Economic Impact of the Irrigation Equipment and Services Industry

For:

Irrigation Association®

Irrigation Innovation Consortium

By:

Headwaters Corporation

November 2021

Table of Contents

Introduction

Irrigation is a big business, encompassing the manufacturing of irrigation systems, their installation, maintenance, services, and, ultimately, the additional economic value the industry provides in crops, higher property value, and aesthetics. The industry has an active trade association, lobbies, organizes annual meetings, and conducts business comparable to other large industries. So how big is the irrigation industry, dollar-wise? This issue is addressed in the following analysis.

In 2010, the Irrigation Association (IA) authorized an economic impact study that estimated annual domestic expenditures for irrigation equipment and services, including installation, totaled a bit over $7.0 billion. This is before applying the multiplier effects associated with input supply expenditures and their employee's household spending. Honey Creek Resources led the consulting team that developed this estimate which conceded that a large degree of uncertainty surrounded the number due to a lack of empirical data.

The irrigation industry is large, but currently lacks an industrial reporting classification, or NAICS code, that would provide instantaneous monthly and annual summaries of business volume and employment.[1] A secondary source of data, using major manufacturers' and distributors' annual reports to "ballpark" annual expenditures had limited potential because a major portion of the firms are privately-held and do not share sales data.

On the crop irrigation side of the industry, publicly available data from the United States Department of Agriculture (USDA) National Agricultural Statistics Service and the USDA's Census of Agriculture (2003, 2008, 2013, 2018), was used to provide irrigation-related expenditures, by system type and by function, on a per acre basis.[2] With supporting assumptions, expenditure estimates were aggregated over total irrigated acreage to estimate total expenditures on equipment and services. For the residential and commercial portion of the industry, less data was available, and individuals within the industry were depended upon to provide their insights about its magnitude.

Regardless, the 2010 study was completed, and the results showed that annual expenditures on the residential and commercial side of the industry were greater than those for crop irrigation equipment and services. This finding seemed counter-intuitive at the time and probably still is to some in the industry.

The industry was going through some significant recession-induced adjustments during the 2010 time period and has since stabilized on a more steady growth path. In response, the IA, with the Irrigation Innovation Consortium (IIC), has authorized this update to the 2010 study.

After reassessing data availability, it was apparent that previous data shortcomings are still present, and a similar "bottom-up" methodology would be needed to estimate industry spending as the sum of spending on a per acre or per square foot basis times total area irrigated.

Two additional Irrigation Census have been published since 2010, doubling the level of empirical data available to examine the statistical properties of crop irrigation expenditure. This allows for some

[1] North American Industrial Classification System (NAICS).

[2] Census of Irrigation data was collected by the Irrigation and Water Management Survey (2018), formally called the Farm and Ranch Irrigation Survey (2003, 2008, 2013). The data can be accessed via this link USDA - National Agricultural Statistics Service - Surveys - Census of Irrigation

statistical analysis into how spending responds to macroeconomic variables, primarily commodity prices, giving the model some predictive capability. However, data has remained constraining since the 2010 study for the residential and commercial components of the industry. As a result, consultation with industry participants and members of the IA is still relied upon to develop these non-crop irrigation estimates.

Steering Committees

In recognition of data limitations and the regional nature of irrigation, two steering committees were consulted to provide guidance and review for this effort. Initially, a steering committee primarily consisting of IIC university representatives was used to assist in the crop irrigation component of the analysis. As it became apparent that the residential and commercial irrigation sectors were under-represented in the steering committee, a second ad hoc committee was used to assist in this component of the analysis.

The steering committee assisting the crop irrigation component of model development and the individuals comprising the supplemental ad hoc steering committee are identified in Appendix A.

Organization

This report is organized through the following sections:

- What is being measured, or estimated, in this updated analysis
- A definition of "direct" irrigation expenditure categories and their components
- Discussion of the data and procedures used to estimate spending in these categories
- Aggregation of the direct spending categories into industry totals
- Estimation of the economic impacts of irrigation spending
- Results, conclusions, and comparisons to the 2010 study

Economic Variables Being Estimated

This analysis estimates the total economic impact of expenditures for irrigation equipment and services across the crop and non-crop irrigation spectrum, on the U.S. economy. The impact estimated here combines the direct, indirect, and induced impacts. These estimates are presented in terms of dollar output and in terms of employment generated.

Direct Impacts

The majority of this analysis focuses upon estimating direct spending on irrigation equipment and services. Direct spending serves as the basis for the multiplier-based analysis used to estimate indirect and induced impacts. Direct spending is at the consumer level, whether that be irrigators, homeowners, businesses, or government entities, and regardless of whether the spending directly originates from the manufacturer or passed through one or more distributors with a mark-up. For this analysis, spending is estimated at the national level and, to the degree possible, includes exports and imports. As a result, the overall direct expenditures represent an equivalent gross domestic product (GDP) of the irrigation equipment and services industry.

Indirect and Induced Impacts

Indirect impacts are those impacts associated with industries supporting irrigation equipment manufacturing, such as raw material suppliers, transportation services, and labor. Induced impacts are those impacts that result from the household spending represented by these labor services.

Indirect and induced impacts are estimated through economic input-output multiplier analysis. Similar to other industry-wide studies, the well-utilized IMPLAN model is used to create the multipliers based on a general equilibrium model of the U.S. economy.[3]

Regional Analysis

During the study, it became apparent that a series of regional models summed to a national level would likely achieve more accurate results providing greater insight into regional characteristics in the industry. This is especially the case with crop irrigation, in which a considerable amount of data is available in specific regions or basins to estimate how a range of economic, climatic, and demographic variables can influence farm-level irrigation decisions. In aggregate, these decisions have industry-wide impacts but their region-specific effects cause a "washing-out" at the national level.

Components of the Modeling Framework

The model, or framework, to estimate total direct spending consists of several components representing the major portions of the industry. Major categories of expenditures include:

- Expenditures for crop irrigation equipment and services
- Landscape and horticultural crops
- Residential irrigation equipment and services
- Commercial irrigation equipment and services, which can be further categorized by the irrigation purpose:
    - Irrigation around commercial buildings
    - Large turf areas
    - Commercial irrigation for golf courses

Expenditures on Crop Irrigation

Expenditures for crop irrigation equipment and services are assumed to be accounted for through the following three categories of expenditures.

1. Expenditures on newly irrigated lands
2. Replacement of existing systems with one of a similar type
3. System upgrades, including upgrading of existing technology and system conversions

In addition, each expenditure category can be further broken into five common supporting subcategories, relating to:

1. Machinery and equipment
2. Groundwater-related source of supply expenditures
3. Surface water-related source of supply expenditures

[3] https://implan.com/

4. Computer and technology expenditures
5. Land leveling and preparation expenditures

For the 2013 and 2018 Irrigation Census, expenditures for all categories are included, except for the system conversions category, which is developed as part of this analysis. However, for years prior to 2013, the Census data is less comprehensive. It is of note that the 2013 and 2018 Census reported total expenditures of $2.6 billion and $2.04 billion, respectively. These figures will be compared with modeled estimates in a subsequent section.

This analysis focuses upon the four main categories of expenditures, how they have changed over time, and what economic variable(s) drive them. It uses simple ordinary least squares (OLS) econometric analysis to estimate the variables' influence, to the degree the data allows. Allocation of these expenditures across supporting subcategories is based on historical proportions rather than statistical analysis.

It should be noted that Census does not distinguish between types of irrigation systems in reported expenditures; they are aggregated across gravity, sprinkler, and drip technologies. A shortcoming of this aggregation is that little is said about how systems may convert from one technology to another over time. In response, this updated analysis allocates expenditures across technologies based on historical trends and assumed future rates of change. These rates of change are applied to assumptions about the rate of conversion in irrigation technology, in annual percentage terms, and the cost of conversion, in dollars per acre.

The Census provides summaries of the relatively broad three categories of irrigation spending on a periodic basis. Therefore, the purpose, or goal, of the model developed here is to use a range of economic-based assumptions about expenditures that, when aggregated across types of irrigation systems, calibrate to these Census values.

Baseline Irrigated Acreage and Investment Value

In terms of a starting point, estimates of irrigated acreage by type of system begin in 2017, as reported by the 2018 Irrigation Census. Irrigated acreage changes over time for each technology based on assumptions described in the analysis. Figure 1 shows baseline irrigated acreage and estimates of future acreage by type, resulting from the crop irrigation analysis presented in the following sections. Figure 1 confirms the historical trend of increasing relative levels of sprinkler and drip systems and declining levels of surface gravity systems. Overall irrigated acreage is estimated to modestly increase over time.

Figure 2 shows estimates of the total value of installed crop irrigation systems, by system type, based on the irrigated acreages shown in Figure 1. Specifically, the value per acre for each system type is defined as its replacement value less depreciation. Assumptions about replacement value are presented below. It is assumed that the existing stock of irrigation equipment is 50 percent depreciated. Based on these assumptions, the existing stock of operating irrigation equipment is approximately $35 billion and anticipated to increase to over $40 billion by 2025.

Figure 1. Estimated Irrigated Acreage by System Type

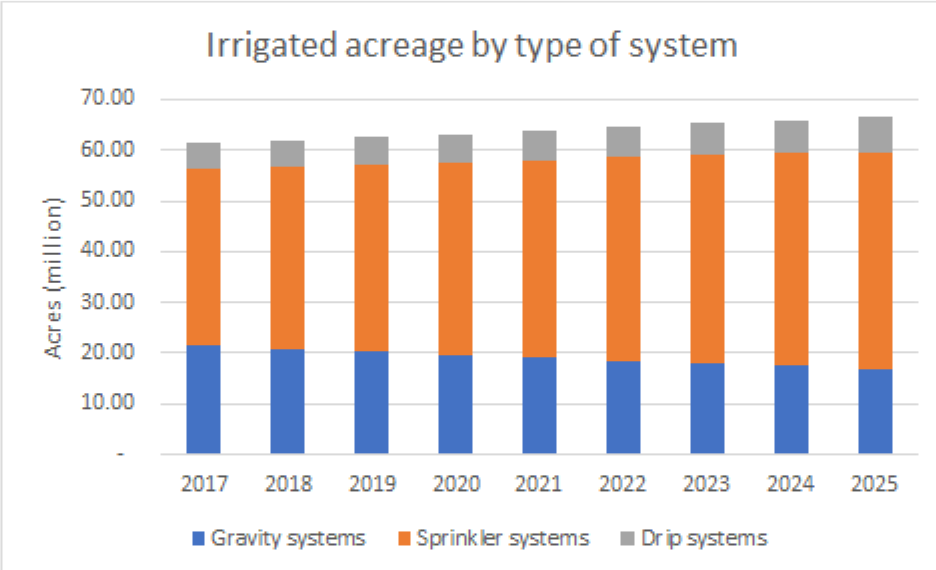
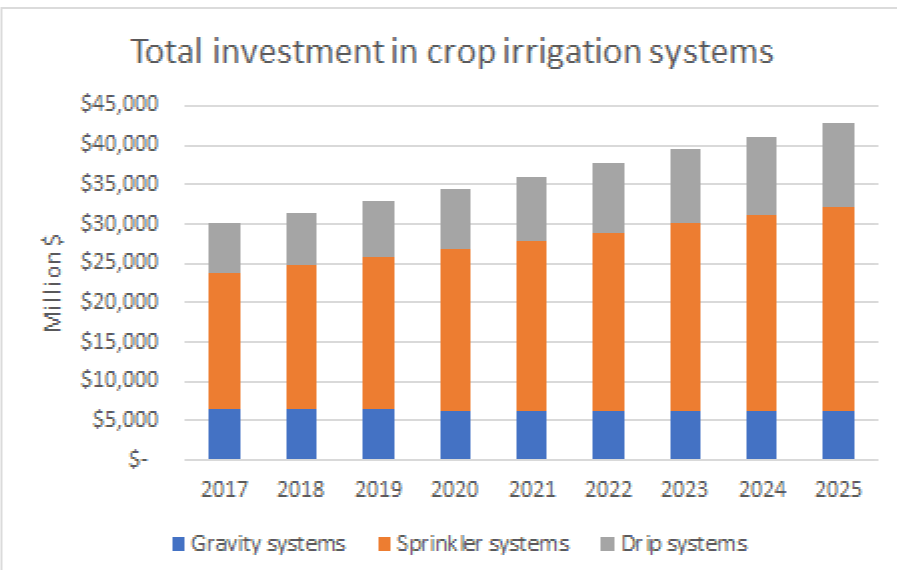


Figure 2. Total Investment in Crop Irrigation Systems



Expenditures on Newly Irrigated Lands

In total, crop irrigation expenditures are based on the annual number of newly irrigated acres multiplied by an assumed expenditure per acre, for each of the three irrigation technologies. Table 1 summarizes the baseline assumptions for the annual rate of change.

Overall, it assumed the U.S. irrigated land base is increasing at a rate of 1 percent per year, and the rate of increase for each technology is also 1 percent. This overall rate corresponds to the long-term rate of increase between 1992 and 2018, although total irrigated acreage has remained relatively flat over the last 10 to 15 years. Despite recent history, this 1 percent annual rate is assumed to account for potential future climate-related irrigated land increases in the Corn Belt and the lower Mississippi Basin.

The economic intuition underlying this rate of change relates to commodity prices. Higher commodity prices (e.g., corn price) tend to result in higher expenditures on newly irrigated lands. The relationship between expenditures on newly irrigated lands and commodity prices, as represented by a commodity price index, was analyzed statistically using OLS regression. Results showed that the price elasticity of spending is about 0.40, which suggests that a 1 percent increase in commodity prices will result in a 0.4 increase in irrigation expenditures on newly irrigated lands.

For purposes of this analysis, this elasticity was applied to the annual rate of change in irrigated acreage. For instance, a 10 percent increase in commodity prices will cause the annual rate of change to increase to 1.04 percent.

Table 1. Baseline Rate of Increase in Newly Irrigated Lands and Assumed Expenditures

Newly irrigated acres			
	Rate of change in new irrigated land, gravity		1.0%
	Rate of change in new irrigated land, sprinkler		1.0%
	Rate of change in new irrigated land, drip		1.0%
Expenditures on newly irrigated lands			
	Gravity systems ($/acre)		$ 600
	Sprinkler systems ($/acre)		$ 1,000
	Drip systems ($/acre)		$ 2,500

Also shown in Table 1 are the assumed expenditures on newly irrigated lands. These are assumed to include expenditures for the supporting subcategories of costs identified above including installation costs. It should be noted that per acre expenditures may vary significantly across each technology, depending land preparation costs, crops to be irrigated, size of parcel, and other local factors.

Replacement of Existing Systems

This category assumes that in every year, some proportion of the total number of irrigation systems are replaced. Some systems are replaced with one of the same technology and others are replaced with different technology.

Similar to the rate of change in newly irrigated lands, the rate of system replacement is also influenced by commodity prices. Regression analysis yielded an elasticity of replacement spending with respect to commodity prices of 0.47, indicating that a 10 percent increase in commodity prices would result in a 4.7 percent increase in replacement spending.

Replacement of Existing Systems with Same Technology

Table 2 summarizes the annual rate of system replacement with a similar type of technology and the associated expenditures on replacement equipment and services. Table 2 implies that in any given year, one in every 50 gravity systems is being replaced with another gravity system. In a similar manner, one in every 33 sprinkler and drip systems is being replaced annually. These rates of replacement assume the equipment is used to the end, or past, its designed useful life.

Table 2. Rate of System Replacement and Associated Expenditures

Rate of system replacement by one of a similar type			
	Gravity systems, %		1.0%
	Sprinkler systems, %		3.0%
	Drip systems, %		1.0%
Expenditure/acre for a replacement system			
	Gravity systems ($/acre)		$ 300
	Sprinkler systems ($/acre)		$ 750
	Drip systems ($/acre)		$ 1,200

Replacement of Existing Systems with Different Technology

This analysis assumes that gravity systems may be replaced with sprinkler or drip systems over time. Although there are instances where sprinklers are replaced with gravity systems, this possibility is not considered here. Table 3 summarizes the assumed annual rates of system conversion and the estimate of the respective expenditure. Table 3 implies that in any given year, one in every 33 gravity systems is being replaced with a sprinkler system and one in 100 gravity systems is being converted to drip.

Table 3. Rate of System Conversions and Associated Expenditures

Rate of conversion for gravity to sprinkler system			3.0%
	Cost of conversion		$ 800
Rate of conversion for gravity to drip system			1.0%
	Cost of conversion		$ 1,200

Overall, replacement expenditures are assumed to be lower than for the first-time buying of equipment because not everything may be replaced or duplicated, such as site preparation costs and buried pipes. Although difficult to verify, these assumptions result in 2017 expenditure estimates which closely match actual expenditures, as shown in the 2018 Census of Irrigation.

System Upgrades

System upgrade expenditures focus upon water and energy conservation, as reported in the 2013 and 2017 Census. Combined, they were found to be the most responsive to commodity prices compared to developing newly irrigated lands or replacing existing systems. This is intuitive because there would seem to be a discretionary component of when to upgrade and high crop prices would tend to trigger such a response. Regression analysis indicated that the elasticity of upgrade expenditures with respect to commodity prices is nearly 1.0, meaning that a 1 percent increase in commodity prices would increase upgrade expenditures by 1 percent.

Baseline values for the proportion of systems being upgraded in each year are shown in Table 4. It assumes that annually, one in 50 gravity and drip systems are upgraded, and about one in 33 sprinkler systems is upgraded. The proportion of systems being upgraded is assumed to change at the same percentage as a change in commodity prices. Upgrade expenditures were estimated based on engineering judgment and, combined with the proportion of systems being upgraded, approximately equal the 2017 Census expenditures for water and energy conservation.

Table 4. Rate of System Upgrades and Associated Expenditures

Proportion of systems being upgraded by type		
Gravity systems		2.0%
Sprinkler systems		3.0%
Drip systems		2.0%
Expenditure/acre for upgrades		
Gravity systems ($/acre)		$ 150
Sprinkler systems ($/acre)		$ 300
Drip systems ($/acre)		$ 700

Estimated Expenditures on Crop Irrigation Equipment and Services

Starting with 2017 Irrigation Census baseline acreage values, the above assumptions were put to work and the model was simulated over the period 2017 through 2027. Actual commodity prices were used for the simulation through 2021, and FAPRI projections were heavily weighted for the years 2022 through 2025.[4] Table 5 shows the results of this simulation.

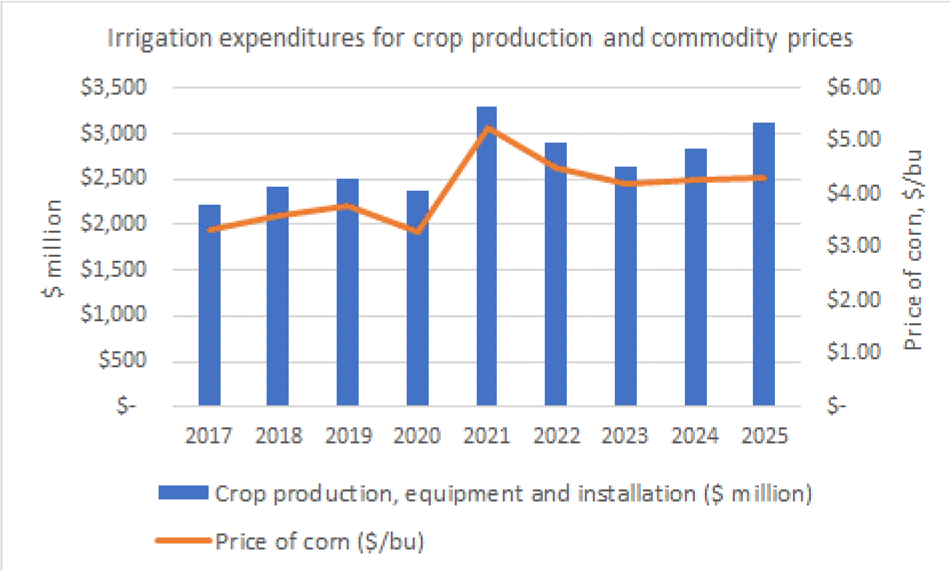
Table 5. Estimated Crop Irrigation Equipment and Services Expenditures (million)

	Newly irrigated lands	Replacement of existing systems with one of a similar type	System conversions	Upgrades to existing systems	Total crop irrigation expenditures
2017	$ 601	$ 909	$ 258	$ 447	$ 2,214
2018	$ 674	$ 970	$ 257	$ 507	$ 2,408
2019	$ 701	$ 1,020	$ 255	$ 528	$ 2,505
2020	$ 600	$ 1,070	$ 254	$ 453	$ 2,377
2021	$ 1,093	$ 1,128	$ 252	$ 827	$ 3,300
2022	$ 833	$ 1,184	$ 252	$ 632	$ 2,901
2023	$ 648	$ 1,238	$ 251	$ 492	$ 2,629
2024	$ 733	$ 1,295	$ 249	$ 558	$ 2,835
2025	$ 859	$ 1,355	$ 247	$ 656	$ 3,118

Figure 3 graphically summarizes estimated expenditures shown in Table 1 and overlays the price of corn during this period. Corn is used here as a proxy for a commodity price index. The model responds well to the commodity price increase experienced during the 2021 time period.

[4] Food and Agricultural Policy Research Institute. August-2021-Baseline-Outlook-Update.pdf (missouri.edu).

Figure 3. Estimated Crop Irrigation Equipment and Services Expenditures



The assumptions underlying the crop irrigation model calibrate well against actual 2017 expenditures, as reported in the 2017 Irrigation Census (Table 6).

Table 6. Crop Irrigation Equipment Expenditures, 2017 Census and Modeled Results (million)

	2017 Census value	Crop irrigation model estimate
New expansion expenditures	$ 634.00	$ 600.50
Water and energy conservation expenditures (system upgrades)	$ 452.00	$ 447.20
Scheduled replacement or maintenance	$ 953.00	$ 1,166.55
System conversions	NA	
Total direct expenditures	$ 2,039.00	$ 2,214.25

Expenditures for Irrigating Landscape and Horticultural Crops

Landscape and horticultural crops account for a relatively small portion of total irrigation industry, although representing a high level of investment per acre or per square foot of irrigated area. Census data from 2013 and 2018 shows that approximately 524,000 acres and 582,000 acres, respectively, were dedicated to irrigating outdoor horticultural crops, primarily sod and nursery crops. This compares to approximately 60 million acres dedicated to traditional crop irrigation. Approximately 1,404 million to

1,525 million square feet of horticultural crops are irrigated indoors. This translates to a range of approximately 32,000 to 35,000 acres grown indoors.

The economic magnitude of these portions of the industry is estimated in a similar manner as the crop irrigation sector – total investment on a per unit basis is estimated, with expenditures on newly irrigated acres, replacement systems, and upgrades and conversions estimated separately. To minimize repetition, assumptions and results used to assess this portion of the industry are shown in Appendix B.

Resulting direct expenditure estimates for this sector will be summarized separately below, but for purposes of estimating total economic impact, landscape and horticultural irrigation expenditures are combined with crop irrigation.

Expenditures for Residential and Commercial Irrigation

The residential and commercial portion of the analysis accounts for the non-crop portions of the irrigation equipment and services industry. These categories are discussed together because they share the same approach and data limitations. Like the crop production side of the industry, equipment manufacture is characterized by a relatively small number of public and privately held firms. Each firm sells a range of similar but somewhat differentiated products, compete for market share, and observe the others' actions closely. The impact of this market structure on equipment prices is yet to be analyzed but an immediate observation is that data such as sales volume and market share is closely guarded and not widely shared. Also, there is no NAICS code that exclusively contains irrigation equipment.

The development of the residential and commercial portions of the overall industry model reflects this lack of empirical data. Like the crop production sector, the approach is bottom-up, examining spending on the basis of irrigated area and summing-up the area at either a regional or national level. However, unlike the crop production sector, data such as a periodic Census is not available to estimate how much area is ultimately being irrigated over time. In effect, the model cannot be calibrated because there are no data or benchmarks to use as a reality check.

As a result, spending on residential and commercial irrigation equipment starts with an assumption of spending on a square foot or acre basis, depending on the portion of the industry being examined, and aggregates this spending over total irrigated area.

However, despite the somewhat speculative nature of estimating non-crop irrigation equipment spending, two observations make the effort worthwhile:

1. The residential and commercial sectors appear intuitively very large because of the level of investment at the household or business level. Where crop irrigation investment may range in the $500 to $1,000 level per acre, a typical residence may represent three to five times this amount for an area measured in square feet. Summed over potentially millions of residential and commercial structures, the total value could be very large and growing at a steady rate.
2. The industry data exists in the form of human capital. That is, individuals working in the business know their industry well and have been valuable contributors in providing anecdotes and pieces of information that, when combined, allow some insight into its magnitude and components.

The following section discusses the assumptions that define the magnitude of the industry and how it is distributed across its components. These assumptions can be attributed to a range of industry representatives contacted over the course of this study, although no individual will be tied to any assumption. However, all of those contacted have had the opportunity to comment on them. Following this will be sections examining the components of the non-crop irrigation equipment industry. These components include:

- Residential irrigation
- Commercial irrigation

Commercial irrigation was assumed to be the sum of the following components:

- Commercial building landscaping
- Large turf areas
- Golf courses

Major Assumptions Defining the Magnitude of the Non-Crop Irrigation Industry

In descending order of importance, the following assumptions appear to be consistent with anecdotes obtained from industry participants.

- The equipment sales portion of the industry was approaching about $2.0 billion prior to the 2008 recession. It fell to less than $1.0 billion shortly afterwards and has been growing back to the $2.0 billion level since. The current level could range from $2.0 billion to $2.3 billion.

- Spending is split about equally between residential uses and commercial uses, with possibly slightly more on the residential side.

- The equipment portion of the industry accounts for about 30 percent of total industry spending. The remaining 70 percent of industry spending is accounted for by mark-up on wholesale equipment and installation cost.

- The residential portion of the non-crop industry is driven by housing starts or some other proxy for new construction, leading to the purchase of new irrigation equipment.

- Since the COVID-19 pandemic, it has also been observed that discretionary household income can also play a significant role in irrigation equipment spending. The pandemic demonstrated that households denied traditional ways of spending discretionary income, such as vacations and entertainment, tend to invest in their property.

- Water conservation initiatives, such as EPA's WaterSense Program, do not appear to be a major driver of irrigation spending or investment when viewed at a national level. However, at a regional level, these programs may slightly increase spending levels due to a need for greater water conserving devices.

- The cost of water, in terms of increasing water rates, has not yet substantially affected the industry. Water rate increases may influence the amount of area irrigated and type of equipment purchased, but the level of overall spending has not responded in a specific manner. Similarly, drought-induced water use restrictions have likely contributed to the demand for precision irrigation devices.

- Anecdotally, it appears that irrigation systems are increasingly being installed for new residential and commercial properties in non-arid regions as a hedge against possible changing rainfall patterns and to otherwise protect the landscape investment.

Residential and Commercial Framework

The residential and commercial models are bottom-up in the sense that spending is estimated on a per acre or square foot basis, and then summed over the total area. The "numerical" model developed through this process requires assumptions about costs, irrigated areas, and how they change over time that result in overall spending levels intended to match historical levels.

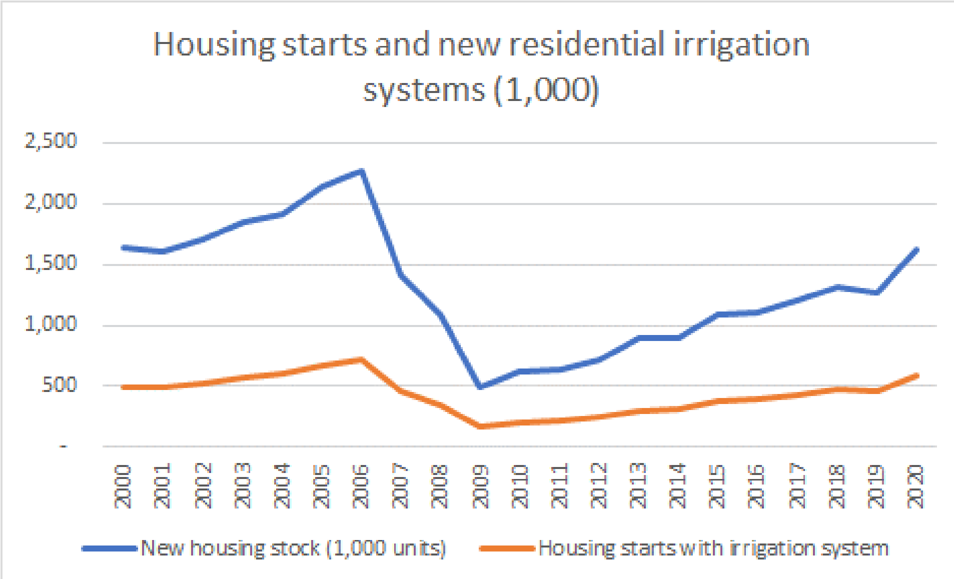
Three types of spending for residential and commercial equipment are estimated:

1. Expenditures on new equipment for new construction. This is the area in which residential housing starts, for instance, are strongly correlated with irrigation equipment sales.
2. Expenditures on retrofit and replacement equipment. For existing systems, this type of spending accounts for upgrade and replacement of equipment beyond levels accounted for in annual operation and maintenance expenditures (O&M), below.
3. Annual expenditures as part of operations and maintenance. For existing systems, some small portion of capital equipment is replaced every year due to normal wear and tear, accidents, and other causes.

Residential Model: Landscape Irrigation for Residential Structures

The top line of Figure 4 shows residential single-family housing starts from the period 2000 through 2020. It shows strong growth through 2006, a steep slide to 2009 and then a slower recovery to levels not quite yet approaching pre-recession levels. This trend strongly matches industry observations about overall residential-commercial equipment sales during this same period. Figure 4 also shows an estimate of the number of new residential irrigation systems across the U.S., derived using assumptions presented it the following section.

Figure 4. Single Family Housing Starts and Estimates of New Residential Irrigation Systems



Expenditures for New Residential Systems

Assumptions developed to estimate expenditures for new residential irrigation systems are as follows:

- New residences installing an irrigation system irrigate 3,500 square feet, reflecting land-use trends of smaller lots.
- Expenditures for new systems of this size were assumed to be $0.70 per square foot, in year 2000 dollars, increasing at an annual inflation rate of 2.5 percent to about $1.15 per square foot in 2020. This includes both equipment and installation. Therefore, the total cost to install a residential irrigation system is calculated to be slightly over $4,000. Based on the assumption that 30 percent of the total cost is for equipment, approximately $1,200 is spent on equipment and the balance accounts for mark-up and installation.
- It is assumed that about 30 percent of new residential construction in 2000 included an irrigation system, at a nation-wide level. This percentage is assumed to be trending upward slowly over time to a present level of about 37 percent. The resulting estimate of new residences with irrigation systems is shown by the lower line in Figure 4.

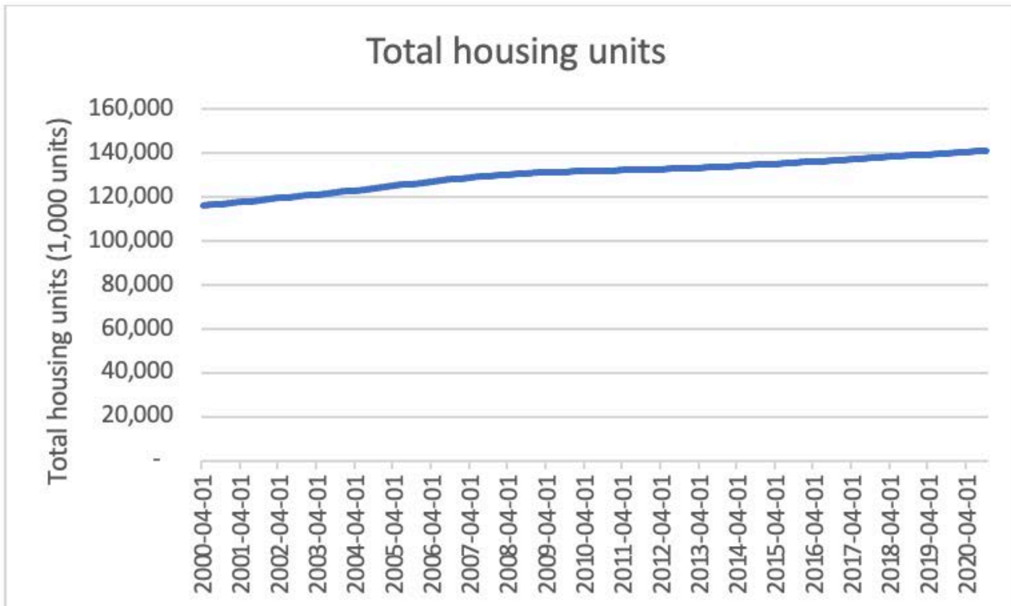
Expenditures for Residential Retrofit and Upgrades

Expenditures on retrofits and upgrades are assumed related to the proportion of the total housing stock with irrigation systems conducting upgrades multiplied by the assumed expenditures per upgrade.

- Housing stock was estimated to be approximately 116 million in 2000, increasing over time as shown in Figure 5 to approximately 142 million units currently.
- It was assumed that in 2000, about 5 percent of residential housing included an irrigation system. Based on the above assumptions about the percent of new residential construction with systems, by 2020 about 10 percent of the total residential housing stock may include an irrigation system.

- The cost of a system retrofit or upgrade is assumed to be one-half the cost of a new system on the basis that not all equipment will be replaced or upgraded, such as pipe.
- It was assumed that 0.4 percent of all residential systems are retrofitted or upgraded in any given year. This would imply that one in every 250 residences with an irrigation system makes significant expenditures on their system per year.

Figure 5. Total Housing Units, 2000-2020 (1,000 units)



Annual Operation and Maintenance Expenditures for Residential Systems

It is assumed that each residence with an irrigation system paid about $40 per year for O&M on their system, split evenly between equipment and installation, in 2000 dollars. With inflation between 2000 and 2006, the current level of spending is assumed to be approximately $66 per system.

Estimated Total Spending on Residential Irrigation

Total spending on residential irrigation is the sum of new systems, retrofits and upgrades, and annual O&M expenditures. Figure 6 shows the total of these three spending categories for the years 2000-2020, including both equipment and mark-up and installation. Figure 7 shows the total by whether it is equipment or mark-up and installation.

Figure 6. Estimated Spending on Residential Irrigation Systems by Category, 2000-2020 (million)

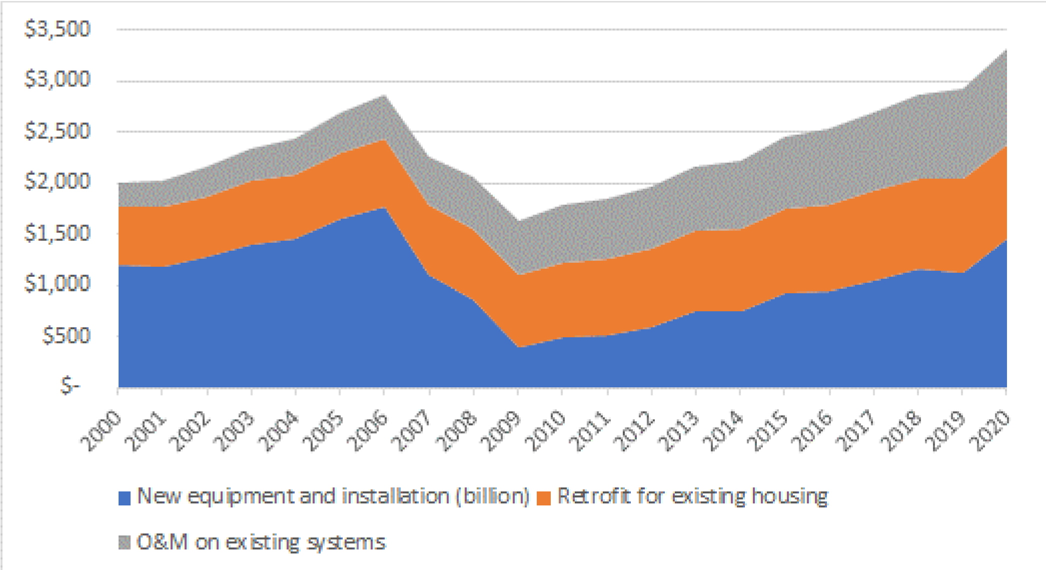
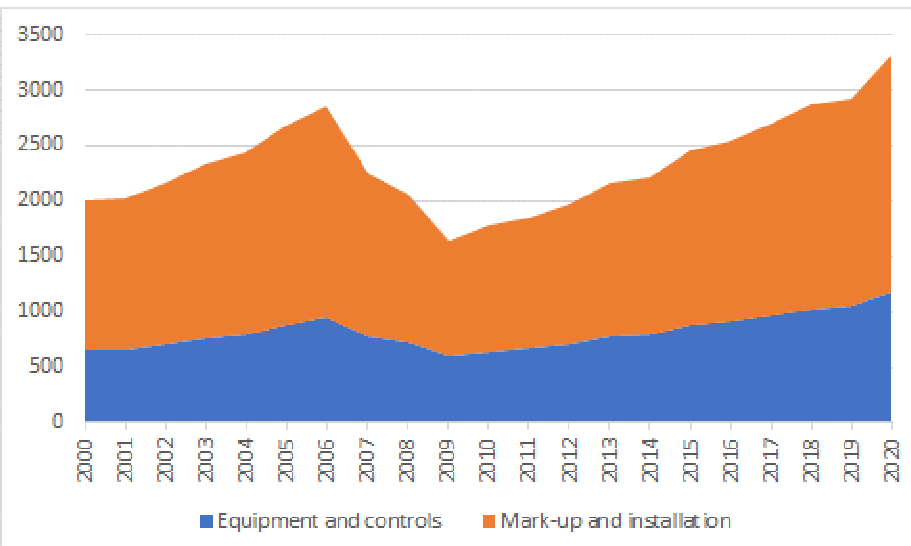


Figure 7. Estimated Spending on Residential Irrigation System by Industry (million)



It is notable that the total spending on residential irrigation equipment is estimated to currently be slightly over $1.0 billion. Also, the shape of the expenditures over time reflects trends in residential housing starts.

Commercial Model: Landscape Irrigation for Commercial Structures

Expenditures for New Systems for New Commercial Construction

Assumptions developed to estimate expenditures for irrigation systems for new commercial structures are as follows:

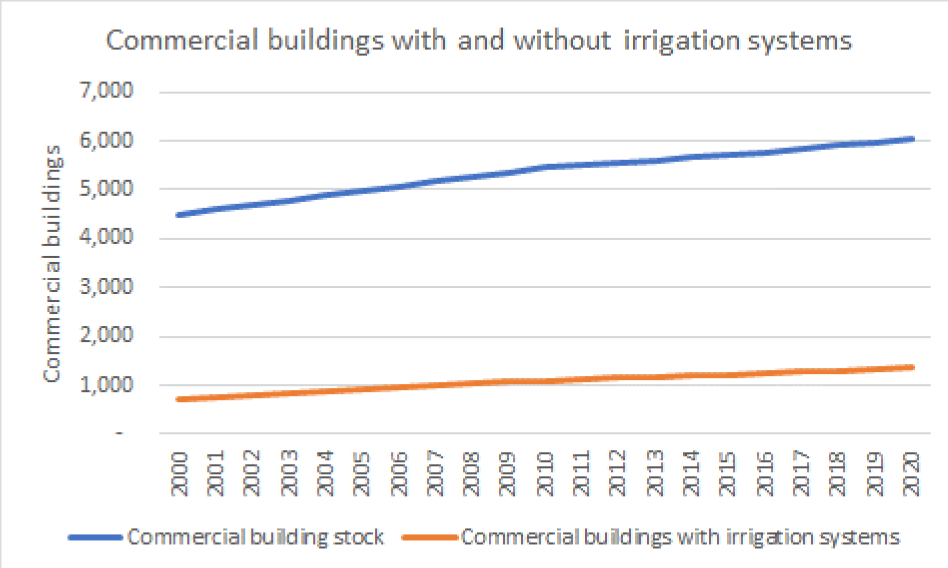
- New structures installing an irrigation system irrigate 10,000 square feet.
- Expenditures for new systems of this size were assumed to be $1.10 per square foot, in year 2000 dollars, increasing at an annual inflation rate of 2.5 percent to about $1.65 per square foot in 2020. This includes both equipment and installation. Therefore, the total cost to install a commercial irrigation system is calculated to be slightly over $16,500. Based on the assumption that 30 percent of the total cost is for equipment, approximately $5,000 per structure is spent on equipment and the balance accounts for mark-up and installation.
- It is assumed that about 40 percent of new commercial construction in 2000 included an irrigation system, at a nation-wide level. This percentage is assumed to be trending upward slowly over time to a present level of about 49 percent.

Expenditures for Retrofit and Upgrades, Commercial Structures

Expenditures on retrofits and upgrades are assumed to be related to the proportion of the commercial building stock with irrigation systems conducting upgrades multiplied by the assumed expenditures per upgrade.

- Commercial building stock was estimated to be approximately 4.5 million in 2000, increasing over time as shown in Figure 8 to approximately 6.0 million units currently.
- It was assumed that in 2000, about 15 percent of commercial buildings included an irrigation system. Based on the above assumptions about the percent of new commercial construction with systems, by 2020 about 22 percent of the total commercial buildings may include an irrigation system.
- The cost of a system retrofit or upgrade is assumed to be one-half the cost of a new system on the basis that not all equipment will be replaced or upgraded, such as pipe.
- It was assumed that 0.4 percent of all commercial systems are retrofitted or upgraded in any given year. This would imply that one in every 250 commercial buildings with an irrigation system makes significant expenditures on their system per year.

Figure 8. New Commercial Buildings and Estimated Number with Irrigation Systems



Annual Operation and Maintenance Expenditures, Commercial Structures

It is assumed that each commercial building with an irrigation system paid about $200 per year on their system, split evenly between equipment and installation, in 2000 dollars. With inflation between 2000 and 2020, the current level of spending is assumed to be approximately $325 per system.

Commercial Model: Irrigation of Large Open Spaces

This category of usage is intended to examine spending for large open areas, including parks, municipal and homeowners' association (HOA) green spaces, cemeteries, athletic fields, and similar large-scale uses not directly tied to a structure. Like other categories of commercial usage, data is constrained at an aggregate level.

A Digression on Data

Over the course of this study, significant efforts were made to identify data that lend insights into this and other categories of irrigated land use. It was determined that geospatial data likely exists to estimate large-space non-residential irrigated areas across the U.S. As an experiment, land use data from the Landfire Program was examined, with selected categories land use that should reveal irrigated non-crop areas within given geographic areas (LANDFIRE Program: Home). For purposes of the experiment, irrigated open spaces were estimated for a range of municipalities in the Western U.S., shown in Table 7, and expressed on a per capita basis.

Table 7. Open Space Irrigated Acreage Estimates for Selected Cities

City	Irrigated Non-residential Urban Area (ac)	Population	Irrigated Urban Area Per Capita (ac)	Irrigaged Urban Area Per Capita (ft2)
Boise, ID	42,461	226,115	0.19	8,180
Eugene, OR	26,180	168,302	0.16	6,776
Fort Collins, CO	30,914	165,609	0.19	8,131
Irvine, CA	36,042	273,157	0.13	5,748
Mesa, AZ	79,780	499,720	0.16	6,954
Provo, UT	25,093	116,403	0.22	9,390
		Average	0.17	7,530
		Standard deviaton	0.03	1,290

Table 7 shows that, at least for medium-sized Western cities, the volume of large-space irrigation is relatively consistent on a per capita basis. By itself, this data is not directly applicable to the analysis. However, the data provides value by demonstrating the ability to examine different geographic areas over different periods of time, which could reveal useful trends in the industry. Ultimately, incorporating this data was beyond the resources of this study, but it demonstrates that an abundance of geospatial data may be available for more detailed studies of specific geographic areas.

Expenditures for New Systems on Newly Irrigated Commercial Open Space

Assumptions developed to estimate expenditures for commercial open space systems are as follows:

- Large open space acreage is assumed to account for approximately 7,500,000 acres, increasing over time at approximately the same rate as population, 1.5 percent per year.
- New systems were assumed to cost $3,000 per acre in 2000 dollars, increasing at the rate of inflation to a 2020 level of about $4,900 per acre.

Expenditures for Retrofit and Upgrades, Commercial Open Space

Expenditures on retrofits and upgrades are assumed to be related to total irrigated acreage times the rate of retrofit and upgrade, times the assumed expenditures per upgrade.

- It is assumed that about 0.40 percent of open space systems are upgraded each year, or alternatively stated, about one of every 250 acres experience upgrades.
- The cost of a system retrofit or upgrade is assumed to be one-half the cost of a new system on the basis that not all equipment will be replaced or upgraded, such as pipe.

Annual Operation and Maintenance Expenditures, Commercial Open Space

It is assumed that each acre of commercial open space paid about $20 per acre per year on their system, split evenly between equipment and installation, in 2000 dollars. With inflation between 2000 and 2020, the current level of spending is assumed to be approximately $33 per acre.

Commercial Model: Golf Courses

In 2012, U.S. Golf Association estimated that golf courses accounted for about 2.2 million acres of land, of which 1.5 million acres were in turf grass, with 80 percent of this turf being irrigated. [5] [6]

Expenditures for New Golf Course Irrigation Systems

Assumptions developed to estimate expenditures for golf course irrigation systems are as follows:

- To reflect a long-term dampening of demand for golf, acreage is assumed to increase over time at one-half the rate of population increase. Therefore, if population is assumed to increase at an annual rate of 1.5 percent, golf course acreage is assumed to increase at 0.75 percent.
- New golf course irrigation systems were assumed to cost about $3,500 per acre in 2000, increasing over time at the rate of inflation, resulting in a cost of about $5,700 per acre in 2020.

Expenditures for Retrofits and Upgrades, Golf Courses

Expenditures on retrofits and upgrades are assumed to be related to total irrigated acreage multiplied by the rate of retrofit and upgrade, multiplied by the assumed expenditures per upgrade.

- It is assumed that about 5 percent of golf course systems are upgraded each year, or alternatively stated, about one of every 20 acres is upgraded upgrades.
- The cost of a system retrofit or upgrade is assumed to be one-half the cost of a new system on the basis that not all equipment will be replaced or upgraded, such as pipe.

Annual Operation and Maintenance Expenditures, Golf Courses

It is assumed that each irrigated golf course paid about $200 per acre per year on their system, split evenly between equipment and installation, in 2000 dollars. With inflation between 2000 and 2020, the current level of spending is assumed to be approximately $330 per acre.

Estimated Irrigation Expenditures for Commercial Uses

Figure 9 shows total estimated expenditures for the commercial irrigation industry for the period 2000 through 2020, for the three market segments discussed above. Total expenditures for 2020 were estimated to be about $2.9 billion, including equipment and installation, with equipment accounting for $1.1 billion of this total and mark-up and installation accounting for $1.8 billion.

Figures 10 and 11 break down the equipment sales by their purpose, including new construction, open space irrigation, and golf courses.

---

[5] Lyman, Gregory T. "Golf's Use of Water". United States Golf Association. 2012; also "Golf Course Environmental Profile". Environmental Institute for Golf, Golf Course Superintendents Association of America. Volume 1: Summary. 2012.

[6] U.S. Golf Association. "Golf's Use of Water". From the Summit on Golf Course Water Use. November, 2012.

Figure 9. Estimated Total Expenditures for Commercial Irrigation

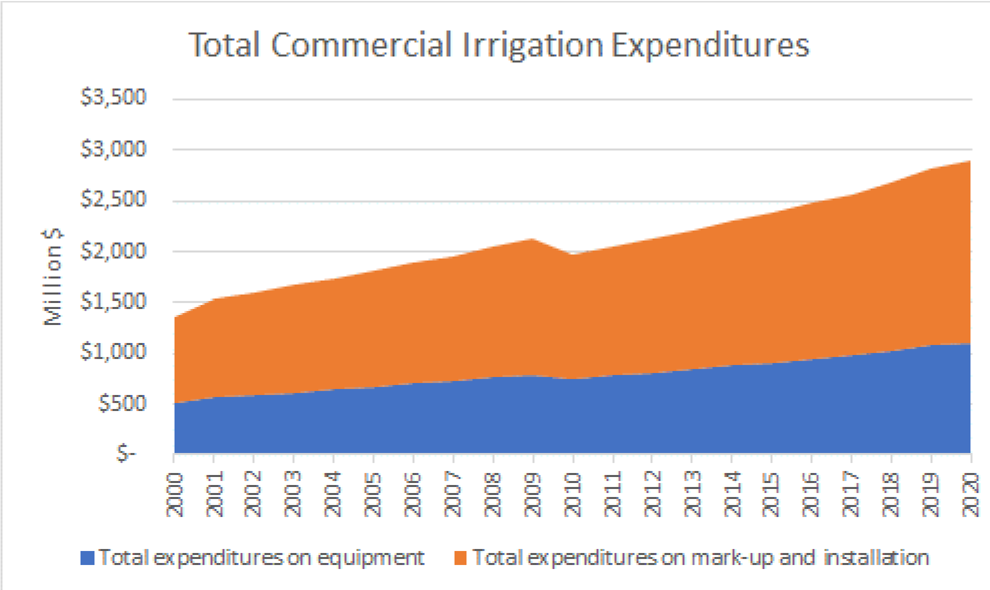


Figure 10. Break-down of Equipment Expenditures for Commercial Uses

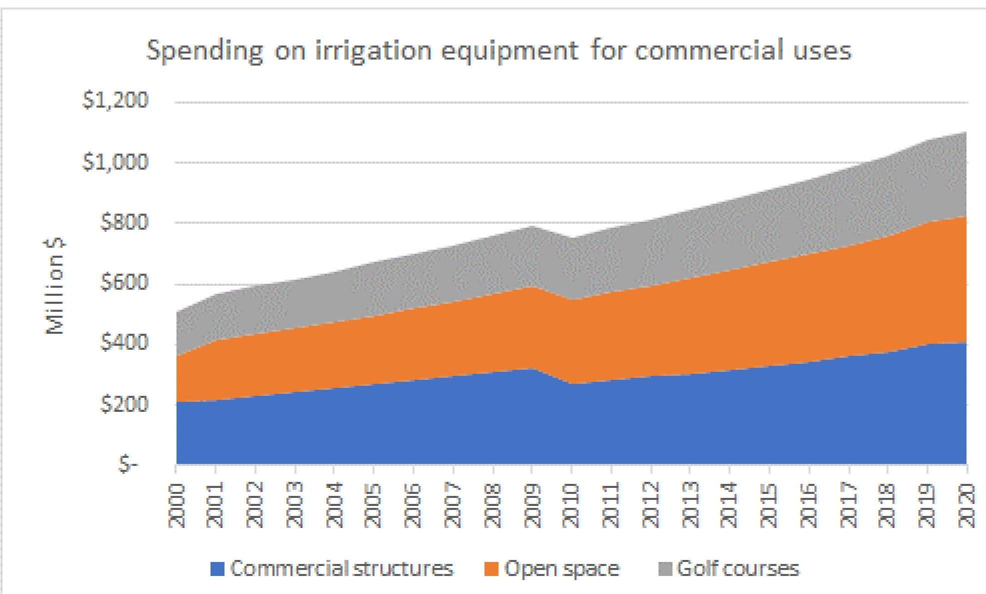
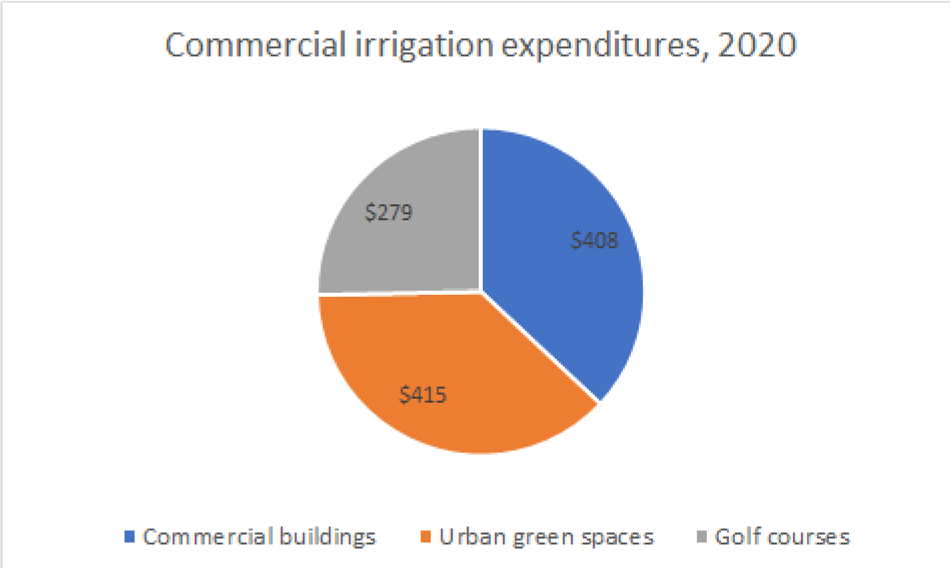


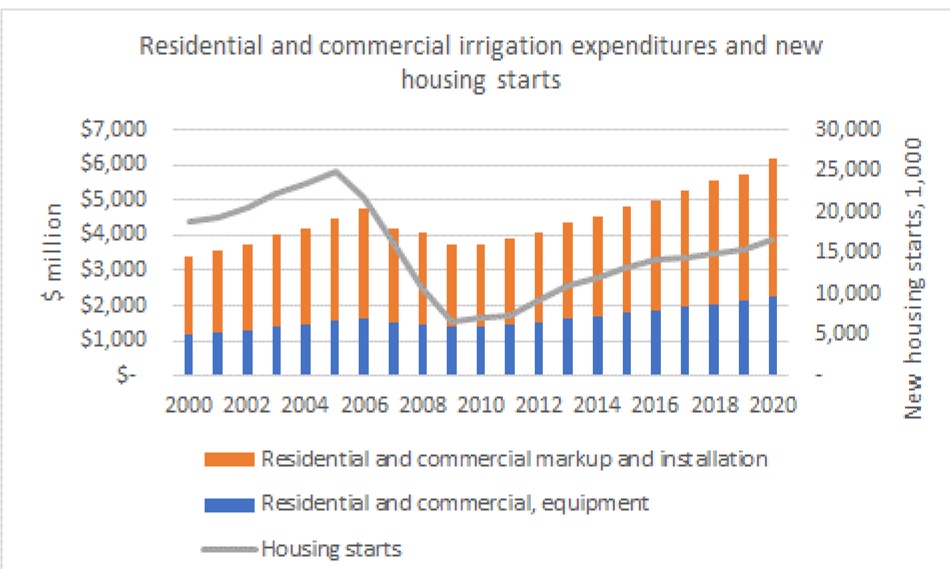
Figure 11. Estimated 2020 Direct Spending Break-down for Commercial Uses



Total Residential and Commercial Spending

Figure 12 shows the sum of the estimated expenditures for the residential and commercial sectors of the irrigation industry mapped with new housing starts. It is noted that estimated expenditures for equipment in year 2020 are approximately $2.3 billion, consistent with industry observations.

Figure 12. Residential and Commercial Irrigation Expenditures, and New Housing Starts

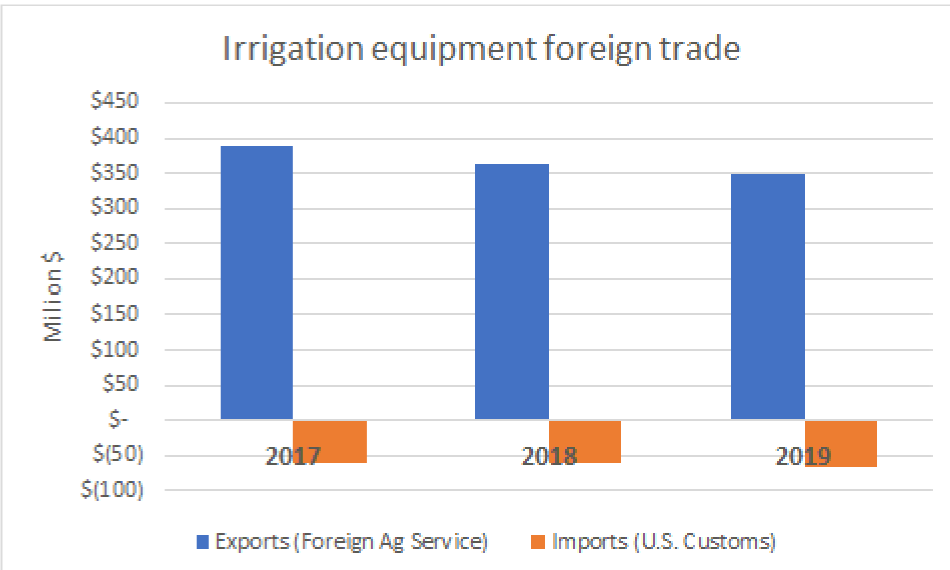


Imports and Exports

The methodologies used in this analysis focus upon domestic expenditures at the per acre or per square-foot level. There is no consideration of geographical source of the product or service being purchased. As a result, imports and exports are not explicitly considered and foreign trade is added and subtracted from industry totals.

The Department of Commerce began monitoring foreign trade specific to irrigation equipment in 2017 using several sources of data. For exports, the Foreign Agricultural Service (FAS) reports irrigation equipment by destination and the U.S. Customs Service tracks imports by source. Figure 13 summarizes these totals for the years 2017 through 2019.

Figure 13. Foreign Trade in Irrigation Equipment (million)



Estimated Total Direct Expenditures for Crop Irrigation, Residential, and Commercial Irrigation

Figure 14 shows estimated direct expenditures for the industry for the baseline year 2020 by component developed above. Total expenditures on irrigation equipment and services are estimated at $8.92 billion.

Figure 14. Year 2020 Estimate of Direct Spending for Irrigation Equipment and Services

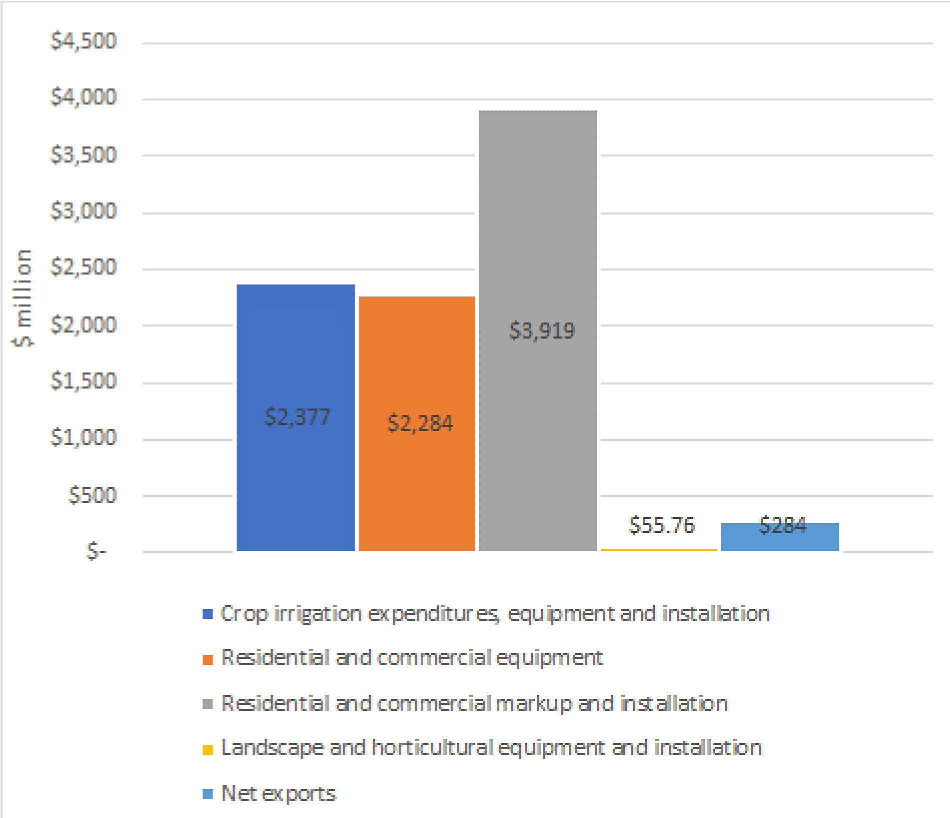


Table 8 compares current results with those estimated in 2010. Overall, the results are comparable and show the industry has grown at an annual rate of over 2 percent, mostly matching U.S. economic growth over this period.

Table 8. Comparison of 2010 and 2020 Direct Spending Results

	2010 estimate	2020 estimate	growth
Crop irrigation	$ 1,324	$ 2,377	6.03%
Landscape and hort.crop irrigation	NA	$ 56	
Residential	$ 2,819	$ 3,315	1.63%
Commercial	$ 1,344	$ 2,236	5.22%
Golf	$ 1,604	$ 653	-8.59%
Net exports	NA	$ 284	
	$ 7,091	$ 8,920	2.32%

Total Economic Impact of Irrigation Equipment and Services Spending

This section applies IMPLAN-based multipliers to the direct expenditures estimated above to estimate the indirect and induced economic impacts. Summed together, the direct, indirect, and induced impacts represent the total economic impact of the industry. Total impact is expressed through two measures, discussed earlier: total output impacts, expressed in dollars per year, and total employment impacts, expressed as jobs.

The multipliers are applied to two types of expenditures: direct expenditures for equipment and services, and installation. There is not an economic sector within IMPLAN that fully accounts for irrigation equipment, so direct expenditures for equipment and services were distributed proportionately across similar sectors in which multipliers were available, including:

- Fabricated pipe and pipe fittings
- Farm machinery and pipe fittings
- Lawn and garden equipment
- Environmental control manufacturing

For installation expenditures, multipliers representing landscape and horticultural services were used.

Table 9 and Figure 15 summarize the total economic impact of the irrigation equipment and services industry on the U.S. economy. When considering indirect and induced impacts, the $8.92 billion dollar direct impact translates to a $23.3 billion total impact.

In a similar manner, Table 10 and Figure 16 summarize the total employment impact of the irrigation industry on the U.S. economy.

Table 9. Total Economic Output Impacts of the Irrigation Equipment and Services Industry (million), not including exports.

Output			
	Crop irrigation	Residential-commercial irrigation	Industry total
Direct expenditures	$ 2,433	$ 6,203	$ 8,636
Indirect output impact	$ 1,138	$ 5,484	$ 6,622
Induced output impact	$ 2,407	$ 5,596	$ 8,004
	$ 5,978	$ 17,283	$ 23,262

Figure 15. Total Economic Output Impacts of the Irrigation Equipment and Services Industry (million)

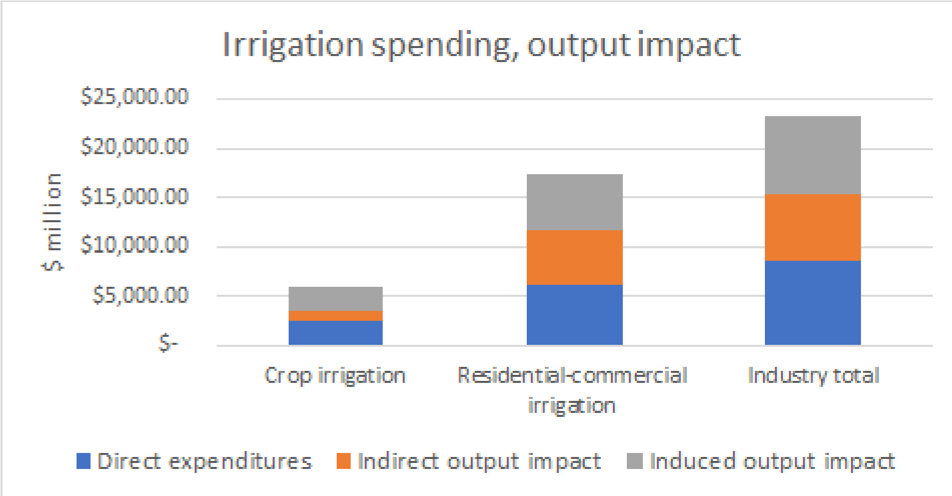


Table 10. Total Employment Impacts of the Irrigation Equipment and Services Industry (Jobs)

Employment			
	Crop irrigation	Residential-commercial irrigation	Industry total
Direct expenditures	18,076	52,247	70,323
Indirect employment impact	7,506	27,685	35,192
Induced employment impact	15,371	46,692	62,063
	40,953	126,625	167,578

Figure 16. Total Employment Impacts of the Irrigation Equipment and Services Industry (Jobs)

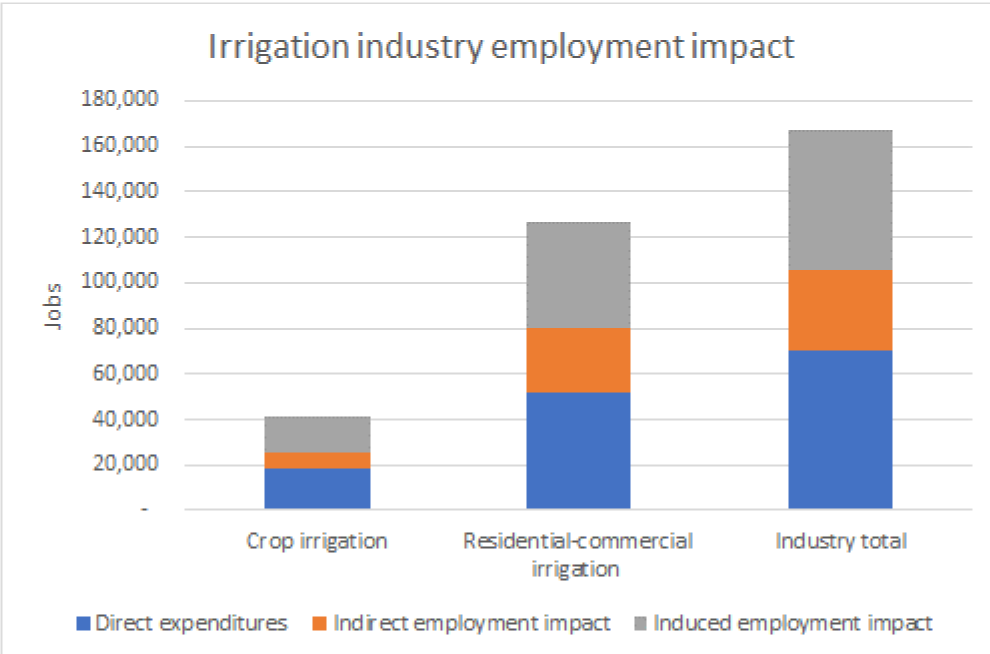


Table 11. Comparison of Direct and Total Impacts of the Irrigation Equipment and Services Industry, 2010 and 2020

	2010 estimate			2020 estimate	
	Direct impact	Total impact		Direct impact	Total impact
Output (million)	$ 7,091	$ 19,205		$ 8,920	$ 23,262
Employment (jobs)	66,000	149,900		70,323	167,578

Results and Conclusions

The modeling framework and underlying assumptions developed to estimate the impacts of the irrigation industry equipment and services suggest that approximately $8.92 billion is spent annually for irrigation equipment, services, and installations, providing approximately 70,000 jobs. When secondary economic effects are considered, the total direct, indirect, and induced annual benefits to the U.S. economy are approximately $23.3 billion in output and 167,600 jobs.

- For comparison with other industries, direct expenditures for agricultural fertilizers and pesticides were recently estimated to be approximately $26.9 and $15.5 billion, respectively, compared to $2.4 billion estimated for crop irrigation equipment and services.[7]
- The agricultural fertilizer industry's total economic output, including direct, indirect, and induced impacts, was estimated to be $141.3 billion and 458,000 jobs. In comparison, the irrigation industry accounts for about $23.3 billion in output and 167,600 jobs.[8]

This analysis updates the 2010 Economic Impact Study and indicates that the industry has grown at rate of slightly over 2 percent per year between the period 2010 and 2020, tracking closely with the general U.S. economic growth trends. The crop irrigation and commercial sectors have shown the largest increase over this time, while the residential sector increased at rate slightly less than two percent. Irrigation expenditures for golf courses have shown a significant decline, but a portion of this impact may be due to different methods of analysis.

Variability in irrigation expenditures between 2010 and 2020 reflects the variability in commodity prices and new housing starts, the major drivers of crop irrigation expenditures and residential and commercial expenditures, respectively. These drivers are intuitive, but due to a lack of data, there have not yet been any statistical analyses to tie these variables together in a comprehensive manner.

This study concludes that annual expenditures on crop irrigation equipment and the equipment-based portion of residential-commercial expenditures are about the same. Both are estimated to be slightly over the $2 billion per year range. However, if one adds mark-up and installation expenditures to the residential-commercial component, this sector is much larger. This observation is intended to address questions within the industry about which portion is larger in dollar terms, crop irrigation or residential-commercial? The 2010 study indicated the latter was larger and, despite not being the purpose of this update, industry representatives have been curious if this result still holds.

The beginning of this analysis coincided with the beginning of the COVID-19 pandemic, which inevitably brought speculation about its potential impacts to the industry. Initially, it appeared that supply chain issues, plus the concern that irrigation system installers may not be essential workers, could result in severe impacts to the industry. However, a strong industry backlog going into 2020, increasing commodity prices, and a strong construction sector resulted in a good year for the industry, despite the pandemic. Also, the pandemic revealed that spending on residential irrigation systems is strongly influenced by discretionary household spending. Industry representatives observed that when typical outlets for discretionary spending are limited, such as vacations, traveling, and nights out, homeowners spend a significant portion of these foregone expenditures on household upgrades, including irrigation systems.

In terms of possible bias, or error, in the analysis, there are concerns. One is the impact of the lack of data. This has been a reoccurring theme over the course of this analysis and needs little additional discussion other than how it can be overcome. It was readily apparent from interviews with industry representatives that:

---

[7] table01a.xlsx (live.com)

[8] https://www.tfi.org/sites/default/files/2015%20Fertilizer%20Methodology.pdf#:~:text=The%20fertilizer%20industry%20is%20a%20dynamic%20part%20of,billion%20in%20federal%2C%20state%20and%20local%20business%20taxes.

- All firms, whether public or privately-held, are interested in knowing the size and growth of the industry and where they lie in comparison to others. However, considering that major segments of the industry are characterized by a relatively small number of large manufacturers, there are concerns about whether they could remain anonymous in the event the industry wanted to collect sales data.
- Since there are few reasons to expect industry ownership characteristics to change soon, and if the industry is indeed interested in the potential economic leverage it may possess, some form of self-reporting of data appears necessary. In addition, it would likely have to be through a mutually-agreeable, neutral third-party and under a set of policies or rules that protect the privacy of the contributors.
- Alternatively, if the results of this analysis are thought to satisfactorily estimate the magnitude of the industry and describe its economic drivers, then additional efforts should be made to shore-up the multitude of assumptions driving the analysis for future updates.

The lack of data and the nationwide nature of this analysis precludes a more microeconomic-based analysis of many factors influencing irrigation investment at the farm level. In addition to commodity prices, there is a range of demographic, climatic, risk-reducing, and other considerations influencing expenditures. At the national level, the observed influence of these factors tends to get washed-out in aggregation, but they are important. A significant benefit to this analysis would be developing methods to scale-up the application of this micro-data.

Another concern is how foreign trade fits into the methodologies used in this analysis since only domestic demand and expenditures are estimated. It is apparent that it does not fit and, as a result, foreign trade is added on the industry results and not attributed to a specific segment of the industry. This is a significant but unavoidable shortcoming of the analysis, leaving additional uncertainty about the industry totals.

Expenditure levels for residential and commercial equipment were assumed to be invariant with respect to future water conservation initiatives. However, anecdotal evidence suggests expenditures per acre or per square foot may increase proportionately with conservation measures. With the exception of eliminating outdoor landscape watering altogether, precision water application is increasingly being demanded for establishing and maintaining even the most water-conserving landscapes. In effect, the more expensive the landscape plan is to establish, the higher the investment in irrigation. This observation has not yet been borne out on a large-scale by empirical data, but appears universally consistent across industry experts.

During the development of the commercial model, it became apparent that large geospatial databases could be helpful for identifying large, non-agricultural irrigated areas. Whether this information is useful to the industry is uncertain, but it identifies potential areas for water conservation and investment in precision irrigation equipment.

The reflection that this analysis updates a previous, 10-year old study leaves a question of whether another 10 years will go by until the next update? Alternatively, will these studies be used as evidence that steps should be taken to more frequently assess the state of the industry? Irrigation industry impact analysis studies should be conducted more regularly – ideally, in 5-year increments, which would follow the timing of the release of the Census of Irrigation data. The analysis regarding the industry's impact on residential and commercial sectors would benefit from more data being made public (e.g., NAICS).

Developing a self-reporting data system within the industry would be the preferred route because it would introduce empirical, verifiable data. With this data, the industry could be more accurately modeled at both national and regional levels, with a foreign trade component.

Appendix A: Preparers and Steering Committee

This report was prepared by Headwaters Corporation, Kearney, Nebraska. Principal authors include:

- George Oamek, Ph.D., Economist, Headwaters Corporation, Kearney, Nebraska
- Renata Rimsaite, Ph.D., Post-Doctoral Research Associate, Daugherty Water for Food Global Institute at the University of Nebraska; National Drought Mitigation Center at the University of Nebraska-Lincoln

Two steering committees supported all phases of this study. The crop irrigation steering committee consisted of Irrigation Innovation Consortium university representatives with strong credentials in agricultural economics, irrigation, and regional economics. They are identified in Table A-1, along with their affiliations.

As the study progressed and the importance of the non-crop components of the industry became increasingly under focus, the study team informally consulted with several industry representatives, also identified in Table A-1. For identification purposes, the industry representatives were termed the ad hoc steering committee.

Table A-1. Steering Committees

Crop Irrigation Steering Committee		**Ad hoc Residential-Commercial Steering Committee**	
Individual	*Affiliation*	*Individual*	*Affiliation*
Dr. William Golden	Kansas State University	John Farner	Netafim
Dr. Bridget Guerrero	West Texas A&M University, Canyon	Tom Childers	Ewing Irrigation
Dr. Eric Thompson	University of Nebraska, Lincoln	Warren Gorowitz	Hunter Industries
Dr. Charles Hall	Texas A&M University, College Station	Josh Friel	The Toro Company
Dr. Serhat Asci	California State University, Fresno	Paul Lierheimer	Rain Bird Corporation
Dr. Christopher Henry	University of Arkansas, Stuttgart		
Dr. Drew Gholson	Mississippi State University, Stoneville		

Appendix B: Assumptions and Results for Landscape and Horticultural Crop Irrigation

Table B-1. Baseline Rate of Increase in Newly Irrigated Areas Producing Landscape and Horticultural Crops and Assumed Expenditures

Newly irrigated acres		
Rate of change in new irrigated land, gravity		1.0%
Rate of change in new irrigated land, sprinkler		1.0%
Rate of change in new irrigated land, drip		1.0%
Expenditures on newly irrigated lands		
Gravity systems ($/acre)		$ 600
Sprinkler systems ($/acre)		$ 1,700
Drip systems ($/acre)		$ 4,000

Table B-2. Rate of System Replacement and Associated Expenditures, Outdoor Irrigation of Landscape and Horticultural Crops

Rate of system replacement by one of a similar type		
Gravity systems, %		1.0%
Sprinkler systems, %		3.0%
Drip systems, %		1.0%
Expenditure/acre for a replacement system		
Gravity systems ($/acre)		$ 600
Sprinkler systems ($/acre)		$ 1,500
Drip systems ($/acre)		$ 3,500

Table B-3. Rate of System Conversions and Associated Expenditures, Outdoor Irrigation of Landscape and Horticultural Crops

Rate of conversion for gravity to sprinkler system		3.0%
Cost of conversion		$ 1,300
Rate of conversion for gravity to drip system		1.0%
Cost of conversion		$ 1,300

Table B-4. Rate of System Upgrades and Associated Expenditures, Outdoor Irrigation of Landscape and Horticultural Crops

Proportion of systems being upgraded by type		
Gravity systems		2.0%
Sprinkler systems		3.0%
Drip systems		2.0%
Expenditure/acre for upgrades		
Gravity systems ($/acre)		$ 150
Sprinkler systems ($/acre)		$ 300
Drip systems ($/acre)		$ 700

Table B-5. Annual Expenditures on Irrigation Equipment and Services for Outdoor Irrigation of Landscape and Horticultural Crops (million)

	Newly irrigated lands	Replacement of existing systems with one of a similar type	System conversions	Upgrades to existing systems	Total crop irrigation expenditures
2017	$ 11.01	$ 15.03	$ 2.27	$ 4.54	$ 32.85
2018	$ 11.52	$ 15.82	$ 2.26	$ 4.76	$ 34.35
2019	$ 12.04	$ 16.64	$ 2.25	$ 4.97	$ 35.90
2020	$ 12.58	$ 17.48	$ 2.23	$ 5.20	$ 37.50
2021	$ 13.15	$ 18.35	$ 2.22	$ 5.44	$ 39.16
2022	$ 13.73	$ 19.26	$ 2.21	$ 5.68	$ 40.87
2023	$ 14.33	$ 20.19	$ 2.19	$ 5.93	$ 42.64
2024	$ 14.95	$ 21.15	$ 2.18	$ 6.19	$ 44.47
2025	$ 15.59	$ 22.15	$ 2.17	$ 6.46	$ 46.37

Indoor Landscape and Horticultural Crops

Table B-6. Baseline Rate of Increase in Newly Irrigated Areas Producing Indoor Horticultural Crops and Assumed Expenditures

Newly irrigated acres			
	Rate of change in new irrigated land, gravity		
	Rate of change in new irrigated land, sprinkler		1.0%
	Rate of change in new irrigated land, drip		1.0%
Expenditures on newly irrigated lands			
	Gravity systems ($/acre)		$ -
	Sprinkler systems ($/acre)		$ 15,000
	Drip systems ($/acre)		$ 25,000

Table B-7. Rate of System Replacement and Associated Expenditures, Indoor Irrigation of Horticultural Crops

Rate of system replacement by one of a similar type			
	Gravity systems, %		0.0%
	Sprinkler systems, %		2.0%
	Drip systems, %		2.0%
Expenditure/acre for a replacement system			
	Gravity systems ($/acre)		$ -
	Sprinkler systems ($/acre)		$ 10,000
	Drip systems ($/acre)		$ 15,000

Table B-8. Rate of System Conversions and Associated Expenditures, Indoor Irrigation of Horticultural Crops

Rate of conversion for gravity to sprinkler system			0.0%
	Cost of conversion		$ -
Rate of conversion for gravity to drip system			0.0%
	Cost of conversion		$ -

Table B-9. Rate of System Upgrades and Associated Expenditures, Indoor Irrigation of Horticultural Crops

Proportion of systems being upgraded by type			
	Gravity systems		0.0%
	Sprinkler systems		2.0%
	Drip systems		2.0%
Expenditure/acre for upgrades			
	Gravity systems ($/acre)		$ -
	Sprinkler systems ($/acre)		$ 1,000
	Drip systems ($/acre)		$ 1,000

Table B-10. Annual Expenditures on Irrigation Equipment and Services for Indoor Irrigation of Horticultural Crops (million)

		Newly irrigated area	Replacement of existing systems with one of a similar type	System conversions	Upgrades to existing systems	Total crop irrigation expenditures
2017		$ 7.00	$ 8.75	$ -	$ 0.70	$ 16.45
2018		$ 7.25	$ 9.06	$ -	$ 0.72	$ 17.03
2019		$ 7.50	$ 9.38	$ -	$ 0.75	$ 17.63
2020		$ 7.77	$ 9.71	$ -	$ 0.78	$ 18.26
2021		$ 8.04	$ 10.05	$ -	$ 0.80	$ 18.90
2022		$ 8.33	$ 10.41	$ -	$ 0.83	$ 19.57
2023		$ 8.62	$ 10.77	$ -	$ 0.86	$ 20.26
2024		$ 8.92	$ 11.15	$ -	$ 0.89	$ 20.97
2025		$ 9.24	$ 11.55	$ -	$ 0.92	$ 21.71

8280 Willow Oaks Corporate Drive, Suite 630 | Fairfax, VA 22031
T: 703.817.6098 | F: 703.536.7019
info@irrigation.org | www.irrigation.org