PRECISION AGRICULTURE INITIATIVE FOR TEXAS HIGH PLAINS

2002 ANNUAL REPORT

Texas Agricultural Experiment Station and Texas Cooperative Extension

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Primary Research Locations:
Western Peanut Growers Research Farm (WPGRF), near Denver City.
Agricultural Complex for Advanced Research and Extension Systems (AG-CARES), near Lamesa.

Project Title: Water Management in Precision Agriculture in Peanut Systems

Project Objectives:
1. Utilize GPS-referenced information on chemical and physical soil properties and soil anomalies; irrigation methods and intensities; plant tissue properties; aerial imaging; and yield mapping technology to diagnose water-related production problems and guide peanut production practices for economically and environmentally sustainable yields of high quality peanuts.

2. Adapt and utilize variable rate technology to measure and manage effects of water inputs, yield mapping harvesters, and other instruments in precision agriculture systems.

3. Evaluate effectiveness of site-specific water management in peanut production systems and transfer useful information to growers, consultants, and industry clientele via meetings, popular and scientific publications, and web sites.

Reporting Period: January 1, 2002 – December 31, 2002

A. Summary of Progress: (Summarize progress on each specific objective listed above)

1. Utilize GPS-referenced information on chemical and physical soil properties and soil anomalies; irrigation methods and intensities; plant tissue properties; aerial imaging; and

yield mapping technology to diagnose water-related production problems and guide peanut production practices for economically and environmentally sustainable yields of high quality peanuts.

Irrigation Application Research

The work was conducted at the Western Peanut Growers Research Farm (WPGRF) in Gaines County, Texas and at the Agricultural Complex for Advanced Research and Extension Systems (AG-CARES) in Dawson County, Texas. Irrigation studies were conducted in the fifth through seventh spans of the east irrigation circle at WPGRF and in the eighth span at AG-CARES. From the beginning of our irrigation research (which predates the PA project), we used the peanut variety that was contracted for sale from the farm that crop year: Florunner in 1995, 1996, and 1997 and Tamrun88 in 1998 and 1999 at AG-CARES; and FlavorRunner 458 in 2000 and 2001 at both AG-CARES and WPGRF. Following the 2001 crop, we began to suspect that FlavorRunner 458 might be reacting differently to irrigation application method than Florunner and Tamrun 88 had in past research. To test this hypothesis, we grew FlavorRunner 458, Florunner, and Tamrun 96 peanuts at both locations in 2002; Tamrun 88 seed was not available. At WPGRF, we used three irrigation strategies after stand establishment: (1) Low-Energy Precision Application (LEPA), using drag tubes and socks; (2) Low Elevation Spray Application (LESA) using two applicator types--low drift spray and wobbler-type nozzles; and (3) LEPA-LESA-LEPA, in which LEPA was used until early-July, LESA (low drift spray) was used during the bulk of the pod-development period, and LEPA resumed late in the season if leaf damage previously associated with long-term LESA developed. In all methods, irrigation amounts were applied to approximate 75% ET replacement; with additional 50% and 100% ET levels using LEPA. At AG-CARES, we used only LEPA and LEPA-LESA-LEPA at one irrigation rate.

At harvest, peanut plants were dug using commercial diggers. Yield estimates were obtained using a plot thresher on four small plot sample locations (4 rows by 20 feet) in each variety-irrigation treatment combination and also using the Peanut Yield Mapping System (PYMS) developed by engineers and scientists at the University of Georgia (UGA) Coastal Plains Research Station at Tifton, Georgia. The PYMS data has the advantages of using the actual harvest equipment used by producers and of gathering numerous GPS-referenced yield numbers that can be compared to site specific environmental and management conditions and spot observations made during the growing season. The PYMS system has been tested and utilized in our peanut PA research since the fall of 1998.

Irrigation Application Rates

Irrigation application rates targeting 50%, 75%, and 100% evapotranspiration replacement were applied through LEPA irrigation during the 2002 cropping season. Standard LEPA practice included application by drag hoses in alternate furrows, circular planting pattern to match traffic of the center pivot irrigation system, and furrow dikes (to the extent practical) to improve in-furrow water application uniformity. Furrow dikes are extremely difficult to maintain in the sandy soils at WPGRF. Yield was determined through small plot sampling (4 rows by 20 ft. for each treatment and replication block) and with the PYMS-equipped peanut combine. Samples were graded in the laboratory to determine whether different irrigation treatments effected differences in product quality. Table 1 illustrates the yield responses of each variety to irrigation application rates using the two data sources, as well as the grades obtained from the small plot samples. When comparing the small plots and yield mapping, the mean yields for each

variety-irrigation level combination are fairly similar. With only four values for each treatment forming the basis for statistical comparison, there are no significant differences among the irrigation levels for any variety. Uncontrolled variability among replicate samples was simply too large to obtain statistical certainty that the differences among treatment means are real. When the numerous observation points from the PYMS were compared, we found that yields for all cultivars were lowest with 50% ET, but not significantly improved by increasing the 75% ET replacement to 100% ET replacement. Grades were not affected by differences in irrigation rate.

Table 1. Mean harvested yield, small plot samples and PYMS data, WPGRF 2002.

Irrigation rate, Target %ET	**50% ET**	**75% ET**	**100% ET**
Small Plot Yield (lb/ac)			
Florunner	3,576 a*	4,447 a	4,792 a
Tamrun 96	3,467 a	4,392 a	4,692 a
FlavorRunner 458	3,666 a	4,556 a	4,056 a
PYMS Yield (lb/ac)			
Florunner	3,910 a	4,547 b	4,644 b
Tamrun 96	3,718 a	4,214 b	4,402 b
FlavorRunner 458	3,997 a	4,255 b	4,283 b
Grade			
Florunner	78.2 a	79.5 a	78.2 a
Tamrun 96	77.6 a	77.2 a	77.4 a
FlavorRunner 458	76.7 a	78.9 a	77.6 a

** Note: values in each row followed by the same letter are not significantly different at 0.05 probability.*

Irrigation Application Methods

Throughout the 2000 and 2001 cropping seasons two LEPA methods (drag hoses and bubbler-mode nozzles) and two LESA methods (low drift spray and wobbler-type nozzles) were used at WPGRF to apply water at a base target irrigation rate of 75% crop evapotranspiration replacement. Because their results were so similar, we eliminated the bubbler applicator and used only drag hoses for LEPA applications in 2002. Yields were determined by small plot sampling (4 rows by 20 ft. for each treatment and replication block) and with the PYMS-equipped peanut combine. Samples were graded in the laboratory to determine whether different irrigation treatments effected differences in product quality.

Effects of irrigation method and strategy are shown in Table 2 for WPGRF and in Table 3 for AG-CARES. As with irrigation rate responses, relative yields among irrigation strategies were not statistically different when we used the small plot data. When the numerous GPS-referenced yield mapping points were analyzed, we were able to identify differences in the effect of irrigation strategy on each cultivar. Of all the cultivars, it appears that Florunner may have

responded more favorably to LEPA, while Tamrun 96 and FlavorRunner 458 responded more favorably to the LEPA-LESA-LEPA sequence.

Table 2. Mean harvested yield, small plot samples and PYMS data, WPGRF 2002.

Irrigation Method	**LESA**	**Wobbler**	**LEPA**	**LEPA-LESA- LEPA**
Small Plot Yield (lb/ac)				
Florunner	3,530 a*	4,383 a	4,292 a	3,866 a
Tamrun 96	3,766 a	3,875 a	4,392 a	3,648 a
FlavorRunner 458	3,775 a	4,383 a	4,556 a	3,666 a
PYMS Yield (lb/ac)				
Florunner	4,271 b	3,996 a	4,547 b	4,397 b
Tamrun 96	4,131 a	4,181 a	4,214 a	4,569 b
FlavorRunner 458	4,057 a	4,298 b	4,255 b	4,319 b
Grade				
Florunner	78.7 a	79.5 a	79.5 a	78.7 a
Tamrun 96	78.4 a	79.2 a	77.2 a	78.2 a
FlavorRunner 458	79.5 a	79.7 a	78.9 a	79.1 a

** Note: values in each row followed by the same letter are not significantly different at 0.05 probability.*

Table 3. Mean harvested yield, small plot samples and PYMS data,, AG-CARES 2002.

Irrigation Method	**LEPA**	**LEPA-LESA- LEPA**
Small Plot Yield (lb/ac)		
Florunner	2,439 a	2,232 a
Tamrun 96	2,526 a	2,211 a
FlavorRunner 458	2,363 a	2,243 a
PYMS Yield (lb/ac)		
Florunner	2,996 b	2,521 a
Tamrun 96	2,944 a	2,702 a
FlavorRunner 458	2,944 a	3,000 a
Grade		
Florunner	70.8 a	68.8 a
Tamrun 96	66.8 a	68.5 a
FlavorRunner 458	66.2 a	63.9 a

** Note: values in each row followed by the same letter are not significantly different at 0.05 probability.*

General Progress

Base information

The completion of chemical and mechanical analyses of all half-acre grid soil samples collected at WPGRF for chemical properties for depths of 0-6", 6-12", 12-24", and 24-36" wherever initial sampling depths allowed have enabled us to develop maps using geographic information software (GIS) for all soil chemical and physical properties. Along with the detailed GPS-referenced elevation data for the entire WPGRF collected in cooperation with USDA Natural Resources Conservation Service collaborator, we have begun the task of relating past yield data to site specific properties of the field. We continue to find correlations of the effect of the caliche and related soil attributes on peanut yields within the irrigation research areas and throughout the field, e.g. reduced yields with increasing pH and calcium and with decreasing sulfur and depth to caliche. These areas are often identifiable from remote imaging data.

Peanut Yield Mapping System

The ability to produce a yield map of the field is a very important tool in site-specific or precision agriculture approaches. Detailed yield maps can then be linked by GPS coordinates to other maps, such as those for soil chemical and physical properties, soil depth, surface slope, remote sensing data (such as, aerial photography), weeds, diseases, nematodes, insects, and varying cultural practices. In 1998, we were able to install and test a peanut yield mapping system (PYMS) developed by engineers and scientists at the University of Georgia (UGA) Coastal Plains Research Station at Tifton, GA. UGA cooperators included Dr. George Vellidis, Calvin Perry, and Jeffrey Durrence. With their cooperation, the Texas Agricultural Experiment Station acquired a four-row peanut combine. The UGA collaborators transported that combine to their shop where they modified it to accept the mapping instrumentation. The combine was then shipped to Lamesa where we installed load cells, wiring, and other instrumentation with the assistance of personnel from Nix Implement Company.

We have used the PYMS in 1998-2002 at AG-CARES, 1999 and 2002 in producers' fields, and 2000-2002 at WPGRF. Information from yield maps shown in Figures 1 and 2 were used in this and past years' research in this report and by other peanut PA researchers. Although the system has not been commercialized to date, it has been rugged and accurate in five years of field use in West Texas, as well as by its developers in the Southeast. If commercialized and sold for a reasonable price, PYMS will be of great value in supplying information for farmers' management decisions.

2. Adapt and utilize variable rate technology to measure and manage effects of water inputs, yield mapping harvesters, and other instruments in precision agriculture systems.

We continue to collaborate with scientists at Halfway and the Uvalde center who are doing actual design and testing of variable rate water application technology. Much of our research information about site specific responses to various irrigation application methods and rates will be valuable in putting their creations into practical use. The Peanut Yield Mapping System has been discussed widely in other sections of this report and those of other peanut researchers. The PYMS allows so many more yield observation points that subtle yield differences among imposed treatments can be identified, even against a background of numerous confounding environmental factors that are both site specific and uncontrollable. Because the

Figure 1. Western Peanut Growers Research Farm yield map determined using the Peanut Yield Mapping System in 2002.

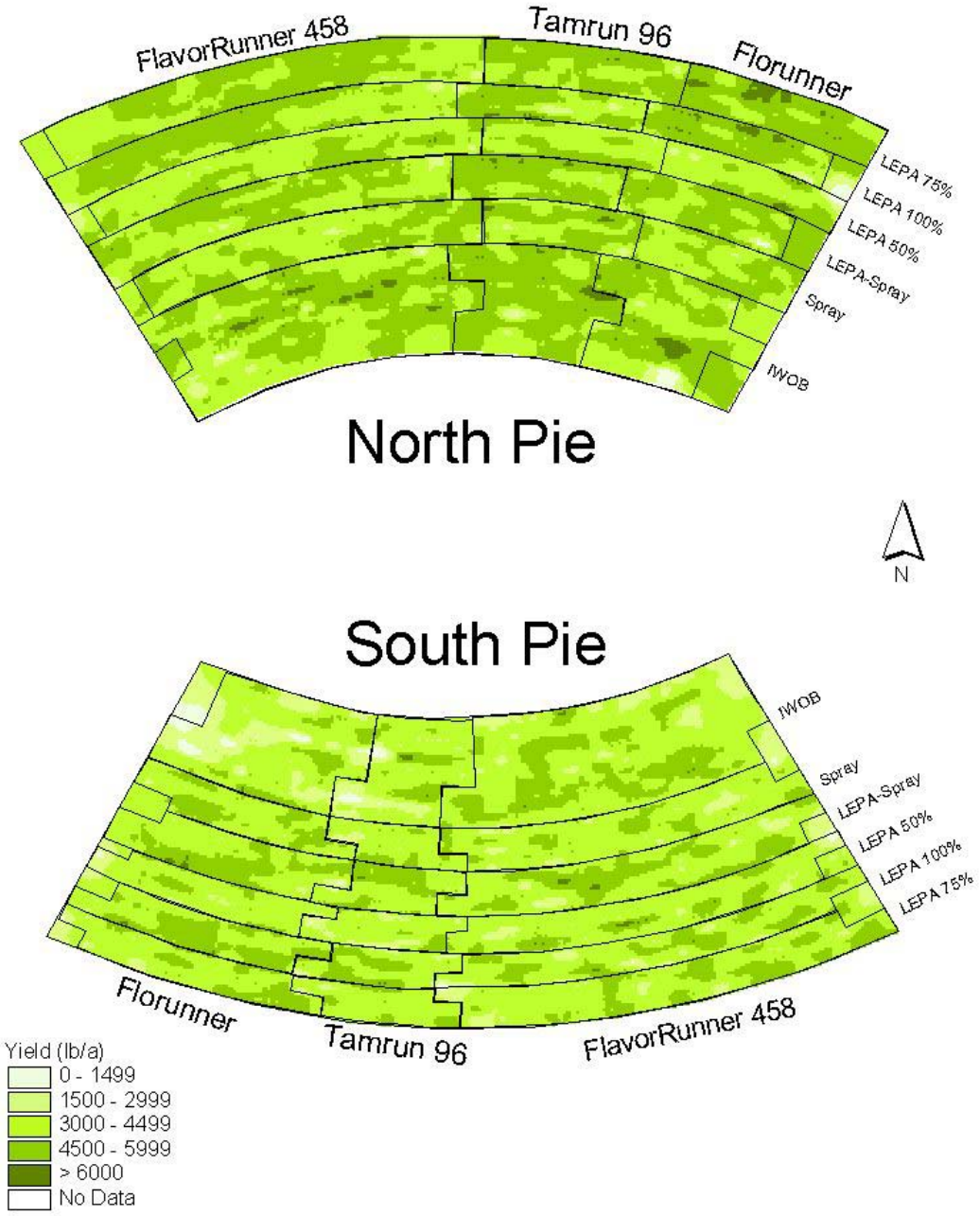
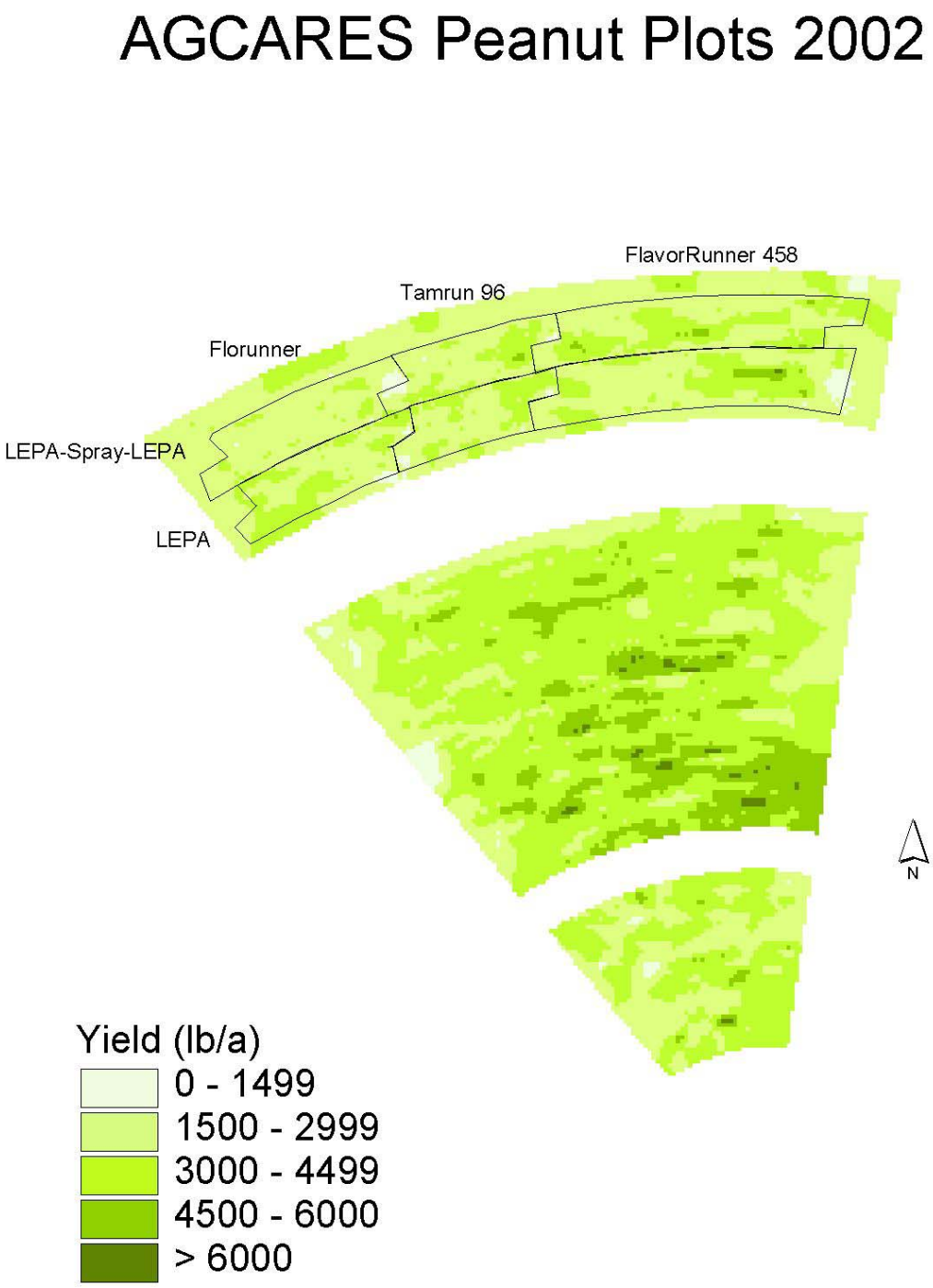


Figure 2. Agricultural Complex for Advanced Research and Extension Systems yield map determined using the Peanut Yield Mapping System in 2002.



PYMS yield data is GPS-referenced, we can relate yield to site specific environmental factors, which may permit us to identify those factors that can be changed or allow us a framework for making management decisions about how to react to those factors that cannot be changed. We have collaborated with scientists who are directly using hyperspectral technology and will work with them to utilize that tool, as well as the infrared, aerial imaging that is already in use.

3. Evaluate effectiveness of site-specific water management in peanut production systems and transfer useful information to growers, consultants, and industry clientele via meetings, popular and scientific publications, and web sites.

Progress under this objective has been fairly well covered in other discussions in this document. We have passed along information to various audiences as soon as we were comfortable enough with the accuracy of our observations to do so.

B. Education/technology transfer:

WEB SITE AND WEB POSTINGS

http://lubbock.tamu.edu/peanut/

Schubert, A.M., Calvin Trostle, and Dana Porter. 2002. Precision Agriculture Yield Mapping System for Peanuts on the Texas South Plains. Texas A&M University Agricultural Research and Extension Center, Lubbock-Halfway, Texas. http://precisionagriculture.tamu.edu/brochures/yldmappnut.pdf

PRESENTATIONS AT PRODUCER AND OTHER PUBLIC MEETINGS

Schubert, Mike. Peanut Physiology Research in Northwestern Texas. Texas Peanut Producers Board. Lubbock. March 7, 2002.

Schubert, Mike. Impact of Temperature on the Growth, Production, and Quality of Peanuts. National Peanut Board. Lubbock. March 7, 2002

Porter, Dana. Texas Peanut Producers Board and National Peanut Board. Lubbock. March 7, 2002.

Mike Schubert. Annual Meeting Western Peanut Growers Association. Report on Research Farm Activities and distributed bound collection of reports from all researchers. March 25, 2002.

Schubert, Mike. AG-CARES/Dawson County Farm Tour. Discussed research conducted at AG-CARES, including Peanut PA. General audience composed primarily of producers and ag industry personnel. September 12, 2002.

Schubert, Mike, Dana Porter, Terry Wheeler, Calvin Trostle, et al. Western Peanut Growers Association Research Farm Tour. Discussed general operations and Peanut

Precision Ag and other research at the WPGRF. Audience primarily composed of members of the Western Peanut Growers Association. September 18, 2002.

PRODUCER GROUP PUBLICATIONS AND POPULAR ARTICLES

New Texas Web site for peanut info and links. 2001. In: The Peanut Farmer. Volume 37. No. 6. June 2001.

Porter, Dana. 2001. "Irrigation Water Management Research Update." Western Peanut News, Western Peanut Growers Association, Inc. Publication Volume 3, September 2001.

Porter, Dana, A. Michael Schubert, and Terry A. Wheeler. 2002. Irrigation Management for Peanut Production Under Water-Limited Conditions. In: Western Peanut News. Western Peanut Growers Association, Inc. Publication Volume 4 No. 2. September 2002.

Porter, Dana O., A. Michael Schubert, Jacob Reed, Terry Wheeler, James P. Bordovsky. 2002. Irrigation Water Management: Irrigation Scheduling and Application Methods. In: Research Conducted at the Western Peanut Growers Research Farm—2001 Crop Year. Annual report to Western Peanut Growers Association. Texas Agricultural Experiment Station, Texas Cooperative Extension, Texas Tech University, and USDA. March 2002.

Porter, Dana. O., A. Michael Schubert, and Terry A. Wheeler. 2002. Irrigation methods and management for peanut production under water-limited conditions. Western Peanut News. Vol. 4. Page 5.

Porter, Dana. O., A. Michael Schubert, Terry A. Wheeler, and Megha Parajulee. 2002. Irrigation methods and management for peanut production under water-limited conditions. The Texas Peanut Producer. Vol. 31. Page 6.

Schubert, Mike. 2002. Peanut physiology research in northwest Texas. The Texas Peanut Producer. Vol. 31. Page 8.

Schubert, Mike, Dana Porter, Terry Wheeler, Calvin Trostle, Kevin Bronson, Peter Dotray, Wayne Keeling, and others. 2002. Peanut Precision Agriculture Studies at WPGRF. In: Western Peanut News. Western Peanut Growers Association, Inc. Publication Volume 4. Page 7.

Schubert, Mike, Calvin Trostle, Dana Porter, Kevin Bronson, Peter Dotray, Wayne Keeling, and Terry Wheeler. 2002. Yield Mapping System for Precision Ag Use in Peanuts. In: Western Peanut News. Western Peanut Growers Association, Inc. Publication Volume 4. Page 7.

Schubert, Mike. 2002. Peanut Precision Agriculture Studies at Western Peanut Growers Research Farm (Gaines County, Texas) 2001. In: Research Conducted at the Western Peanut Growers Research Farm—2001 Crop Year. Annual report to Western Peanut Growers Association. Texas Agricultural Experiment Station, Texas Cooperative Extension, Texas Tech University, and USDA. March 2002.

Stalcup, Larry and Dana Porter. 2002. Which Irrigation System Works Best? 2002 Research Looks at Advantages in Both. In: The Texas Peanut Report. Quarterly Publication of the Texas Peanut Producers Board. Summer 2002.

Wheeler, Terry, Dana Porter, and Mike Schubert. 2002. Use of Aerial Hyperspectral Sensor to Identify Stresses Which Limit Cotton Production. In: Research Conducted at the Western Peanut Growers Research Farm—2001 Crop Year. Annual report to Western Peanut Growers Association. Texas Agricultural Experiment Station, Texas Cooperative Extension, Texas Tech University, and USDA. March 2002.

C. Milestones achieved:

With the completion of all soil chemical and physical analyses at 0-6, 6-12, 12-24, and 24-36" depths and elevation maps at WPGRF, we have begun the process of assessing numerous site specific effects on peanut yield and quality under both extant and imposed conditions.

We have used infrared aerial images from the WPGRF and AG-CARES sites along with maps of soil chemical and physical properties and yield maps to make management decisions and decisions about location of specific research projects at these sites. This use constitutes a prototype application of PA technology that can be utilized by producers and consultants.

D. Publications:

GRANT & CONTRACT REPORTS

Schubert, A.M., and J.D. Reed. 2002. Peanut Physiology Research in Northwestern Texas. Peanut Research and Education Review, Texas Peanut Producers Board. Report No. 12. p. 6.

Porter, D.O., A.M. Schubert, and J.P. Bordovsky. 2002. Irrigation Water Management: Irrigation Scheduling and Application Methods. Peanut Research and Education Review, Texas Peanut Producers Board. Report No. 14. p. 5.

UNIVERSITY PUBLICATIONS

Schubert, A.M., Calvin Trostle, and Dana Porter. 2002. Precision Agriculture Yield Mapping System for Peanuts on the Texas South Plains. Texas A&M University Agricultural Research and Extension Center, Lubbock-Halfway, Texas.

Schubert, Mike, Dana Porter, and Jacob Reed. 2003. Irrigation/Precision Agriculture Study at AG-CARES. Lamesa, Texas 2002. In: 2002 Annual Report: Agricultural Complex for Advanced Research and Extension Systems AG-CARES). Texas A&M University Agricultural Research and Extension Center, Lubbock-Halfway, Texas.

JOURNAL ARTICLES

Bronson, K.F., A.M. Schubert, J.D. Booker, C.L. Trostle, and T.T. Chua. 2002 Leaf Nutrients and yields of irrigated peanut in the Southern High Plains: Influence of nitrogen, phosphorus, and zinc fertilizer. Submitted to Field Crops Research.

E. Precision agriculture proposals:

Burow, Mark, Michael Schubert, John Burke. 2002. Development of Peanut Varieties with Greater Efficiency in Water Usage (Genetic Improvement of Peanuts for Water and Heat Stress Response). Southwest Consortium on Plant Genetics and Water Resources. $49, 733. Schubert portion $8,500 FUNDED.

Porter, D.O., A.M. Schubert, and J.P. Bordovsky. 2002. Irrigation Water Management: Irrigation Scheduling and Application Methods. Submitted to the Texas Peanut Producers Board. $13,900 Requested. $5,000 FUNDED.

Schubert, A. Michael. Impact of Temperature on the Growth, Production, and Quality of Peanuts. National Peanut Board. $18,230. NOT FUNDED.

Schubert, A. Michael, and Dana O. Porter Irrigation Management and Drought Stress Resistance. National Peanut Board. $19,996. FUNDED.

Schubert, A.M. and J.D. Reed. 2002 Peanut Physiology Research in Northwestern Texas. Submitted to the Texas Peanut Producers Board. $9,500 Requested. $5,000 FUNDED.

F. Precision Agriculture meetings attended/papers (posters) presented:

Bronson, K.F., A.M. Schubert, C.L. Trostle, J.D. Booker, and T.T. Chua. 2002. Landscape-Scale Spatial Characterization of Soil Properties and Peanut Yield. [CD-ROM computer file]. In: P.C. Roberts et al. (eds.) Proceedings of the 6th International Conference on Precision Agriculture, Minneapolis, MN, Jul. 14-17, 2002, ASA, CSSA, and SSSA, Madison, WI.

VijayKumar Choppakatla, T. Wheeler, G. Schuster, C. Robinson, and D. Porter. 2002. The Influence of Soil Moisture on Incidence of Pod Rot of Peanut Caused by Pythium myriotylum and Rhizoctonia solani. Presented at TAMUS Ag Program Conference, College Station, TX. January 7-11, 2002. Awarded first place in the Graduate Student Competition.

Porter, Dana, A.M. Schubert, J. Reed, T.A. Wheeler. 2002. Irrigation Management for Peanut Production under Water-Limiting Conditions. Presented at: 34th Annual APRES (American Peanut Research and Education Society) Meeting. Research Triangle Park, North Carolina. July 16-19, 2002.

Porter, D.O., A.M. Schubert, and T.A. Wheeler. 2002. Irrigation Management for Profitable Peanut Production under Water-Limited Conditions. Presented at: 2002 Annual International Meeting of the American Society of Agricultural Engineers. Chicago, Illinois. July 29-31, 2002.

G. Other developments: (Anything that impacted research progress, positive or negative)

The decline in water supply at AG-CARES has adversely affected peanut yields at that location. This has mixed effects, because while it might reduce the reliability of the data in the view of some observers, it also allows us to work in a short-water situation typical of many area farms. Water supply issues at WPGRF led us to forego any research on the west circle. Although this reduces the amount of land available for use in extant site specific comparisons, it allowed us to do a better job of growing peanut and cotton for research on the west circle, as indicated by higher yields than in the first two years at the WPGRF site.