Soil Science in Precision Agriculture Lesson Plan

A Senior Project
presented to
the Faculty of the Agricultural Science and Communications Department
California Polytechnic State University, San Luis Obispo

In Partial Fulfillment
of the Requirements for the Degree
Bachelor of Science

by

Carson Ellis Cronkright

© Carson Ellis Cronkright

Spring 2018

Introduction

Due to the increasing demands for the American agricultural industry to provide exceptional products at an increasing rate of production, as well as implement the practice of sustainable farming, it is imperative that more modern concepts be taught at a younger age (Ray, 2013). In order to inform students of advancements and the future of agriculture in the United States, curriculum and lesson plans should reflect this movement in industry in order to provide relevant information and maintain the highest quality of education possible. This project will provide a constructed lesson plan as one example of adopting more progressive methods of agricultural education, farming and understanding the importance of good soil health. This project's lesson plan supports the concept of precision farming and aligns with the California CTE Model Curriculum.

Background

Agriculture has been a central part of our nation's history, with approximately 90 percent of the labor force in 1790 involved in agricultural production (Spielmaker, n.d.). From that point on, the percentage of Americans involved in agriculture has steadily declined. Currently, there is 1.5 percent of the labor force involved in agriculture (Employment, n.d.). To account for the decrease in workforce, there have been many technological advancements, as well as improvements in cultural practices. And as land resources decrease and the population continues to grow, the need for more efficient and effective farming practices became pertinent to the continual success of our nation's agricultural industry. This new method/farming philosophy is commonly known as precision farming.

Methodology

Information, along with any research gathered for this project was obtained from the experiences and classes the author has taken at California Polytechnic State University San Luis Obispo —specifically Plant Nutrition and Soil Health (SS 221) and Precision Farming (AEPS 244). Both of these classes emphasize the importance of soil health and understanding farming mediums.

The information gathered from Cal Poly classes includes Lab 2 (Lazcano, 2017), in which a soil sample is collected from an area of field and then vegetable plugs are transplanted into the soil to provide a visual representation of soil nutrients (or lack thereof). It also measures the effects of additional carbon content added to the soil and the response in nitrogen availability to the crop.

The carbon content portion was omitted and in place, the remaining portion of the experiment was paired with the principles of precision farming to introduce students to more critical thinking regarding agricultural production. Precision farming includes efficient and effective management of resources, amendments, and the critical analysis of the soil quality, nutrient levels. These principles are crucial for laying out a field management plan.

The curriculum standards were gathered from the California CTE Model Curriculum Standards:

- G6.2: Analyze soil properties necessary for successful plant production, including pH, EC, and essential nutrients.
- G7.0: Integrate effective tillage and soil conservation management practices
- G10.1: Practice local cultural techniques, including monitoring, pruning, fertilization, planting, irrigation, harvest treatments, processing, and packaging practices for various tree, grain, hay, and vegetable classes.

This lesson plan is best suited for high school students enrolled in a crops or soil science class. Respectively, an introductory soil science class or advanced cropping class with approximately 30 students. The activity is best performed in a school that has at least a quarter acre of agricultural/farming land available to take soil samples with. If the school has previous farming data on the land, this information can be helpful in making predictions and assumptions on what are the best farming practices to implement. Use of greenhouse could be beneficial in monitoring the growth of the samples, but not necessary, so long as all are kept in the same conditions to eliminate experimental variables.

The procedure itself has been constructed into a lesson form based on the Madeline Hunter Lesson Plan format. Follow up questions and lab worksheets were constructed as well, as was a visual aid for the sectioning of a field and a soil survey map of the same field. These can all be used to further enrich and aid demonstrate the concepts presented to the class.

(See following pages for lesson plan).

Results

Name: Carson Cronkright		Subject: Soil Science / Crop Science
Grade: 9-12		Unit: Soil Science in Precision Agriculture
Lesson Title: Practical Applications of Soil Testing in Agriculture		
Learning Objectives:	• Students will learn of new methods of farming, as well as the importance of having healthy soil to farm on. • Students will learn how to identify various issues in soil, and how plants can help indicate these problems. • Students will learn how to assess soil though testing.	
Materials and Resources:	• 30 vegetable plugs (broccoli, lettuce, etc.) • 30 small pots • 6 permanent markers • 30 surveyor flags/place-markers • 6 hand trowels • Watering utensils • Fine wire mesh • pH testing strips • Digital scale	
Anticipatory Set:	Know / The Future of Agriculture video (https://www.youtube.com/watch?V=Fr29UKzm2CI) This video is to expose students to what is currently being done in industry and show them practical applications of the curriculum material. Specifically, this lesson focuses on the soil aspect, and can be expanded upon in lecture.	
Lesson Objective:	G6.2: Analyze soil properties necessary for successful plant production, including pH, EC, and essential nutrients. G7.0: Integrate effective tillage and soil conservation management practices G7.1: Plan how to effectively manage and conserve soil through conventional, minimum, conservation, and no-tillage irrigation and through drainage and tillage practices. G7.2: Assess how global positioning systems, surveying, laser leveling, and other tillage practices conserve soil. G7.3: Use tools such as the USDA and the local Resource Conservation District soil survey maps to determine appropriate soil management practices. G10.1: Practice local cultural techniques, including monitoring, pruning, fertilization, planting, irrigation, harvest treatments, processing, and packaging practices for various tree, grain, hay, and vegetable classes. Student understanding of lesson objectives will be demonstrated through teacher-student discussion, as well as through lab questions following the activity.	

Input	Discuss the implications of having a good understanding of soil properties, and specifically in the soil that you plan to farm on. How is this being done in industry? - Many farmers still rely on seasonal patterns and often follow the same applications of fertilizers and soil amendments as the previous year. What is wrong with this system? - The problem with this is that the soil may not need any additional nutrients, or may in fact be overly rich in one, but too low in another. - There are a multitude of possible issues that can arise when soil is not properly tested. What are the solutions? - GPS/GIS systems and field mapping have greatly improved accuracy and efficiency of farm operations - Specifically, one way has been creating a nutrient management plan for your crops - This is in line with the field maps that specialize in soil qualities - These field maps are attained through extensive soil sampling to depict an accurate representation of your field's current conditions. What is the industry standard for soil testing? - Currently the industry average is one sample per every 2.5 acres. What are the issues with this sampling rate? - 2.5 acres is a large amount of land to be narrowed down to one sample - The alternative is to take more samples, but this will also cost more What are some potential payouts for having more soil samples? - By taking more samples, even 1 to two samples per acre, your accuracy of soil amendment application is greatly increased. - This means you will ultimately save money and reduce waste by applying only what is needed, where it is needed.
Model	Use image examples (such as attached) for visual aid. Explain general premise of the lab activity, and how it connects to what's being done in industry.
Check for Understanding:	Be sure to check for understanding by asking the questions above. These questions are provided to encourage students towards thinking critically, and provoke classroom discussion.
Guided Practice:	• Form six groups of five students • Each group will receive five planting pots, one hand trowel, five flags, and five patches of fine wire mesh. • Students will go out to the school farm, and select a "block" from the field, as outlined, and take 5 soil samples per group. For each sample, a labeled surveyor flag (with the sample number and block) will be placed. • Be sure to have the same information recorded on the corresponding planting pot. • When all samples are taken, students will return back to class/greenhouse to test soil and plant vegetable plugs. • Students will measure the following:

	○ <u>Before vegetable planting:</u> ○ Soil pH (take approximately 30g of soil and measure in 50 ml of DI water, mix well, and test with pH test strips) ○ Test ribboning of soil to approximate clay content/characteristics ○ <u>After planting:</u> ○ Measure the height of the vegetable plug from soil base ○ Take note of general appearance (vegetable coloration, twisted/shape of leaves, any damages, etc.) • Over the next three weeks, students will monitor the growth of the vegetables, take measurements and write down observations. • At the end of the three weeks from planting, students will look at the overall shape/wellbeing of the plant and determine if there appears to be any issues.
Closure:	Recap on main concepts Seek feedback from students: - Any additional questions
Independent Practice:	Students will answer questions regarding lab – both predictions (planting day) and post experiments, as well as define key vocabulary terms to familiarize them with concepts and common terminologies in industry.

Precision/Soil Sampling Lab:

Name:______________________________ Period:______ Date:________________

VOCABULARY:

1. Precision Farming:
2. pH:
3. Electro Conductivity (EC):
4. Transplant/Plug:
5. Root Shock:
6.

LAB QUESTIONS:

1. Why is taking soil samples a necessary part of farming?

2. Why is pH important to the soil and the availability of nutrients?

3. What are the three main nutrients for plants?

4. What do you predict to see, in terms of plant behavior (nutrient deficiencies? If so, which ones? Stunted growth? Normal growth?)

5. What effect could root shock have on the transplants?

Precision/Soil Sampling Lab:

Name:______________________________ Period:______ Date:________________

Now that you have observed the growth of your vegetable plug, what did you conclude?

FOLLOW UP QUESTIONS:

1. What was the total height of your plant?

2. For plant behavior, was your prediction correct? Explain why.

3. How could you use this data for your school farm?

4. Were there any nutrient deficiencies? If so, how could you tell?

5. How do you think your soil texture/soil type affected your plant growth?

Precision/Soil Sampling Lab:

Name:________________________________ Period:______ Date:_________________

LAB DATA & OBSERVATIONS:

Soil pH:	
Soil Type:	

Plant Height (in) Week 1	
Plant Height (in) Week 2	
Plant Height (in) Week3	

Date:	Observations:

Figure 1 - Cal Poly SLO, Field 25. An example of a field being divided into blocks
Map retrieved from Google Maps

Figure 2 - Web Soil Survey Soil Map of Cal Poly SLO, Field 25
Soil 197: Salinas silty clay loam, 0 to 2 percent slopes, MLRA 14
168: Los Osos variant clay loam, 15 to 50 percent slopes.

Recommendations and Conclusion

To further refine and improves the lesson plan, several local (San Luis Obispo County) high school agricultural teachers were asked review the lesson plan and provide feedback and answer five questions:

1. Do you see this being a practical lesson plan for current and future agricultural students?
2. Would your school/program have the ability, with or without modification, to perform this lesson plan?
3. Are there any key components or principles that are being over looked? Any adjustments that should be made?
4. Do you see this fitting in better with crop/horticultural courses or soil courses?
5. Is precision agriculture a topic that is/should be addressed in high school agriculture?

Chris Hildebrand of Templeton High School provided feedback. When asked if he saw this lesson being practical for current and future agricultural students, he responded with "I see it as a valuable lesson that uses hands on approaches to help with a conclusion based on real data." He also advised that the size of the operation be taken into effect – not every school will have a large farm or space to grow crops. Some high schools will have small gardens or planters instead. It was also advised to increase the number of samples per site to better improve results. Mr. Hildebrand also said that, when asked if [precision agriculture] was a topic that should be covered in high school, "it is the new technology."

Upon reviewing this feedback, the author would provide variations of this experiment so as to make the lesson more flexible for highs school with smaller learning laboratories like school farms. This would be a very easy revision that has the potential to reach a greater number of classrooms. Furthermore, increase the number of samples taken from each location, so as to improve the data set the class can work with. This will improve the accuracy of the results from the experiment and give students more information to draw conclusions from.

References:

California Department of Education (2016). California Career Technical Education Model Curriculum Standards. Retrieved March 14, 2018, from https://www.cde.ca.gov/ci/ct/sf/documents/agnatural.pdf

Lazcano, C., Dr. (2017). SS 221 Lab Manual(1st ed., Ser. 2017). San Luis Obispo, CA: Cal Poly Reader.

Mayo, D. (2016, March 04). Population Growing but US Farm Acreage Declining. Retrieved March 14, 2018, from http://nwdistrict.ifas.ufl.edu/phag/2016/03/04/population-growing-but-us-farm-acreage-declining

Ray, D. K., Mueller, N. D., West, P. C., & Foley, J. A. (2013). Yield Trends Are Insufficient to Double Global Crop Production by 2050. *PLoS ONE,8*(6). doi:10.1371/journal.pone.0066428

Spielmaker, D. (n.d.). Historical Timeline - Farmers & the Land. Retrieved March 14, 2018, from https://www.agclassroom.org/gan/timeline/farmers_land.htm

United States Department of Agriculture. Soil Survey Staff, Natural Resources Conservation Service,. Web Soil Survey. Retrieved March 15, 2018 from https://websoilsurvey.sc.egov.usda.gov/.

World Bank. Employment in agriculture. (n.d.). Retrieved March 14, 2018, from https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?Locations=US