD Differences from FSAID 2050 Projections

Scenario description	Scenario #	Irrigated acreage change from base projection	MGD change from base projection
West to East irrigation transition	1	14,000	14.2
Trade adjustments and market improvements: Fruit (Non-citrus) increase	2	12,954	27.7
Citrus greening solution: Citrus increase	3	52,499	44.2
Increased conversion of irrigated lands to non-agricultural uses	4	(9,022)	-9.9

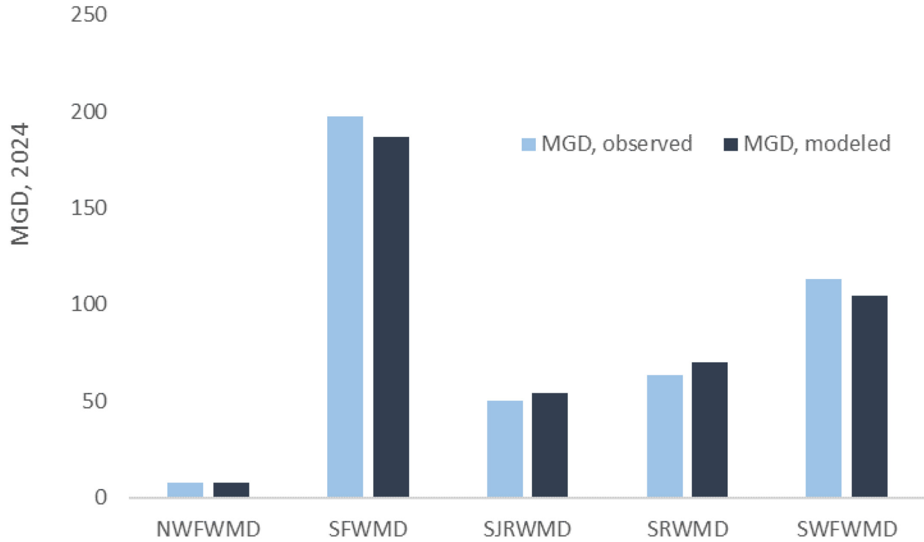
Figure E- 2. Scenario Analysis Impacts on Irrigation Demand by District



Model Performance

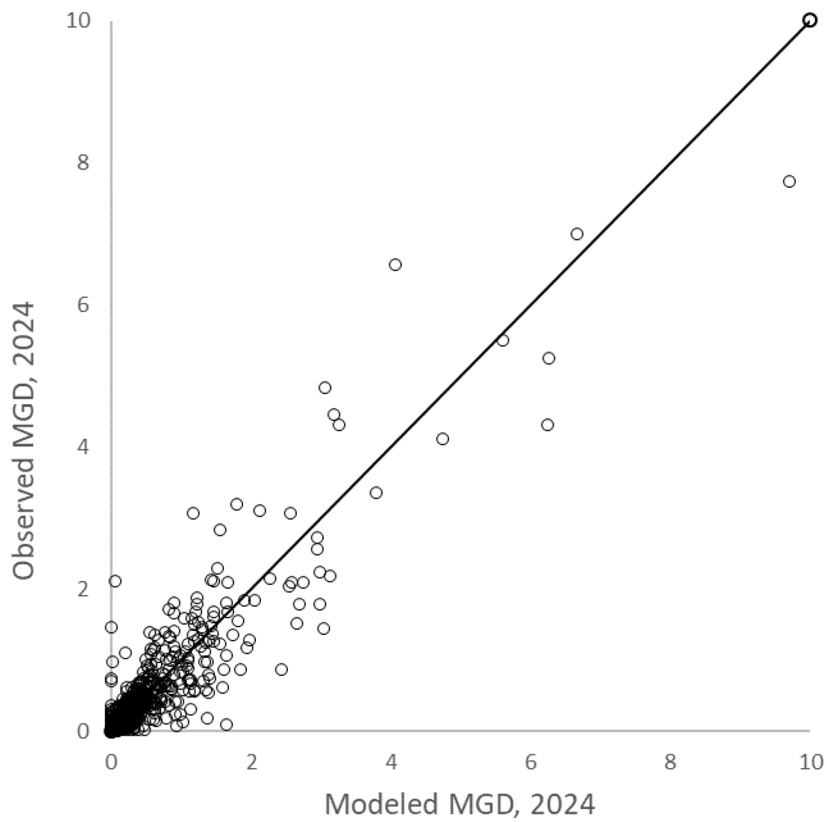
Several performance measures are used to compare the FSAID model results to field-level observations: model R^2, graphical comparisons of annual and District totals, and scatterplots of permit-level totals. The water use model has an R^2 of about 0.77. **Figure E- 3** shows a comparison of the 2024 water use data from Districts compared to the FSAID model estimates for each District. Total differences (modeled – reported) aggregated within each District ranged from 1 to 10 MGD. Note: this does not show the total irrigation water demands, **Figure E- 3** is illustrating only the sums of FSAID model results for permits where there is non-zero metered or reported water use data in 2024.

Figure E- 3. Modeled and Measured 2024 MGD



A plot of modeled and metered/reported data by permit for 2024 are shown in **Figure E- 4** with a one-to-one line; this provides a graphical assessment of model performance as seen in the general clustering near the line.

Figure E- 4. Modeled and Measured 2024 MGD Permit Comparison



Climate Risks to Florida Agriculture

Florida's agricultural producers are accustomed to dealing with seasonal and year-to-year variability. Irrigated production mitigates much of the climate risks related to droughts and dry spells, but periods of low rainfall can still have substantial economic impacts by increasing pumping costs. Also, temperature extremes can impact production by directly damaging crops or by affecting pest or disease risks. Elevated temperatures result in increased ET, which may increase irrigation requirements depending on associated rainfall changes. Also, the intensification of the hydrologic cycle (more extreme rain events) is likely to mean production challenges to farmers in Florida, but it also emphasizes the importance of retaining agricultural lands for their contributions to rainfall infiltration and groundwater recharge. The FSAID model has been used directly to estimate agricultural irrigation demand impacts from ET and rainfall changes in 2045. The datasets and methods used are summarized briefly in the following section and more detail can be found in the FSAID VIII report.

Agricultural markets are global; this means that climate changes in Florida are not the only changes that will affect Florida agriculture. For example, if freeze risks are reduced in northern parts of the U.S., this could expand the range of southern highbush blueberries – a crop where Florida has historically held a unique marketing window due to the earliness of harvest. With more areas in the U.S. growing southern highbush, this could increase competition and drive down prices received by Florida producers.

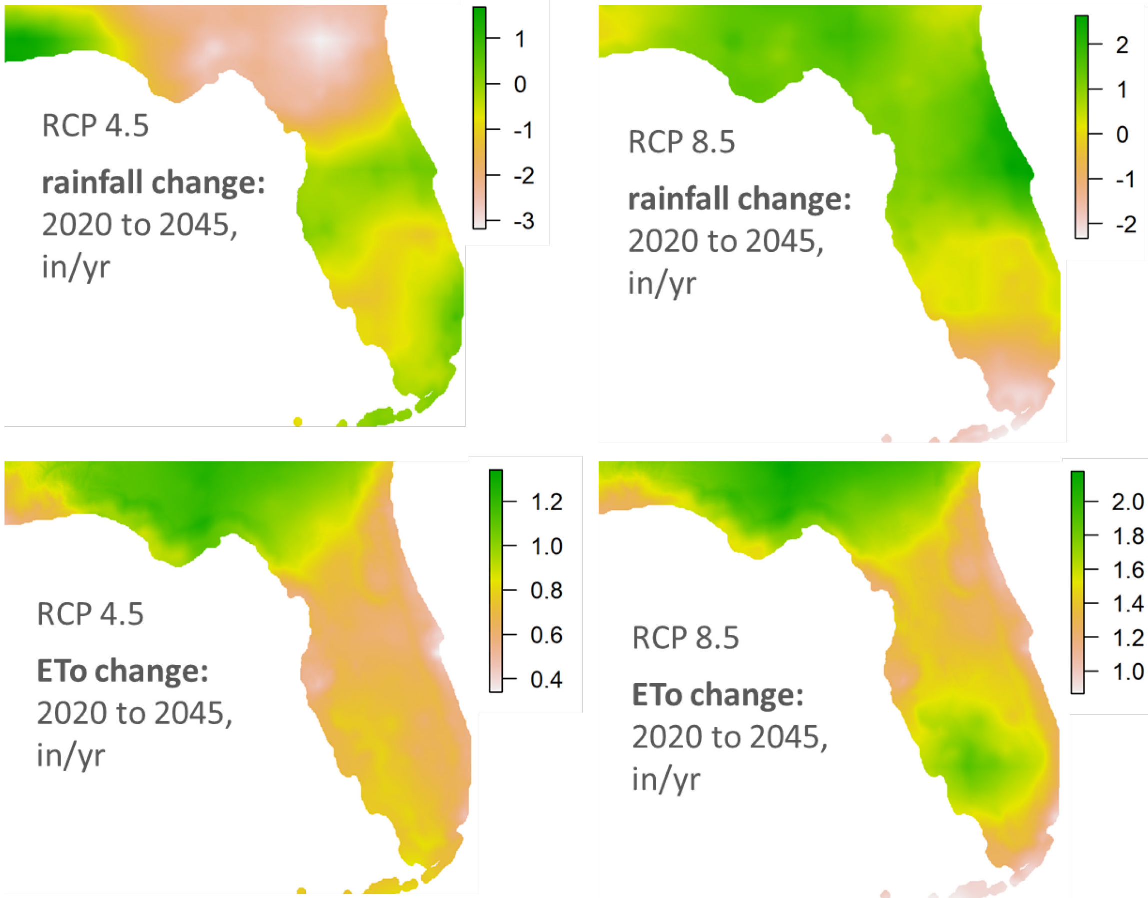
FSAID Modeled Impacts on Agricultural Water Demand

To provide quantitative agricultural irrigation water demand impacts from future climate, the FSAID model from FSAID 2021 was run with rainfall and ET for 2045 from both RCP 4.5 and RCP 8.5. This was published in the FSAID VIII report and a summarized version is retained here for reference. Please see the prior FSAID report for complete detail (FDACS 2021).

The following figures show the spatial variability in ETo and rainfall changes from 2020 to 2045 (**Figure E-5**). The most significant annual rainfall declines show up in RCP 4.5 in north Florida: about 3 in/yr. less than current average rainfall in some areas. Other parts of Florida are expected to see slight increases in rainfall in both RCP 4.5 and 8.5, with the exception of south Florida predicted to have slightly less rainfall in RCP 8.5. With both minimum and maximum daily temperatures expected to increase, there are ETo increases – of varying amounts – everywhere in Florida by 2045.

Using FSAID base year 2019 irrigated areas (from prior FSAID model) with future modeled climate changes, the FSAID modeled increase in irrigation demand is about 10 MGD statewide for RCP 4.5 and 22 MGD statewide for RCP 8.5, corresponding to about 0.5% and 1% increases, respectively. These projected increases in irrigation water demand resulting from climate changes are in line with values from recent literature (Wang 2016).

Figure E- 5. CMIP5 Model Mean Annual Rain and ET Changes 2020 to 2045



Source: NASA NEX-DCP30 downscaled climate projections

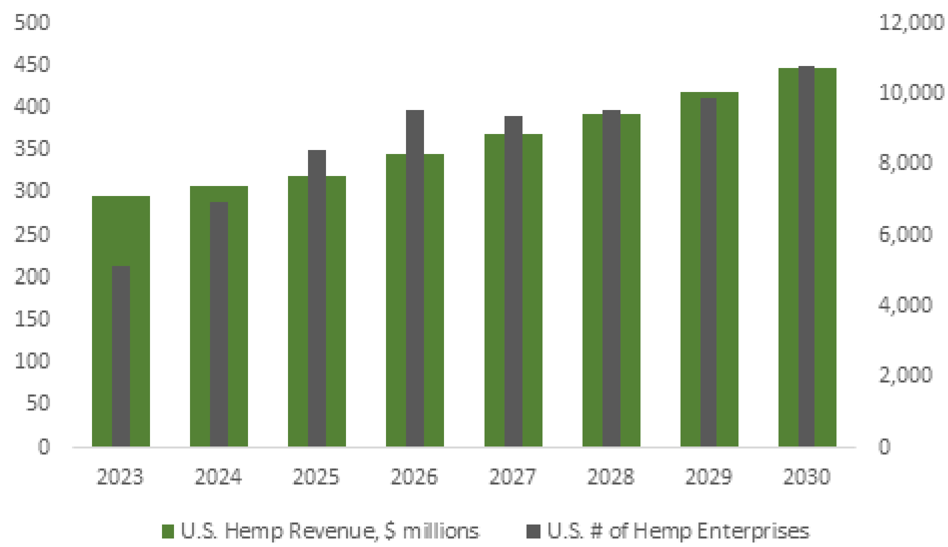
Emerging Crops

Hemp

Consumer demand for hemp-derived cannabidiol (CBD) oil has increased dramatically in recent years. Presently, while there are numerous locations licensed for hemp production in Florida, the active hemp growing operations in Florida include comparatively fewer locations. Access to processing, distribution networks, and unique security concerns due to the regulated nature of cannabis are prerequisites for a successful supply chain to support viable hemp and/or cannabis production at scale in Florida. While there has been significant growth in the hemp industry nationally from about 2015 to 2024, there is currently an oversupply of hemp which has put some downward pressure on hemp prices. There are not enough established buyers of industrial hemp, for fiber and textile applications, which buts downward pressure on hemp production.

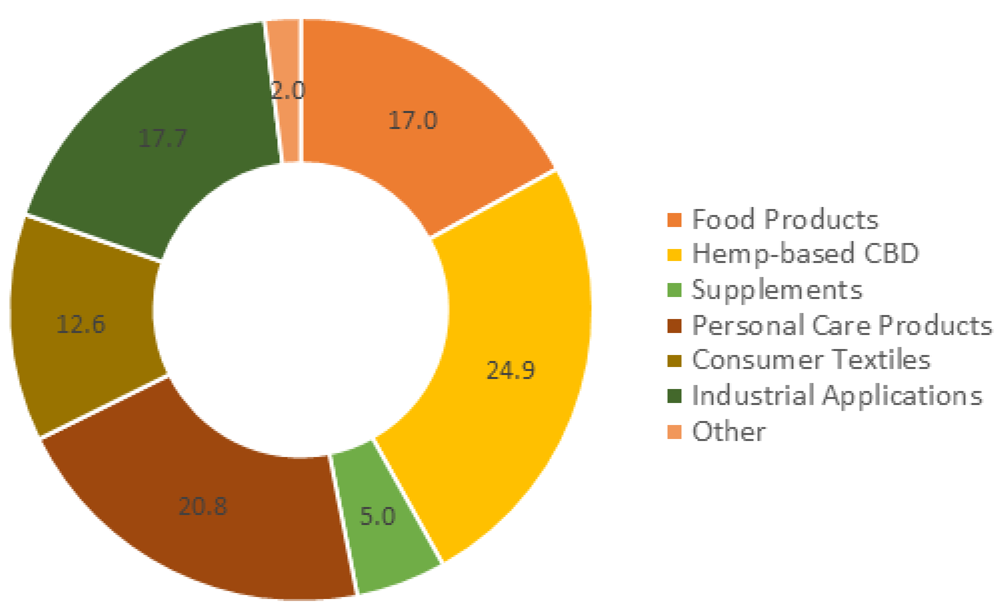
A recent industry report for hemp production (IBISWorld, 2024) shows total hemp revenues in the U.S. increasing by about 5% annually from 2023 to 2030 (See **Figure E-6**: 2023 data are historical, 2024 and later are projected future – latest report from Sep. 2024), while the number of enterprises declines, as unsuccessful early enterprises leave the industry or are consolidated into large enterprises. Montana, Colorado, Oregon, Kentucky, and Tennessee are the leading U.S. states for total hemp acreage.

Figure E- 6. Projected U.S. Hemp Revenue and Enterprises



Source: IBISWorld Hemp Industry Report Sep 2024

Figure E- 7. Estimated Hemp Product Sales by Category



Source: IBISWorld Hemp Industry Report Sep 2024

There are four main hemp varieties: oilseed/grain, fiber, hybrid (grown for both fiber and seed), and cannabinoids (grown for CBD oil). Hemp production for CBD oil is the most expensive and is potentially the most profitable if all the testing, marketing, and production challenges are overcome. Anecdotal reports suggest the large majority of early entrants into Florida hemp production are growing for CBD, but there have been substantial production and marketing challenges. **Figure E-7** shows recent data reflecting the breakdown of industrial hemp production, which has a broad variety of applications. Changes in the legal status of recreational marijuana could have major impacts on the demand for hemp and/or marijuana cultivation, but there is major uncertainty in the legalization of recreational marijuana.

Most hemp varieties reportedly need about 25-30 inches of water per year, and are most sensitive to water stress in the first six weeks of production[1]. Compared to the statewide average irrigation demands of 12 in/yr. for citrus and about 10 in/yr. for field crops, which likely represent the most probable crops displaced, hemp irrigation requirements could more closely resemble greenhouse needs if it is fully irrigated. This makes sense, given the highly controlled nature that is anticipated for Florida hemp production.

Presently irrigated hemp production shows up in the FSAID datasets within the Greenhouse/Nursery crop category, but the FSAID projections have not yet introduced hemp as a separate, future-irrigated crop given the limited acreage currently and the uncertainty around market conditions and production practices in Florida. The FSAID model is heavily dependent on crop-specific water use data, and there is currently very little hemp-specific water use data in Florida. Also, it will likely be several years before it is known what hemp production systems will look like in terms of size, irrigation systems, and open or covered (greenhouse) production.

Bamboo

Bamboo cultivation has been gaining some momentum as a popular crop in Florida. The U.S. imports roughly $500 million annually in bamboo wood products, causing farmers to seek opportunities here within the borders for potential growth and commercial businesses in bamboo production (Specialty Crop Grower, 2022). Bamboo, which is a type of woody grass, grows exceptionally fast compared to most plants. It is used as a material for many different items from furniture, constrictions, fencing, and more areas of business. Even though Florida only presently has around 1,000 commercial acres of bamboo production, it could become more attractive as an alternative crop for farmers seeking new income opportunities. An anticipated 30 to 40 additional farms or growers are forecasted to add to the production in Florida in the coming years (Specialty Crop Grower, 2022)

Citrus Evaluation

Citrus irrigation is second only to sugarcane in both acreage and in water demand, but it is substantially more volatile due to citrus greening, natural disaster impacts, and competition from Brazil and other major citrus producing regions. Florida's citrus industry output consists mostly of processed (juice) fruit, and processed orange prices have averaged about 65% of fresh orange prices in recent years; see **Table E- 8**. The notable drop in 2022-2023 citrus production (**Table E- 9**) is largely resulting from Hurricane Ian impacts (September 2022). This historic storm went directly through the major citrus production regions

[1] Purdue Hemp Project, Purdue University

(Charlotte, DeSoto, Highlands, Hardee, and Polk). Additionally, Hurricane Nicole (November 2022) also damaged trees and reduced yields; most of the impacts from Nicole were in grapefruit production areas. Hurricane Milton in 2024 also caused major fruit drop and some tree damage in Polk County and surrounding major production areas.

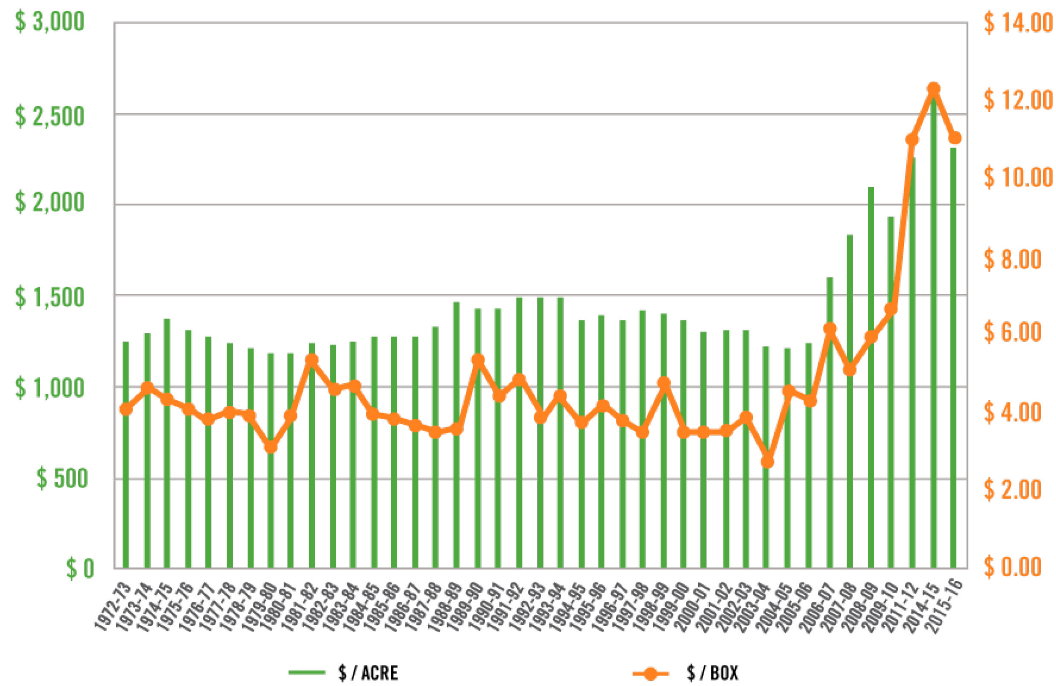
Citrus production costs have increased sharply since the onset of greening (around 2006-2007 season) but have leveled off somewhat is recent years as management practices have stabilized. **Figure E-8** provides a graphic timeline of costs per acre which have jumped by nearly 70% since the onset of greening; production costs have stabilized in recent years as greening management strategies have become more efficient and affordable. The 2023/2024 total production costs were about $1,700/acre in Southwest region (UF-IFAS 2024).

Table E- 9. Fresh vs. Processed Citrus (Oranges, FL) by Year

Crop Year	Utilization of Production			Price per Box			Value of Production		
	Fresh (1,000 boxes)	Processed (1,000 boxes)	Total (1,000 boxes)	Fresh (dollars per box)	Processed (dollars per box)	Total (dollars per box)	Fresh (1,000 dollars)	Processed (1,000 dollars)	Total (1,000 dollars)
2012-2013	5,974	127,626	133,600	10.86	7.27	7.43	64,867	927,659	992,526
2013-2014	5,500	99,200	104,700	13.62	9.41	9.63	74,923	933,699	1,008,622
2014-2015	4,970	91,980	96,950	14.39	9.11	9.38	71,507	837,880	909,387
2015-2016	3,930	77,770	81,700	15.14	9.63	9.90	59,484	749,281	808,765
2016-2017	2,841	65,909	68,750	17.51	9.33	9.67	49,759	614,877	664,636
2017-2018	2,759	42,291	45,050	22.95	15.10	15.58	63,307	638,548	701,885
2018-2019	2,737	69,150	71,850	17.71	14.36	14.48	48,467	992,796	1,041,263
2019-2020	3,238	64,062	67,300	13.56	12.85	12.89	43,919	823,285	867,204
2020-2021	3,270	49,608	52,950	18.88	13.02	13.38	61,734	646,847	708,581
2021-2022	2,613	38,587	41,200	19.05	13.69	14.03	49,779	528,117	577,896
2022-2023	1,577	14,243	15,820	18.89	13.59	14.12	29,785	193,522	223,307
2023-2024	1,752	16,208	17,960	20.18	12.66	13.4	35,357	205,242	240,599
2024-2025	1,078	11,122	12,200	22.35	17.44	17.87	24,091	193,952	218,043

Source: USDA Citrus Fruits summary (2025)

Figure E- 8. Total Historical Citrus Production Costs



Source: Florida Department of Citrus, 2016

Given the high production costs largely due to HLB in Florida, and the intense foreign competition, there is still significant uncertainty about future citrus production in Florida. The price projection trend for citrus in FSAID was based on the trend in round orange production and prices from FDOC, adjusted to all citrus prices and extended to 2050. The projections considered a confidence interval on price forecasts, a linear trend on price forecast in the outer years, and an upper bound on overall production.

Citrus acreage has declined by over 100,000 acres in the ILG from 2023 to 2024 base year. Over the short run, citrus acreage decline is likely to continue, but newer nursery stocks that exhibit more tolerance to greening are beginning to be used in re-plantings such that within 5-7 years, acreage could stabilize and possibly improve citrus acreage. It is expected that in the next several years, there will be new data and insights from the citrus industry that provides more certainty about the potential recovery of citrus. Based on best-available and current information, the FSAID acreage projections for citrus are about 35,000 acres of decline from the 2024 baseline acreage of around 260,000. The scenario for citrus recovery described above (see section “Global Agricultural Context and Scenarios”) provides an alternative projection for citrus based on an assumed amount of citrus recovery through improvement in disease management and possible funding support for long-term acreage resets/replanting.

FSAID Methodology for Dry-Year Water Demand Estimation

Florida statute requires agricultural demand estimates be developed for use in regional water supply planning to include average year and 1-in-10-year drought demands. In FSAID, the approach is to base the dry-year estimates on modeled irrigation demand that occurs with a 1-in-10 frequency. This approach reflects the reality that the years of high irrigation demand might correspond to years with normal or above-average rainfall because of the difference in timing of rainfall events and cropping seasons. The relevant water supply planning statute language is as follows:

From Statue 373.709 Regional water supply planning:

> "A quantification of the water supply needs for all existing and future reasonable-beneficial uses within the planning horizon. The level-of-certainty planning goal associated with identifying the water supply needs of existing and future reasonable-beneficial uses must be based upon meeting those needs for a 1-in-10-year drought event."
>
> "Agricultural demand projections used for determining the needs of agricultural self-suppliers must be based upon the best available data. In determining the best available data for agricultural self-supplied water needs, the district shall consider the data indicative of future water supply demands provided by the Department of Agriculture and Consumer Services pursuant to s. 570.93 and agricultural demand projection data and analysis submitted by a local government pursuant to the public workshop described in subsection (1), if the data and analysis support the local government's comprehensive plan. Any adjustment of or deviation from the data provided by the Department of Agriculture and Consumer Services must be fully described, and the original data must be presented along with the adjusted data"

From Statue 570.93 Department of Agriculture and Consumer Services; agricultural water conservation and agricultural water supply planning: "Estimates of historic and current water demands must take into account actual metered data as available."

Estimates of Dry Year Water Demand are calculated using the ratio of dry-to-average 1-in-10 irrigation needs. Based on a statewide batch run of AFSIRS, the 90th percentile irrigation demand by crop was determined. The dry-to-average ratios (by crop by District) used throughout the estimates are shown in **Table E- 10**.

Table E- 10. Dry to Average Year Ratio

Primary Crop	NWFWMD	SFWMD	SJRWMD	SRWMD	SWFWMD	Statewide
Citrus	1.5	1.43	1.58	1.47	1.5	1.5
Field Crops	1.39	1.32	1.48	1.27	1.29	1.35
Fruit (Non-citrus)	1.6	1.17	1.44	1.41	1.3	1.31
Greenhouse/Nursery	1.17	1.1	1.14	1.13	1.1	1.13
Hay	1.72	1.36	1.64	1.36	1.37	1.46
Potatoes	1.45	1.23	1.53	1.45	1.31	1.45
Sod	1.34	1.18	1.31	1.2	1.17	1.22
Sugarcane	1.38	1.38	1.2	1.38	1.38	1.38
Vegetables (Fresh Market)	1.45	1.23	1.34	1.31	1.29	1.28
				Statewide overall		**1.34**

Irrigation Efficiency Improvements

The efficiency of an irrigation system describes the relationship between the amount of irrigation water retained in crop root zones and the total amount of water withdrawn from a source for irrigation. Improvements to irrigation efficiency are generally the result of the following changes:

- Management or scheduling improvements (possibly resulting from implementation of soil moisture sensors or weather stations or other monitoring equipment)
- Equipment change to irrigation equipment that is more efficient
- Equipment maintenance and upgrades that improve uniformity and/or efficiency (resulting from nozzle replacement, adding pressure regulators, or other equipment improvements)

One option for estimating future improvements in irrigation efficiency requires estimating the field-level improvements in efficiency and estimating the number of fields or farms that are expected to achieve those efficiency improvements. The advantage of this approach is that it can be linked to on-farm data where irrigation efficiency improvements have been made in the past. However, a challenge with this approach is estimating the numbers of farms that can be expected to realize similar efficiency improvements in the future.

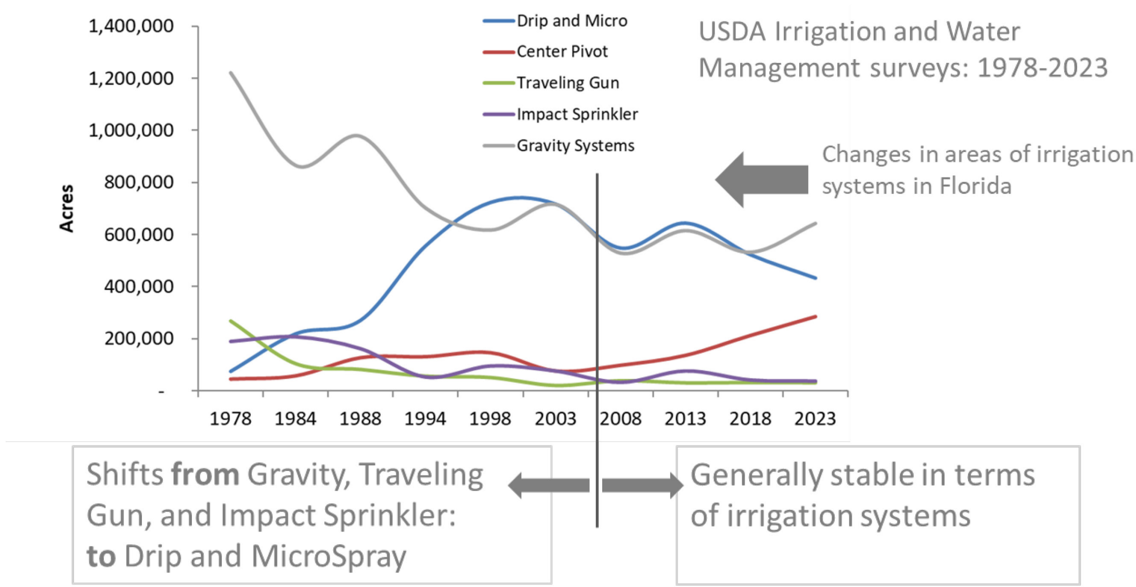
The approach used in FSAID relies on statewide, aggregated historical trends in Florida irrigation efficiency in agriculture to predict future improvements. The Farm and Ranch Irrigation Surveys (FRIS), now referred to as the Irrigation and Water Management (IWM) survey, of the USDA were utilized as the data source for statewide irrigated area and total volume of water applied. The IWM data are a subset of USDA's Ag Census; producers are required by law to respond to the Ag Census (Title 7 USC 2204(g) Public Law 105-113). IWM data used in FSAID to estimate irrigation efficiency improvements are based on Florida producers' self-reported water use volumes and irrigated area. A main advantage of this method is that it avoids the uncertainty of estimating at the field level exactly what type of management change would be made and how many farms or fields would be expected to make that change. It also recognizes the equipment and management changes made by producers which happen outside of any particular conservation initiative.

IWM survey data from 1978-2023 were used to develop trends in water per area for irrigated areas in Florida. The 2023 IWM survey from USDA was released November 2024, and was incorporated into the historical dataset to update the conservation/ efficiency trends for Florida. While these survey-based data are sensitive to farmer response rates and the rainfall conditions of the survey year, the additional year of data added to the historical time series did not meaningfully change the future conservation projections.

The time series of the IWM-derived ratio of irrigation water volume applied to irrigated area was used to develop two exponential functions of efficiency improvements, where water per area is used as a proxy for efficiency. The function derived from the more recent IWM data (2003-2023) is assumed to be representative of efficiency improvements resulting mostly from management/scheduling changes.

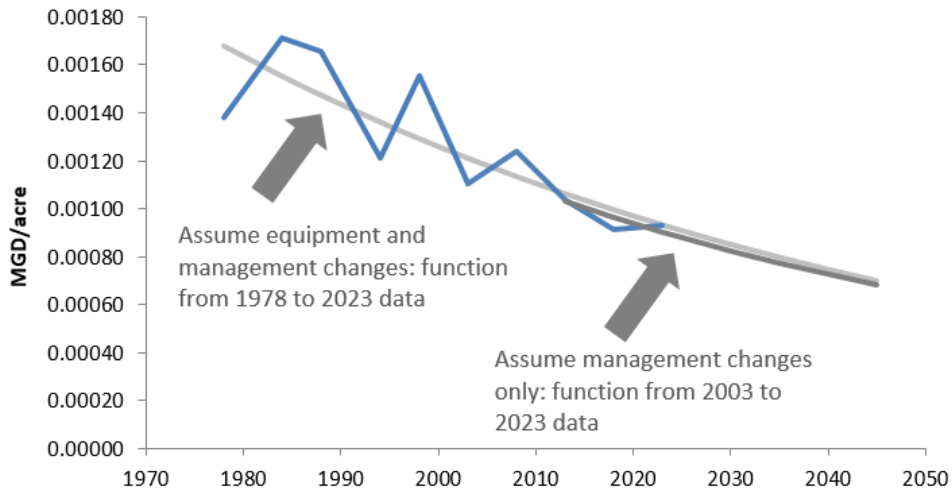
The exponential function derived from the entire time series (1978-2023) is used to represent the combined impacts of irrigation system equipment changes and management improvements. **Figure E- 9** illustrates the shift in types of irrigation equipment. It can be seen that there is a sizeable shift from gravity systems to drip and micro-spray systems. There appears to be relative stability in the equipment trends beginning with the 2003 IWM; the increase in Center Pivot irrigation is largely from irrigation area expansion in SRWMD and NWFWMD – changes that have now roughly stabilized.

Figure E- 9. Shift in Types of Irrigation Equipment



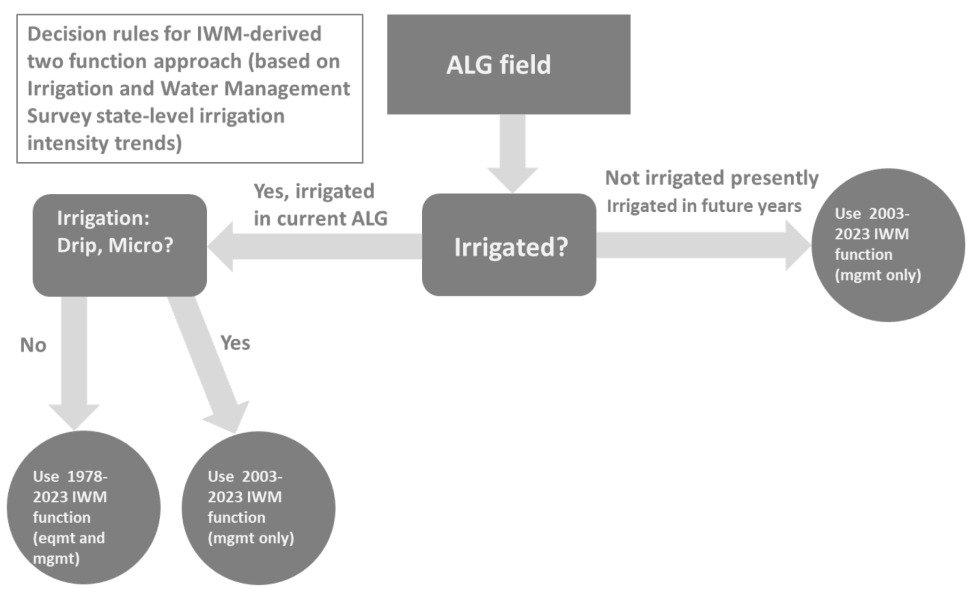
Both IWM-derived efficiency improvement functions are used in the FSAID estimates (**Figure E- 10**). The approach of using two functions allows for less efficiency improvements to be projected in the coming decades for newly irrigated fields or for existing irrigated fields that have drip or micro-spray systems. It is assumed that newly irrigated fields or fields with drip or micro-spray systems would achieve efficiency improvements largely resulting from management improvements.

Figure E- 10. IWM Survey Data of Irrigation Amount (MGD) Per Irrigated Acre



Other fields (that are not new, or have not yet upgraded their equipment) could be expected to achieve efficiency improvements of a larger amount resulting from combinations of equipment and management improvements; this is represented by the exponential function built from the entire IWM time series of water applied per irrigated area. A diagram of these decision rules is illustrated by **Figure E- 11.** It should be noted that the use of exponential trends in conservation results in slopes that are flattening in the future periods (see **Figure E- 10**).

Figure E- 11. Methodology for Applying IWM-Derived Efficiency Improvement Functions



Limits on irrigation efficiency were defined using the metered/reported irrigation data. The median irrigation intensity (in/year) by crop type, based on all 2007-2024 metered/reported water use data, was used to constrain additional efficiency improvements at the field level if the irrigation intensity dropped below the median value (**Table E- 11**). This means that for an individual Field Crop field, for example, if the irrigation rate decreases below 9.1 in/yr as a result of the conservation trend, then no further irrigation conservation would be estimated for that field. For citrus, the average irrigation intensity (11.7 in/yr.) from the historical data, rather than the median, was used to constrain efficiency improvements. This was done to reflect the potentially higher irrigation rates in new citrus fields resulting from greater planting densities. Similarly, for fresh vegetable crop types, the average intensity (16.2 in/yr) was used to limit irrigation efficiency improvements in order to accommodate the likely crop rotation intensification (more crops per year in some fields) that will happen within that crop type.

Table E- 11. Median Metered Irrigation Intensity Reported by Crop, 2007-2024

Primary Crop	in/year
Citrus	11.7 (10.1 median)
Field Crops	9.1
Fruit (Non-citrus)	24.3
Greenhouse/Nursery	21.0
Hay	8.8
Potatoes	11.7
Sod	8.3
Sugarcane	16.0
Vegetables (Fresh Market)	16.2 (13.0 median)

To summarize the irrigation conservation estimates:

- Irrigated efficiency improvement estimates should not be treated as a guaranteed “water supply” or reduction in average year demands.
- The future trends are based on a long-term time historical time series of Florida producer-reported irrigation volumes and areas.
- Future conservation estimates for FSAID use a trend from the IWM, constrained by irrigation intensities from permit level water use data.
- There is uncertainty in the conservation estimates from the historical data used and from the future climate conditions.
- Increasingly frequent droughts or dry spells or unanticipated production changes, might mean that the conservation estimates presented here would not be achievable.

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