Memorandum

To: *Agricultural Demand Work Group*

From: *Rick Brown, Mitch Horrie, Jessica Fritsche, CDM Smith*

Date: *March 1, 2013*

Subject: *Irrigated Agriculture Forecast Update*

The purpose of this memorandum is to update the Agriculture Demand Work Group (Work Group) on data collection and methodology development progress for generating the irrigation water use and demand forecast for the Arkansas Water Plan Update. Feedback is sought from members of the Work Group on the proposed methodology, data sources, and inherent assumptions.

Please keep in mind that the overall goal is to have a technically sound final draft forecast presented to the overall demand work group at a meeting in May 2013. The final draft forecast will then be distributed and comments will be collected from Arkansas residents via a series of stakeholder and general public meetings tentatively scheduled for June 2013. Please also note that due to the increasing complexity of the materials, a face-to-face meeting with the Work Group is proposed in Little Rock, tentatively scheduled for March 15th. Additional details regarding the meeting will be forthcoming. **In preparation for the March meeting, please send any comments, suggestions, or questions regarding this document by March 11, 2013 via email to: ArkansasWater@cdmsmith.com**.

Within this memorandum, key points and summary information are first provided followed by details on each component of the forecast for which detailed information has been developed at this time. Memorandum sections are as follows:

- 1.0 Overview and Key Points
- 2.0 Data Sources
- 3.0 Methodology
- 4.0 Irrigated Acres
- 5.0 Water Application Rate Per Acre
- Appendix A - County Results of Irrigated Acreage Trend Analysis

It should be noted that not all components of the forecast are fleshed out at this time. CDM Smith anticipates the remaining details will be finalized in the upcoming month with the support of the Work Group. This memorandum will be finalized and redistributed at that time.

1.0 Overview and Key Points

CDM Smith has made significant progress on collecting and analyzing data available for the irrigation water demand forecast. During this process, the quality of the data and its potential to be utilized in a forecasting model were considered. The "model" is intended to be very straight-forward but please note that there are several complex factors to be determined which are largely influenced by the available data.

The basic formula for forecasting irrigation demand is irrigated acres times an irrigation water application rate (application rate). However, there are many details within that basic formula that need to be specified, such as at what geographic scale to generate a forecast, whether to generate the forecast by crop type or for overall total irrigated acres, assumptions for extent of future irrigated acres, etc. As the data becomes more fully known, the detailed methodology takes shape and can be finalized as a balanced product of data availability, water plan goals, budget, and time constraints.

At this point in the process, the following summarizes CDM Smith's proposed approach to forecasting the *baseline* irrigation demands. Note that *baseline* represents the potential future irrigation withdrawals if current conditions continue throughout the forecast period. Baseline demands do not capture any potential, unknown changes in policy or regulations, unanticipated producer changes in irrigation behaviors, changes stemming from instability in commodity markets, etc. Rather, the baseline demands intend to model behaviors and limitations that are known and capture a potential future for irrigation in Arkansas. As the Water Plan develops, it is anticipated that scenarios of water use may need to be considered in addition to the baseline.

With this consideration, the following provides a summary of the proposed method for the baseline forecast. Details on each component are provided in the sections noted.

- The historical trend in irrigated acres by county by crop type were mathematically modeled using data from the Arkansas Water Use Data Base (WUDBS) from 2000-2010. Assumed future growth in irrigated acres by county are forecasted using these modeling results. For counties where models indicate a statistically significant trend in irrigated acreage growth, future irrigated acreage is forecasted to 2050 either by irrigated acres for major crop types or total irrigated acres, depending on county-specific modeling results. For counties with no measurable trend in the growth of irrigated acres, current (2010) irrigated acres by crop type are held constant from 2010 to 2050. [Section 4.0]
- An assessment of total crop production over time (2000-2010) by county is underway using the Arkansas Cropland Data Layer (CDL) available through USDA. These data will be used to determine the current (2010) total row crop production in a county and to assess whether or not trends exist within a county for increased acreage of row crop production. Note that

details on this component of the forecast are still in the developmental stage. In counties where positive growth trends in irrigated acres are modeled, forecasted irrigated acres will be capped according to current row crop production acres. If a notable upward trend in row crop production is found for that county, then the cap will be expanded to some future value of row crop production (to be determined). [Section 4.0]

- County average irrigation water application rates by crop type will be derived from the WUDBS using data from 2000-2010. These application rates will be developed at a monthly time-step and will exclude off-season water withdrawals thought to be predominately associated with waterfowl habitat development (this use will be included in Duck (Hunting) Clubs sector of the Water Plan). [Section 5.0]
- Future irrigated acres by crop type will be multiplied by the corresponding crop type application rate to derive total irrigation water use by county. The potential adoption of multiple inlet irrigation techniques for rice fields will be assessed and future rice application rates will be adjusted according to the most likely adoption rate by county. Note that details on this component of the forecast are still in the development stage. [Section 5.0]
- Supply source (groundwater or surface water), aquifer code, and surface water basin will be tracked for all demand and aggregated as needed for input into the groundwater and surface water supply models or other quantification techniques necessary to complete the water supply quantification analysis for the Water Plan update. CDM Smith recommends that the 2010 ratio of groundwater and surface water use to total use will remain constant through 2050 as our initial assumption, unless input from the Work Group or assessment of trends in source support an alternate assumption.

2.0 Data Sources

Extensive review was conducted to assess the quality and completeness of the potential data available for use in developing the agriculture irrigation water demand forecast. As this is a data driven forecast, this was necessary in order to finalize the proposed methodology for quantifying and forecasting irrigation demands. These data sources are discussed below.

2.1 WUDBS

Irrigation withdrawal data available in the WUDBS were analyzed by CDM Smith. This database identifies water withdrawals by water source from registered water users as identified by the Arkansas Natural Resource Commission's (ANRC) Water-Use Registration Program and is maintained by the U.S. Geological Survey (USGS). Data extractions were provided from 2000-2010 for monthly and annual irrigation.

The basic reporting unit within the WUDBS is the Measurement Point Identification (MPID), which is a unique number identifying a withdrawal point (i.e., geographic coordinate). For each MPID, there are a number of data that can be known about the withdrawal: county, latitude, longitude, water source, aquifer code, well depth, irrigation system, and 8-digit Hydrologic Unit Classification

(HUC), for example. In each year, the user reports on a number of data including crop type, irrigated acres, annual application rate, annual amount withdrawn, and monthly amount withdrawn.

Initial quality checks were conducted to determine the appropriateness of the data for use in the irrigation forecast. Queries were developed to check the quality of data entries. For example, the number of blank entries in fields such as Hydrologic Unit Code (HUC) and county were determined. MPID entries were analyzed for uniqueness and consistency among data entries. No major data quality issues were uncovered.

It was determined that for some years, when two crops were reported as irrigated for a single MPID diversion, duplicate entries would be found in the data provided. Also, water withdrawals were found to be reported outside of the growing season, which is believed to represent water used predominately for waterfowl recreation.

Overall, the data available through the WUDBS were determined to be a good source for assessing irrigation activities in Arkansas both currently and over time. It is a complete data source as it provides irrigated acres at any geographic scale (by using the latitude/longitude to display the data in a GIS), by crop type, the source of the water, and monthly application rates. Data checks will be implemented to assess any values derived from the data that fall outside of an expected range, both for irrigated acres and application rate.

2.2 USDA

The U.S. Department of Agriculture's (USDA) National Agriculture Statistics Service (NASS) has the Federal mission of providing agricultural statistics for the nation. There are several NASS programs that provide useful information relevant to the Water Plan.

The Census of Agriculture (Census), taken every 5 years, captures a detailed picture of farms and ranches across the U.S. by state and county. Among the data collected for the Census are irrigated acres by crop type and by county. The last Census for which data are available was taken in 2007. As a follow on survey to the Census, NASS conducts the Farm and Ranch Irrigation Survey (FIRS). This survey provides specific information relating to on-farm irrigation activities, including irrigated acreage by irrigation method. However, FIRS data are only available at the state level. The last FIRS was conducted in 2008. In addition to the Census, NASS conducts numerous annual surveys and collects irrigated acreage data for rice, soybeans, and cotton in Arkansas by county. Data for all NASS programs are available for query and download through the Quick Stats 2.0 web portal (http://quickstats.nass.usda.gov/).

Several data were gathered from the available NASS datasets. Census data by county for total irrigated acres were collected for the following years: 1978, 1982, 1987, 1992, 1997, 2002, and 2007. For the 2002 and 2007 Census datasets, irrigated acres by county and crop type were collected. Additionally, annual survey data on irrigated acres of rice, soybeans, and cotton by county were collected from 1983-2012.

Note that NASS is bound to confidentiality agreements where measures are taken to prevent producer-specific data to be derived. Therefore, data at the county level can be undisclosed in order to uphold the agreements. Total irrigated acres by county from the Census years are complete datasets with no disclosures issues. Within the 2002 and 2007 Census estimates of irrigated acres by crop type and county, there are 50 and 57 total undisclosed values, respectively. If land in orchards and forage acres are included, the count of undisclosed values nearly doubles. The disclosures are typically in counties where a crop is minimally irrigated.

Within the NASS annual statistics data, some quality issues were noted that should be considered. For many counties, zero acres are reported for a given year where significant acreage was reported in the previous and following year. For example, in Desha County in 2007 and 2009 irrigated acres of soybeans were reported as 72,000 and 117,000, respectively. Yet, the 2008 number was reported as zero. For soybeans, 14 such zero values are noted for an in-between year. The disclosure issues as well as the zeros in the annual survey should be considered when selecting a source for irrigated acres for use as the basis of the demand forecast.

In addition to the producer-completed reports, NASS generates an annual Cropland Data Layer (CDL) for Arkansas. This is a geo-referenced, crop-specific land cover data layer for use in GIS. The 2010 CDL has a ground resolution of 56 meters and is produced using satellite imagery collected during the growing season. This data source and its potential usefulness and accuracy level in analyzing the spatial patterns in irrigated acres by crop type over time is currently being assessed.

2.3 USGS Reports

The USGS generates statewide water use reports every five years that characterizes water withdrawals by county and source of supply (surface water and groundwater) for the major water using sectors in the state. The latest available USGS water use report depicts water withdrawals that occurred during calendar year 2005. To generate the Arkansas report, the USGS relies on the WUDBS as a primary data source. Because of this, the 2005 USGS report serves as an excellent source to quality check data WUDBS processing efforts for the irrigation forecast.

2.4 Additional Resources

An extensive literature search was conducted to support the assumptions and data requirements for the irrigation water demand forecast. Only the documents that are proposed as a potential source to meet a data requirement are discussed below. A fully annotated summary can be provided to Work Group members upon request.

Two potential literature sources were identified for providing insight into the future commodity market outlook: *FAPRI-ISU 2011 World Agriculture Outlook* (published by the Food and Agricultural Policy Research Institute at Iowa State University) and the *USDA Agricultural Projections to 2021*. Specifically, these reports provide useful projections for major U.S. farm commodities, including import/export quantities, yield projections, planted acres, variable costs, and market price. The USDA report projects these data to 2021 while the FAPRI report projects to 2026. While these

reports are quite rich in data, the most useful piece of information is the U.S. corn long-term projection of commodity price, as recent corn prices have driven irrigated acreage of corn in Arkansas. Both reports have similar projections for the price of corn, however, the USDA report projects the on-farm price received while the FAPRI report projects the Free On Board (FOB) price for the Gulf (a value used in determining the prices that producers receive).

As mentioned, the WUDBS reported crop irrigation water withdrawals by month include off-season uses. Thus, the *USDA Planting and Harvesting Dates for U.S. Field Crops* report was referenced to determine off-season use (http://www.nass.usda.gov/Publications/Usual_Planting_and_Harvesting_Dates/uph97.pdf).

Several academic research papers and miscellaneous reports were reviewed in support of the data analysis and methodology development. The following provides the key points gleaned from the literature with full citations of the sources. How this information supports further analysis is explained in the sections that follow.

- Using modeling techniques, adoption of irrigation production for corn in Alabama was found to be a reasonable risk reduction measure at $3.75 per bushel and quite profitable at $4.75 per bushel. [Novak, J. L., Nadolnyak, D., & McNider, R. (2008). *Analysis of Irrigated Corn Production Adoption Decisions in Alabama*. 2008 Annual Meetings, February 4-7, 2008, Dallas, Texas, Southern Agricultural Economics Association.]
- In Arkansas, potential yield increases resulting from multiple inlet rice irrigation (MIRI) do not have to be significantly large to increase the monetary payoff of MIRI technology in rice production. [Watkins, K. B., Hristovska, T., & Anders, M. M. (2010). Measuring the Monetary Benefits of Multiple Inlet Irrigation in Rice Production. *B.R. Wells Rice Research Studies 2010. Arkansas Agricultural Experiment Station Research Series 591, Fayetteville, Arkansas, University of Arkansas Division of Agriculture.]*
- Two field studies in Arkansas comparing MIRI to conventional rice irrigation on flat clay soil showed a water savings of about 18% on the MIRI fields. Fuel-use measurements also indicated a savings of 400 gallons of diesel on one MIRI field and 425 gallons on the other MIRI field. A survey of growers using MIRI indicates most feel it is providing water-management advantages that will result in them using it on more fields. [Norman, R.J. & B.R. (Ed.) (2001). Wells Rice Research Studies. *Arkansas Agricultural Experiment Station Research Series 485, University of Arkansas Division of Agriculture, Fayetteville, Arkansas. Rice irrigation-water management for water, labor, and cost savings. P. Tacker, E. Vories, and D. Kratz.]*
- In Arkansas, the majority of rice is still produced on silt loam soils. However, an increasingly more important factor is the amount of rice produced on clay or clay loam soils (27% and 21% of the acreage, respectively). The increase in rice acreage on clay soils has been observed in counties along the Mississippi River, where historically non-irrigated soybeans have dominated. Poly-tubing (also MIRI) is used as a means of irrigating rice to conserve water and labor. In 2009, rice farmers have adopted this practice on more than 42% of the

rice acreage. The adoption of multiple-inlet irrigation using poly-tubing has increased from 17% in 2002. [Wilson, C.E., Jr., Runsick, S.K., & Mazzanti, R. (2009) Trends in Arkansas Rice Production. *B.R. Wells Rice Research Studies 2008*. R.J. Norman, J.-F. Meullenet, and K.A.K. Moldenhauer, eds. Fayetteville, Arkansas: Arkansas Agricultural Experiment Station, Research Series No. 571, 13-23.]

- Rice production is limited to certain areas within the United States, based on the physiological needs of the rice plant. Abundant irrigation water, whether from surface-water sources like rivers, bayous, or canals, or pumped from groundwater aquifers, is required. All U.S. rice acreage is irrigated. There is an increasing concentration of rice acreage and share of total output in the Delta, with production moving away from the Gulf Coast. The geographical shifts in production are closely related to regional differences in production costs. In the South, for example, production costs in the Gulf Coast were 15-16 percent greater than in the other two regions (Arkansas Non-Delta and Mississippi River Delta) in 2009, with operating costs being the main distinguishing factor. One of the biggest differences in operating costs comes from Gulf Coast producers' planting method. Thus, rice acreage is expected to increase in the lower cost Arkansas Non-Delta rice growing area, with Missouri and Northeast Arkansas likely to gain the most acreage. The 2011 baseline projections indicate U.S. rice acreage over the next decade will average slightly less than 3.3 million acres per year, well below the record 3.8 million acres planted in 1981, but close to the nearly 3.3-million acres planted on average each year from 2001 to 2005. From 2014 onward, net returns per acre to rice exceed other planting options by an increasing margin, encouraging a small boost in rice acreage in competitive regions. [Baldwin, K., Dohlman, E., Childs, N., & Foreman, L. (2011). *Consolidation and Structural Change in the U.S. Rice Sector*. U.S. Department of Agriculture, Economic Research Service, RCS-11d-01. http://www.ers.usda.gov/media/111364/rcs11d01_1_.pdf]

3.0 Methodology

A basic methodology that captures the components driving irrigation water withdrawals will be employed to estimate irrigation water demands now and in the future by county. The basic methodology is executed at the county level and is defined as total irrigated acres by crop type times the average application rate for the crop(s) in that county, as shown in Equation 1.

$$Q_{c,i,y} = IA_{c,i,y} \times AR_{c,i,y} \qquad \textbf{\textit{Equation 1}}$$

Where:

$Q_{c,i,y}$= Crop irrigation withdrawal in acre feet per year (AFY) in county (c) for crop (i) in year (y)

$IA_{c,i,y}$ = Total irrigated acres in county (c) for crop (i) in year (y)

$AR_{c,i,y}$ = Average application rate per acre AFY for crop (i) in county (c) in year (y)

Total water demand for all irrigated agricultural in the county is then the sum of crop withdrawals in Equation 1 for all crops. This estimates the gross irrigation water requirement and thus includes what the crop requires and what is applied to the scheme in addition to what the crop required,

referred to as system inefficiencies. The baseline scenario will consider whether or not to include changes in the application rate from inefficiency improvements, as discussed in Section 5.0.

A total county demand forecast will be developed by crop type. These demands can then be dispersed to basin, grid, surface water source, aquifer, etc., as required to fulfill the analyses requirements of the Water Plan surface water and ground water supply models. The exact inputs required are not fully known at this time. When these components are finalized, methods will be developed for the aggregations and provided to the Work Group for review.

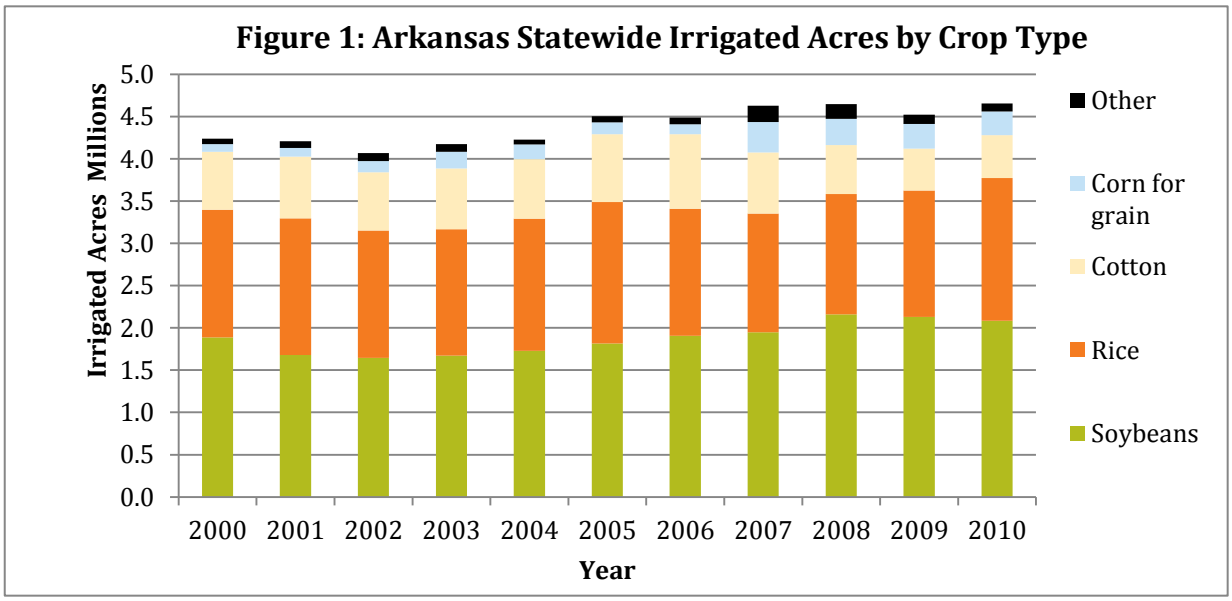
4.0 Irrigated Acres

Equation 1 requires total irrigated acres by crop type for all counties, both currently and in the future. An analysis was carried out to examine the historic trends in irrigated acres by major crop type utilizing the ANRC WUDBS. The analysis determines any measurable trends in irrigated acres from 2000-2010 and provides a *base year* for the forecast. The base year represents the starting point of the forecast. *For the irrigation forecast, a base year of 2010 is recommended as this is the most recent year of data provided in the WUDBS and this year appears to reasonably reflect the current irrigation patterns and water use*

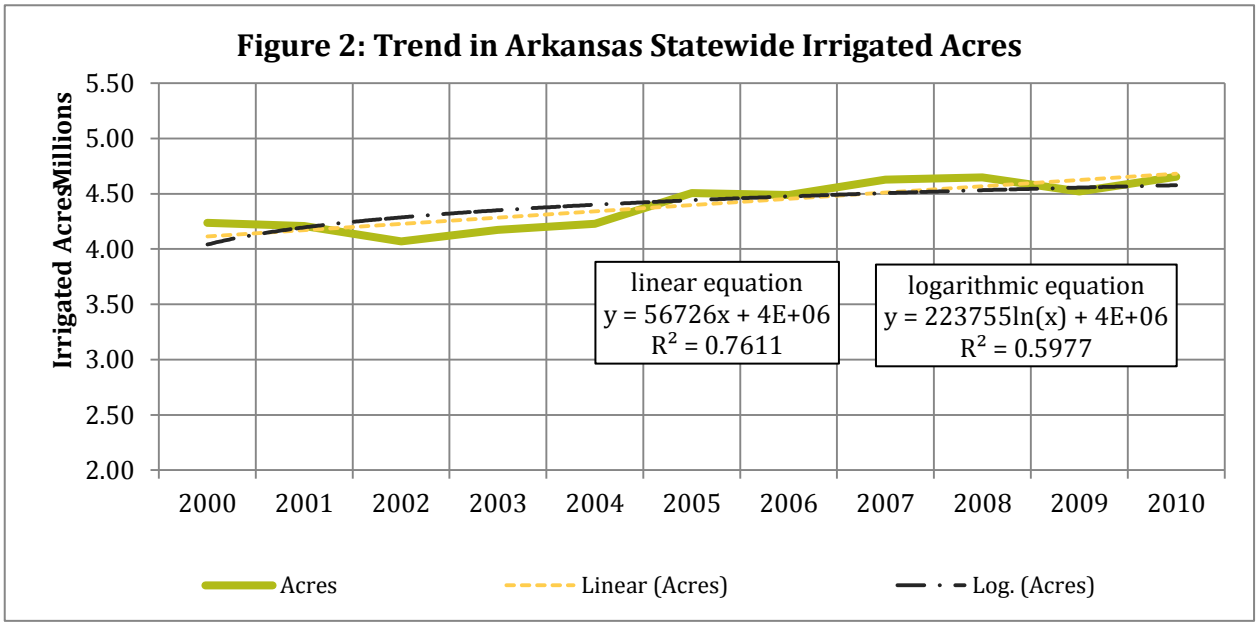
The following sections provide general information regarding statewide and regional trends in irrigation over the period of analysis. Then, county-level trends are provided along with a discussion as to how the results of the trend analysis are used to forecast irrigated acres to 2050. All data presented in the sections that follow regarding irrigated acreage were developed from the WUDBS.

4.1 Statewide Trends

On a statewide basis, irrigated acres were reported as 4.23 million in 2000, growing to 4.65 million in 2010, as shown in Figure 1. Overall, irrigated acres grew by 10% from 2000-2010. Soybeans and rice are the prominent irrigated crops in the state, accounting for over 80% of the irrigated acres in 2010 (45% and 36%, respectively). Corn irrigation, while only 6% of the irrigated acres in 2010, grew by 208% from 2000 to 2010. This trend is likely due to the increasing market price for corn over that time period, which increased from $1.85 per bushel to $5.18 (U.S. average price received during marketing years). Irrigated acres of soybeans and rice grew by 10% and 12%, respectively from 2000 to 2010.



Using the Excel function "Trendline", the linear and logarithmic mathematical equations for the growth in statewide irrigated acres was estimated, as shown in Figure 2. *Note that the difference between the linear and logarithmic equations is that the independent variable is transformed to its natural log in the logarithmic equation.* The linear model explains the greatest amount of variation in the data, with an R^2 of 0.76 when using time as the independent variable. While R^2 is a somewhat subjective measure, it is widely accepted that with statistically significant results, higher R^2 values means that the model explains more of the variation in the data and indicates a better fit. For example, an R^2 value of 0.50 indicates that 50% of the variation in the data is explained by the model functions. Results of the statewide trend suggests that time is a reasonable predictor of irrigated acres over the period of analysis.



4.2 Regional Trends

Trends in irrigated acres were also analyzed for each Water Resource Planning Region (Planning Region). Planning Regions, shown in Figure 3, are areas across the state useful for analyzing water resources. For the Water Plan, Planning Regions include North Arkansas, Arkansas River Valley, South-central Arkansas, Southwest Arkansas, and the Delta. Results of the analysis show that the Delta region accounts for over 90% of the total irrigated acreage in the state.

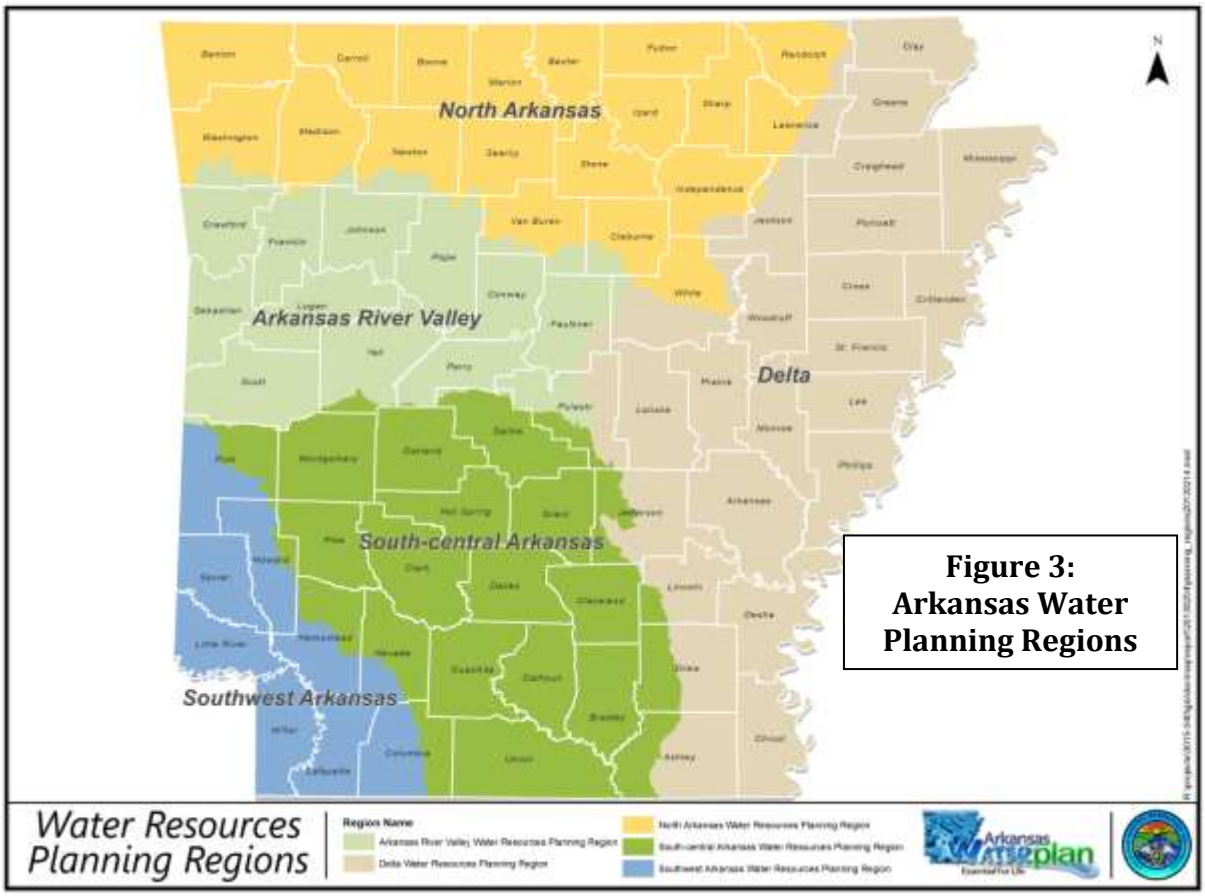
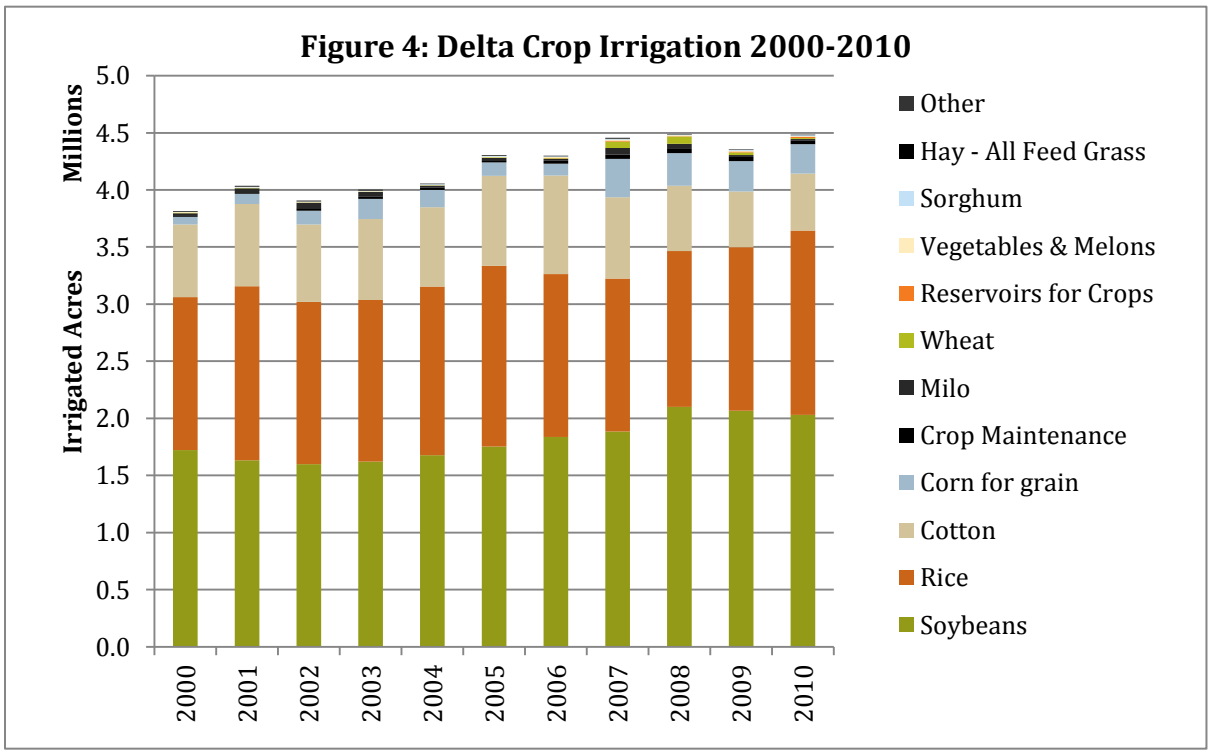


Figure 3: Arkansas Water Planning Regions

Further assessment was conducted for the counties making up the Delta Planning Region. Note, that an assessment of the counties in the Delta Planning Region was conducted first because of the high concentration of irrigated acres in this region compared to other areas of the state. The same process will be conducted for the remaining counties in the state in the upcoming month.

4.3 Delta Region County Trends

The Delta irrigation trends over time were analyzed at the county scale to identify any measurable trend in cropping patterns. As a whole, the Delta Region trend in irrigated acres is comparable to the statewide trend, as expected, given that the Delta irrigation accounts for most of the irrigation in the state. Soybeans and rice are the dominant crops planted under irrigation, as shown in Figure 4. Together with cotton and corn, these four crops account for 98% of total crops irrigated in the Delta.



The major river basins and counties that fall within the Delta Region are shown in Figure 5 and Figure 6, respectively. As county lines do not intersect perfectly with regional boundaries, counties identified as in the Delta are those completely within the Delta regional boundary and those falling along the Delta's western boundary. Historic trend assessments on irrigated acres, both total and by primary crop type were conducted for counties within the Delta. This assessment will be conducted for the remaining counties in the state in the upcoming month.

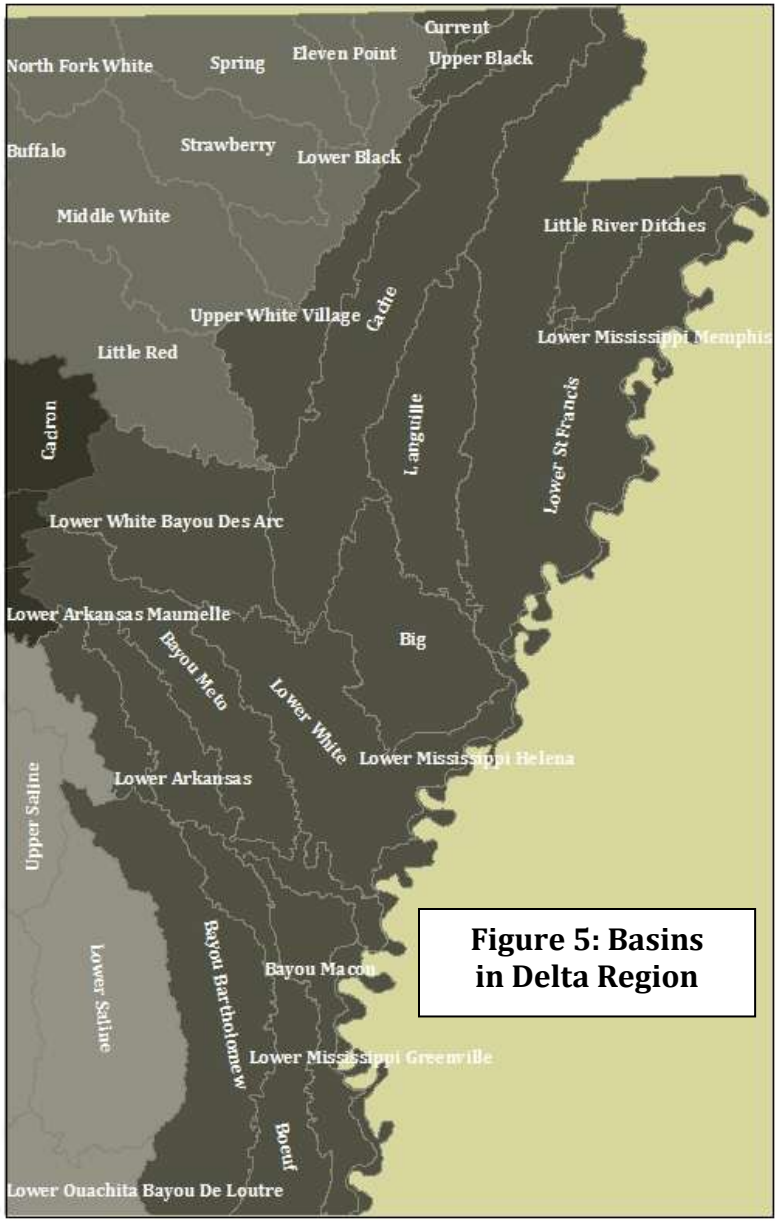


Figure 5: Basins in Delta Region

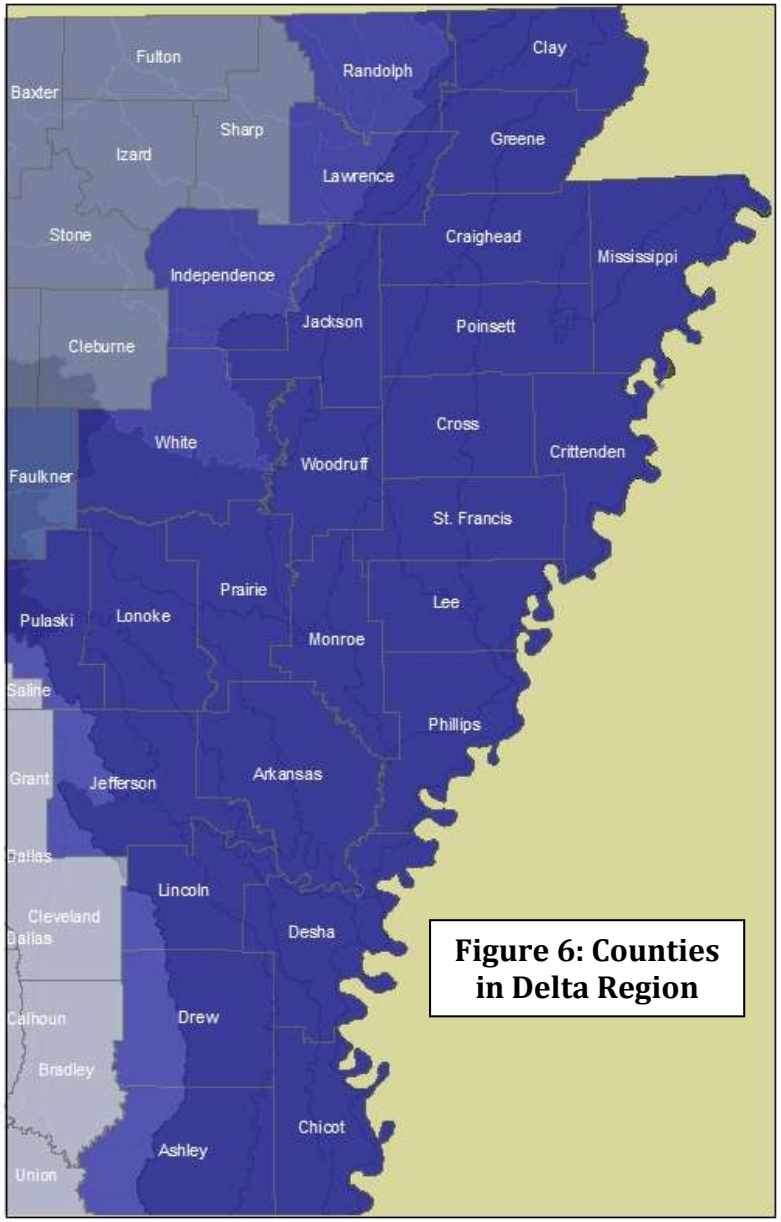


Figure 6: Counties in Delta Region

The analysis was conducted in the exact same manner for all counties within the Delta. Historical irrigated acres, total and by major crop type (soybeans, rice, cotton, and corn), were determined for each county based on WUDBS entries from 2000-2010. The linear and logarithmic best fit equation was generated for total irrigated acres overall and for rice, soybeans, and cotton, with time as the independent variable. For acres of corn for grain, linear and logarithmic equations were determined with price as the independent variable, as tests revealed that price was a stronger indicator of irrigated acres over time compared to time and literature suggested that the price of corn and the decision to irrigate corn are related (see Novak et. al. in Section 2.4)). Price data for corn were collected from http://www.farmdoc.illinois.edu/manage/pricehistory/PriceHistory.asp. The R^2 value was determined for each equation and compared to determine if a well-fitted model could be estimated from the data. Results of the analysis for each county in the Delta are provided in the Table A-1 in Appendix A.

Table 1 summarizes results from Table A-1, showing the count and percent of counties with a linear or logarithmic model that produced an R^2 greater than 0.65. [Note: this is a conservative threshold for fit of model and is subject to change. The models that fit the 0.65 or higher R^2 criteria are henceforth referred to as "good fit".]

Table 1: Statistics on Models with R^2 Greater than 0.65

ANALYSIS BY COUNTY (27 Counties Total)										
	Total(Time)		Rice(Time)		Soybeans(Time)		Cotton(Time)		Corn(Price)	
	Linear	Log	Linear	Log	Linear	Log	Linear	Log	Linear	Log
Count	11	9	4	1	6	1	5	2	12	12
Percent	41%	33%	15%	4%	22%	4%	19%	7%	44%	44%

When grouping total irrigated acres by the 27 counties that fall within the Delta, 41% of the counties have a good fit linear model. Data for four counties showed a good fit linear model for rice acreage. These counties are Greene, Jackson, Randolph, and Woodruff. In terms of trends in soybean irrigated acres, six counties had good fit linear models and one had a good fit logarithmic model. Results for cotton indicate that 19% and 7% of counties had a good fit linear model and logarithmic model, respectively. Nearly half of the counties showed strong trends in explaining growth in irrigated acres of corn when the price of corn was used as the independent variable.

4.4 Use of Trend Results to Forecast Irrigated Acres

CDM Smith is proposing that results of the trend analysis be used to forecast irrigated acres by county through 2050 for the purposes of forecasting crop irrigation water demand. Note that the county forecast will be aggregated to basin, region, and state by source, aquifer, etc., as needed to support analyses in the Water Plan. Details will be provided as the Water Plan needs emerge.

The following provides details on how results of the trend analysis will be applied to forecast irrigated acres to 2050:

- For each county, the trend models for total irrigated acres will be compared against each separate trend model for irrigated acres by crop type to determine which model, or sets or models, explain the most variance in irrigated acres over time and thus are most appropriate for projecting irrigated acres into the future.

- If total irrigated acres has a better fit model (higher R^2) when compared to the crop type model(s), this model will be used to forecast total irrigated acres from 2010 to 2050 in 10 year increments. This is done in *Microsoft Excel* by using the "Trend" function. An analysis of the trend in each crop will be assessed to determine how to apply the growth in irrigated acres to each crop.

- If the models for irrigated acres by crop type have a higher R^2 value when compared to total irrigated acres model, then those best fit models for crop types will be used to forecast future irrigated acres from 2010 to 2050 at 10 year increments. This is done in *Microsoft Excel* by using the "Trend" function. Any crop type without a good fit model will result in irrigated acres throughout the forecast periods equal to the 2010 value (i.e., no growth or decline in irrigated acres will be assumed).

    - Any trend model selected and applied for corn will assume the corn for grain commodity price from the *USDA Agricultural Projections to 2021*, which forecasts U.S. commodity prices to 2021. The 2021 price will be held constant to 2050 (the 2021 price is projected at $4.65 per bushel).

- If neither total irrigated acres nor irrigated acres by crop type produce good fit models (R^2 0.65 or less), irrigated acres by crop type will be held constant throughout the forecast period.

- In any instance where growth is experienced in a county model, the overall growth in irrigated acres will be capped according to results of a GIS analysis of potential additional irrigated acreage within the county. That is to say, growth in irrigated acres cannot exceed the total potential farmland within a county that is available to be converted to irrigation. [This component of the forecast is still in data exploration and planning phase. Details will be provided at a later date.]

5.0 Water Application Rate Per Acre

Water application rates for irrigated agriculture varies widely and is driven by the type of crop produced, planting date, seed variety, amount of rainfall received, daily temperatures, type of irrigation system used, water availability, and producer behaviors, among other drivers. Equation 1 requires an estimate of the water use applied to each irrigated acre within a county by crop type.

The WUDBS does collect monthly withdrawals by MPID, thus the actual application rates can be derived from this database.

To determine the average application rate by county and crop type, the data provided from the WUDBS was queried to extract the data needed. Within the WUDBS structure, monthly irrigation amounts are associated with total irrigated acres. If a withdrawal is supplying water for more than one crop type, there is no way to distinguish what portion of the monthly withdrawal was applied to which crop. So, to begin the analysis, records where more than one crop type is associated with a reported withdrawal registration were dropped from the analysis. This does not impact the overall result, as Equation 1 requires an *average* application rate and not total.

Records with only single crop types associated with the reported withdrawals were then extracted from the WUDBS. These records were grouped by county, year, and crop type. Next the sum of irrigated acres and each month's reported irrigation withdrawal were computed to derive monthly irrigation application rate by county, year, and crop type. The monthly irrigation rate is expressed as acre-feet per acre (AF/A) for each year and converted to inches per acre (in/A).

The monthly application rate values from 2000 to 2010 were averaged by county and crop type to derive the average monthly application rates from during the period of analysis.

Off-season water use was then removed from this analysis. Off-season use is assumed to be used for waterfowl habitat development and is included in the Duck (Hunting) Clubs sector of the Water Plan update. Assumptions for seasonal crop production patterns were formed using the *USDA Planting and Harvesting Dates for U.S. Field Crops* report. Using this resource, the following seasonal crop patterns were assumed:

- Berries, Crop Maintenance, Fruit & Nut Trees, Hay, Pastures & Lawns, Reservoirs for Crops, Vegetables & Melons, and Wheat – all use assumed for crop production
- Cash Grains – Apr-Sep use assumed for crop production, all other use assumed for waterfowl
- Corn for Grain – Mar-Sep assumed for crop production, all other use assumed for waterfowl
- Cotton – Apr- Nov assumed for crop production, all other use assumed for waterfowl
- Milo, Grain Sorghum – Apr-Oct assumed for crop production, all other use assumed for waterfowl
- Oats – May-Oct use assumed for crop production, all other use assumed for waterfowl
- Rice – Feb-Oct use assumed for crop production (early months included to account for field flushing), all other use assumed for waterfowl
- Soybeans – Apr-Nov use assumed for crop production, all other use assumed for waterfowl
- Tobacco – Apr-Sept use assumed for crop production, all other use assumed for waterfowl

The county-specific average application rates for a crop are a product of the type of irrigation system used, average weather over the period of analysis, soil type, and producer behaviors. As such, variations in the data from county-to-county are expected.

Table 2, Table 3, Table 4, and Table 5 provide preliminary results for the average application rate for rice, soybeans, cotton, and corn, respectively. The average application rates along with irrigated acres of the crop are provided for the top ten counties producing the crop. Table 6 provides a summary of the preliminary results for the average application rates by county and crop type for all counties and crops in Arkansas. These values will be quality checked before becoming final to determine any values that fall outside of an expected, normal range. Feedback from the Work Group is desired regarding the use of these derived values and any values that seem abnormally high or low.

For the top ten rice-producing counties, producers in Arkansas County report the highest average application rate, totaling 47.6 inches/acre from 2000-2010. The lowest reported application rates were reported in Greene County, averaging 28.8 inches/acre. The average total seasonal application rate for these counties is 36 inches/acre. [Reference Table 2]

For the top ten soybean-producing counties, producers in Cross County report the highest average application rate, totaling 25.1 inches/acre from 2000-2010. The lowest reported application rates were reported in Prairie County, averaging 10.2 inches/acre. The average total seasonal application rate for these counties is 16.5 inches/acre. [Reference Table 3]

For the top ten cotton-producing counties, producers in Clay County report the highest average application rate, totaling 30.2 inches/acre from 2000-2010. The lowest reported application rates were reported in Mississippi County, averaging 10.6 inches/acre. The average total seasonal application rate for these counties is 16.8 inches/acre. [Reference Table 4]

For the top ten corn-producing counties, producers in Clay County report the highest average application rate, totaling 30.6 inches/acre from 2000-2010. The lowest reported application rates were reported in Chicot County, averaging 11.3 inches/acre. The average total seasonal application rate for these counties is 18 inches/acre. [Reference Table 5]

With respect to the observed application rates for rice and assumptions for future application rates, research shows that the adoption of MIRI is likely as it not only reduces water use and pumping costs but also decreases labor costs. Because the adoption of this practice reduces water use by some 18% (see Norman et. al. in Section 2,4) and produces a potential yield increase that makes MIRI installation profitable (see Watkins et. al. in Section 2,4), it is logical to include its impact on rice irrigation water application rates in the baseline projections. Also, consider that MIRI adoption rates in Arkansas have increased from 17% in 2002 to 42% in 2009 (see Wilson et. al in Section 2.4). Therefore, the county average application rate values for rice will be analyzed in greater detail to determine the likely future application rates that may be realized as a result of increased adoption rates for MIRI. Additional data is being sought in order to formulate a likely future

condition for MIRI adoption rates by county. This component of the analysis will be finalized in the upcoming month and details will be provided at that time.

Table 2: Average Irrigation Application Rate for Rice, Top Ten Rice-Producing Counties (inches/acre)

County	Irrigated Acres (2010)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
ARKANSAS	152,900	0.0	0.0	0.0	0.1	14.2	15.0	14.6	2.7	0.4	0.4	0.0	0.0	47.6
POINSETT	147,833	0.0	0.0	0.0	0.0	8.6	13.2	11.8	5.5	0.0	0.0	0.0	0.0	39.1
JACKSON	127,220	0.0	0.0	0.0	0.0	0.1	11.8	11.9	11.8	0.0	0.0	0.0	0.0	35.7
CROSS	110,126	0.0	0.0	0.0	0.0	5.4	13.2	11.4	6.5	0.1	0.0	0.0	0.0	36.5
CRAIGHEAD	96,297	0.0	0.0	0.0	0.0	8.9	9.0	9.0	9.0	0.0	0.0	0.0	0.0	35.9
LONOKE	91,278	0.0	0.0	0.0	0.1	4.0	8.2	13.4	10.7	0.1	0.4	0.0	0.0	36.8
GREENE	90,389	0.0	0.0	0.0	0.5	7.2	7.2	7.2	6.7	0.0	0.0	0.0	0.0	28.8
JEFFERSON	80,597	0.0	0.0	0.0	2.9	6.4	8.2	6.7	5.6	1.2	0.1	0.0	0.0	31.2
PRAIRIE	75,969	0.0	0.0	0.0	0.0	4.2	6.4	10.2	8.8	0.0	0.0	0.0	0.0	29.7
CLAY	69,829	0.0	0.0	0.0	0.0	1.6	12.3	12.3	12.4	0.2	0.0	0.0	0.0	38.9

Table 3: Average Irrigation Application Rate for Corn, Top Ten Corn-Producing Counties (inches/acre)

County	Irrigated Acres (2010)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
ARKANSAS	218,141	0.0	0.0	0.0	0.0	0.5	6.3	7.6	7.3	2.1	0.1	0.0	0.0	24.0
POINSETT	145,914	0.0	0.0	0.0	0.0	0.7	9.3	8.5	3.9	0.0	0.0	0.0	0.0	22.3
MISSISSIPPI	133,923	0.0	0.0	0.0	0.0	0.0	3.4	3.5	3.4	0.0	0.0	0.0	0.0	10.2
CROSS	127,518	0.0	0.0	0.0	0.2	2.3	9.7	9.4	3.3	0.3	0.0	0.0	0.0	25.1
PHILLIPS	110,019	0.0	0.0	0.0	0.0	0.3	2.5	5.6	3.0	0.1	0.0	0.0	0.0	11.6
PRAIRIE	106,293	0.0	0.0	0.0	0.0	0.2	0.8	3.8	4.1	1.2	0.1	0.1	0.0	10.2
ST FRANCIS	98,037	0.0	0.0	0.0	0.0	0.1	1.5	6.0	5.6	1.2	0.0	0.1	0.0	14.5
LONOKE	95,364	0.0	0.0	0.0	0.0	0.1	0.4	4.5	4.8	0.4	0.0	0.0	0.0	10.3
DESHA	89,061	0.0	0.0	0.0	0.0	0.1	3.8	7.3	6.7	0.5	0.1	0.1	0.0	18.5
CRITTENDEN	86,799	0.0	0.0	0.0	0.0	1.0	4.4	6.0	5.0	1.6	0.0	0.0	0.0	17.9

Table 4: Average Irrigation Application Rate for Cotton, Top Ten Cotton-Producing Counties (inches/acre)

County	Irrigated Acres (2010)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
MISSISSIPPI	87,119	0.0	0.0	0.0	0.0	0.0	3.5	3.6	3.5	0.0	0.0	0.0	0.0	10.6
CRAIGHEAD	64,648	0.0	0.0	0.0	0.0	0.0	4.0	4.0	4.1	0.0	0.0	0.0	0.0	12.1
DESHA	57,158	0.0	0.0	0.0	0.0	0.1	3.9	7.6	6.6	0.3	0.0	0.0	0.0	18.4
LEE	48,215	0.0	0.0	0.0	0.0	0.2	4.8	7.0	4.9	0.0	0.0	0.0	0.0	17.0
CHICOT	29,240	0.0	0.0	0.0	0.0	0.0	0.8	6.4	5.4	0.0	0.0	0.0	0.0	12.7
POINSETT	26,004	0.0	0.0	0.0	0.0	0.2	7.3	6.7	3.6	0.0	0.0	0.0	0.0	17.8
PHILLIPS	24,199	0.0	0.0	0.0	0.0	0.4	2.8	6.8	3.5	0.0	0.0	0.0	0.0	13.5
ST FRANCIS	23,744	0.0	0.0	0.0	0.0	0.2	2.4	6.4	5.5	0.5	0.0	0.0	0.0	14.9
CLAY	22,727	0.0	0.0	0.0	0.0	0.3	8.4	10.0	10.1	1.2	0.3	0.0	0.0	30.2
LINCOLN	18,148	0.0	0.0	0.0	0.0	0.9	4.6	5.3	6.6	3.2	0.0	0.0	0.0	20.5

Table 5: Average Irrigation Application Rate for Corn, Top Ten Corn-Producing Counties (inches/acre)

County	Irrigated Acres (2010)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
LONOKE	21,712	0.0	0.0	0.0	0.0	0.2	5.7	6.5	3.0	0.0	0.0	0.0	0.0	15.5
JEFFERSON	19,997	0.0	0.0	0.0	0.2	1.2	6.5	7.0	5.3	0.4	0.0	0.0	0.0	20.6
CLAY	17,588	0.0	0.0	0.0	0.0	1.8	10.0	10.0	8.6	0.2	0.0	0.0	0.0	30.6
CRAIGHEAD	16,406	0.0	0.0	0.0	0.0	0.0	4.0	4.0	4.1	0.0	0.0	0.0	0.0	12.0
PHILLIPS	14,656	0.0	0.0	0.0	0.0	1.1	4.1	6.4	2.4	0.0	0.0	0.0	0.0	13.9
LEE	14,381	0.0	0.0	0.0	0.1	1.2	6.6	7.5	4.1	0.1	0.0	0.0	0.0	19.5
MONROE	14,246	0.0	0.0	0.0	0.0	2.3	6.8	9.4	5.7	0.0	0.0	0.0	0.0	24.3
CHICOT	14,179	0.0	0.0	0.0	0.0	0.4	5.2	5.0	0.6	0.0	0.0	0.0	0.0	11.3
DESHA	12,900	0.0	0.0	0.0	0.9	2.9	5.4	6.1	2.7	0.1	0.0	0.0	0.0	18.0
MISSISSIPPI	12,438	0.0	0.0	0.0	0.0	0.0	4.6	4.7	4.6	0.0	0.0	0.0	0.0	13.9

Table 5: Average Application Rate from 2000-2010 by County and Crop Type in the Delta Planning Region (inches/acre)

County	Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Arkansas	Berries	0.0	0.0	0.0	0.0	4.2	4.2	4.2	4.2	0.0	0.0	0.0	0.0	16.7
Benton	Berries	1.5	1.5	2.1	2.7	2.7	3.0	3.0	3.0	3.0	2.7	1.8	1.5	28.5
Boone	Berries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	5.9	0.0	0.0	0.0	6.9
Jackson	Berries	0.0	0.0	0.0	2.1	5.4	8.4	0.0	0.0	0.0	0.0	0.0	0.0	15.9
Johnson	Berries	0.0	0.0	0.1	0.7	0.2	0.7	0.8	1.4	0.8	0.1	0.0	0.0	4.9
Washington	Berries	0.0	0.0	0.0	0.2	0.3	0.8	1.5	1.3	1.3	0.5	0.1	0.0	5.9
White	Berries	0.0	0.0	0.0	0.0	4.0	7.6	7.6	5.3	3.6	3.6	0.0	0.0	31.7
Craighead	Cash Grain	0.0	0.0	0.0	0.0	0.0	11.9	12.2	11.9	0.0	0.0	0.0	0.0	36.0
Crawford	Cash Grain	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.4	0.0	0.0	0.0	0.0	1.3
Jackson	Cash Grain	0.0	0.0	0.0	0.0	2.5	1.0	4.7	2.4	0.0	0.0	0.0	0.0	10.6
Lincoln	Cash Grain	0.0	0.0	0.0	0.0	0.0	4.2	4.2	4.2	4.2	0.0	0.0	0.0	16.8
Lonoke	Cash Grain	0.0	0.0	0.0	1.2	1.2	1.2	3.6	3.6	1.2	0.0	0.0	0.0	12.0
Mississippi	Cash Grain	0.0	0.0	0.0	0.0	0.0	2.9	3.0	2.9	0.0	0.0	0.0	0.0	8.9
Monroe	Cash Grain	0.0	0.0	0.0	0.0	0.0	2.7	2.7	2.7	0.0	0.0	0.0	0.0	8.0
Polk	Cash Grain	0.0	0.0	0.0	0.0	0.0	0.0	6.0	6.0	0.0	0.0	0.0	0.0	12.0
Prairie	Cash Grain	0.0	0.0	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	3.8
Arkansas	Corn for Grain	0.0	0.0	0.0	0.3	8.4	9.3	9.1	2.2	0.2	0.0	0.0	0.0	29.6
Ashley	Corn for Grain	0.0	0.0	0.0	0.0	0.7	4.2	4.6	2.4	0.0	0.0	0.0	0.0	11.8
Carroll	Corn for Grain	0.0	0.0	0.0	0.0	0.0	0.0	6.0	6.0	6.0	0.0	0.0	0.0	18.0
Chicot	Corn for Grain	0.0	0.0	0.0	0.0	0.4	5.2	5.0	0.6	0.0	0.0	0.0	0.0	11.3
Clark	Corn for Grain	0.0	0.0	0.0	0.0	0.0	0.0	8.0	4.0	0.0	0.0	0.0	0.0	12.0
Clay	Corn for Grain	0.0	0.0	0.0	0.0	1.8	10.0	10.0	8.6	0.2	0.0	0.0	0.0	30.6
Conway	Corn for Grain	0.0	0.0	0.0	0.0	0.0	3.2	3.3	1.3	0.5	0.0	0.0	0.0	8.3
Craighead	Corn for Grain	0.0	0.0	0.0	0.0	0.0	4.0	4.0	4.1	0.0	0.0	0.0	0.0	12.0
Crawford	Corn for Grain	0.0	0.0	0.0	0.0	0.0	0.4	1.5	1.0	0.0	0.0	0.0	0.0	2.8
Crittenden	Corn for Grain	0.0	0.0	0.0	0.0	1.7	5.1	5.1	2.1	0.0	0.0	0.0	0.0	14.0
Cross	Corn for Grain	0.0	0.0	0.0	0.4	3.2	10.4	9.1	4.5	0.7	0.0	0.0	0.0	28.5
Desha	Corn for Grain	0.0	0.0	0.0	0.9	2.9	5.4	6.1	2.7	0.1	0.0	0.0	0.0	18.0
Drew	Corn for Grain	0.0	0.0	0.0	0.0	0.4	3.6	3.9	3.1	0.0	0.0	0.0	0.0	11.1
Faulkner	Corn for Grain	0.0	0.0	0.0	0.0	1.4	3.1	4.9	4.1	2.2	0.0	0.0	0.0	15.8
Greene	Corn for Grain	0.0	0.0	0.0	0.0	5.6	6.3	3.7	2.9	0.0	0.0	0.0	0.0	18.5

Table 5: Average Application Rate from 2000-2010 by County and Crop Type in the Delta Planning Region (inches/acre)

County	Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Independence	Corn for Grain	0.0	0.0	0.0	0.7	2.4	4.3	5.3	1.9	0.1	0.0	0.0	0.0	14.6
Jackson	Corn for Grain	0.0	0.0	0.0	0.0	4.4	7.0	4.3	1.6	0.1	0.0	0.0	0.0	17.4
Jefferson	Corn for Grain	0.0	0.0	0.0	0.2	1.2	6.5	7.0	5.3	0.4	0.0	0.0	0.0	20.6
Johnson	Corn for Grain	0.0	0.0	0.0	0.0	0.0	0.4	1.4	0.9	0.0	0.0	0.0	0.0	2.6
Lafayette	Corn for Grain	0.0	0.0	0.1	0.6	1.2	4.7	4.8	2.2	0.1	0.0	0.0	0.0	13.8
Lawrence	Corn for Grain	0.0	0.0	0.0	0.0	0.8	5.5	6.8	2.1	0.0	0.0	0.0	0.0	15.2
Lee	Corn for Grain	0.0	0.0	0.0	0.1	1.2	6.6	7.5	4.1	0.1	0.0	0.0	0.0	19.5
Lincoln	Corn for Grain	0.0	0.0	0.0	1.0	2.4	5.9	6.7	5.9	3.3	0.0	0.0	0.0	25.3
Little River	Corn for Grain	0.0	0.0	0.0	0.0	1.8	5.9	5.8	0.0	0.0	0.0	0.0	0.0	13.4
Logan	Corn for Grain	0.0	0.0	0.0	0.0	0.3	1.5	2.7	1.2	0.4	0.0	0.0	0.0	6.1
Lonoke	Corn for Grain	0.0	0.0	0.0	0.0	0.2	5.7	6.5	3.0	0.0	0.0	0.0	0.0	15.5
Miller	Corn for Grain	0.0	0.0	0.1	0.1	0.1	3.2	3.3	3.4	0.1	0.0	0.0	0.0	10.3
Mississippi	Corn for Grain	0.0	0.0	0.0	0.0	0.0	4.6	4.7	4.6	0.0	0.0	0.0	0.0	13.9
Monroe	Corn for Grain	0.0	0.0	0.0	0.0	2.3	6.8	9.4	5.7	0.0	0.0	0.0	0.0	24.3
Phillips	Corn for Grain	0.0	0.0	0.0	0.0	1.1	4.1	6.4	2.4	0.0	0.0	0.0	0.0	13.9
Poinsett	Corn for Grain	0.0	0.0	0.0	0.0	0.9	10.3	9.7	5.4	0.0	0.0	0.0	0.0	26.3
Prairie	Corn for Grain	0.0	0.0	0.0	0.0	3.0	7.2	7.4	2.1	0.2	0.0	0.0	0.0	19.9
Pulaski	Corn for Grain	0.0	0.0	0.0	0.0	0.4	4.3	3.4	3.6	0.3	0.0	0.0	0.0	12.0
Randolph	Corn for Grain	0.0	0.0	0.0	0.0	0.1	12.5	12.5	0.9	0.1	0.0	0.0	0.0	26.0
St Francis	Corn for Grain	0.0	0.0	0.0	0.0	1.4	7.2	8.2	4.7	0.5	0.0	0.0	0.0	22.0
Stone	Corn for Grain	0.0	0.0	0.0	0.0	0.0	0.0	7.6	7.6	0.0	0.0	0.0	0.0	15.1
White	Corn for Grain	0.0	0.0	0.0	0.0	4.5	8.1	5.8	1.3	0.6	0.0	0.0	0.0	20.3
Woodruff	Corn for Grain	0.0	0.0	0.0	0.0	0.5	2.8	4.3	2.1	0.2	0.0	0.0	0.0	9.9
Arkansas	Cotton	0.0	0.0	0.0	0.0	4.0	6.4	6.4	3.8	0.0	0.0	0.0	0.0	20.5
Ashley	Cotton	0.0	0.0	0.0	0.0	0.1	4.0	5.1	4.5	0.1	0.0	0.0	0.0	13.7
Chicot	Cotton	0.0	0.0	0.0	0.0	0.0	0.8	6.4	5.4	0.0	0.0	0.0	0.0	12.7
Clay	Cotton	0.0	0.0	0.0	0.0	0.3	8.4	10.0	10.1	1.2	0.3	0.0	0.0	30.2
Craighead	Cotton	0.0	0.0	0.0	0.0	0.0	4.0	4.0	4.1	0.0	0.0	0.0	0.0	12.1
Crittenden	Cotton	0.0	0.0	0.0	0.0	1.3	5.7	6.1	2.5	0.0	0.0	0.0	0.0	15.6
Cross	Cotton	0.0	0.0	0.0	0.1	1.2	9.2	7.7	2.6	0.1	0.0	0.0	0.0	20.9
Desha	Cotton	0.0	0.0	0.0	0.0	0.1	3.9	7.6	6.6	0.3	0.0	0.0	0.0	18.4
Drew	Cotton	0.0	0.0	0.0	0.0	0.0	3.7	4.3	3.9	0.2	0.1	0.0	0.0	12.1
Greene	Cotton	0.0	0.0	0.0	0.0	2.6	3.7	6.3	5.3	0.0	0.0	0.0	0.0	18.0
Independence	Cotton	0.0	0.0	0.0	0.0	2.3	4.3	5.8	4.3	0.0	0.0	0.0	0.0	16.6

Table 5: Average Application Rate from 2000-2010 by County and Crop Type in the Delta Planning Region (inches/acre)

County	Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Jackson	Cotton	0.0	0.0	0.0	0.2	1.8	3.7	5.5	2.7	0.6	0.2	0.0	0.0	14.8
Jefferson	Cotton	0.0	0.0	0.0	0.1	1.2	5.1	7.4	6.4	0.8	0.0	0.0	0.0	21.1
Lafayette	Cotton	0.0	0.0	0.0	0.3	0.7	3.0	6.1	4.2	0.4	0.0	0.1	0.0	14.9
Lawrence	Cotton	0.0	0.0	0.0	0.0	0.0	0.0	3.0	3.0	0.0	0.0	0.0	0.0	6.0
Lee	Cotton	0.0	0.0	0.0	0.0	0.2	4.8	7.0	4.9	0.0	0.0	0.0	0.0	17.0
Lincoln	Cotton	0.0	0.0	0.0	0.0	0.9	4.6	5.3	6.6	3.2	0.0	0.0	0.0	20.5
Lonoke	Cotton	0.0	0.0	0.0	0.0	0.0	1.2	6.7	6.5	0.0	0.0	0.0	0.0	14.5
Miller	Cotton	0.0	0.0	0.0	0.0	0.1	2.3	3.5	1.9	0.0	0.0	0.0	0.0	7.8
Mississippi	Cotton	0.0	0.0	0.0	0.0	0.0	3.5	3.6	3.5	0.0	0.0	0.0	0.0	10.6
Monroe	Cotton	0.0	0.0	0.0	0.0	0.4	2.6	6.1	6.6	2.4	0.0	0.0	0.0	18.2
Phillips	Cotton	0.0	0.0	0.0	0.0	0.4	2.8	6.8	3.5	0.0	0.0	0.0	0.0	13.5
Poinsett	Cotton	0.0	0.0	0.0	0.0	0.2	7.3	6.7	3.6	0.0	0.0	0.0	0.0	17.8
Prairie	Cotton	0.0	0.0	0.0	0.0	0.9	2.1	5.0	3.2	0.0	0.0	0.0	0.0	11.1
Pulaski	Cotton	0.0	0.0	0.0	0.0	0.0	1.6	6.0	5.7	0.0	0.0	0.0	0.0	13.3
St Francis	Cotton	0.0	0.0	0.0	0.0	0.2	2.4	6.4	5.5	0.5	0.0	0.0	0.0	14.9
Woodruff	Cotton	0.0	0.0	0.0	0.0	0.2	2.0	4.4	2.7	0.2	0.3	0.1	0.0	9.9
Arkansas	Crop Maintenance	0.8	0.8	0.4	0.6	3.1	4.0	4.2	3.4	1.4	0.7	0.6	0.8	20.9
Chicot	Crop Maintenance	0.0	0.0	0.0	0.7	5.5	7.3	7.0	5.3	0.0	0.0	0.0	0.0	25.8
Clay	Crop Maintenance	0.0	0.0	0.0	1.2	2.4	2.4	2.4	2.4	1.2	0.0	0.0	0.0	12.0
Conway	Crop Maintenance	0.0	0.0	0.0	0.0	2.0	2.0	0.0	0.0	3.0	3.0	3.0	3.0	16.0
Crittenden	Crop Maintenance	0.0	0.0	0.0	0.0	0.0	4.0	4.1	4.0	0.0	0.0	0.0	0.0	12.0
Desha	Crop Maintenance	0.0	0.0	9.1	9.1	9.1	11.8	26.8	19.0	0.0	0.0	0.0	0.0	84.9
Franklin	Crop Maintenance	0.0	0.0	0.0	0.0	0.0	2.3	4.6	4.6	3.5	0.0	0.0	0.0	15.0
Independence	Crop Maintenance	0.0	0.0	0.0	0.0	6.8	13.5	13.5	13.5	6.8	0.0	0.0	0.0	54.0
Lee	Crop Maintenance	0.0	0.0	0.0	0.0	0.0	3.4	11.7	3.2	0.0	0.0	0.0	0.0	18.3
Lonoke	Crop Maintenance	1.7	1.7	1.7	1.6	1.2	1.8	4.4	3.0	1.0	2.2	2.3	1.7	24.6
Miller	Crop Maintenance	0.0	0.0	0.0	0.0	9.0	9.0	9.0	9.0	0.0	0.0	0.0	0.0	36.0
Mississippi	Crop Maintenance	0.0	0.0	0.0	0.0	0.0	3.0	3.1	3.0	0.0	0.0	0.0	0.0	9.1
Phillips	Crop Maintenance	0.0	0.0	0.0	0.0	3.1	3.9	5.5	0.8	0.0	0.0	0.0	0.0	13.2
Poinsett	Crop Maintenance	0.0	0.0	0.0	0.0	0.0	10.5	1.5	0.0	38.3	0.0	38.3	0.0	88.6
Polk	Crop Maintenance	0.0	1.8	3.2	3.2	3.2	3.2	1.4	1.4	0.9	0.0	0.0	0.0	18.0
Pope	Crop Maintenance	0.0	0.0	0.0	0.0	0.0	0.0	12.0	12.0	0.0	0.0	0.0	0.0	24.0
Prairie	Crop Maintenance	0.0	1.4	7.3	1.7	1.7	0.8	0.8	0.8	0.8	15.1	7.3	7.2	44.9
Pulaski	Crop Maintenance	0.0	0.0	0.2	2.0	10.7	9.2	0.2	0.3	0.3	0.3	0.1	0.0	23.5

Table 5: Average Application Rate from 2000-2010 by County and Crop Type in the Delta Planning Region (inches/acre)

County	Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Sevier	Crop Maintenance	1.6	0.5	0.6	0.8	0.8	1.2	1.4	1.2	1.3	0.9	0.9	0.9	12.0
Woodruff	Crop Maintenance	0.0	0.0	0.0	0.0	0.8	0.8	3.8	0.8	0.0	0.0	0.0	0.0	6.0
Clay	Fruit & Nut Trees	0.0	0.0	0.0	0.0	0.0	5.9	11.2	11.4	5.3	5.3	0.0	0.0	39.0
Conway	Fruit & Nut Trees	0.0	0.0	0.0	0.8	3.2	6.7	8.7	9.1	6.7	5.8	0.0	0.0	40.9
Craighead	Fruit & Nut Trees	0.0	0.0	0.0	0.0	0.0	4.0	4.0	4.1	0.0	0.0	0.0	0.0	12.0
Greene	Fruit & Nut Trees	0.0	0.0	0.0	0.0	3.0	3.0	4.8	4.8	0.0	0.0	0.0	0.0	15.6
Jackson	Fruit & Nut Trees	0.0	0.0	0.0	0.0	1.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	2.4
Johnson	Fruit & Nut Trees	0.0	0.0	0.0	0.0	0.0	0.0	3.3	3.4	0.1	0.0	0.0	0.0	6.7
Phillips	Fruit & Nut Trees	0.0	0.0	0.3	1.2	3.7	4.6	3.3	0.4	0.0	0.0	0.0	0.0	13.5
Polk	Fruit & Nut Trees	0.0	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.3	0.0	0.0	0.0	9.5
Pulaski	Fruit & Nut Trees	0.0	0.0	0.0	0.0	2.1	4.1	2.4	3.3	1.0	0.3	0.0	0.0	13.2
Washington	Fruit & Nut Trees	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.2
White	Fruit & Nut Trees	0.0	0.0	0.0	0.0	1.2	2.4	3.5	3.5	1.8	1.2	0.0	0.0	13.6
Arkansas	Hay - All Feed Grass	0.0	0.0	0.0	0.0	2.7	4.1	4.5	3.7	0.7	0.0	0.0	0.0	15.7
Benton	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.1	0.1	0.2	0.0	0.0	1.0
Bradley	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.4	0.4	0.4	0.4	0.0	0.0	0.0	0.0	1.6
Carroll	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.7	0.0	0.0	0.0	2.2
Chicot	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.6	3.9	5.7	2.4	0.0	0.0	0.0	0.0	12.6
Clark	Hay - All Feed Grass	0.0	0.0	0.0	0.0	1.1	1.1	2.9	3.9	1.6	0.0	0.0	0.0	10.5
Clay	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.0	10.1	11.5	11.7	1.6	0.0	0.0	0.0	34.9
Cleburne	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.0	3.0	3.0	0.0	0.0	0.0	0.0	0.0	6.0
Columbia	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.0	6.0	12.0	6.0	0.0	0.0	0.0	0.0	24.0
Conway	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.0	0.0	9.0	9.0	0.0	0.0	0.0	0.0	18.0
Craighead	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.0	3.4	3.4	3.5	0.0	0.0	0.0	0.0	10.3
Crawford	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.7	5.3	7.1	6.1	2.3	0.0	0.0	0.0	21.5
Crittenden	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.6	13.4	13.8	13.1	0.0	0.0	0.0	0.0	40.8
Cross	Hay - All Feed Grass	0.0	0.0	0.0	0.0	3.0	11.7	13.0	5.3	0.3	0.0	0.0	0.0	33.3
Desha	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.0	3.4	8.7	8.6	0.9	0.0	0.0	0.0	21.7
Drew	Hay - All Feed Grass	0.0	0.0	0.0	0.0	1.1	3.7	2.8	2.9	0.2	0.0	0.0	0.0	10.5
Faulkner	Hay - All Feed Grass	0.0	0.0	0.0	0.0	3.6	4.6	5.1	5.1	4.9	0.9	0.0	0.0	24.2
Fulton	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.0	0.0	2.4	3.6	0.0	0.0	0.0	0.0	6.0
Greene	Hay - All Feed Grass	0.0	0.0	0.0	0.0	4.4	7.5	6.4	3.3	0.0	0.0	0.0	0.0	21.6
Hot Spring	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.0	0.0	4.9	10.5	3.2	0.0	0.0	0.0	18.6
Independence	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.6	2.2	5.6	3.4	0.8	0.0	0.0	0.0	12.6

Table 5: Average Application Rate from 2000-2010 by County and Crop Type in the Delta Planning Region (inches/acre)

County	Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Jackson	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.3	9.6	4.9	2.4	0.2	0.2	0.0	0.0	17.5
Jefferson	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.9	2.5	7.5	7.2	0.0	0.0	0.0	0.0	18.1
Lafayette	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.0	1.7	7.1	6.7	2.9	0.0	0.0	0.0	18.4
Lawrence	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.8	5.9	4.1	2.7	0.2	0.2	0.0	0.0	13.9
Lee	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.9	3.2	2.6	2.9	0.2	0.1	0.0	0.0	9.8
Lincoln	Hay - All Feed Grass	0.0	0.0	0.0	0.0	2.4	5.8	9.5	7.1	2.0	0.0	0.0	0.0	26.8
Lonoke	Hay - All Feed Grass	0.0	0.0	0.0	0.2	0.5	3.0	3.8	3.9	0.9	0.1	0.0	0.0	12.4
Madison	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.0	0.0	1.9	1.9	0.4	0.0	0.0	0.0	4.3
Miller	Hay - All Feed Grass	0.0	0.0	0.0	0.0	4.3	4.7	4.7	4.6	0.0	0.0	0.0	0.0	18.3
Mississippi	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.0	4.7	4.8	4.8	0.0	0.0	0.0	0.0	14.4
Monroe	Hay - All Feed Grass	0.0	0.0	0.0	0.3	0.7	1.7	3.7	4.0	1.3	0.1	0.1	0.0	12.0
Montgomery	Hay - All Feed Grass	0.0	0.0	0.0	0.1	0.3	0.7	1.0	1.0	0.9	0.2	0.0	0.0	4.1
Newton	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.0	1.2	2.1	2.4	1.2	0.0	0.0	0.0	6.9
Perry	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.0	2.7	4.7	4.9	2.1	0.0	0.0	0.0	14.4
Phillips	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.0	3.2	4.4	4.4	0.0	0.0	0.0	0.0	12.0
Pike	Hay - All Feed Grass	0.0	0.0	0.0	0.3	0.3	0.3	1.1	0.8	1.2	0.3	0.0	0.0	4.3
Poinsett	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.8	6.4	4.7	1.7	0.0	0.0	0.0	0.0	13.5
Polk	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.3	0.7	2.6	3.0	1.5	0.3	0.0	0.0	8.4
Pope	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.9	1.0	1.5	1.5	0.9	0.0	0.0	0.0	5.8
Prairie	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.0	0.0	0.9	3.8	1.9	0.0	0.0	0.0	6.6
Pulaski	Hay - All Feed Grass	0.0	0.0	0.0	0.0	1.0	3.4	2.9	3.3	0.7	0.3	0.0	0.0	11.6
Randolph	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.0	3.0	4.6	1.6	0.0	0.0	0.0	0.0	9.2
Saline	Hay - All Feed Grass	0.3	0.2	7.2	14.2	15.0	16.0	18.5	19.5	17.3	0.3	0.3	0.3	109.2
Sevier	Hay - All Feed Grass	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.1
Sharp	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.0	1.2	4.5	1.9	1.0	0.0	0.0	0.0	8.6
St Francis	Hay - All Feed Grass	0.0	0.0	0.0	0.9	5.4	11.6	15.4	16.0	1.4	0.8	1.5	1.1	54.0
Washington	Hay - All Feed Grass	0.2	0.0	0.0	0.0	0.0	1.5	3.4	3.4	2.2	0.4	0.2	0.2	11.7
White	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.3	2.6	4.4	4.0	1.3	0.4	0.0	0.0	13.4
Woodruff	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.5	1.7	1.5	1.9	0.6	0.5	1.1	0.6	8.5
Yell	Hay - All Feed Grass	0.0	0.0	0.0	0.0	0.6	2.3	4.2	5.4	4.9	0.5	0.0	0.0	18.0
Arkansas	Milo	0.0	0.0	0.0	0.0	0.4	4.8	5.2	3.6	0.8	0.8	0.0	0.0	15.6
Ashley	Milo	0.0	0.0	0.0	0.0	0.6	3.7	4.4	2.6	0.0	0.0	0.0	0.0	11.3
Chicot	Milo	0.0	0.0	0.0	0.1	1.3	3.1	4.2	2.1	0.0	0.0	0.0	0.0	10.8
Clay	Milo	0.0	0.0	0.0	0.0	1.4	9.0	8.6	6.8	0.0	0.0	0.0	0.0	25.8

Table 5: Average Application Rate from 2000-2010 by County and Crop Type in the Delta Planning Region (inches/acre)

County	Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Conway	Milo	0.0	0.0	0.0	0.0	0.0	1.2	2.6	1.6	0.5	0.0	0.0	0.0	5.9
Craighead	Milo	0.0	0.0	0.0	0.0	0.0	4.0	4.0	4.1	0.0	0.0	0.0	0.0	12.0
Crittenden	Milo	0.0	0.0	0.0	0.0	0.7	5.7	5.9	2.8	0.2	0.0	0.0	0.0	15.3
Cross	Milo	0.0	0.0	0.0	0.1	2.6	10.2	7.6	3.2	0.1	0.0	0.0	0.0	23.8
Desha	Milo	0.0	0.0	0.0	0.6	2.0	4.5	8.5	6.4	0.9	0.9	0.0	0.0	23.8
Drew	Milo	0.0	0.0	0.0	0.0	0.2	3.7	3.7	3.0	0.0	0.0	0.0	0.0	10.7
Greene	Milo	0.0	0.0	0.0	0.0	2.2	4.5	6.1	5.5	0.0	0.0	0.0	0.0	18.4
Independence	Milo	0.0	0.0	0.0	0.0	0.0	0.0	6.0	2.0	2.0	0.0	0.0	0.0	10.0
Jackson	Milo	0.0	0.0	0.0	0.0	0.7	3.6	5.0	2.6	0.0	0.0	0.0	0.0	12.0
Jefferson	Milo	0.0	0.0	0.0	0.0	0.7	2.4	5.9	3.5	0.3	0.0	0.0	0.0	12.6
Lafayette	Milo	0.0	0.0	0.0	0.0	0.0	0.0	1.5	1.5	0.0	0.0	0.0	0.0	3.0
Lawrence	Milo	0.0	0.0	0.0	0.1	0.6	3.2	5.0	3.2	0.0	0.0	0.0	0.0	12.2
Lee	Milo	0.0	0.0	0.0	0.0	0.5	4.4	5.5	3.3	0.0	0.0	0.0	0.0	13.7
Lincoln	Milo	0.0	0.0	0.0	0.0	1.3	3.5	3.6	6.4	0.8	0.0	0.0	0.0	15.7
Lonoke	Milo	0.0	0.0	0.0	0.0	0.1	2.8	4.1	1.3	0.0	0.0	0.0	0.0	8.3
Miller	Milo	0.0	0.0	0.0	0.0	0.0	2.0	2.0	2.0	0.0	0.0	0.0	0.0	6.0
Mississippi	Milo	0.0	0.0	0.0	0.0	0.0	1.8	1.9	1.8	0.0	0.0	0.0	0.0	5.5
Monroe	Milo	0.0	0.0	0.0	0.0	0.7	3.7	5.1	3.1	0.3	0.1	0.0	0.0	12.9
Phillips	Milo	0.0	0.0	0.0	0.0	0.8	4.2	5.7	1.9	0.0	0.0	0.0	0.0	12.6
Poinsett	Milo	0.0	0.0	0.0	0.0	0.0	8.1	7.0	0.5	0.0	0.0	0.0	0.0	15.6
Pope	Milo	0.0	0.0	0.0	0.0	0.0	2.2	2.2	2.2	0.0	0.0	0.0	0.0	6.5
Prairie	Milo	0.0	0.0	0.0	0.1	0.6	2.3	3.4	0.8	0.0	0.0	0.0	0.0	7.2
Pulaski	Milo	0.0	0.0	0.0	0.0	0.1	0.6	6.0	3.2	0.5	0.2	0.0	0.0	10.7
Randolph	Milo	0.0	0.0	0.0	0.0	0.1	4.7	4.7	0.1	0.0	0.0	0.0	0.0	9.6
St Francis	Milo	0.0	0.0	0.0	0.0	0.5	6.1	7.4	2.9	0.1	0.0	0.0	0.0	16.9
White	Milo	0.0	0.0	0.0	0.0	2.4	3.0	4.2	1.2	0.0	0.0	0.0	0.0	10.8
Woodruff	Milo	0.0	0.0	0.0	0.0	0.1	0.9	3.1	1.6	0.0	0.0	0.0	0.0	5.7
Lee	Oats	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	0.0	0.0	0.0	0.0	6.0
Woodruff	Oats	0.0	0.0	0.0	0.0	0.0	3.0	3.0	0.0	0.0	0.0	0.0	0.0	6.0
Arkansas	Pastures & Lawns	0.0	0.0	0.0	0.0	2.7	4.2	5.3	4.9	0.9	0.0	0.0	0.0	17.9
Benton	Pastures & Lawns	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.4	0.5	0.7	0.5	0.0	4.1
Boone	Pastures & Lawns	0.0	0.0	0.0	0.0	28.8	32.0	0.0	0.0	0.0	0.0	0.0	0.0	60.8
Chicot	Pastures & Lawns	0.0	0.0	0.0	0.0	0.6	2.1	5.4	3.9	0.0	0.0	0.0	0.0	12.0
Clay	Pastures & Lawns	0.0	0.0	0.0	0.0	0.0	11.9	11.9	12.2	0.0	0.0	0.0	0.0	36.0

Table 5: Average Application Rate from 2000-2010 by County and Crop Type in the Delta Planning Region (inches/acre)

County	Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Craighead	Pastures & Lawns	0.0	0.0	0.0	0.0	0.0	4.0	4.0	4.1	0.0	0.0	0.0	0.0	12.0
Drew	Pastures & Lawns	0.0	0.0	0.0	0.0	0.0	0.6	4.2	0.0	1.2	0.0	0.0	0.0	6.0
Franklin	Pastures & Lawns	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.6	0.0	0.0	0.0	0.0	2.6
Hot Spring	Pastures & Lawns	0.0	0.0	0.0	0.0	0.0	0.0	12.0	6.0	0.0	0.0	0.0	0.0	18.0
Independence	Pastures & Lawns	0.0	0.0	0.0	0.0	0.0	6.0	12.0	6.0	0.0	0.0	0.0	0.0	24.0
Jackson	Pastures & Lawns	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	2.4
Lafayette	Pastures & Lawns	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2.3
Lawrence	Pastures & Lawns	0.0	0.0	0.0	0.0	3.0	3.0	5.2	5.2	0.0	0.0	0.0	0.0	16.4
Lee	Pastures & Lawns	0.0	0.0	0.0	0.0	0.0	0.7	3.6	0.8	0.0	0.0	3.6	0.0	8.7
Lonoke	Pastures & Lawns	0.0	0.0	0.0	0.0	0.0	1.6	7.2	7.2	0.0	0.0	0.0	0.0	16.0
Madison	Pastures & Lawns	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.6	0.0	0.0	0.0	3.2
Mississippi	Pastures & Lawns	0.0	0.0	0.0	0.0	0.0	9.9	10.2	9.9	0.0	0.0	0.0	0.0	30.0
Montgomery	Pastures & Lawns	0.0	0.0	0.0	0.0	0.0	0.8	0.7	1.5	1.1	0.8	0.0	0.0	4.8
Phillips	Pastures & Lawns	0.0	0.0	0.0	0.0	0.0	5.0	6.3	2.2	0.0	0.0	0.0	0.0	13.5
Poinsett	Pastures & Lawns	0.0	0.0	0.0	0.0	0.0	2.5	2.5	2.2	0.0	0.0	0.0	0.0	7.2
Prairie	Pastures & Lawns	0.0	0.0	0.0	1.2	1.8	3.8	3.7	4.1	1.2	0.2	0.0	0.0	16.0
Sharp	Pastures & Lawns	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
Washington	Pastures & Lawns	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.0	0.0	0.0	0.0	0.0	12.0
Woodruff	Pastures & Lawns	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	3.0
Ashley	Peanuts	0.0	0.0	0.0	0.0	1.9	4.4	3.9	2.0	0.0	0.0	0.0	0.0	12.1
Clay	Peanuts	0.0	0.0	0.0	5.9	12.4	13.5	12.8	11.0	11.7	5.7	0.0	0.0	73.0
Conway	Peanuts	0.0	0.0	3.2	3.2	3.2	3.2	3.2	3.2	3.2	1.2	0.0	0.0	23.6
Craighead	Peanuts	0.0	0.0	0.0	0.0	0.0	4.0	4.0	4.1	0.0	0.0	0.0	0.0	12.0
Crittenden	Peanuts	0.0	0.0	0.0	0.0	0.0	5.9	6.1	5.9	0.0	0.0	0.0	0.0	18.0
Desha	Peanuts	0.0	0.0	0.0	0.0	9.0	9.0	9.0	9.0	0.0	0.0	0.0	0.0	36.0
Greene	Peanuts	0.0	0.0	0.0	0.0	6.0	6.0	6.0	6.0	0.0	0.0	0.0	0.0	24.0
Jackson	Peanuts	0.0	0.0	2.0	2.0	2.0	4.4	6.4	2.0	2.0	2.0	0.0	0.0	22.8
Lawrence	Peanuts	0.0	0.0	0.0	0.0	0.0	0.0	7.5	7.5	0.0	0.0	0.0	0.0	15.0
Phillips	Peanuts	0.0	0.0	0.0	2.8	2.8	2.8	2.8	0.8	0.0	0.0	0.0	0.0	12.0
Arkansas	Reservoirs for Crops	0.0	0.0	0.0	0.0	1.8	2.1	2.1	2.1	1.5	0.0	0.0	0.0	9.5
Chicot	Reservoirs for Crops	0.0	0.0	0.0	0.5	27.1	27.5	13.1	11.7	0.0	0.0	0.0	0.0	79.8
Clay	Reservoirs for Crops	0.0	0.0	0.0	0.0	0.0	16.3	15.8	15.8	0.0	0.0	0.0	0.0	48.0
Cross	Reservoirs for Crops	0.0	0.0	0.0	0.0	0.0	4.7	4.7	0.0	0.0	0.0	0.0	0.0	9.5
Drew	Reservoirs for Crops	0.0	0.0	0.0	0.0	9.0	9.0	9.0	9.0	0.0	0.0	0.0	0.0	36.0

Table 5: Average Application Rate from 2000-2010 by County and Crop Type in the Delta Planning Region (inches/acre)

County	Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Greene	Reservoirs for Crops	0.0	0.0	0.0	0.0	0.0	0.0	12.0	12.0	0.0	0.0	0.0	0.0	24.0
Jefferson	Reservoirs for Crops	0.2	0.2	3.4	3.7	4.8	5.1	4.8	5.0	3.6	3.5	5.8	0.2	40.1
Lafayette	Reservoirs for Crops	0.0	0.0	0.0	1.8	1.8	9.9	9.9	0.6	0.0	0.0	0.0	0.0	24.0
Lawrence	Reservoirs for Crops	0.0	0.0	0.0	5.6	7.4	7.4	7.4	1.8	0.0	0.0	0.0	0.0	29.6
Lee	Reservoirs for Crops	0.0	0.0	0.0	0.0	11.8	13.7	11.8	0.0	0.0	0.0	0.0	0.0	37.2
Lincoln	Reservoirs for Crops	0.0	0.0	0.0	0.0	0.0	4.0	4.0	4.1	0.0	0.0	0.0	0.0	12.0
Lonoke	Reservoirs for Crops	4.9	7.6	7.3	4.4	2.6	3.6	0.6	1.6	0.9	4.1	4.5	3.3	45.4
Mississippi	Reservoirs for Crops	0.0	0.0	0.0	0.0	0.0	13.9	14.3	13.9	0.0	0.0	0.0	0.0	42.0
Poinsett	Reservoirs for Crops	0.0	0.0	6.3	11.5	5.3	9.2	4.3	3.1	0.0	0.0	6.2	0.0	45.9
Prairie	Reservoirs for Crops	0.0	6.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.0
Pulaski	Reservoirs for Crops	0.0	0.0	0.0	0.0	11.5	18.0	2.2	4.3	0.0	0.0	0.0	0.0	36.0
White	Reservoirs for Crops	0.0	0.0	0.0	0.0	0.0	11.9	11.9	12.2	0.0	0.0	0.0	0.0	36.0
Woodruff	Reservoirs for Crops	0.0	0.0	0.0	0.0	10.0	10.0	10.0	10.0	0.0	0.0	0.0	0.0	40.0
Arkansas	Rice	0.0	0.0	0.0	0.1	14.2	15.0	14.6	2.7	0.4	0.4	0.0	0.0	47.6
Ashley	Rice	0.0	0.0	0.0	0.1	7.0	8.8	9.5	8.3	0.1	0.0	0.0	0.0	33.7
Chicot	Rice	0.0	0.0	0.0	7.3	7.3	7.3	7.3	7.3	0.0	0.0	0.0	0.0	36.4
Clark	Rice	0.0	0.0	0.0	0.0	0.2	2.7	4.6	4.3	1.7	0.0	0.0	0.0	13.5
Clay	Rice	0.0	0.0	0.0	0.0	1.6	12.3	12.3	12.4	0.2	0.0	0.0	0.0	38.9
Cleburne	Rice	0.0	0.0	0.0	0.0	6.8	10.4	10.4	9.6	0.0	0.0	0.0	0.0	37.2
Cleveland	Rice	0.0	0.0	0.0	6.0	7.8	7.2	4.5	4.5	0.0	0.0	0.0	0.0	30.0
Conway	Rice	0.0	0.0	0.0	0.0	2.3	5.7	17.0	2.1	0.0	0.0	0.0	0.0	27.2
Craighead	Rice	0.0	0.0	0.0	0.0	8.9	9.0	9.0	9.0	0.0	0.0	0.0	0.0	35.9
Crittenden	Rice	0.0	0.0	0.0	0.0	8.5	10.5	10.6	9.3	0.0	0.0	0.0	0.0	38.9
Cross	Rice	0.0	0.0	0.0	0.0	5.4	13.2	11.4	6.5	0.1	0.0	0.0	0.0	36.5
Desha	Rice	0.0	0.0	0.0	0.2	9.1	9.4	9.4	9.1	0.1	0.0	0.0	0.0	37.2
Drew	Rice	0.0	0.0	0.0	0.2	5.7	8.8	9.2	6.9	0.4	0.0	0.0	0.0	31.3
Faulkner	Rice	0.0	0.2	0.2	0.0	2.2	9.0	5.0	6.4	6.3	0.0	0.0	0.0	29.3
Fulton	Rice	0.0	0.0	0.0	0.0	0.7	12.6	12.5	12.6	0.0	0.0	0.0	0.0	38.4
Greene	Rice	0.0	0.0	0.0	0.5	7.2	7.2	7.2	6.7	0.0	0.0	0.0	0.0	28.8
Independence	Rice	0.0	0.0	0.0	0.1	2.9	8.1	12.7	11.2	0.9	0.0	0.0	0.0	35.9
Jackson	Rice	0.0	0.0	0.0	0.0	0.1	11.8	11.9	11.8	0.0	0.0	0.0	0.0	35.7
Jefferson	Rice	0.0	0.0	0.0	2.9	6.4	8.2	6.7	5.6	1.2	0.1	0.0	0.0	31.2
Lafayette	Rice	0.0	0.0	0.2	2.8	5.4	6.5	7.2	3.5	0.2	0.0	0.0	0.0	25.8
Lawrence	Rice	0.0	0.0	0.0	2.4	9.1	9.1	9.1	6.7	0.0	0.0	0.0	0.0	36.5

Table 5: Average Application Rate from 2000-2010 by County and Crop Type in the Delta Planning Region (inches/acre)

County	Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Lee	Rice	0.0	0.0	0.0	0.0	5.7	10.4	11.4	8.4	0.1	0.0	0.0	0.0	36.0
Lincoln	Rice	0.0	0.0	0.0	1.0	9.3	9.4	8.4	7.9	1.3	0.0	0.0	0.0	37.4
Little River	Rice	0.0	0.0	0.0	0.0	0.0	10.0	14.0	12.0	0.0	0.0	0.0	0.0	36.0
Lonoke	Rice	0.0	0.0	0.0	0.1	4.0	8.2	13.4	10.7	0.1	0.4	0.0	0.0	36.8
Miller	Rice	0.0	0.0	0.0	0.4	0.6	14.8	14.4	14.1	0.0	0.0	0.0	0.0	44.3
Mississippi	Rice	0.0	0.0	0.0	0.0	0.0	11.6	11.9	11.6	0.0	0.0	0.0	0.0	35.1
Monroe	Rice	0.0	0.0	0.0	0.0	3.9	8.0	12.1	10.5	1.8	0.0	0.0	0.0	36.3
Perry	Rice	0.0	0.0	0.0	0.5	6.4	8.4	8.7	8.4	4.2	0.0	0.0	0.0	36.5
Phillips	Rice	0.0	0.0	0.0	0.0	13.9	10.9	9.6	1.3	0.0	0.0	0.0	0.0	35.7
Poinsett	Rice	0.0	0.0	0.0	0.0	8.6	13.2	11.8	5.5	0.0	0.0	0.0	0.0	39.1
Pope	Rice	0.0	0.0	0.0	0.0	4.8	7.4	7.4	5.6	0.0	0.0	0.0	0.0	25.3
Prairie	Rice	0.0	0.0	0.0	0.0	4.2	6.4	10.2	8.8	0.0	0.0	0.0	0.0	29.7
Pulaski	Rice	0.0	0.0	0.0	0.5	5.0	10.4	8.7	9.3	1.6	0.1	0.0	0.0	35.7
Randolph	Rice	0.0	0.0	0.0	0.0	8.9	8.9	8.9	8.9	0.0	0.0	0.0	0.0	35.6
Sharp	Rice	0.0	0.0	1.5	1.9	3.3	12.1	9.9	10.0	0.0	0.0	0.0	0.0	38.6
St Francis	Rice	0.0	0.0	0.0	0.0	5.3	13.0	17.1	10.7	0.5	0.0	0.0	0.0	46.6
Stone	Rice	0.0	0.0	0.0	1.1	10.3	10.3	10.3	9.1	0.0	0.0	0.0	0.0	41.0
White	Rice	0.0	0.0	0.0	0.0	0.1	11.7	11.9	12.1	0.2	0.1	0.0	0.0	36.1
Woodruff	Rice	0.0	0.0	0.0	0.0	2.7	11.8	12.1	12.4	0.4	0.4	0.0	0.0	39.8
Yell	Rice	0.0	0.0	0.0	0.9	2.0	7.5	9.4	11.1	1.3	0.0	0.0	0.0	32.2
Arkansas	Sorghum	0.0	0.0	0.0	0.0	0.0	6.7	7.7	7.6	0.6	0.1	0.0	0.0	22.7
Ashley	Sorghum	0.0	0.0	0.0	0.0	0.0	4.4	4.1	3.6	0.0	0.0	0.0	0.0	12.2
Chicot	Sorghum	0.0	0.0	0.0	0.0	0.0	2.8	6.0	3.2	0.0	0.0	0.0	0.0	12.0
Clay	Sorghum	0.0	0.0	0.0	0.0	0.0	4.5	10.5	9.8	0.8	0.0	0.0	0.0	25.5
Craighead	Sorghum	0.0	0.0	0.0	0.0	0.0	4.0	4.0	4.0	0.0	0.0	0.0	0.0	12.0
Crittenden	Sorghum	0.0	0.0	0.0	0.0	2.4	2.4	2.4	0.0	0.0	0.0	0.0	0.0	7.2
Cross	Sorghum	0.0	0.0	0.0	0.1	2.9	9.3	7.9	5.2	0.1	0.0	0.0	0.0	25.6
Desha	Sorghum	0.0	0.0	0.0	0.0	12.8	27.6	29.0	16.2	0.0	0.0	0.0	0.0	85.7
Drew	Sorghum	0.0	0.0	0.0	0.0	0.0	4.0	4.0	4.1	0.0	0.0	0.0	0.0	12.0
Greene	Sorghum	0.0	0.0	0.0	0.0	0.0	0.0	4.2	4.2	0.0	0.0	0.0	0.0	8.4
Jackson	Sorghum	0.0	0.0	0.0	0.0	0.1	2.1	5.9	3.2	0.2	0.0	0.0	0.0	11.7
Jefferson	Sorghum	0.0	0.0	0.0	0.0	0.1	3.2	4.9	5.6	0.0	0.0	0.0	0.0	13.8
Lafayette	Sorghum	0.0	0.0	0.0	0.0	6.0	6.0	6.0	6.0	0.0	0.0	0.0	0.0	24.0
Lawrence	Sorghum	0.0	0.0	0.0	0.0	0.0	1.0	5.9	5.9	0.0	0.0	0.0	0.0	12.8

Table 5: Average Application Rate from 2000-2010 by County and Crop Type in the Delta Planning Region (inches/acre)

County	Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Lee	Sorghum	0.0	0.0	0.0	0.0	0.7	5.6	6.0	1.4	0.0	0.0	0.0	0.0	13.7
Lonoke	Sorghum	0.0	0.0	0.0	0.0	0.0	0.0	5.8	5.8	0.0	0.0	0.0	0.0	11.6
Mississippi	Sorghum	0.0	0.0	0.0	0.0	0.0	2.3	2.4	2.3	0.0	0.0	0.0	0.0	7.1
Monroe	Sorghum	0.0	0.0	0.0	0.0	0.2	3.1	4.9	3.7	0.2	0.0	0.0	0.0	12.1
Phillips	Sorghum	0.0	0.0	0.0	0.0	1.3	3.7	5.8	1.3	0.0	0.0	0.0	0.0	12.1
Poinsett	Sorghum	0.0	0.0	0.0	0.0	1.1	11.4	11.1	4.4	0.0	0.0	0.0	0.0	28.0
Prairie	Sorghum	0.0	0.0	0.0	0.0	0.0	2.1	1.1	2.5	2.5	0.0	0.0	0.0	8.2
Pulaski	Sorghum	0.0	0.0	0.0	0.0	0.0	3.6	3.6	3.6	1.2	0.0	0.0	0.0	12.0
St Francis	Sorghum	0.0	0.0	0.0	0.0	0.0	0.7	6.7	6.7	0.2	0.0	0.0	0.0	14.4
White	Sorghum	0.0	0.0	0.0	0.0	0.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0
Woodruff	Sorghum	0.0	0.0	0.0	0.0	0.3	1.1	4.0	2.1	0.0	0.0	0.0	0.0	7.5
Arkansas	Soybeans	0.0	0.0	0.0	0.0	0.5	6.3	7.6	7.3	2.1	0.1	0.0	0.0	24.0
Ashley	Soybeans	0.0	0.0	0.0	0.0	0.1	4.5	4.8	3.7	0.1	0.0	0.0	0.0	13.2
Chicot	Soybeans	0.0	0.0	0.0	0.0	0.0	0.8	6.2	5.2	0.0	0.0	0.0	0.0	12.2
Clark	Soybeans	0.0	0.0	0.0	0.0	0.0	1.1	3.3	2.2	1.1	0.0	0.0	0.0	7.6
Clay	Soybeans	0.0	0.0	0.0	0.0	0.0	8.7	11.3	11.2	1.0	0.0	0.0	0.0	32.3
Cleveland	Soybeans	0.0	0.0	0.0	0.0	0.0	4.4	10.1	4.3	0.0	0.0	0.0	0.0	18.8
Conway	Soybeans	0.0	0.0	0.0	0.1	0.3	0.4	3.2	2.6	2.1	0.0	0.0	0.0	8.7
Craighead	Soybeans	0.0	0.0	0.0	0.0	0.0	3.9	4.0	4.1	0.0	0.0	0.0	0.0	12.0
Crawford	Soybeans	0.0	0.0	0.0	0.0	0.0	1.2	3.4	1.2	1.2	0.0	0.0	0.0	7.0
Crittenden	Soybeans	0.0	0.0	0.0	0.0	1.0	4.4	6.0	5.0	1.6	0.0	0.0	0.0	17.9
Cross	Soybeans	0.0	0.0	0.0	0.2	2.3	9.7	9.4	3.3	0.3	0.0	0.0	0.0	25.1
Desha	Soybeans	0.0	0.0	0.0	0.0	0.1	3.8	7.3	6.7	0.5	0.1	0.1	0.0	18.5
Drew	Soybeans	0.0	0.0	0.0	0.0	0.2	3.4	4.0	3.3	0.4	0.0	0.0	0.0	11.3
Faulkner	Soybeans	0.0	0.0	0.0	0.0	0.3	2.1	5.0	2.8	2.3	0.0	0.0	0.0	12.5
Franklin	Soybeans	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.4
Fulton	Soybeans	0.0	0.0	0.0	0.0	0.0	8.8	10.6	9.6	1.0	0.0	0.0	0.0	30.0
Greene	Soybeans	0.0	0.0	0.0	0.0	0.1	0.8	7.3	6.7	0.0	0.0	0.0	0.0	14.8
Independence	Soybeans	0.0	0.0	0.0	0.0	0.2	2.1	5.0	4.8	0.8	0.0	0.0	0.0	12.8
Jackson	Soybeans	0.0	0.0	0.0	0.0	0.0	1.3	6.2	5.9	0.0	0.0	0.1	0.0	13.6
Jefferson	Soybeans	0.0	0.0	0.0	0.1	0.7	5.1	7.5	6.0	0.4	0.0	0.0	0.0	20.0
Johnson	Soybeans	0.0	0.0	0.0	0.0	0.1	0.0	0.9	0.0	0.0	0.0	0.0	0.0	1.0
Lafayette	Soybeans	0.0	0.0	0.0	0.4	1.7	3.3	5.0	4.2	0.4	0.0	0.4	0.0	15.4
Lawrence	Soybeans	0.0	0.0	0.0	0.0	0.3	2.1	6.7	5.0	0.0	0.0	0.0	0.0	14.1

Table 5: Average Application Rate from 2000-2010 by County and Crop Type in the Delta Planning Region (inches/acre)

County	Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Lee	Soybeans	0.0	0.0	0.0	0.0	0.2	4.5	7.3	4.3	0.2	0.0	0.1	0.0	16.5
Lincoln	Soybeans	0.0	0.0	0.0	0.0	0.5	3.4	4.3	4.5	1.1	0.0	0.0	0.0	13.7
Little River	Soybeans	0.0	0.0	0.0	0.0	0.9	2.4	7.9	7.7	0.0	0.0	0.0	0.0	18.9
Logan	Soybeans	0.0	0.0	0.0	0.0	0.0	0.6	3.6	4.9	0.7	0.1	0.0	0.0	9.9
Lonoke	Soybeans	0.0	0.0	0.0	0.0	0.1	0.4	4.5	4.8	0.4	0.0	0.0	0.0	10.3
Miller	Soybeans	0.0	0.0	0.0	0.0	0.7	4.6	5.8	5.7	1.9	0.0	0.0	0.0	18.6
Mississippi	Soybeans	0.0	0.0	0.0	0.0	0.0	3.4	3.5	3.4	0.0	0.0	0.0	0.0	10.2
Monroe	Soybeans	0.0	0.0	0.0	0.0	0.1	3.0	5.2	4.4	0.1	0.1	0.1	0.0	13.0
Perry	Soybeans	0.0	0.0	0.0	0.0	0.0	0.7	11.8	35.9	11.0	0.0	0.0	0.0	59.5
Phillips	Soybeans	0.0	0.0	0.0	0.0	0.3	2.5	5.6	3.0	0.1	0.0	0.0	0.0	11.6
Poinsett	Soybeans	0.0	0.0	0.0	0.0	0.7	9.3	8.5	3.9	0.0	0.0	0.0	0.0	22.3
Pope	Soybeans	0.0	0.0	0.0	0.0	0.0	0.9	3.0	2.5	0.1	0.0	0.0	0.0	6.6
Prairie	Soybeans	0.0	0.0	0.0	0.0	0.2	0.8	3.8	4.1	1.2	0.1	0.1	0.0	10.2
Pulaski	Soybeans	0.0	0.0	0.0	0.0	0.2	2.7	3.9	4.5	0.9	0.0	0.0	0.0	12.2
Randolph	Soybeans	0.0	0.0	0.0	0.0	0.0	0.3	12.4	12.3	0.1	0.0	0.0	0.0	25.2
Sharp	Soybeans	0.0	0.0	0.0	0.0	0.0	7.7	9.9	9.1	0.9	0.0	0.0	0.0	27.6
St Francis	Soybeans	0.0	0.0	0.0	0.0	0.1	1.5	6.0	5.6	1.2	0.0	0.1	0.0	14.5
Stone	Soybeans	0.0	0.0	0.0	0.0	0.0	2.6	7.1	4.6	0.0	0.0	0.0	0.0	14.2
White	Soybeans	0.0	0.0	0.0	0.0	0.0	1.3	7.2	7.4	0.7	0.1	0.0	0.0	16.7
Woodruff	Soybeans	0.0	0.0	0.0	0.0	0.2	0.8	4.2	4.4	0.7	0.7	0.1	0.0	11.0
Yell	Soybeans	0.0	0.0	0.0	0.0	0.0	0.0	2.7	4.9	0.0	0.0	0.0	0.0	7.6
Cross	Tobacco	0.0	0.0	0.0	0.0	0.0	5.9	5.9	6.1	0.0	0.0	0.0	0.0	18.0
Greene	Tobacco	0.0	0.0	0.0	0.0	6.0	6.0	6.0	6.0	0.0	0.0	0.0	0.0	24.0
Jackson	Tobacco	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	0.0	0.0	0.0	0.0	6.0
Mississippi	Tobacco	0.0	0.0	0.0	0.0	0.0	1.6	1.6	1.6	0.0	0.0	0.0	0.0	4.8
Arkansas	Vegetables & Melons	0.0	0.0	0.0	0.0	34.1	59.6	59.6	59.4	24.5	0.0	0.0	0.0	237.0
Ashley	Vegetables & Melons	0.0	0.0	0.0	0.0	1.2	5.4	6.7	2.8	0.1	0.0	0.0	0.0	16.2
Chicot	Vegetables & Melons	0.0	0.0	0.0	0.2	0.6	4.3	5.7	0.9	0.0	0.0	0.0	0.0	11.7
Clay	Vegetables & Melons	0.0	0.0	0.0	0.0	3.1	9.5	10.7	6.8	0.2	0.0	0.0	0.0	30.2
Cleburne	Vegetables & Melons	0.0	0.0	0.0	0.0	2.6	3.1	3.5	3.6	1.8	0.2	0.0	0.0	14.8
Craighead	Vegetables & Melons	0.0	0.0	0.0	0.0	0.0	4.0	4.0	4.1	0.0	0.0	0.0	0.0	12.0
Crittenden	Vegetables & Melons	0.0	0.0	0.0	0.0	0.0	1.6	1.6	1.6	0.0	0.0	0.0	0.0	4.8
Cross	Vegetables & Melons	0.0	0.0	0.0	0.0	1.2	5.4	6.8	1.9	0.0	0.0	0.0	0.0	15.3
Desha	Vegetables & Melons	0.0	0.0	0.0	0.0	0.0	7.2	7.2	7.2	7.2	7.2	0.0	0.0	36.0

Table 5: Average Application Rate from 2000-2010 by County and Crop Type in the Delta Planning Region (inches/acre)

County	Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Drew	Vegetables & Melons	0.0	0.0	0.0	0.0	0.0	4.0	4.0	4.1	0.0	0.0	0.0	0.0	12.0
Jackson	Vegetables & Melons	0.0	0.0	0.0	0.7	2.1	2.8	3.8	2.5	0.0	0.0	0.0	0.0	11.9
Jefferson	Vegetables & Melons	0.0	0.0	0.2	1.4	2.8	6.1	7.2	5.8	1.0	0.0	0.0	0.0	24.4
Lee	Vegetables & Melons	0.0	0.0	0.0	0.0	1.5	3.4	4.9	3.5	1.2	0.4	0.0	0.0	14.9
Lincoln	Vegetables & Melons	0.0	0.0	0.0	0.0	3.6	5.9	7.4	7.8	4.8	0.0	0.0	0.0	29.6
Lonoke	Vegetables & Melons	0.0	0.0	0.0	0.0	0.5	0.7	0.8	0.0	0.0	0.0	0.0	0.0	2.0
Mississippi	Vegetables & Melons	0.0	0.0	0.0	0.0	0.0	4.4	4.5	4.4	0.0	0.0	0.0	0.0	13.3
Monroe	Vegetables & Melons	0.0	0.0	0.1	0.1	0.5	2.7	3.6	3.3	0.4	0.0	0.0	0.0	10.7
Newton	Vegetables & Melons	0.0	0.0	0.0	0.0	0.0	3.8	3.8	4.3	0.0	0.0	0.0	0.0	12.0
Phillips	Vegetables & Melons	0.0	0.0	0.0	0.0	1.6	3.0	5.9	3.4	1.1	0.0	0.0	0.0	15.0
Pike	Vegetables & Melons	0.0	0.0	0.0	0.0	1.5	1.5	1.5	1.5	0.0	0.0	0.0	0.0	6.0
Pope	Vegetables & Melons	0.0	0.0	4.8	4.8	4.8	4.8	2.3	2.3	0.0	0.0	0.0	0.0	24.0
Pulaski	Vegetables & Melons	0.0	0.0	0.0	0.0	0.0	3.0	2.8	3.5	1.9	0.0	0.0	0.0	11.3
Saline	Vegetables & Melons	0.0	0.0	0.0	0.2	0.4	0.6	0.9	0.8	0.8	0.3	0.1	0.0	4.2
Sebastian	Vegetables & Melons	0.0	0.0	0.0	8.2	31.5	31.2	27.4	25.0	17.1	0.0	0.0	0.0	140.5
St Francis	Vegetables & Melons	0.0	0.0	0.0	0.1	0.1	1.8	5.0	2.0	0.1	0.1	0.0	0.0	9.2
White	Vegetables & Melons	0.0	0.0	0.0	0.0	0.0	2.0	2.0	2.0	0.0	0.0	0.0	0.0	6.0
Woodruff	Vegetables & Melons	0.0	0.0	0.0	0.0	0.8	0.8	1.8	1.5	0.0	0.0	0.0	0.0	5.0
Clay	Wheat	0.0	0.0	0.0	0.0	0.0	0.0	15.0	15.0	0.0	0.0	0.0	0.0	30.0
Craighead	Wheat	0.0	0.0	0.0	0.0	1.3	4.0	4.0	2.7	0.0	0.0	0.0	0.0	12.0
Crittenden	Wheat	0.0	0.0	0.3	0.3	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	1.2
Greene	Wheat	0.0	0.0	0.0	0.0	0.0	0.0	12.0	0.0	0.0	0.0	0.0	0.0	12.0
Lafayette	Wheat	0.0	0.0	0.0	5.4	5.4	5.4	5.4	5.4	0.0	0.0	0.0	0.0	27.0
Lawrence	Wheat	0.0	0.0	0.0	3.0	3.0	3.0	3.0	0.0	0.0	0.0	0.0	0.0	12.1
Lee	Wheat	0.0	0.0	0.0	0.0	0.0	0.4	0.6	0.4	0.0	0.0	0.0	0.0	1.4
Mississippi	Wheat	0.0	0.0	0.0	0.0	0.0	4.6	4.7	4.6	0.0	0.0	0.0	0.0	14.0
Monroe	Wheat	0.0	0.0	0.0	0.0	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.0
Phillips	Wheat	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.4
Woodruff	Wheat	0.0	0.0	0.0	0.0	0.0	0.0	6.0	0.0	0.0	0.0	0.0	0.0	6.0

cc: Nicole Rowan, CDM Smith

Appendix A: County Results of Irrigated Acreage Trend Analysis

The following table provides the county results of the irrigated acres trend analysis for each county identified within the Delta region. Irrigated acres from 2000-2010 as extracted from the WUDBS are shown as the total and then for the major crops: rice, soybeans, cotton, and corn. Results of the trend analysis for the linear and logarithmic model are below irrigated acres. Any model with an R^2 greater than the 0.65 threshold are shown in bold. To interpret results, consider that any irrigated acre trend with a bold R^2 indicates that a strong trend in the change of irrigated acres was measured.

Table A-1: Delta County Trend Analysis Results

ARKANSAS

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	422,945	156,212	251,944	10,676	1,323
2001	380,531	148,210	213,568	13,505	482
2002	367,885	139,334	203,914	19,712	2,270
2003	384,920	144,473	217,473	19,095	1,893
2004	375,009	143,645	210,538	18,394	1,007
2005	397,067	151,070	218,711	19,349	894
2006	373,762	135,965	212,082	23,659	465
2007	440,916	130,628	218,252	33,058	2,858
2008	446,441	128,016	216,363	37,053	4,941
2009	401,585	134,716	203,492	33,461	8,355
2010	419,740	152,900	218,141	31,097	7,825
Linear R^2	0.203	0.204	0.156	**0.839**	0.599
Logarithmic R^2	0.070	0.300	0.342	**0.767**	0.587

Table A-1: Delta County Trend Analysis Results

ASHLEY

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	93,423	14,429	28,101	48,253	2,185
2001	98,309	18,148	24,927	52,927	1,596
2002	96,841	15,584	25,986	52,455	2,639
2003	96,952	15,970	24,023	51,419	4,569
2004	97,952	16,192	25,276	50,116	5,220
2005	99,287	16,940	23,975	53,414	4,626
2006	98,901	13,480	26,586	55,033	3,355
2007	98,474	10,319	23,422	52,121	10,637
2008	101,577	11,614	28,971	46,787	12,894
2009	94,755	11,025	26,200	41,329	15,475
2010	98,161	13,700	28,435	41,637	13,604
Linear R^2	0.144	0.474	0.063	0.344	**0.722**
Logarithmic R^2	0.274	0.322	0.001	0.135	**0.734**

CHICOT

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	118,256	39,379	52,090	23,449	1,558
2001	110,710	36,858	48,774	22,037	1,355
2002	106,526	33,111	45,714	24,598	1,878
2003	138,153	41,413	61,621	28,276	6,235
2004	147,590	37,739	71,955	30,333	6,032
2005	155,751	39,886	75,192	32,348	6,324
2006	161,024	40,925	77,953	34,294	5,952
2007	163,054	37,860	78,263	30,827	12,930
2008	165,154	35,818	83,611	28,772	13,302
2009	156,669	31,660	80,877	27,728	13,285
2010	163,858	35,707	81,543	29,240	14,179
Linear R^2	**0.768**	0.116	**0.828**	0.347	**0.798**
Logarithmic R^2	**0.767**	0.063	**0.797**	0.513	**0.817**

Table A-1: Delta County Trend Analysis Results

CLAY

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	172,385	65,871	75,773	15,760	14,192
2001	188,231	77,091	74,339	22,386	12,800
2002	175,781	65,470	76,840	19,985	12,656
2003	176,158	65,230	71,582	20,347	17,445
2004	180,055	68,984	72,723	18,657	18,906
2005	198,519	75,810	78,334	24,341	18,813
2006	194,842	71,164	72,942	30,932	19,035
2007	191,656	61,349	70,313	26,463	32,232
2008	183,141	58,966	73,759	22,560	27,092
2009	190,307	66,719	74,393	23,492	24,827
2010	172,867	69,829	62,448	22,727	17,588
Linear R^2	0.066	0.066	0.314	0.286	0.373
Logarithmic R^2	0.141	0.042	0.217	0.386	0.434

CRAIGHEAD

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	244,650	88,508	73,419	80,373	1,748
2001	246,852	91,301	67,518	84,521	2,809
2002	233,135	83,362	60,505	86,087	2,237
2003	233,463	81,243	58,643	87,807	5,263
2004	244,802	89,163	61,850	87,898	5,646
2005	255,911	90,977	73,001	87,080	4,529
2006	251,926	87,201	71,144	88,526	4,183
2007	261,160	81,550	83,944	78,361	15,761
2008	263,218	83,963	90,276	72,500	12,368
2009	256,814	90,060	84,345	65,439	14,703
2010	262,425	96,297	84,275	64,648	16,406
Linear R^2	0.621	0.049	0.560	0.514	**0.837**
Logarithmic R^2	0.438	0.006	0.313	0.239	**0.831**

Table A-1: Delta County Trend Analysis Results

CRITTENDEN

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	116,146	28,708	60,263	18,879	4,728
2001	124,225	38,270	52,456	23,581	4,899
2002	122,703	35,059	52,925	22,392	6,837
2003	121,131	32,837	51,540	20,837	11,700
2004	125,231	34,726	59,455	20,525	8,630
2005	124,153	35,718	58,425	25,246	2,486
2006	135,743	34,529	65,219	31,800	1,342
2007	139,219	34,109	68,551	26,668	6,313
2008	149,722	33,405	86,869	17,880	6,599
2009	147,008	34,004	89,982	14,713	6,004
2010	154,886	44,927	86,799	15,277	4,473
Linear R^2	**0.886**	0.216	**0.764**	0.068	0.008
Logarithmic R^2	**0.694**	0.203	0.492	0.007	0.004

CROSS

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	227,181	103,798	120,998	1,941	148
2001	221,161	113,396	103,652	2,417	194
2002	219,677	109,901	103,305	1,385	589
2003	226,901	111,235	110,841	1,385	705
2004	228,284	112,641	109,194	2,290	1,239
2005	235,815	122,895	105,194	4,436	2,016
2006	235,654	107,452	118,138	5,376	2,604
2007	238,512	99,823	121,148	5,555	6,838
2008	248,007	95,516	134,670	4,938	5,182
2009	248,643	100,015	135,932	4,382	4,637
2010	251,535	110,126	127,518	4,593	5,087
Linear R^2	**0.885**	0.132	0.522	0.636	**0.804**
Logarithmic R^2	**0.652**	0.047	0.271	0.565	**0.831**

Table A-1: Delta County Trend Analysis Results

DESHA

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	204,304	46,395	70,055	84,178	1,367
2001	188,614	46,757	59,223	80,198	280
2002	186,759	47,203	59,840	75,286	976
2003	196,856	46,896	64,749	78,423	2,598
2004	203,419	49,889	68,930	77,572	3,513
2005	211,607	52,520	72,393	79,619	3,386
2006	209,672	48,652	73,560	78,981	4,679
2007	214,801	47,832	70,555	75,657	14,939
2008	214,619	44,663	83,549	64,908	15,232
2009	214,016	47,655	88,734	58,531	13,521
2010	217,485	53,116	89,061	57,158	12,900
Linear R^2	**0.676**	0.124	**0.760**	**0.715**	**0.805**
Logarithmic R^2	0.497	0.142	0.497	0.528	**0.830**

DREW

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	51,394	10,783	18,831	21,240	380
2001	51,507	12,111	15,444	23,133	659
2002	50,411	10,937	16,335	21,607	988
2003	51,146	12,654	13,779	22,852	1,512
2004	51,972	13,981	12,940	22,591	1,608
2005	54,524	15,371	14,973	22,373	1,035
2006	53,956	14,053	15,458	22,294	1,087
2007	52,582	10,557	12,335	19,164	8,713
2008	56,062	9,465	21,809	16,130	7,668
2009	53,046	9,666	26,094	10,407	6,740
2010	46,239	6,031	22,700	11,100	6,283
Linear R^2	0.001	0.235	0.279	0.647	**0.761**
Logarithmic R^2	0.016	0.067	0.094	0.378	**0.783**

Table A-1: Delta County Trend Analysis Results

GREENE

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	124,748	62,160	44,315	13,482	4,500
2001	132,233	68,572	43,780	15,930	3,564
2002	122,814	61,905	43,813	13,679	3,079
2003	129,803	72,248	38,409	13,821	5,037
2004	130,525	75,107	36,250	13,999	4,787
2005	143,330	83,709	40,262	16,142	2,491
2006	137,574	77,414	39,794	16,967	2,406
2007	146,981	75,348	43,361	14,642	12,688
2008	151,140	81,736	43,521	12,345	12,873
2009	143,207	80,019	43,910	9,252	9,746
2010	150,841	90,389	42,319	8,725	9,127
Linear R^2	**0.795**	**0.764**	0.001	0.329	0.631
Logarithmic R^2	**0.683**	**0.732**	0.030	0.150	0.642

INDEPENDENCE

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	24,154	11,554	9,080	0	2,591
2001	25,014	13,766	7,208	0	3,439
2002	20,696	9,468	8,105	0	2,650
2003	18,156	10,940	3,582	0	3,195
2004	23,703	12,282	8,213	0	2,764
2005	28,796	14,059	9,735	0	3,897
2006	28,331	11,696	12,699	0	2,911
2007	29,695	11,344	11,975	0	5,400
2008	28,360	13,474	11,118	0	3,209
2009	28,116	11,848	10,658	0	4,799
2010	33,095	15,621	12,988	0	3,593
Linear R^2	0.567	0.191	0.481	0.000	0.246
Logarithmic R^2	0.381	0.112	0.317	0.000	0.266

Table A-1: Delta County Trend Analysis Results

JACKSON

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	178,446	90,675	80,487	760	5,434
2001	178,156	96,414	71,703	1,018	6,492
2002	181,740	92,366	75,580	895	8,555
2003	178,373	92,324	71,163	282	11,155
2004	196,124	106,154	77,824	627	10,690
2005	209,279	109,350	84,247	1,293	12,469
2006	206,053	101,396	91,341	1,612	9,287
2007	215,581	105,838	90,572	1,832	13,886
2008	208,468	110,077	84,790	1,627	9,828
2009	181,771	109,792	62,618	903	7,235
2010	214,949	127,220	78,514	437	7,472
Linear R^2	0.473	**0.762**	0.014	0.062	0.012
Logarithmic R^2	0.495	0.632	0.024	0.084	0.022

JEFFERSON

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	170,143	65,295	68,106	33,351	2,300
2001	168,815	66,592	62,697	36,306	2,140
2002	172,239	74,305	60,332	32,102	3,663
2003	157,711	57,935	52,915	35,832	8,036
2004	168,154	63,116	59,521	34,902	7,758
2005	171,934	65,650	58,292	38,290	7,664
2006	178,248	58,133	71,938	37,970	7,116
2007	182,903	55,833	81,511	21,783	19,035
2008	181,981	58,837	89,478	11,747	18,079
2009	177,436	64,376	82,944	8,452	17,873
2010	187,963	80,597	79,398	5,102	19,997
Linear R^2	0.578	0.002	0.540	0.642	**0.841**
Logarithmic R^2	0.381	0.004	0.311	0.388	**0.852**

Table A-1: Delta County Trend Analysis Results

LAWRENCE

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	128,686	80,080	47,508	0	709
2001	133,618	89,305	43,271	0	618
2002	123,574	84,881	37,407	0	416
2003	120,783	89,366	29,622	0	1,070
2004	121,289	92,306	27,719	0	734
2005	136,252	102,613	32,396	0	216
2006	136,894	96,302	39,221	0	255
2007	113,118	73,714	34,339	0	3,311
2008	109,413	70,268	34,747	0	3,565
2009	105,426	76,912	27,282	0	893
2010	109,178	78,732	27,410	0	2,100
Linear R^2	0.451	0.147	0.460	0.000	0.557
Logarithmic R^2	0.317	0.038	0.594	0.000	0.549

LEE

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	140,623	34,016	72,774	26,608	5,833
2001	150,248	43,563	64,277	35,131	4,708
2002	153,584	39,248	58,219	41,770	9,286
2003	152,343	30,768	53,820	47,081	15,995
2004	147,533	31,309	55,187	48,419	11,538
2005	161,367	31,771	58,175	66,744	3,878
2006	165,910	26,724	49,373	82,476	3,390
2007	171,534	24,722	51,787	58,587	27,799
2008	174,066	28,064	78,237	46,185	16,218
2009	169,353	31,399	77,068	46,856	11,830
2010	168,696	36,581	68,235	48,215	14,381
Linear R^2	**0.813**	0.220	0.053	0.202	0.387
Logarithmic R^2	**0.792**	0.272	0.000	0.368	0.404

Table A-1: Delta County Trend Analysis Results

LINCOLN

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	105,847	30,117	43,579	30,262	206
2001	112,132	32,249	40,981	36,381	590
2002	103,833	29,535	41,830	28,804	851
2003	108,171	30,459	37,528	35,339	2,467
2004	106,261	31,372	36,117	34,451	2,896
2005	113,065	35,523	37,643	36,639	1,037
2006	114,798	25,506	46,481	40,959	467
2007	111,430	28,203	40,092	34,435	5,489
2008	112,962	27,817	48,597	28,703	4,851
2009	112,390	29,723	50,693	21,912	8,179
2010	112,832	30,205	54,550	18,148	8,601
Linear R^2	0.421	0.087	0.431	0.258	**0.716**
Logarithmic R^2	0.384	0.062	0.191	0.092	**0.699**

LONOKE

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	226,973	81,451	115,667	26,270	596
2001	219,779	83,389	105,664	25,445	665
2002	207,944	75,843	102,983	20,765	1,378
2003	211,924	77,078	101,266	23,446	3,622
2004	215,802	81,934	104,337	21,604	3,043
2005	240,759	96,560	110,840	24,836	3,112
2006	229,927	83,725	114,299	25,222	3,154
2007	230,659	79,115	112,222	19,636	13,140
2008	211,112	75,390	103,263	10,407	16,688
2009	192,214	76,405	88,294	3,181	21,887
2010	217,884	91,278	95,364	6,023	21,712
Linear R^2	0.046	0.013	0.256	**0.670**	**0.792**
Logarithmic R^2	0.031	0.011	0.216	0.468	**0.790**

Table A-1: Delta County Trend Analysis Results

MISSISSIPPI

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	198,742	26,583	62,852	99,887	5,545
2001	209,332	37,237	48,744	114,196	5,258
2002	214,747	36,181	50,103	113,867	10,503
2003	234,563	37,872	65,335	116,728	10,205
2004	229,518	37,478	65,936	113,972	10,265
2005	249,552	42,460	72,647	123,530	8,451
2006	259,388	38,322	87,998	126,718	3,419
2007	258,909	32,474	94,683	112,854	16,609
2008	267,654	34,209	119,504	98,989	12,278
2009	271,364	39,697	136,445	79,100	13,789
2010	281,097	44,831	133,923	87,119	12,438
Linear R^2	**0.966**	0.277	**0.878**	0.244	0.401
Logarithmic R^2	**0.921**	0.382	**0.627**	0.064	0.413

MONROE

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	154,613	53,060	70,708	16,682	10,014
2001	193,249	71,191	78,890	19,936	17,909
2002	169,375	59,069	73,036	11,342	22,868
2003	163,647	52,809	70,114	11,814	26,207
2004	161,360	57,432	71,648	11,778	19,863
2005	164,614	62,702	67,737	20,074	13,033
2006	163,585	48,306	76,208	26,238	12,047
2007	168,192	44,985	75,912	15,849	29,853
2008	168,877	49,458	88,794	9,620	19,834
2009	164,067	55,044	84,036	5,879	18,687
2010	168,441	63,753	82,140	7,609	14,246
Linear R^2	0.014	0.065	0.419	0.172	0.034
Logarithmic R^2	0.006	0.068	0.265	0.108	0.056

Table A-1: Delta County Trend Analysis Results

PHILLIPS

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	153,051	28,537	57,325	60,677	2,696
2001	148,304	38,010	36,809	65,664	4,244
2002	146,389	32,867	40,840	54,481	11,336
2003	149,774	24,890	52,454	52,362	16,409
2004	155,813	26,033	68,891	50,290	9,456
2005	177,687	26,754	75,129	70,566	4,670
2006	186,848	28,777	68,761	84,290	2,872
2007	195,828	19,876	73,223	47,874	44,713
2008	200,967	31,933	115,335	19,899	30,093
2009	205,577	33,316	134,474	18,151	15,853
2010	194,305	43,087	110,019	24,199	14,656
Linear R^2	**0.851**	0.042	**0.775**	0.405	0.409
Logarithmic R^2	**0.687**	0.003	0.561	0.253	0.446

POINSETT

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	343,058	144,671	133,345	62,600	1,152
2001	301,290	135,887	115,241	47,437	1,348
2002	301,725	128,657	123,085	45,232	3,693
2003	304,687	135,835	118,072	45,852	3,585
2004	311,269	135,886	129,505	42,414	3,097
2005	322,489	140,101	134,991	45,067	1,382
2006	321,796	130,575	135,909	52,687	750
2007	329,970	130,805	139,887	46,629	7,297
2008	328,607	124,226	154,970	37,583	8,389
2009	331,853	130,473	166,948	27,107	5,462
2010	330,104	147,833	145,914	26,004	8,335
Linear R^2	0.185	0.022	**0.653**	0.629	**0.766**
Logarithmic R^2	0.037	0.083	0.433	0.582	**0.751**

Table A-1: Delta County Trend Analysis Results

PRAIRIE

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	195,287	74,765	116,247	526	1,458
2001	197,639	78,868	111,802	659	2,846
2002	187,927	75,259	106,453	383	3,139
2003	191,478	72,897	111,273	774	3,734
2004	191,276	75,897	109,697	877	3,224
2005	195,279	80,956	109,815	1,013	2,483
2006	194,260	72,185	115,760	796	4,137
2007	200,378	67,532	116,464	892	9,299
2008	194,057	68,808	113,928	763	8,318
2009	189,871	70,767	110,796	709	6,785
2010	191,533	75,969	106,293	731	6,905
Linear R^2	0.008	0.199	0.016	0.191	**0.793**
Logarithmic R^2	0.015	0.162	0.034	0.308	**0.841**

PULASKI

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	26,977	5,582	15,418	1,179	602
2001	26,925	6,440	12,926	1,088	942
2002	24,806	4,777	14,050	772	842
2003	24,624	4,619	14,743	915	842
2004	22,985	5,390	13,780	707	1
2005	25,083	5,975	14,113	973	278
2006	23,496	4,587	13,964	1,013	154
2007	23,614	4,282	11,986	605	2,324
2008	22,771	4,627	13,265	315	1,857
2009	22,670	5,672	11,444	350	3,095
2010	23,842	5,266	12,105	85	4,600
Linear R^2	0.641	0.085	0.552	**0.741**	**0.756**
Logarithmic R^2	**0.762**	0.135	0.467	0.603	**0.694**

Table A-1: Delta County Trend Analysis Results

RANDOLPH

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	50,618	23,300	20,682	0	6,396
2001	54,549	26,710	22,976	0	4,598
2002	50,660	22,625	23,096	0	4,614
2003	56,741	26,521	22,990	0	6,433
2004	53,784	28,574	19,679	0	5,445
2005	61,512	31,618	24,988	0	3,975
2006	60,775	28,834	28,561	0	2,606
2007	63,951	26,752	26,648	0	10,286
2008	64,407	30,272	25,848	0	7,982
2009	65,477	32,109	27,600	0	5,395
2010	65,848	38,562	22,076	0	4,603
Linear R^2	**0.880**	**0.677**	0.279	0.000	0.111
Logarithmic R^2	**0.787**	0.560	0.319	0.000	0.115

ST FRANCIS

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	158,940	55,773	87,609	12,949	2,104
2001	163,579	63,320	77,865	16,904	2,811
2002	151,807	58,723	68,377	19,115	2,563
2003	157,430	55,783	75,711	18,624	4,534
2004	157,528	58,090	77,286	18,195	3,526
2005	165,120	60,859	79,863	21,690	2,006
2006	161,093	46,310	84,567	27,922	1,429
2007	174,135	41,353	92,265	26,215	8,252
2008	176,665	45,061	100,133	23,216	5,395
2009	174,531	49,172	94,050	23,875	5,453
2010	183,303	55,613	98,037	23,744	4,268
Linear R^2	**0.713**	0.349	0.557	**0.662**	0.403
Logarithmic R^2	0.470	0.299	0.287	**0.756**	0.431

Table A-1: Delta County Trend Analysis Results

WHITE

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	46,188	21,292	22,511	0	1,206
2001	38,182	16,099	19,006	0	1,865
2002	29,953	15,360	13,150	0	224
2003	31,320	14,516	13,634	0	1,549
2004	33,446	15,879	15,388	0	744
2005	42,021	17,034	21,876	0	906
2006	39,322	14,734	20,719	0	1,782
2007	43,158	14,748	22,954	0	3,284
2008	20,192	8,855	9,377	0	1,050
2009	30,306	13,223	14,863	0	1,769
2010	30,143	11,228	16,865	0	1,325
Linear R^2	0.196	0.606	0.047	0.000	0.156
Logarithmic R^2	0.224	0.637	0.075	0.000	0.173

WOODRUFF

Year	Total (time)	Rice (time)	Soybeans (time)	Cotton (time)	Corn (price)
2000	107,436	39,997	57,286	2,433	7,282
2001	103,935	41,387	50,517	2,223	8,334
2002	104,167	40,798	53,800	1,536	6,243
2003	103,468	40,853	49,842	2,031	8,787
2004	107,017	45,960	49,578	2,176	8,406
2005	108,317	47,744	47,072	2,531	9,307
2006	119,616	45,245	58,781	5,704	6,573
2007	133,979	47,910	65,711	5,844	9,959
2008	164,255	55,291	88,868	3,829	12,273
2009	153,750	56,317	77,470	4,419	10,895
2010	165,692	62,611	84,944	4,770	10,178
Linear R^2	**0.789**	**0.861**	0.620	0.555	0.394
Logarithmic R^2	0.533	0.646	0.364	0.439	0.390

Comprehensive Update of the Arkansas Water Plan

Water Demand and Forecasting Work Group

Water Demand Forecast Methodology

March 15, 2013

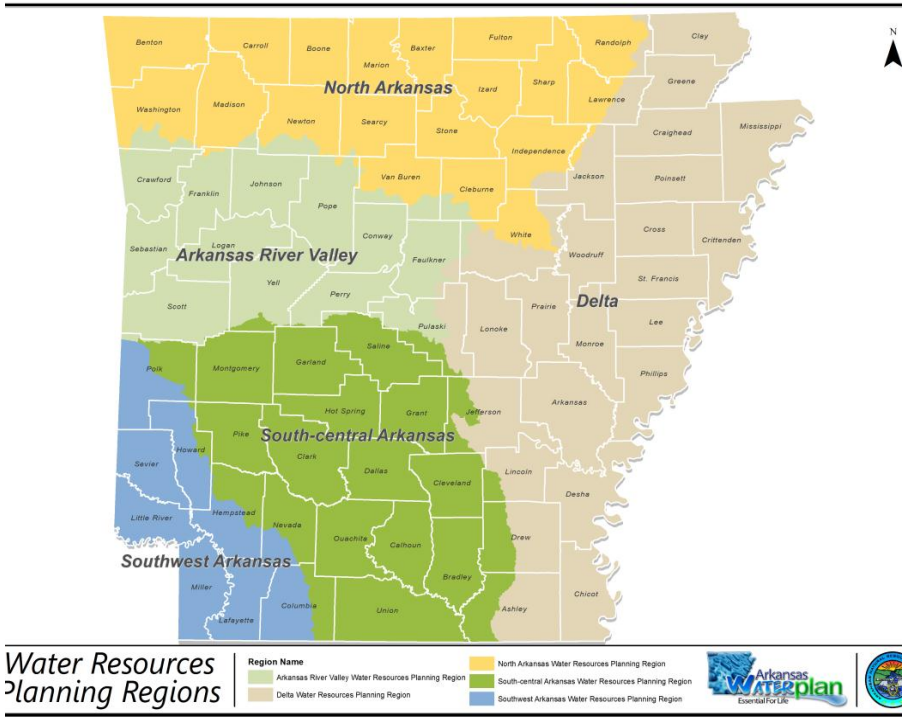
Agenda

- 9:00 – 9:15 Welcome and Introductions
- 9:15 - 10:00 Discuss livestock water demand forecast
- 10:00 – 10:30 Irrigation water demand forecast overview & data source comparison
- 10:30 – 10:45 Break
- 10:45 – 12:00 Irrigation water demand forecast methodology and discussion

Welcome and Introductions

<u>PURPOSE</u>

Discuss the current status of the Agricultural Water Demand Forecast effort, including progress on data analysis and methodological development



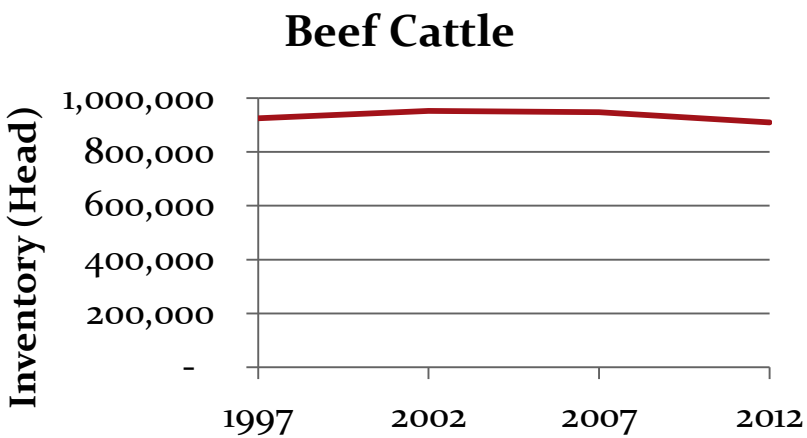
Livestock

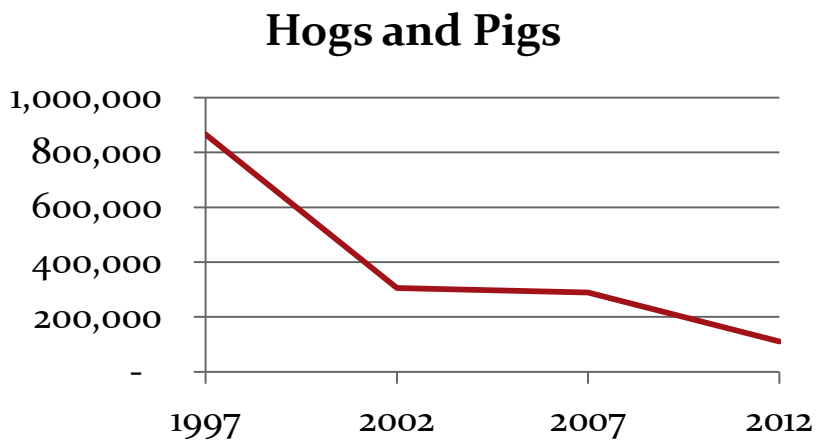
Livestock Groups

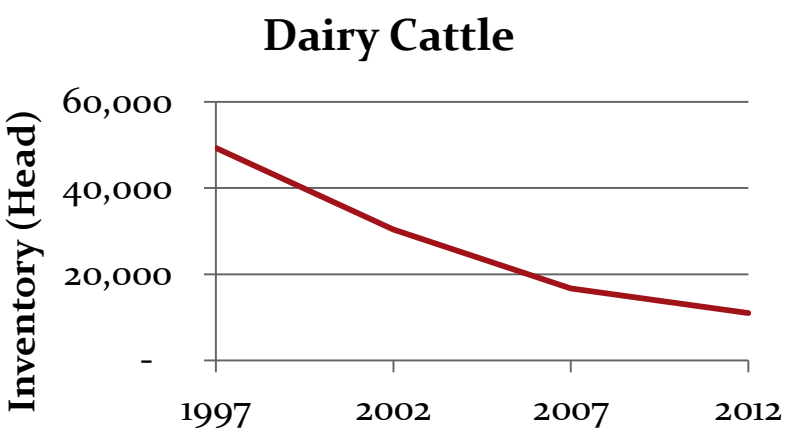
Livestock Group	Daily Water Requirement (GPD)
Dairy Cows	35
Beef Cattle	12
Hogs and Pigs	3.5
Chickens	0.06
Turkeys	0.1
Sheep and Goats	2
Horses	12

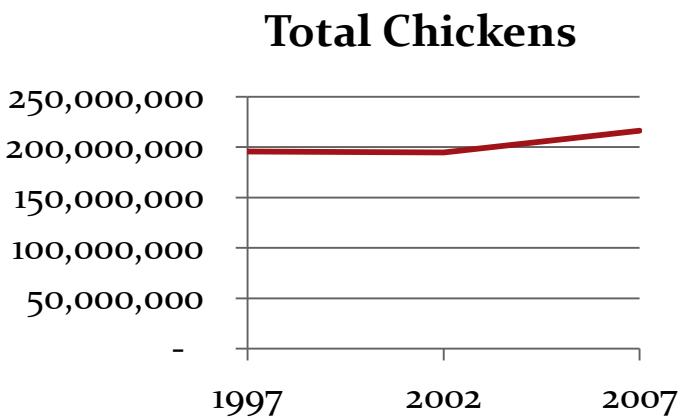
Historical Statewide Animal Counts

Source: NASS Agriculture Census (1997, 2002, 2007); NASS Annual Statistics (2012)









Livestock Water Demand Forecast

- Number of animals x daily water requirement
- County level forecast
- Data Sources
  - Daily water use requirement from "USGS Method for Estimating Water Withdrawals for Livestock in the United States", 2009
  - Livestock count from NASS Census of Agriculture (2007) and Agricultural Survey (2012)
  - Growth rate to 2022 derived from national USDA Agricultural Projections through 2022
    - Cattle, Hogs, and Poultry (all other livestock: no growth)
  - Demand from 2022-2050 held constant (no additional growth)

Data Limitations

- 2007 Agriculture Census last complete dataset available for county
  - Undisclosed data for several counties for all livestock groups

Program	Year	Period	State	County	Data Item	Value
CENSUS	2007	END OF DEC	ARKANSAS	ARKANSAS	CHICKENS, LAYERS - INVENTORY	337
CENSUS	2007	END OF DEC	ARKANSAS	ASHLEY	CHICKENS, LAYERS - INVENTORY	824
CENSUS	2007	END OF DEC	ARKANSAS	BAXTER	CHICKENS, LAYERS - INVENTORY	1,663
CENSUS	2007	END OF DEC	ARKANSAS	BENTON	CHICKENS, LAYERS - INVENTORY	1,664,829
CENSUS	2007	END OF DEC	ARKANSAS	BOONE	CHICKENS, LAYERS - INVENTORY	229,148
CENSUS	2007	END OF DEC	ARKANSAS	BRADLEY	CHICKENS, LAYERS - INVENTORY	317,755
CENSUS	2007	END OF DEC	ARKANSAS	CALHOUN	CHICKENS, LAYERS - INVENTORY	(D)
CENSUS	2007	END OF DEC	ARKANSAS	CARROLL	CHICKENS, LAYERS - INVENTORY	1,147,788
CENSUS	2007	END OF DEC	ARKANSAS	CHICOT	CHICKENS, LAYERS - INVENTORY	114

- 2012 Agricultural Survey state-wide estimates used to update cattle, dairy, and hogs; not available for other animals
  - 2007 Census of Agriculture county/state ratios used to calculate county estimates
- Variation in base year (historical starting point of forecast)

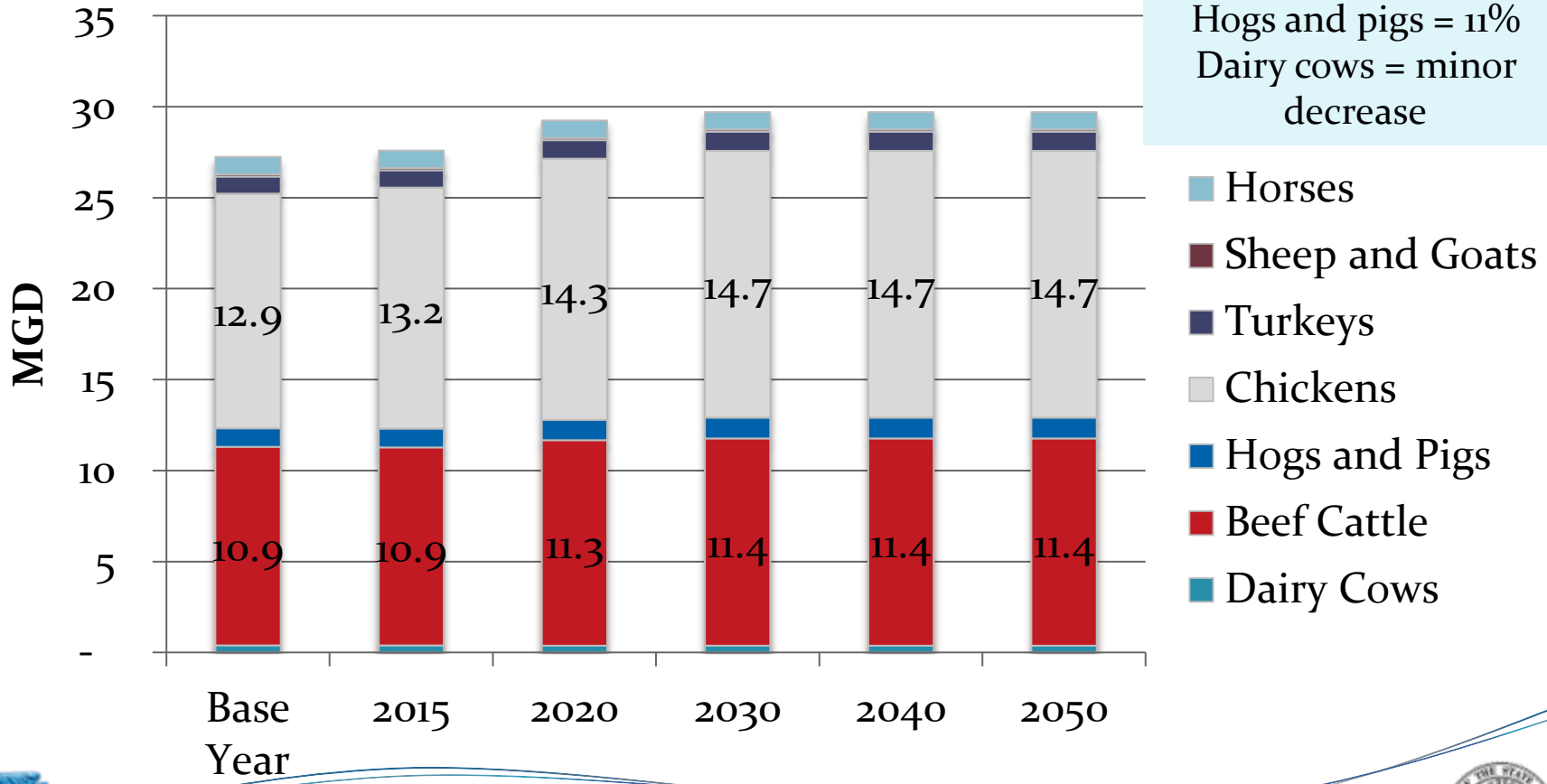
Base Year Livestock Count, Statewide

Animal Type	Base Year Count	Daily Water Requirement (GPD)	Base Year Demands (MGD)	% of Total Base Year Demand
Dairy Cows[1]	11,000	35	0.39	1 %
Beef Cattle[1]	909,000	12	10.91	40 %
Hogs and Pigs[1]	290,00	3.5	1.02	4 %
Chickens[2]	215,082,000	0.06	12.90	47 %
Turkeys[2]	9,339,000	0.1	0.93	3 %
Sheep and Goats[2]	67,000	2	0.13	0.5 %
Horses[2]	79,000	12	0.95	4 %

1. *Data from the Census of Agriculture, 2007*
2. *Data from the Livestock Survey, 2012*

Livestock Annual Water Demand Forecast

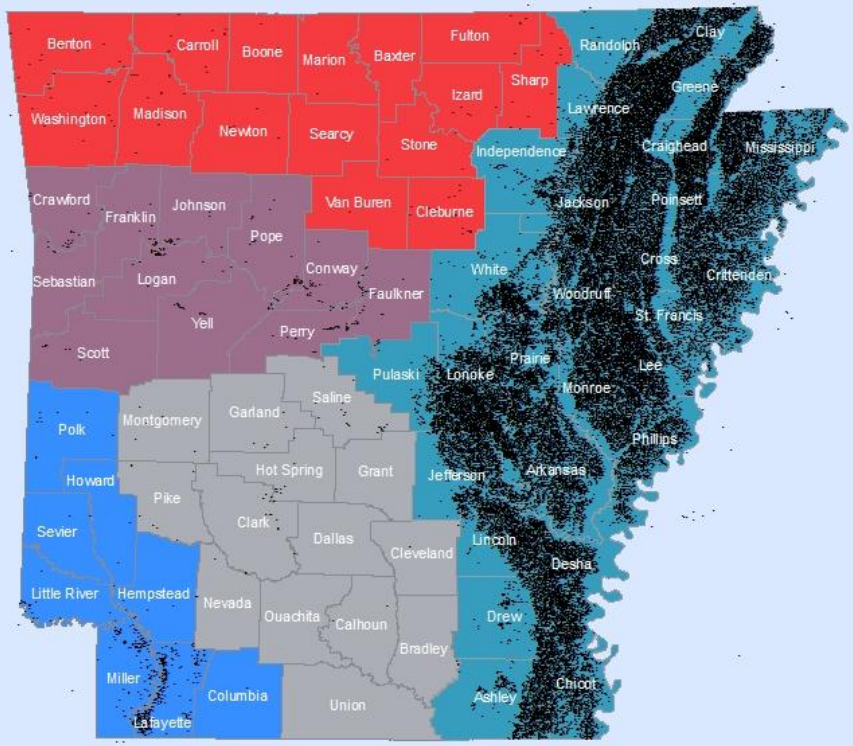
Growth rate
Chickens = 14%
Beef Cattle = 5%
Hogs and pigs = 11%
Dairy cows = minor decrease



Livestock Remaining Action Items

- Alternative Future Scenarios
  - Alternative growth rates?
  - 2022-2050 projected growth rate?
- Water Source (Groundwater/Surface Water)
  - WUDBS to allocate demands to source of supply by county
  - Assume baseline source ratios stay constant into future
- Aquaculture Water Demands
  - Currently underway
  - Development of methodology and future demands

Crop Irrigation



Basic Methodology

- Data driven forecast
  - Meaning, the methodology itself is driven by data availability
  - Use of certain data may require adjustments to methodology
- Total irrigated acres by crop type *times* the average application rate for the crop(s)
- Executed at county level
- Total water demand for all irrigated agricultural in the county is then the sum of crop withdrawals
- Demands then dispersed to basin, grid, surface water source, aquifer, etc.

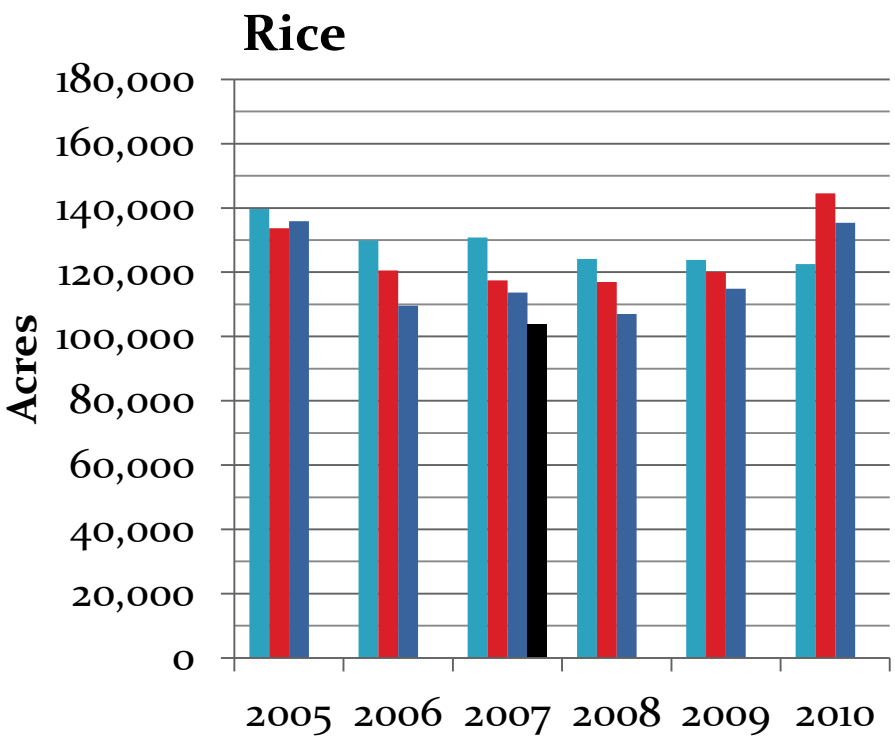
Data Needs

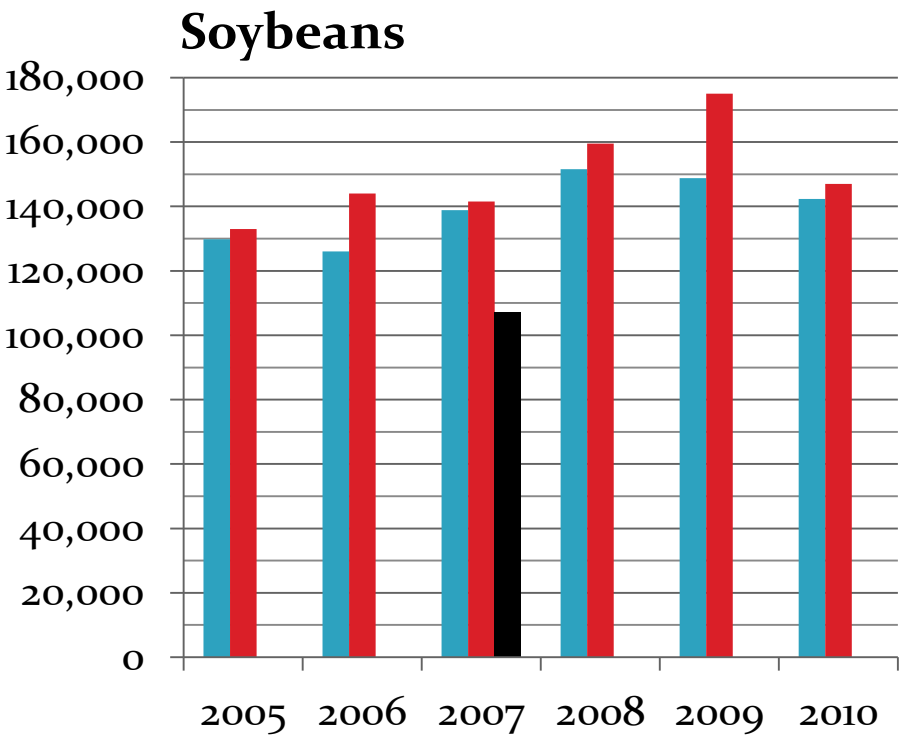
- Irrigated acres by crop type by county
  - Needed for base year (historical starting point of forecast) AND
  - At each planning interval in the future (2020, 2030, 2040, and 2050)
- Method for assessing future irrigated acres
  - Many modeling options available, must consider data availability and time constraints
  - Proposed to assess historical trends using mathematical modeling
  - Requires stable dataset of historical irrigated acres by crop type and by county
  - Any growth in model must be reviewed to determine if it exceeds a reasonable maximum
- Crop specific application rates by county
  - Use empirical data OR
  - Use theoretical model (crop needs plus water withdrawn in excess)

Data Sources – Irrigated Acres

- WUDBS
  - Provided from 2000-2010
  - Self-reported with data checks
- USDA
  - Agriculture Census, FRIS, Annual Surveys, and CDL
  - Self-reported with data checks
  - Not all data available for all years
    - Census data are complete for irrigated crops by counties, with some undisclosed data, but only available in 5 year increments
    - Annual survey data only available for rice, cotton, and soybeans and has some undisclosed data
    - FRIS statewide only
  - Farm Service Agency
    - Self-reported with data checks, USDA program participation requires accuracy
    - 2009 and 2010 available for rice
    - 2011 and 2012 available for all irrigated crops

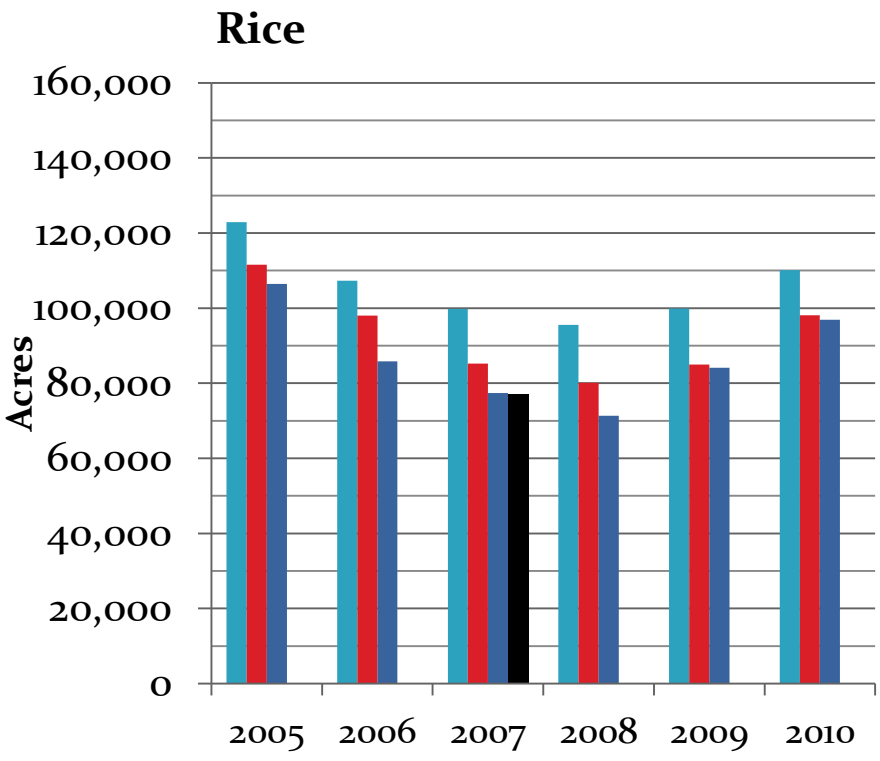
Poinsett County Irrigated Acres Data

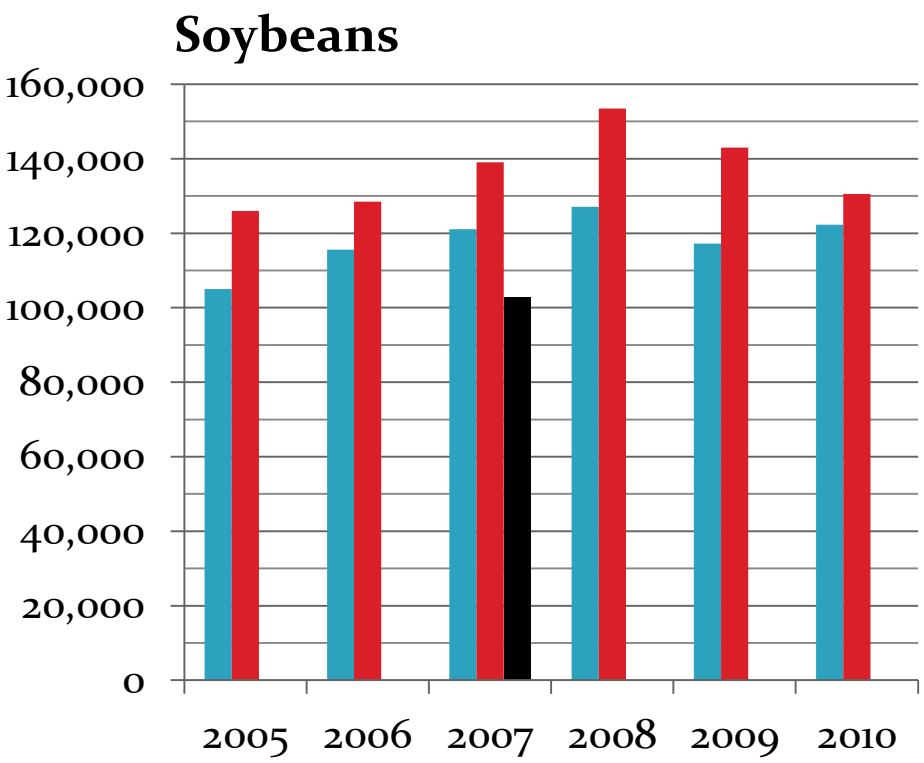




WUDBS NASS CDL Ag Census

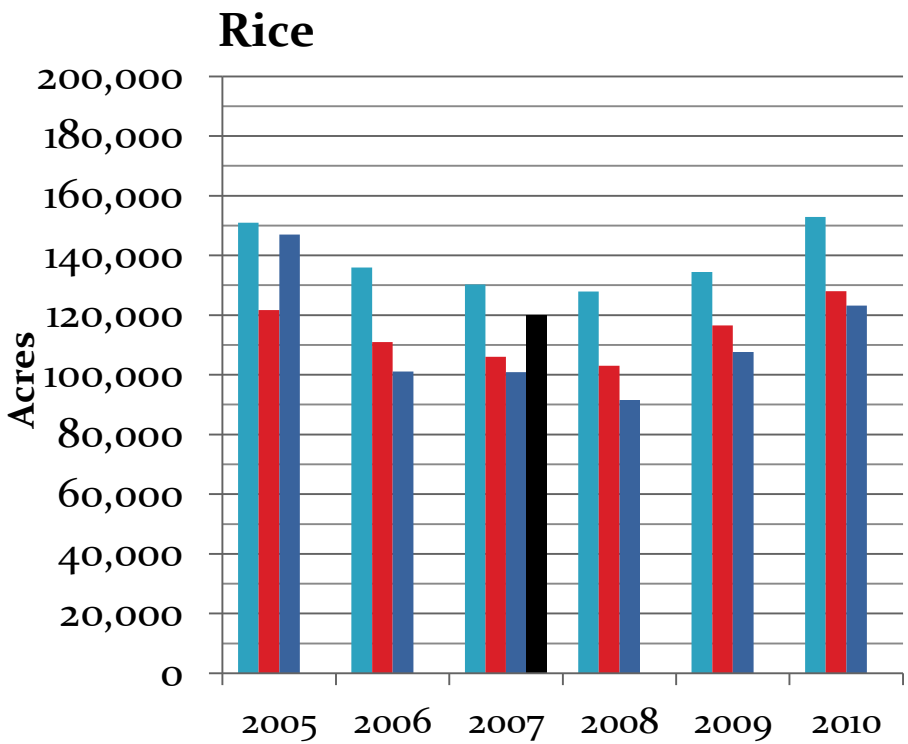
Cross County Irrigated Acres Data

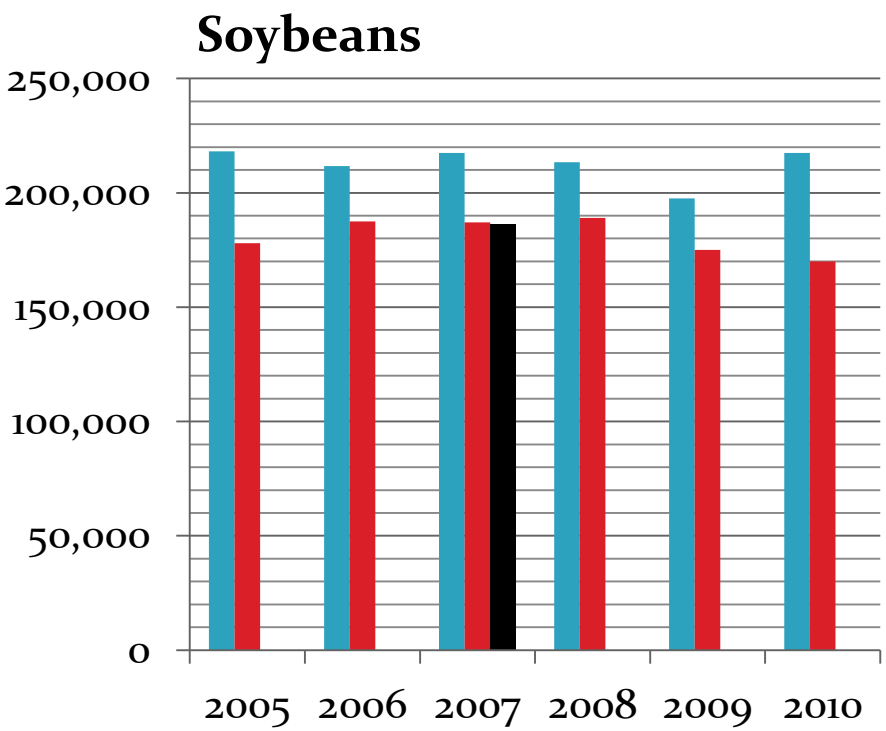




WUDBS NASS CDL Ag Census

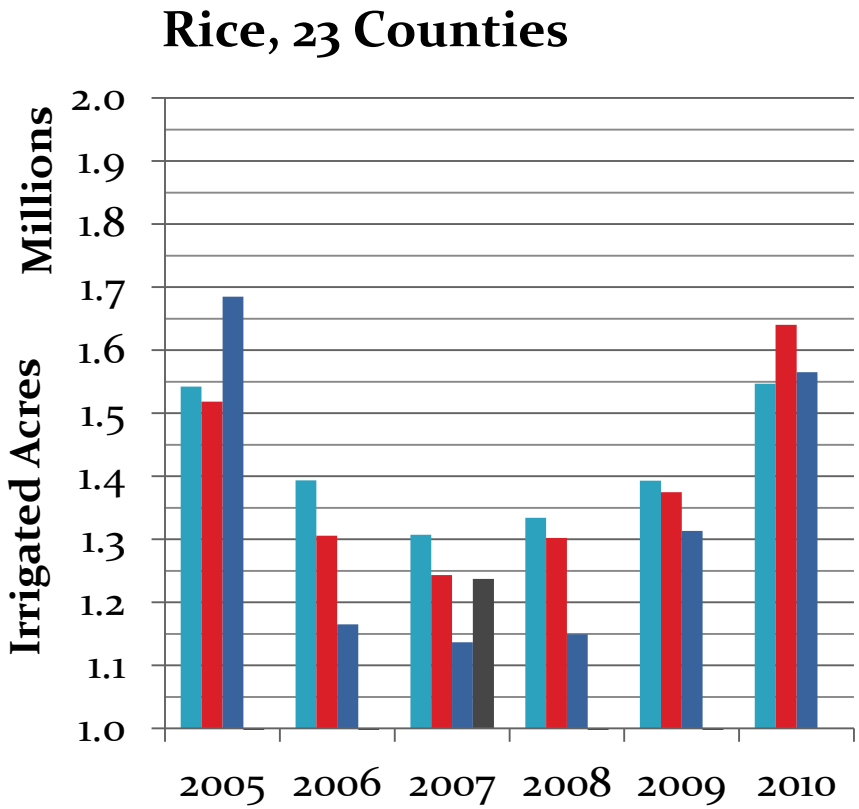
Arkansas County Irrigated Acres Data

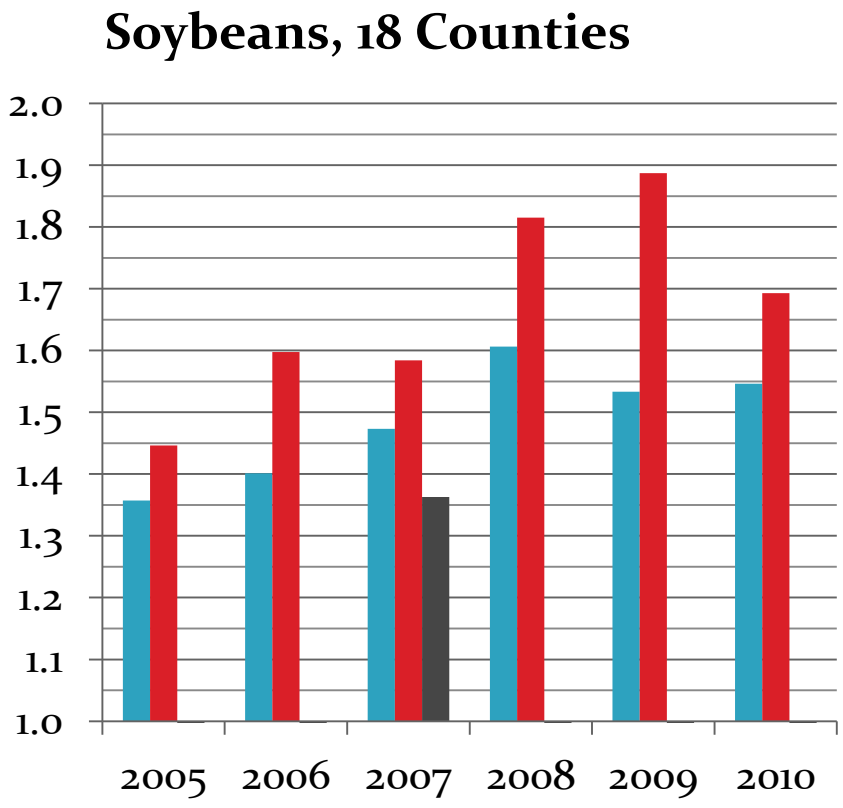




WUDBS NASS CDL Ag Census

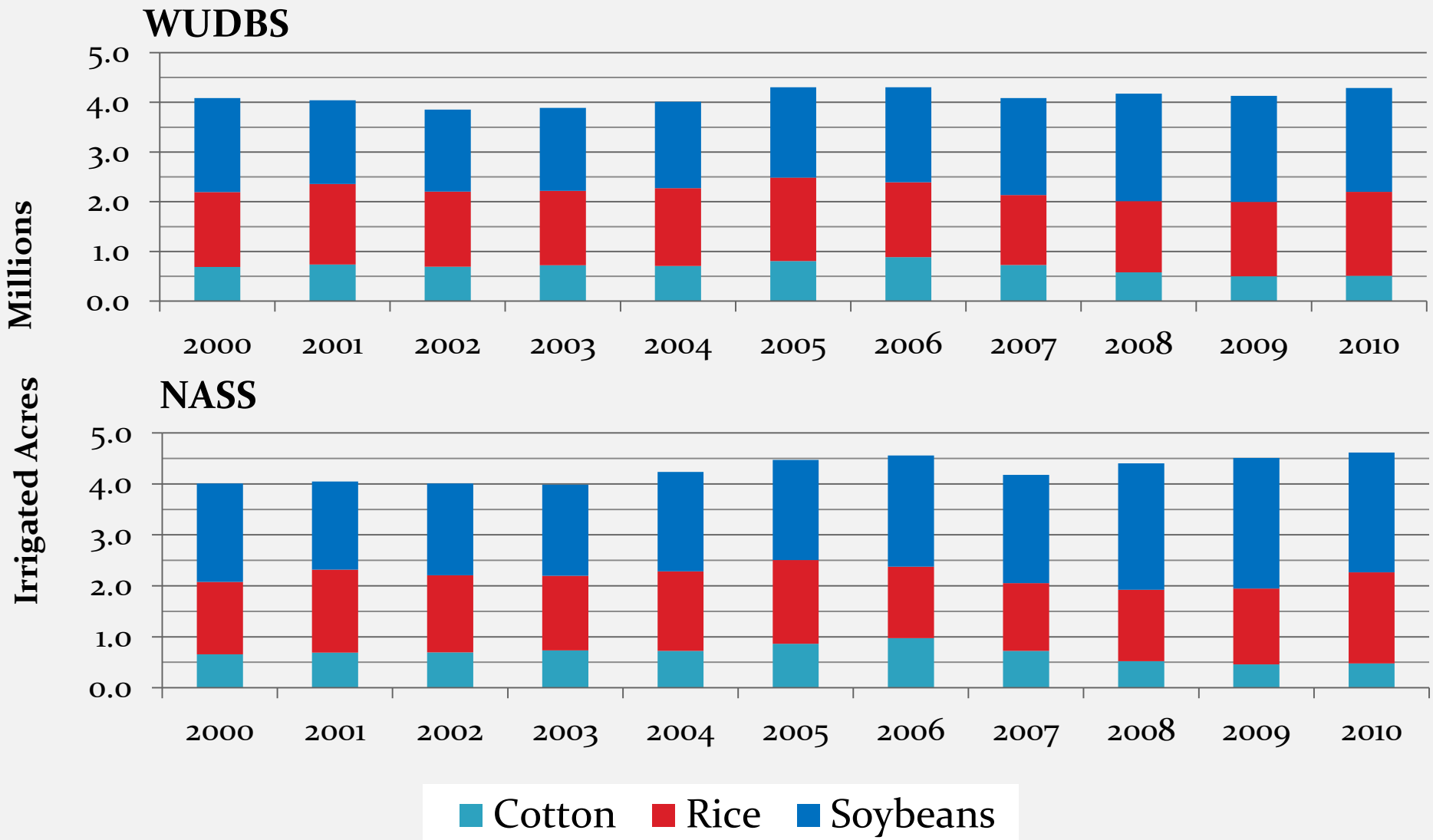
Combined Counties Irrigated Acres Data





WUDBS NASS CDL Census

Comparison of Statewide Irrigation Data for Major Crops



Cotton, Rice, and Soybeans only irrigated acreage data available from NASS

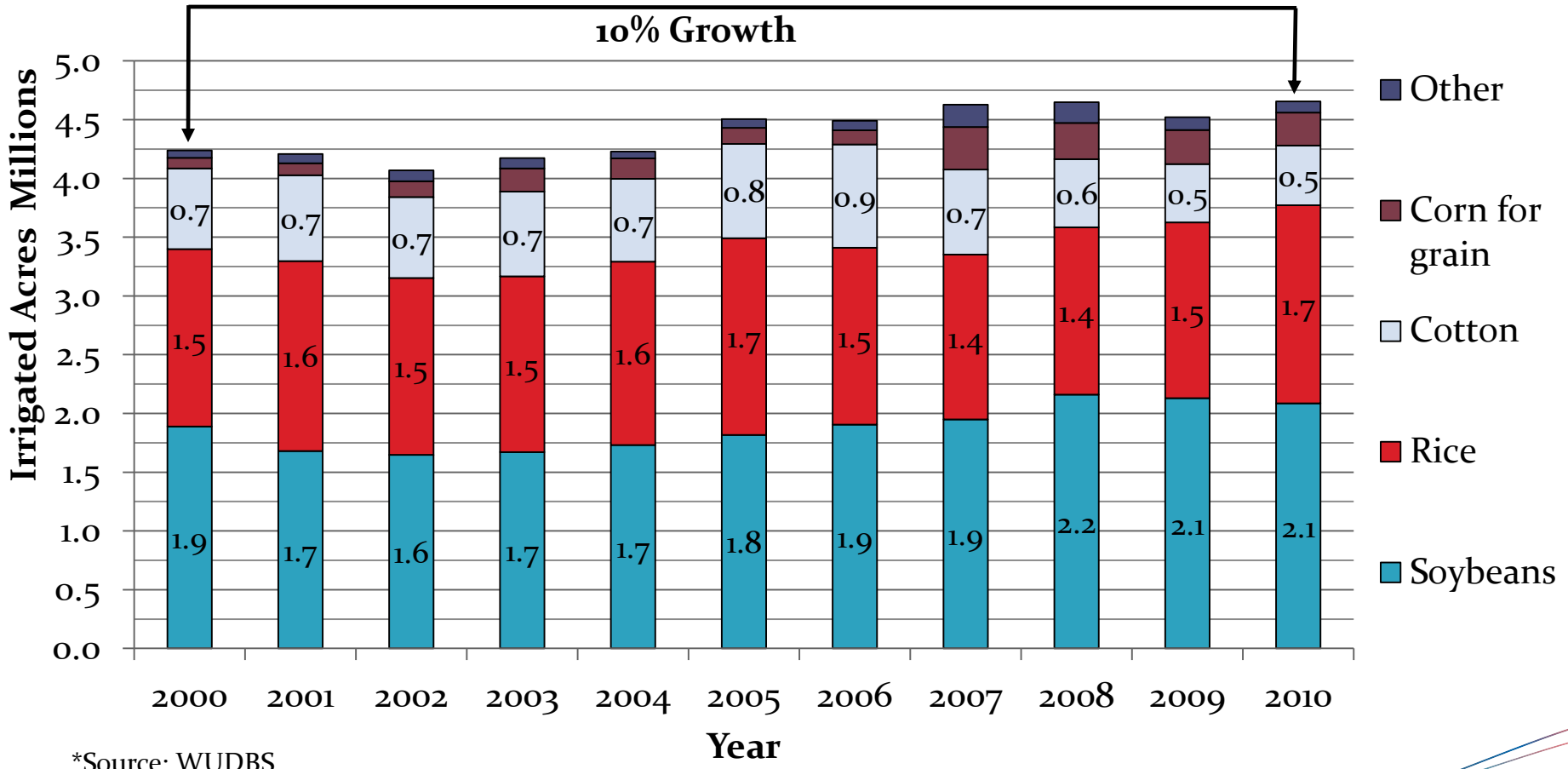
Selecting Source for Irrigated Acres

Source	Pros	Cons
ANRC WUDBS	•Complete source •Recent data for base year •Includes all crop types •Used by USGS for reports/models •Quality checks implemented	•Self-reported •Some blanks in data •Quality checks instituted in early part of 2000's
USDA NASS Survey Data	•Lengthy time series available for rice, soybeans, and cotton •Quality checks implemented	•Self-reported •Undisclosed values •Most recent complete county-level data from 2007 Agriculture Census
USDA CDL	•Science based, rather than self-reported	•Science has changed over time •Cloud coverage can limit accuracy •Only for rice irrigation
USDA FSA	•Recent data for base year •USDA program participation dependent on accurate reporting	•Self-reported •Website download did not have historical time series available

Decision as to which dataset is most appropriate is on the critical path to finalizing irrigation demands

Break

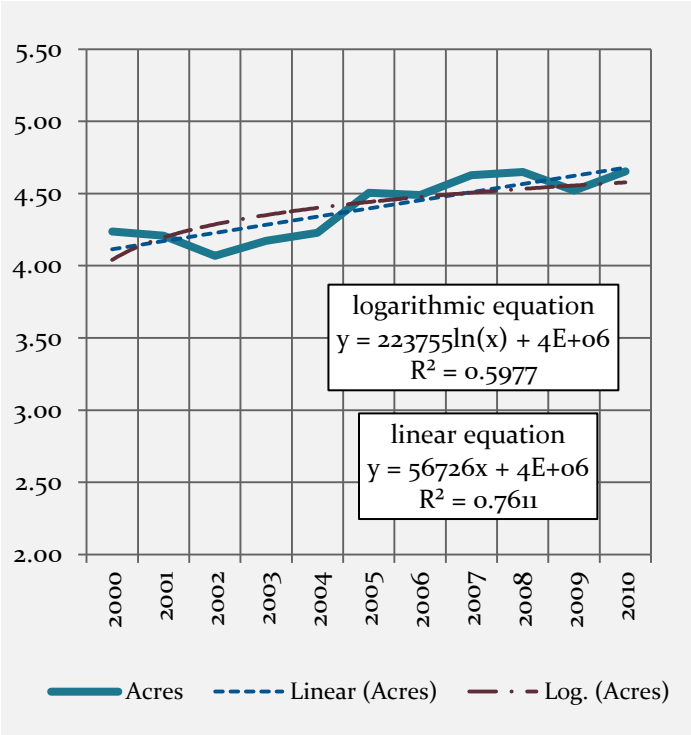
Trend in Irrigated Acres, Statewide



*Source: WUDBS

Proposed Method to Forecast Irrigated Acres
(1 of 3)

- 10 years historical data
  - Summarized by crop type
  - Grouped by county
- Generate mathematical models that estimate trends over time for major crop types and "other" group
  - For corn, use price as trend driver rather than time
  - Use statistics that characterize the strength of the mathematical models to determine an acceptability threshold, i.e. "good fit" models



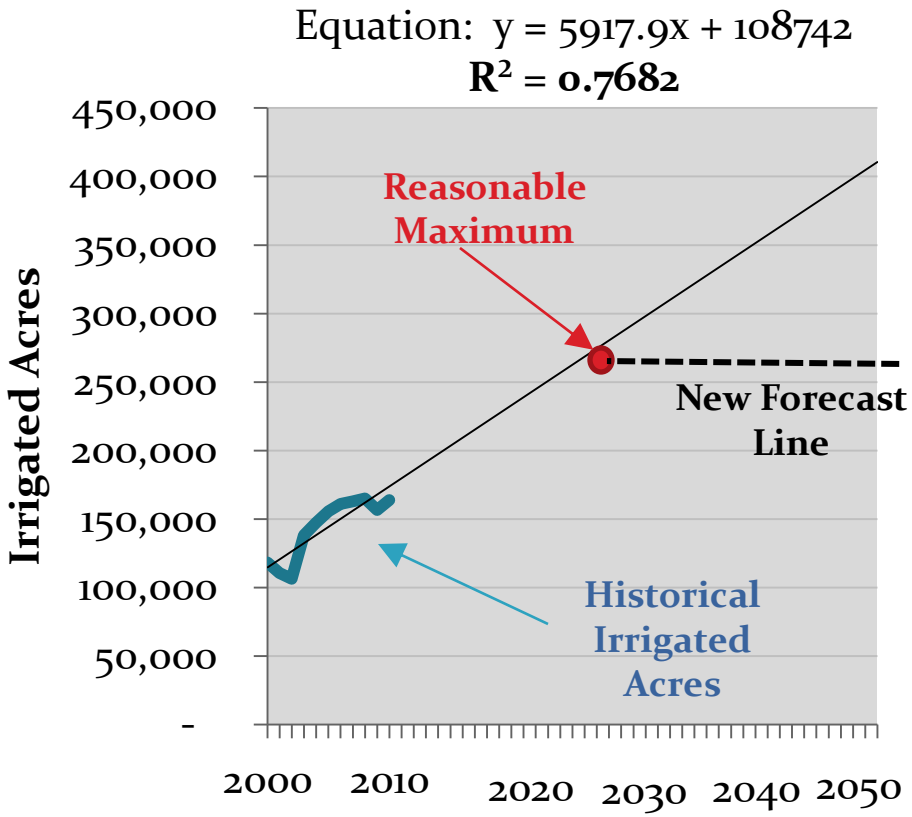
Proposed Method to Forecast Irrigated Acres
(2 of 3)

- Use results of good fit models to extrapolate the trend to 2050
  - Corn: variable driving growth will be price from USDA Long-term Projections to 2022
  - Soybeans, Rice, and Cotton: variable driving growth will be time
- No good fit model = no assumed growth in irrigated acres

Year	Corn ($/bushel)
2013	$5.00
2014	$4.30
2015	$4.40
2016	$4.45
2017	$4.50
2018	$4.50
2019	$4.55
2020	$4.60
2021	$4.65
2022	$4.65

Proposed Method to Forecast Irrigated Acres
(3 of 3)

- Some of the trend models have strong slopes and may produce a forecast of irrigated acres that is unreasonable (i.e., only so much land available)
- When trend model reaches a "reasonable maximum" irrigated acres, no more growth applied
- Reasonable maximum based on planted acres of field crops for given county in base year



Statistics on "Good Fit" Models for Irrigated Acres

	Total (Time)		Rice (Time)		Soybeans (Time)		Cotton (Time)		Corn (Price)	
	Linear	Log	Linear	Log	Linear	Log	Linear	Log	Linear	Log
Count	11	9	4	1	6	1	5	2	12	12
Percent	41%	33%	15%	4%	22%	4%	19%	7%	44%	44%

- Analysis conducted on 27 counties in Delta region, remaining counties to be completed
- "Good Fit" defined as having an R2 greater than 0.65
- General results
  - Price is good indicator of growth in irrigated acres of corn
  - Cotton irrigation showed generally declining trends, all others increasing
  - For many counties where no strong trends were measured, observed that soybeans went up and down in negative correlation to rice

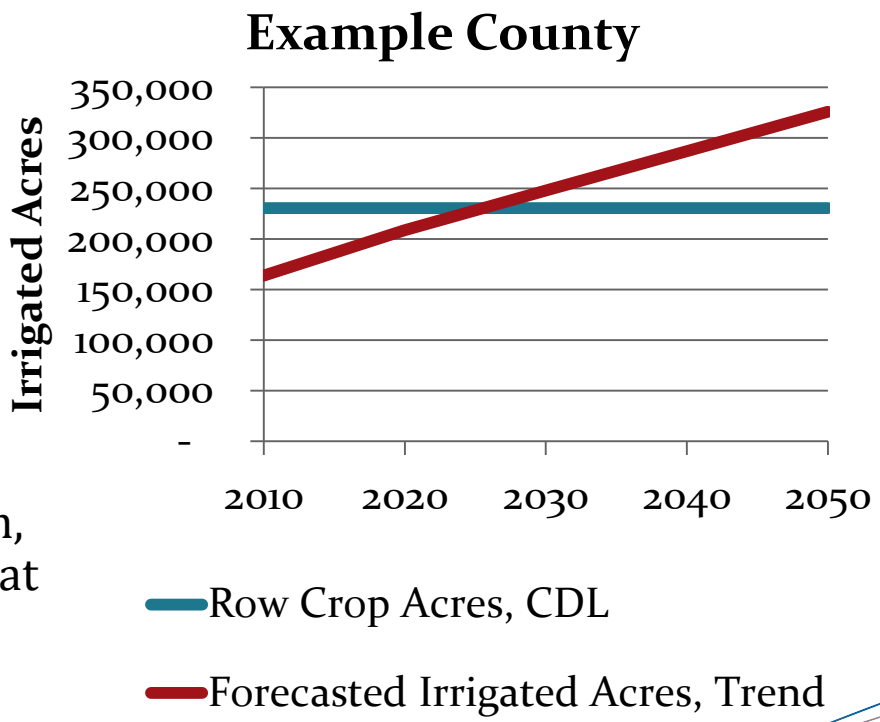
Full Extrapolation of Growth - Results, Statewide

Year	Rice	Soybeans	Cotton	Corn	Other	Total
2010	1,689,362	2,089,060	508,610	281,334	96,930	4,665,296
2020	1,753,950	2,438,286	494,528	275,113	96,991	5,058,867
2030	1,843,778	2,771,392	481,872	279,782	97,222	5,474,046
2040	1,933,666	3,104,450	476,748	282,378	97,454	5,894,697
2050	2,023,588	3,437,482	486,576	284,974	97,686	6,330,306
Growth, Acres	334,226	1,348,422	(22,034)	3,640	756	1,665,010
Growth, %	20%	65%	-4%	1%	1%	36%

- These results show the growth in irrigated acres without reasonable maximum consideration
- Preliminary and subject to change
- County results will be assessed to determine if trend model exceeds the reasonable maximum

Reasonable Maximum Irrigated Acres

- Apply trend model until reasonable maximum is achieved
- Reasonable maximum defined according to 2010 field crop acres
- Two sources identified:
  - USDA CDL (2010)
    - Data available for 30 counties
    - Would reduce irrigated acres forecast of 11 counties by 785,000 acres *preliminary
  - USDA Annual Survey (2010)
    - Sum acres planted for corn, cotton, rice, sorghum, soybeans, and wheat
    - Undisclosed data poses challenge (i.e., 40,900 acres of cotton undisclosed in 2010)



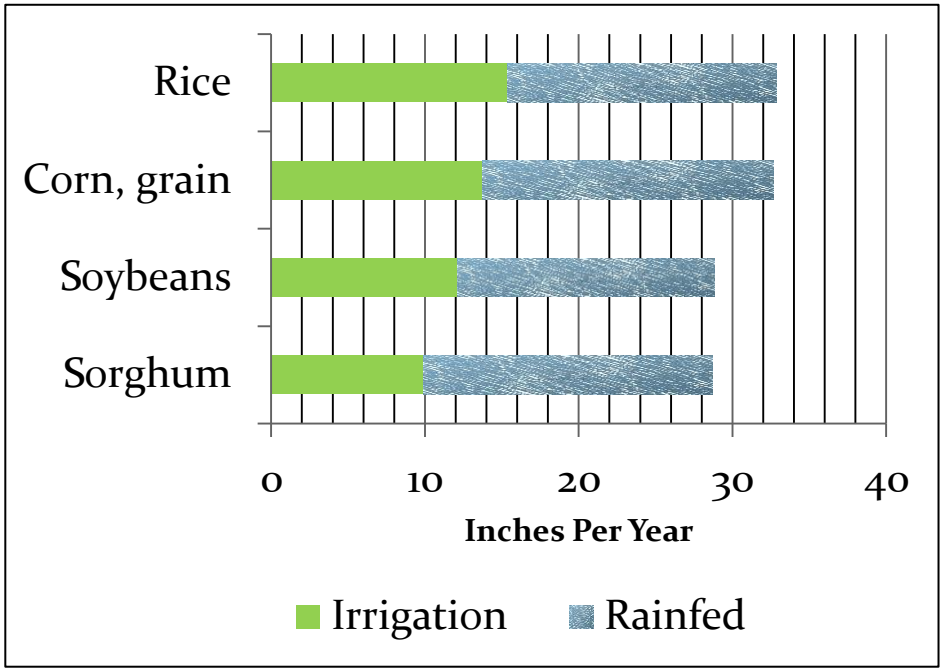
Before Moving on….

Let's finalize assumptions on irrigated acres!

Additional discussion? Unresolved concerns?

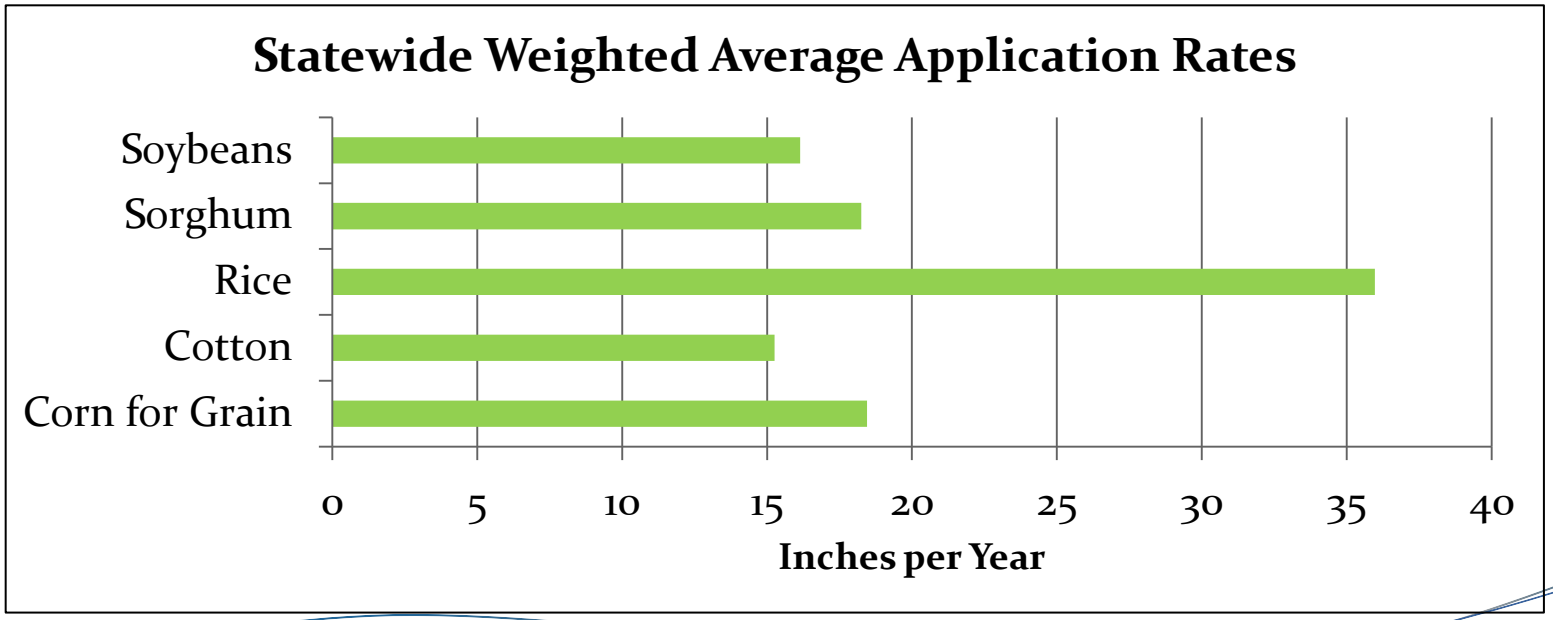
Water Application Rates (1 of 2)

- Options for modeling: modeled or observed values
- Modeled includes using method such as Blaney-Criddle to estimate consumptive use
  - USDA Soil Conservation Service produce values for rice, corn, soybeans, and sorghum; used in Eastern Arkansas Region Comprehensive Study (shown)
  - If use modeled, add factor to account for system losses, overages , weed control, etc



Water Application Rates (2 of 2)

- Observed values have been derived from WUDBS (2000-2010)
- Weighted average for each crop by county
- Off-season use removed (source used: *USDA Planting and Harvesting Dates for U.S. Field Crops*)
- Variation by county



Adjustments to Application Rate in Future

- Consider conservation practices that have a high probability of occurring naturally
  - Example: adoption of MIRI technology in rice fields
    - Reduces water use by average of 18%
    - Reduces pumping costs and decreases labor costs
    - Produces a potential yield increase making it profitable
    - Adoption rates in Arkansas have increased from 17% (2002) to 42% (2009)
- Any other such practices?
- Will need to collect data at county scale, if possible

Other Assumptions and Follow-up Items

- Alternative future scenarios
- Water Source (Groundwater/Surface Water)
  - WUDBS to allocate demands to source of supply by county
  - Assume baseline source ratios remain constant thru 2050
  - OR…Are there areas where supply source switching has a high probability of occurring?
- Emerging trends that may not be present in historical irrigated acres
  - Increased irrigation of pastures (not seen in data)?
  - Significant switching from one crop to another?
  - Can we model these trends and is the inclusion of such trend in the forecast defensible?

Next Steps

- Finalize forecast methodology and produce results
- Share full results with Work Group
- Present results to public and stakeholders

Additional Discussion

THANK YOU!