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7. **Principal Investigator:**

Cora Lea West Emerson, J.D., M.S.
Doctoral Candidate
Texas Tech University/Texas AgriLife Research
Department of Plant & Soil Sciences
Campus Box 42122
Lubbock, Texas 79409
806-742-2837 (TTU)
806-889-3315 (TAMU)

8. **Co-Principal Investigator(s):**

Dr. Dick L. Auld
Professor and Rockwell Chair
Texas Tech University/Texas AgriLife Research
Department of Plant & Soil Sciences
Campus Box 42122
Lubbock, Texas 79409
dick.auld@ttu.edu
806-742-5704

James P. Bordovsky
Senior Scientist and Agricultural Engineer
Texas AgriLife Research Center
823 W. U.S. Highway 70
Plainview, Texas 79072
jbordovsky@ag.tamu.edu
806-889-3315

9. **Congressional District(s):** Congressional Dist. 19; Senate Dist. 28; House Dist. 84 & 85

10. **Abstract:**

Water-level decline in the Ogallala Aquifer, the principal groundwater source for the Texas High Plains, is due primarily to withdrawals for irrigated agriculture (McGuire, 2007). As water use issues in this region become ever more critical, it is our hypothesis that, while cotton production will continue to be a mainstay of the High Plains economy, agricultural production systems will shift to incorporate more drought tolerant

(deep-rooted) crops. The concern over declining water tables, coupled with other issues, such as Texas' evolving water policy aimed at conserving groundwater, elevated cotton disease pressures, and amplified interest in biofuels crops will surely impact production decisions. A field experiment will be conducted at the Texas AgriLife Research Center in Halfway, TX. This location is suitable for large plot, irrigated studies. Crop rotations will be initiated on a 14.2-ha area irrigated with a pivot LEPA system. Changes in volumetric soil water content due to cultivar, crop sequence, and irrigation level will be determined from each sub-plot over the course of the study. Representative samples will be harvested and yield/quality of all crops determined. Water input and yield will be used to determine water use efficiency and economic value of treatments will be compared.

11. Statement of Critical Regional Water Problems:

Texas has long faced the reality of declining water tables in the state's major aquifers. Storage in the southern region of the Ogallala Aquifer has declined from 500 billion m³ in 1990 to approximately 436 billion m³ in 2004, a 12% decline over the 15-year period (Ogallala Aquifer Maps, TTU-CGT); and, according to the 2007 State Water Plan, the volume of Ogallala water available for use in 2010 was 7 billion m³ and will decline annually to 4.2 billion m³ by 2060 (Water for Texas, 2007). The Texas Water Code now requires groundwater conservation districts to develop each aquifer's "desired future conditions" within groundwater management areas to determine management goals for that aquifer, essentially regionalizing water management (TWC §35.004 *et seq.*). The code also requires a target and/or cap for groundwater permitting. The practical effect of this mandate on the High Plains will be to restrict irrigation volumes to less than the already very limited irrigation capacities.

In 2009, the 81st Legislature established the Texas Bioenergy Policy Council and the Texas Bioenergy Research Committee under the umbrella of the Texas Department of Agriculture. These bodies are charged with the task of developing strategies to further the state's goal of positioning itself as the nation's leader in bioenergy production. Meanwhile, federal mandates and incentives are also driving the expectation of major increases in the production of biomass (U.S. DOE, 2009). Federal policy requires that 28 million m³ of renewable fuel be produced annually by 2012, and the Energy Independence and Security Act of 2007 expanded that production target to 136 million m³ per year by 2022 (U.S. DOE, 2009).

Another growing issue is disease pressure in cotton monoculture. *Verticillium* wilt is currently the most yield-limiting cotton disease in the High Plains and can drastically affect water use efficiency by reducing yield (Wheeler, *et al.*, 2009). In field tests at the Helms Research Farm in 2008 and 2009, the incidences of wilt in cotton were reduced from 30% to less than 8% by using sorghum every third year in rotation with cotton (Wheeler, *et al.*, 2009). While cotton crop rotation strategies in this region typically include cotton in rotation with grain sorghum; an 8-year cotton/grain sorghum study showed that rotation with grain sorghum did *not* favorably compare to continuous cotton either economically or from a water use efficiency perspective at current commodity prices (Bordovsky, *et al.*, 2009).

The uncertain future of the state's water regulatory scheme coupled with the push for bioenergy production and the growing issue of disease pressure requires area producers to implement alternatives to traditional crop rotation practices. Several crops have been identified as reasonable alternatives for rotation with cotton due to adaptability to the region and potential value in the biofuels market. These include the oilseed crops safflower, sunflower, canola and sesame, as well as forage sorghums for potential biomass conversion among others. Each of these crops has been grown with varying levels of success in the region; although there are no known long-term studies documenting detailed water use when incorporated in cotton rotation systems.

12. Nature, Scope and Objectives of the Research:

The experiment will be initiated in 2011 at the Texas AgriLife Research Center at Halfway, TX on a 14.2 ha site. A cotton/alternative (AC) crop rotation (2:1) will be established under an 8-span center pivot with crops irrigated by LEPA using circular rows oriented perpendicular to the pivot lateral. Rotation treatment plots will include: cotton followed by cotton and then the AC treatment; cotton followed by AC and then cotton, and; AC followed by two years of cotton. Cotton production parameters from individual rotation treatments and the rotation system will be compared to continuous cotton. Treatment areas will be 16 1-m rows wide and arc 180° of the pivot circle. The four treatments will be replicated twice along the length of the pivot lateral. The 180° pivot arc will be split into six smaller wedge-shaped areas where in-season irrigation capacity will be held to 0.0 mm/d (no seasonal irrigation), 2 mm/d, and 4 mm/d approximating 0%, 25% and 50% of peak cotton ET, respectively in each of two randomly selected wedges. Treatment plots will be arranged in a randomized block design within 4 blocks (two replications along the pivot lateral and two replications along the pivot arc). Irrigation quantities will be controlled by adjusting pivot speed crossing each wedge. A programmable irrigation controller with appropriate electronic valves will be used to pressurize, set the appropriate pivot speed, and interrupt irrigation flow between irrigation treatments (wedges). Plot sizes will range from 0.1 to 0.2 ha in size allowing 4 alternative crops or varieties to be planted as subplots in the AC treatment areas. Alternative crops will include sunflower, safflower, canola, forage sorghum and/or other appropriate annuals. Changes in volumetric soil water content due to cultivar, crop sequence, and irrigation levels will be determined from each sub-plot using nuclear methods over the course of the study. Representative samples will be harvested and lint yield and quality will be determined from all crops in treatment areas. Water input and yield from treatments will be used to determine water use efficiency and economic value of treatments compared to continuous cotton. Measured parameters will be analyzed using standard statistical methods.

The overall objective of this project is to document total water use and crop response in rotation systems where alternative crops are grown with cotton. Specific objectives are to: 1) establish a 2:1 cotton rotation using biofuels crops in the rotation; 2) begin documenting and comparing water use among rotation sequences versus continuous cotton where the primary water resource is rainfall supplemented by very limited irrigation; and 3) begin documenting crop yield and quality, nutrient use, pest and disease pressures and determining water use efficiency and economic advantages/disadvantages of alternative crops rotated with cotton compared to the traditional continuous cotton system.

13. Results Expected from this Research:

To date there are no known long-term studies documenting detailed water use in cotton rotation systems that incorporate drought tolerant (deep-rooted) biofuels crops. The question is whether these alternative crops are a better choice in rotation with cotton than traditional crops such as grain sorghum or if these rotations are better than continuous cotton in this water-short environment. The efficient use of low levels of supplemental irrigation in such rotations may stabilize crop production (compared to dryland), reduce disease and pest pressures in cotton, and provide economic return as available irrigation quantities decline in the near future.

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