Title: Improving farmer's "Revenue to Irrigation Ratio" through production of high value vegetable crops

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Summary

In 1960, over 32,000 acres of fresh market tomatoes were planted in Texas, but by 2009 this number was reduced to less than 1,000 acres. The majority of this lost acreage went to Mexico and Florida, and at today's yields and prices it represents approximately $250M/yr in lost revenue. With the recent upsurge in consumer demand for high quality, locally grown produce, Texas farmers in the High Plains have an unprecedented opportunity to regain a significant portion of fresh tomato market share. To accomplish this, Texas growers will need to take advantage of recent advances in vegetable production techniques, which include efficient irrigation technologies and high tunnels. These techniques can extend the growing season, maximize yield and quality, and optimize water-use efficiency. Currently, farmers in the High Plains apply from 28 to 35 inches of irrigation water to produce an average of 225 bushels of corn, with expected revenue of $792/acre at today's market price. With the same amount of water, farmers could produce approximately 140 cwt of tomatoes, and at prices near $60/cwt they could dramatically improve their "*Revenue to Irrigation Ratio*" with expected revenue close to $8,400/acre. At this level of income, marginal land could be removed from production, less total acreage would have to be irrigated, irrigation water would be saved and overall farm sustainability and profitability increased. A multiagency, multidisciplinary group of scientists, including two irrigation engineers, a plant pathologist, a vegetable production specialist and an agricultural economist have formed a team that will evaluate three irrigation scenarios for tomato production: open-field center pivot sprinkler, open-field drip and drip in high tunnels. Comparisons of crop yield and quality, water-use efficiency, pest pressure, and economic viability among the three irrigation scenarios will be determined. Results will be disseminated through Fact Sheets and Extension Bulletins, presentations at grower meetings and field days, and through video and news media releases aimed at producers and consumers/retailers. This project was conceived following conversations with local and regional retailers, in which the need for a dependable supply of high quality, locally grown tomatoes was clearly expressed. Results from this project will be of value and interest to a wide range of stakeholders throughout the High Plains, extending beyond large irrigated producers to commercial retailers, small producers, truck farmers and home gardeners.

Project Narrative

Goals and Objectives. The long-term goal of this project is to determine the feasibility of commercial tomato production in the Texas Panhandle and provide current and potential vegetable growers with the information needed to produce a high yielding, high quality crop. To achieve this goal, a multidisciplinary, multiagency team of scientists will initiate a project with the following objectives: 1) compare yield and quality of tomato varieties produced with open-field sprinkler irrigation, open-field drip irrigation or drip irrigation under high tunnels, 2) evaluate the impact of these three irrigation treatments on crop water-use efficiency, insect pressure and disease incidence, 3) conduct an economic analysis of tomato production under the three irrigation treatments, and 4) provide project results to stakeholders through fact sheets, Extension Bulletins, print and web-based news articles and field days. Success in achieving these objectives will provide growers with the option to greatly increase their

"Revenue to Irrigation Ratio" (RIR), i.e. the dollars returned for each inch of irrigation water they apply in crop production, and thereby the potential to conserve groundwater, by reducing irrigation of comparatively low-value crops, and increase sustainability of their overall farming operation.

Rationale. There is little debate that farm fresh, locally grown produce is tastier and more nutritious than produce imported long distances from other states and even other countries, and this is especially true for tomatoes. In the last 50 years, there has been a 97% reduction in commercial production of fresh market tomatoes in Texas, but the recently increasing public demand for high quality, locally grown produce is creating an expanding economic opportunity for Texas vegetable farmers and retail marketers alike. In order for Texas vegetable growers to take advantage of this opportunity and be able to supply the high quality tomatoes that retail marketers and consumers want, they need information on production of tomatoes that are regionally adapted (able to withstand heat, drought stress, high wind, severe weather, insect pests and diseases) and use water efficiently. Currently there is no single program, publication or news source in Texas that provides this information for producers. Existing tomato breeding programs in Texas have focused on yield and quality, but the focus of this proposed project on drought stress, water-use efficiency and how these impact insect and disease incidence will be new. This will be the first study for the Texas High Plains that compares open-field sprinkler irrigation, open-field drip irrigation and high tunnel drip irrigation with regard to yield and quality, disease and insect pressure, and crop water-use efficiency for tomato production. Project results and an economic analysis of the three systems will be provided to farmers, members of the public such as Master Gardeners and others with an interest in the economics and commercial potential for high quality vegetable production in the Texas High Plains. This study represents an initial step in reestablishing a commercial vegetable industry in the High Plains and providing a steady supply of high quality, locally grown produce to commercial retailers, such as United, Walmart and HEB grocers, and to the public at large.

Commercial vegetable production, especially fresh market tomatoes, has potential to greatly increase the RIR of a farming operation, whether large or small. For instance, farmers in the High Plains apply from 28 to 35 acre-inches of irrigation water to produce an average of 225 bushels of corn, with expected revenue of $792/acre inch of irrigation water (Amosson, et al., 2015). This gives an RIR of $28.28 ($792/28" water). With the same amount of water, farmers in the Texas Panhandle could produce approximately 140 cwt of tomatoes, and at prices near $60/cwt they could dramatically increase their expected revenue to $8,400/acre, giving an RIR of $300.00/acre inch ($8,400/28" water). Using data from Texas Crops and Livestock Budgets (Amosson, et al., 2015), Table 1 was generated to show RIR for the major crops grown in the Texas Panhandle. Clearly, when high value crops are grown, the potential for a grower to increase the overall RIR is greatly enhanced. Thus, even though tomatoes may require relatively high rates of irrigation, the farmer receives a much greater return for each inch of irrigation water applied. This is true with tomato production and even more so with tomato production in high tunnels (Wallace, et al., 2013).

High tunnels are rapidly gaining popularity in many areas of the US with climates that are non-conducive, for much of the year, for commercial vegetable production. High tunnels, also known as hoop houses, are solar-heated structures that resemble Quonset huts covered with polyethylene or fabric. They are manually vented and do not use fans for cooling. High tunnels extend the growing season, by warming the soil and air environments allowing earlier planting in the spring and later growth into the fall (Jett, et al., 2004; Jett, 2012). They also protect plants against adverse weather conditions, such as high winds and hail, and typically result in higher yields, improved quality, but may increase or decrease pest pressure (Miles, et al., 2012; Wallace, et al., 2012). There is also the potential that crops produced in high tunnels will exhibit greater water use efficiency because previous studies in semi-closed greenhouses revealed that the plant's ability to recover transpired water resulted in greater water use efficiency (Katsoulas, et al., 2015). Since the plastic covering is rarely removed, natural rainfall does not get through to the soil inside tunnels. However, drip irrigation coupled with plastic mulches is a common use in tomato production. Plastic mulches are excellent tools for further reducing water evaporation from the soil surface. Vegetable yields in high tunnels are typically much greater than open field production and the potential for significant economic returns is very high. For instance, in a study of tomato production in high tunnels in western Washington, 480 plants in a 20' x 96' high tunnel produced an average of 9 pounds of tomatoes per plant, with a total return of $12,960 and a net return of $5,561 (Galinato, et al., 2012). The average tomato yield in high tunnels is 10 – 12 lbs per plant but price per pound can vary significantly (Jett, et al., 2004). However, even if Galinato's net profit was reduced by half that would still approximate $63,000 net profit on a per acre basis.

Table 1: Economic water use efficiency estimates for major crops grown in the Texas Panhandle *

Commodity	Avg. yield/acre **	Acre inches of irrigation water applied	Current market price ($/unit)	Crop value ($ / acre)	Revenue to Irrigation Ratio (RIR) - $$ returned per acre inch of water applied***
Wheat	62 bushel	15"	$4.82 / bushel	$ 298.84	$ 19.92
Corn	225 bushel	28"	$3.52 / bushel	$ 792.00	$ 28.28
Sorghum	75 cwt	14"	$3.80 / cwt	$ 285.00	$ 20.36
Cotton	1100 lb	12"	$0.64 / lb	$ 704.00	$ 58.67
Peanuts	3.6 ton	21"	$425 / ton	$ 1,530.00	$ 72.85
Potatoes	500 cwt	24"	$12.00 / cwt	$ 6,000.00	$ 250.00
Field Tomatoes	140 cwt	28"	$60.00 / cwt	$ 8,400.00	$ 300.00

*Data Source: Amosson, et al., 2015. Texas Crop and Livestock Enterprise Budgets. Texas A&M AgriLife Extension B-1241 . Values presented for RIR in Table 1 are for comparative purposes only and in this proposal do not include expenses associated with crop production. However, a detailed economic analysis is one of the major objectives of this study.

** Expected yield with good management and listed inputs

*** RIR = crop value in $/acre divided by acre inches of water applied.

Approach. As soon as notification of project approval is received, the research team will construct a drip irrigation system on an allotted tract of land at the USDA/AgriLife-Conservation and Production Research Laboratory, Bushland, TX. This land is located in the corner of an existing center pivot field, used for long-term plant pathology research. The drip system will be designed and constructed by the two irrigation engineers involved in this project for maximum flexibility in research treatments and water delivery. Following completion of the drip system, three 30ft x 96ft high tunnels will be erected over a portion of the drip system.

Six-week old tomato plants will be transplanted to field areas where they will be irrigated by center pivot sprinklers, open-field drip plus plastic mulch, or drip plus plastic mulch within a high tunnel. Mid to large size slicing cultivars, with demonstrated heat tolerance, will be selected for these studies. Tomatoes in the open-field will be transplanted in early-May but those within the high tunnel will be transplanted in mid-to-late March (due to warmer soil and air temperatures). During the growing season, the soil water profile will be monitored weekly in all three irrigation main treatments by field-calibrated neutron probe and electromagnetic sensors and irrigation will be applied to replace full crop evapotranspiration (ET). Irrigation applied through the center pivot and through drip will be applied weekly or biweekly and these different scheduling regimes will be considered as subplots. Tomato cultivars will be randomized within each irrigation subplot treatment. Marketable fruit will be harvested and crop yield, quality and water-use efficiency will be quantified. Data will be analyzed as previously described for a similar field study evaluating different irrigation methods (Colaizzi, et al., 2004). In addition, disease incidence and insect pressure in each of the three irrigation treatments will be monitored weekly. Previous studies have demonstrated that insect populations can be influenced by irrigation regimes (Michels, et al., 2002) and that plant diseases can impact crop water use efficiency (Workneh, et al., 2010). All expenses associated with each of the irrigation treatments will be recorded, and a detailed economic analysis will be conducted. During the season, a field day will be arranged to allow interested farmers to see the plots and ask questions, and members of the public, from groups such as Master Gardeners, also will be invited to attend.

Expected Outcomes. This will be the first study for the Texas High Plains that will compare production from different tomato cultivars under center pivot irrigation, open-field drip irrigation and high tunnel drip irrigation, in terms of yield and quality, disease and insect pressure and crop water-use efficiency. Project results and an economic analysis of the three main irrigation methods will be provided to farmers, members of the public such as Master Gardeners, and others with an interest in the economics and commercial potential for high quality vegetable production in the Texas High Plains. Results of this study also will be presented at scientific meetings of the various PIs involved in this project and published as press releases, web-based news stories/videos and in scholarly journals. This study represents an initial step in reestablishing a commercial vegetable industry in the High Plains and providing a steady supply of high quality, locally grown produce to commercial retailers, such as United, Walmart and HEB grocers, and to the public at large. It is expected that farmers who implement our research findings will substantially improve the overall RIR of their farming systems.

Relevant Publications

Belasco, E., Galinato, S., Marsh, T., Miles, C. and **Wallace, R**. 2013. High Tunnels Are My Crop Insurance: An Assessment of Risk Management Tools for Small-Scale Specialty Crop Producers. Agric. Resource Economics Review 42(2):403-418.

Colaizzi, P.D., Evett, S.R., Howell, T.A., and Baumhardt, R.L. 2010. Crop production comparison with spray, LEPA, and subsurface drip irrigation in the Texas High Plains. In: Proceedings of the 5th Decennial National Irrigation Symposium, December 5-8, 2010, Phoenix, Arizona. Paper No: IRR10-9704. (Peer-Reviewed Conference Proceedings).

Hillyer, C. and Robinson, R. 2010. Envisioning the Next Generation of Irrigation Schedulers. In: 5th National Decennial Irrigation Conference, Phoenix, AZ: ASABE

Obembe, O.S., **Almas, L.K**., Guerrero, B.L., and Lust, D.G. 2014. Economic Analysis of Sorghum Silage Potential for Dairy Industry in the Texas High Plains. Conference Proceeding Paper presented at the Southern Agric. Economics Association (SAEA) Annual Meetings, Dallas, TX February 2014.

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7. Miles, C., **Wallace, R.,** Wszelaki, A., Martin, J., Cowan, J., Walters, T. and Inglis, D. 2012. Deterioration of Potentially Biodegradable Alternatives to Black Plastic Mulch in Three Tomato Production Regions. HortScience 47(9):1270-1277.
8. **Wallace, R**., Masabni, J., Gu, M., Nesbitt, M., Porter, P., and Palma, M. 2013. Specialty Crops for High Tunnel Production in Texas. Texas A&M AgriLife Extension Bulletin. HT-029. 16 pp.
9. **Wallace, R.**, Wszelaki, A., Miles, C., Martin, J., Cowan, J., Gunderson, B., and Inglis, D. 2012. Lettuce Yield and Quality when Grown in High Tunnel and Open-Field Production Systems under Three Diverse Climates. HortTechnology 22(5):659-668.
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