**Influence of Agricultural Terraces on Soil Water and Physical Properties in Oklahoma**

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**Overview**

Understanding the effects of agricultural terraces in soil physical properties, wheat (*Triticum aestivum* L.) growth and by-plant variability in central Oklahoma is fundamental for improving resource use efficiency, such as water and nitrogen fertilizer, and thus arises as a valuable tool for precision agriculture and leads to greater economy at landowner and State levels. Terracing is a necessary practice in avoiding soil and nutrient losses in sloping areas, and is a common feature in Oklahoma's agricultural land due to the characteristic sloping landscape. Terraces increase temporary surface moisture storage capacity, encourage infiltration, and conserve more water for plant growth. Field research has indicated greater soil moisture content throughout the root zone in the terrace channel when compared to the in-between channel intervals. The greater water content in the channel can lead to a better efficiency in the use of nitrogen, as its absorption by the root via mass flux is dependent on water and, therefore, facilitated by greater water availability. However, the gradient of change of soil water and physical properties across the soil profile as affected by terraces in Oklahoma is unknown. Given the wide use of terraces in Oklahoma and the increasing adoption of precision agriculture and variable rate nitrogen application, the knowledge on the distribution of soil water and physical properties as affected by terracing is critical.

The *long-term goal* of the team, as Master and Ph.D. candidates at the Department of Plant and Soil Sciences at Oklahoma State University, is to better understand and improve the agricultural systems of Oklahoma, focusing on soil and crop management. The *objective* of this proposal is to complete a preliminary step of in-situ physical properties characterization across terraces in Oklahoma, through determining how soil moisture, physical impedance and bulk density, varies with increasing distances from terrace. The *rationale* behind this proposal is that the knowledge of soil physical parameters distribution across terraces will help site-specific crop management via variable-rate application of fertilizers in precision agriculture; thus resulting in lower production costs and higher nutrient use efficiency for Oklahoma producers. The research team is *well qualified* to thrive in the proposed project due to the strong background in plant and soil sciences, experience in collecting and analyzing soil samples and plant tissue, and knowledge in processing and presenting data by the use of Geographic Information Systems. The specific *aims* of this proposal are:

**1. Assess soil physical properties on the soil profile as a function of horizontal and vertical distances from agricultural terraces.** Volumetric soil water content, mechanical impedance and bulk density, will be measured at regular distances from terraces. General soil texture will also be analyzed.

**2. Determine the effects of possible differences in soil physical properties resulting from terraces on wheat growth and by-plant variability.** Dry matter, normalized difference vegetative index (NDVI), and CV from NDVI readings will be measured at regular distances from terraces.

**3. Develop a grid-based representation of soil physical properties, plant growth and variability affected by distance from the terrace.** Geo-statistical tools such as Krigging will be

applied to the dataset to create a visual representation of the terrace influence on studied variables.

This project has as expected benefits the intensive training of the students enrolled in SOIL 5583 in both field and laboratory analysis of soil physical parameters, such as volumetric water content, mechanical impedance, bulk density, and soil texture. The main product this project will deliver is a detailed grid representation of soil physical parameters across terraces, depicting the gradient in changes in each measured physical property as influenced by the terraces. The nitrogen use-efficiency in Oklahoma's farms can be increased by the use of these products by variable rate nitrogen application used in precision agriculture. The innovation of this research lies in linking soil physical parameters to the necessity of increasing the efficiency in use of nitrogen fertilizers, through better understanding terracing, a broadly used agricultural practice in Oklahoma. Due to the great extent and use of terraces in Oklahoma, this project can be expected to impact the farmland profitability through a more efficient use of nitrogen fertilizer based on soil physical parameters.

**Significance**

Oklahoma's farmland is characterized by the extensive presence of terraces due to its inherent sloping landscape. The effectiveness of using level terraces to prevent surface runoff, increase soil water infiltration, and plant available water, have been widely discussed (Saxton and Spomer, 1968; Miller and Shrader, 1972; Phillips and Beauchamp, 1966; Ballantyne et al., 1965). However, soil moisture content differs from the terrace channel to the in-between terraces areas in terraced land (Miller and Shrader, 1972). In addition, soil moisture content influences nitrogen uptake by plants, and thus adequate levels of soil water can increase the use-effectiveness of nitrogen fertilizer, which today is considered to be 33% (Marschner, 1995; Raun and Johnson, 1999). Therefore, understanding the gradient of soil water and physical parameters distribution across terraces in Oklahoma becomes an important factor increasing the accuracy in variable rate nitrogen application.

The proposed work is *significant* to Oklahoma's agricultural production due the possibility of decrease costs by increasing the nitrogen use efficiency through soil physics parameters. It is an initial step in the characterization of soil physical properties across terraces, which can ultimately affect nutrient use efficiency and thus lead to lower costs of production associated with variable rate applications. Previous work performed in contour hedgerow systems (Agus et al., 1997) or dryland terraces in the Loess Plateau in China (Lu et al., 2009) supports the feasibility of the proposed work, delineates possible methodologies, and suggests differences in soil physical properties across contours and terraces studied in different environmental conditions. The proposed work is also significant as it will help in the knowledge-building process of students in SOIL 5583, serving as a training in several field and laboratory methodologies applied in soil physics.

**Narrative**

The methodology to be followed in this study will be adapted from Lu et al. (2009).

**1. Assess soil physical properties on the soil profile as a function of horizontal and vertical distances from agricultural terraces.** The central terrace of a field cultivated to dual-purpose winter wheat in a Kirkland silt loam near Marshall, OK, will be used to collect soil samples. Deep soil cores will be collected using a Giddings soil probe at specific distances from the terrace, repeated four times in the terrace. Distances from the terrace will be 0 m (top of the terrace), 1, 2, 4, 6, 8, and 10 m, up and down the slope (Figure 1A). Samples will be collected down to 120 cm in at the following intervals: 0 – 10 cm, 10 – 20 cm, 20 – 40 cm, 40 – 80 cm, and 80 – 120 cm (Figure 1B). Each sample will be analyzed in the laboratory for volumetric soil water content and bulk density. Soil texture will also be analyzed from a composite sample for each depth studied. Mechanical impedance will be measured with a penetrometer at a neighboring point from the sample collection.

**2. Determine the effects of possible differences in soil physical properties resulting from terraces on wheat growth and by-plant variability.** The study field should be planted to winter wheat during September as it is intended to a dual-purpose situation. Thus, by late October measurements of dry matter (collected from 1 linear meter), canopy cover, and normalized difference vegetative index (NDVI via GreenSeeker Sensor), will be taken at the same distances where the soil samples were collected.

**3. Develop a grid-based representation of soil physical properties, plant growth and variability affected by distance from the terrace.** Geo-statistical tools such as Krigging will be applied to the dataset to create a visual representation of the terrace influence on studied variables.

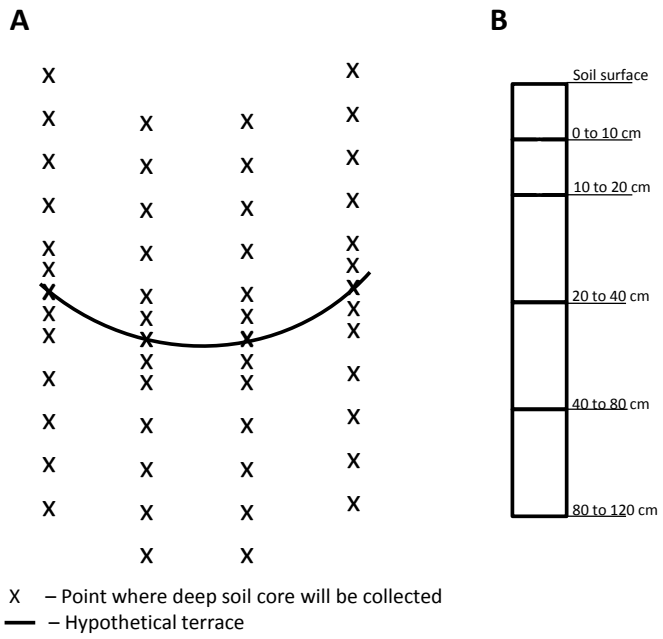



**Figure 1.** Representation of the points where deep soil cores will be collected from in a hypothetical terrace (A); and five different depths of soil cores to be collected and analyzed from each point (B).

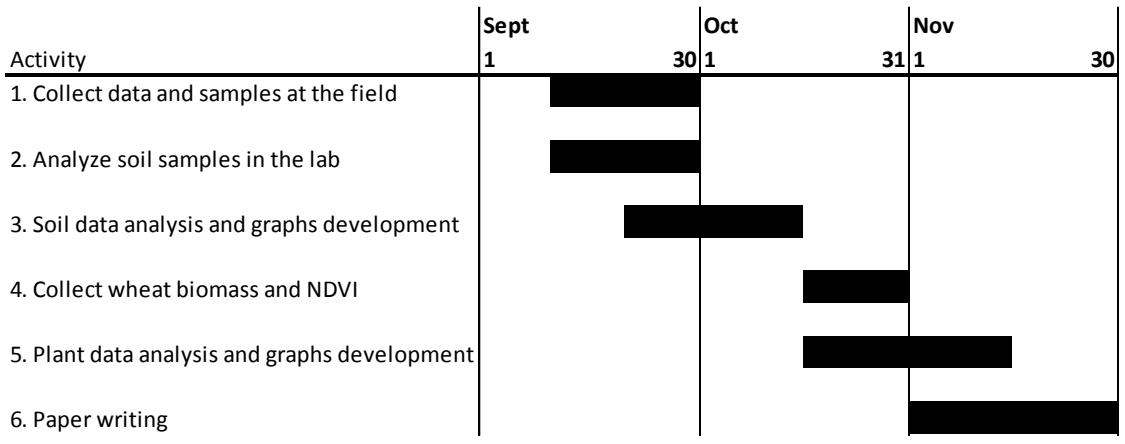
**Budget**

| Item | Unit cost ($) | Quantity | Total cost ($) |
|---|---|---|---|
| *Transportation* | | | |
| 12 Passenger Van | | | |
| Daily Rental | $60/day | 5 days | $300.00 |
| Mileage | $0.45/mi | 500 miles | $225.00 |
| Truck and Trailer | | | |
| Diesel | $4.00/gal | 10 mi/gal | $84.00 |
| *Soil physical properties* | | | |
| Penetrometer | No Cost | 1 | |
| Plastic bags (Zip Loc) | $7.12 | 8 (400) | $56.96 |
| Paper bags | $45.00 | 1 (80) | $45.00 |
| Flags | $10.00 | 1 (80) | $10.00 |
| Field supplies | | | $50.00 |
| Total Estimated Costs | | | $770.96 |

**Extra Items Needed (cost not applicable)**

Measuring tape, GreenSeeker sensor, digital camera, Giddings probe and tractor, scale, oven (for both soil samples and plant tissue), ice chests and ice, sharpies.

**Timeline**



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**Education**

Oklahoma State University, Stillwater, Oklahoma. College of Agricultural Sciences and Natural Resources. Currently pursuing PhD in the Department of Plant and Soil Sciences, Anticipated July 2015. GPA:

Sao Paulo State University, Botucatu, Sao Paulo, Brazil. College of Agricultural Sciences. Master of Science in the Department of Agricultural Sciences, Graduated May 2012. GPA: 4.0

Sao Paulo State University, Botucatu, Sao Paulo, Brazil. College of Agricultural Sciences. Bachelor of Science in the Department of Agricultural Sciences, Graduated December 2009. GPA: 3.6

**Experience**

**Graduate Research Assistant** **August 2012 - present**

Oklahoma State University, Stillwater, Oklahoma. Currently working under Dr. Chad J. Penn, studying the physical and chemical effects of gypsum application on Oklahoma subsoil acidity.

**Graduate Research Assistant** **March 2010 - May 2012**

Sao Paulo State University, Botucatu, Sao Paulo, Brazil. Working under Dr. Ciro A. Rosolem, studying Soil fertility and cropping systems.

**Undergraduate Research Assistant** **March 2005 - December 2009**

Sao Paulo State University, Botucatu, Sao Paulo, Brazil. Working under Dr. Ciro A. Rosolem, studying Plant mineral nutrition and cropping systems.

**Internship in crop management** **March 2005 - December 2007**

Sao Paulo State University, Production Farm. Botucatu, Sao Paulo, Brazil. Learning the crop management, in soil chemical and physical parameters, weeds, insects and disease control, working with corn, wheat, barley, soybeans, rice and common beans.

**Publications**

Rosolem, C., Steiner, F., Zoca, S.M., Ducatti, C.. Nitrogen Immobilization by Congo Grass Roots Impairs Cotton Initial Growth. 2012. **Journal of Agricultural Science.** Vol. 4, n.9, 126:136

Rosolem C.A., Andrade G.J., Lisboa I.P., Zoca, S.M. 2010. Manganese uptake and redistribution in soybean as affected by glyphosate. Brazilian Journal of Soil Science. Vol. 34, n.6, 1915:1922

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Londrina State University, Londrina, Parana, Brazil. College of Agricultural Sciences. Bachelor of Science in the Agricultural Sciences Center, Graduated December 2009. GPA: 3.6

## Experience

**Graduate Research Assistant** **August 2010-present**
Oklahoma State University, Stillwater, Oklahoma.
Currently working under Dr. Jeffrey T. Edwads, studying small grain production in Oklahoma and more specifically the effect of acidity amelioration treatments on soil pH and wheat growth and development.

**Crop Analyst** **August 2009 – July 2010**
Cargill S/A, Sao Paulo, Sao Paulo, Brazil.
Analyzed the current crop year, estimating total production of these crops in Brazil based on field trips, yield and acreage estimations per state, to enable the company to have better positions on the stock market.

**International Internship in Plant Breeding** **January 2008 - February 2008**
National Institute of Farming and Livestock Raising Technology (INTA), Cerrillos, Salta, Argentina. Explored exportation opportunities for Brazil in the white and colored beans market; assessed and reported an economic analysis of edible bean production in Argentina; performed experimental field tasks.

**Internship in Plant Breeding** **March 2006 - August 2008**
Agronomic Institute of Parana (IAPAR), Londrina, Parana, Brazil. Researched and published results in plant breeding, including analysis of the genotype by environment interaction effects on agronomic and nutritional factors.

## Publications

Lollato, R.P.; Lollato, M.A., and Edwards, J.T. Soil organic carbon replenishment through long-term no-till on a Brazilian family farm. J. Soil Water Conserv. 67:74A-76A.

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**Education**

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Texas Tech University, Lubbock, Texas, College of Agricultural Sciences and Natural Resources
Masters of Science in the Department of Plant and Soil Sciences, Graduated December 2011.
GPA: 3.6
Texas Tech University, Lubbock, Texas, College of Agricultural Sciences and Natural Resources
Bachelors of Science in the Department of Animal and Food Sciences, Graduated August 2007.
GPA: 3.5

**Experience**

**Graduate Research Assistant** **January 2012-present**
Oklahoma State University, Stillwater, Oklahoma
Currently working under Dr. Chad Godsey, studying Oklahoma cropping systems and more specifically the integration of cover crops and grazing in current systems.

**Graduate Research Assistant** **January 2010- December 2011**
Texas Tech University, Lubbock, Texas
Studied under Dr. Dick Auld, evaluated and modified a hydroponic greenhouse screening technique to determine salt tolerance to Safflower (*Carthamus tinctorius* L.) Also conducted valuable field studies for multiple Lubbock AgriLife researchers at the Pecos AgriLife Research Station.

**Real Estate, Farm and Ranch Land Appraiser** **June 2008- December 2009**
Pritchard and Abbott Valuation Consultants, Amarillo, Texas
Learned valuable and hands-on information about the tax appraisal system and tax code, appraising throughout the panhandle of Texas

**Production Supervisor** **September 2007- June 2008**
Cargill Meat Solutions, Plainview, Texas
Managed approximately 40 people, in a fast-paced, high volume area. Learned the process of cattle buying, cattle harvesting, fabrication and product shipping.

**Awards and Accomplishments**

Water Conservation Research Scholarship- 2011
Triumph Seed Company Graduate Fellowship- 2011
David Koeppe Memorial Scholarship- 2010
Texas Tech Plant and Soil Science Departmental Scholarships-2010, 2011
Gordon W. Davis Meat Science Scholarship- 2004, 2005, 2006, 2007