Oroville Union High School District
Agriculture

Agriculture and Soil Chemistry (UCCI)

COURSE TITLE: Agriculture and Soil Chemistry (UCCI)

CBEDS CODE: 4012

LENGTH OF COURSE: One Year

TYPE OF CREDIT: Chemistry or Agriculture

2+2 CREDIT: No

GRADE LEVEL: 10-12

PRE-REQUISITES: Math I

TEXTBOOK(S)/INSTRUCTIONAL RESOURCES:
Primary Materials:

Plant & Soil Science Fundamentals and Applications. Rick Parker. Delmar Cengage Learning.

Principles of Soil Chemistry. 4th edition. Kim Tan. CRC Press.

Supplemental Materials:

Environmental Science Fundamentals and Applications. Delmar Cengage Learning. Chapters 1-3; 5 & 6.

Environmental Science and Technology. Second Edition. Agriscience & Technology. Chapters 10, 13, 14 & 15.

Environmental Science .10th Edition. G. Tyler Miller, Jr. Chapters 9, 13 & 14.

Environmental Science. 7th Edition. Bernard J. Nebel & Richard T. Wright. Prentice Hall.

The Science of Agriculture A Biological Approach. 2nd Edition. Ray V. Herren. Delmar Thomson Learning.

Agriscience Fundamentals and Applications. 6th Edition. L. DeVere Burton. Cengage Learning.

Environmental Science. 1st Edition. 2013. Michael Heithaus, Karen Arms. Houghton, Mifflin, Harcourt.

How to Write a Scientific Paper by Robert A. Day.

National FFA Agriscience Fair Handbook: https://www.ffa.org/documents/agsci_handbook.pdf

National FFA Research Report Template
https://www.ffa.org/programs/awards/agrisciencefair/Pages/default.aspx

Unit 1-Assignment 1:
http://www.todayshomeowner.com/diy-soil-texture-test-for-your-yard/

Unit 3- Assignment 2:
https://www.lcmm.org/education/resource/on-water-ecology/worksheet-water-quality-testing.pdf

Unit 4 Assignment 1
http://www.cfaitc.org/lessonplans/pdf/403.pdf
http://www.cfaitc.org/lessonplans/pdf/404.pdf

Unit 5 Assignment 1
http://www.sites.ext.vt.edu/newsletter-archive/livestock/aps-06_04/aps-313.html

COURSE DESCRIPTION:
This course explores the physical and chemical nature of soil as well as the relationships between soil, plants, animals and agricultural practices. Students will examine properties of soil and land and their connections to plant and animal production. Using knowledge of scientific protocols as well as course content, students will develop an Agriscience research program to be conducted throughout the first semester of the course.To complete that whole project each student will investigate and test an Agriscience research question by formulating a scientific question related to the course content, formulating a hypothesis based on related research, conducting an experiment to test the hypothesis, collecting quantitative data, and forming a conclusion based on analysis of the data. The result of this research program will be an in depth research and experimentation paper that is technically written, based on scientific protocol, and cited using APA formatting. Additionally, students will develop and present a capstone soil management plan for agricultural producers, using the content learned throughout the course. Throughout the course, students will be graded on participation in intracurricular FFA activities as well as the development and maintenance of an ongoing Supervised Agricultural Experience (SAE) program.

BOARD ADOPTION DATE: 12/16/2015

COURSE CONTENT:
Unit 1: Agriscience Practices
This introductory unit will focus on proper methods of agriscience inquiry. Through a series of mini-lab experiences based on the course content, students will learn to ask questions and define problems, conduct research to form a hypothesis, determine the experimental design and conduct

experimentation, analyze and interpret data, develop conclusions and then communicate their findings in lab reports. Not only will the students learn to utilize proper scientific method protocol through conducting these mini-labs, they will also learn what topics will be taught throughout the year in order to guide them in selecting the problem/question for their individual Agriscience Project. Through these mini-lab experiences and unit content, students will be provided with the skills and knowledge to successfully establish the idea they will pursue in their Agriscience Project. By the end of this unit, students will complete the Agriscience Project Research Proposal for their on-going science experiment that will be conducted throughout the first semester of the course.

Unit 1: Key Assignments

1. Soil Structure and Composition Mini-Lab – Calgon Testing

Students will learn that soil is composed of different size particles at varying percentages by conducting an experiment where students separate, examine and identify the major components of soil to better understand how these components give soil its unique physical characteristics. Students will learn to measure the percentage of sand, silt, and clay in a soil sample. Soil samples should be collected in the course of a walking field trip where students will take samples from varying locations on the walk. Students will mix one cup of soil sample with laundry detergent powder in a mason jar in order to dissolve the soil aggregates and keep the individual particles separated. Once the soil sample mixture sits for three days, students will measure and determine the percentage of each particle within their specific soil sample. Students will write a lab report to summarize what occurred throughout the experiment, their data, and analysis/conclusion.

2.Water and Soil Management Mini-Lab – Water Percolation

Students will learn how to design a scientific experiment through proper scientific method and how to develop a research proposal. Students will be put into groups to produce a mini-proposal which will include the specific water percolation problem/question they will research for this lab, three literary research references, a hypothesis and scientific procedure. Students will also learn how soil composition impacts the speed of water percolation or amount of water absorption by conducting the experiment they designed. Students will create a lab report that includes their data and analysis/conclusion. The lab not only develops students ability to write a proposal and a scientific experiment, but exposes them to the relationship between water and soil management.

3. Plant and Soil Management Mini-Lab – Nutrient Uptake

Students will learn that plants utilize nutrients in soil to grow and develop. Each student will bring in a soil sample from their yard to utilize in this lab. They will divide the sample into two pots, one that will be a control sample and the other will be amended with animal manure compost. They will test the nutrients of these two pots of soil with a standard soil testing kit in order to record the levels of Nitrogen, Phosphorus, and Potassium in their control and amended samples. A bean seed will be planted in each pot of soil to germinate and grow over the course of a two week period. Throughout the two weeks, students will be recording quantitative data on seed germination, plant growth, and soil nutrients. After analyzing their data, students will determine how much of each nutrient was utilized by the bean plant. A lab report will be written to summarize what occurred throughout the experiment, their data, and analysis/conclusion.

4. Animal and Soil Management Mini-Lab – Animal Manure Amendment

To build on to the learning of nutrient uptake in the previous lab, students will extend their data analysis to make conclusions on why the bean plant in the amended soil sample had more optimal growth over the past two weeks than the bean plant in the controlled soil sample. This extended analysis of their data will allow the students to learn that animal waste can be composted and used as a soil amendment to increase soil nutrients for optimal plant growth. A lab report will be written to summarize what occurred throughout the experiment, their data, and analysis/conclusion.

5. Technology Mini-Lab – Soil Moisture Testing
Building on the learning of soil composition in the Calgon lab, in this mini-lab, students will learn that the moisture levels in soil vary depending on the soil composition through the use of soil moisture sensing equipment. Students will learn how to operate a soil moisture sensor by testing the moisture levels in various soils. Students will return to the locations where soil samples were collected for the Calgon testing lab in order to test the moisture levels of those specific soils. They will use their data from the Calgon testing lab alongside the data from the soil moisture tests to determine how the composition of the soil impacts the soil moisture levels. A lab report will be written to summarize what occurred throughout the experiment, their data, and analysis/conclusion.

6. Agriscience Research Project Proposal
The key assignment for this introductory unit will be writing a research proposal for the student's planned Agriscience Project. To guide the students in deciding their agriscience research questions/problem, the mini lab experiences completed in this unit should be utilized.The written proposal will include their chosen problem/question that they will be researching and investigating, five pieces of literary references, and the steps to complete for their research project. This assignment marks the first in a series of assignments that will be necessary for students to complete in order to successfully complete their agriscience research project.

Unit 2: The Nature of Soil
Students will use the methods of scientific inquiry, developed in the previous unit, to investigate the composition of the physical world, and discover how matter and energy change forms through biogeochemical cycles. Students will understand where soil originates by investigating the role of the rock cycle in soil formation. Students will learn how the electron configurations of different elements, present in the parent material, give them unique physical and chemical properties, and will further investigate how these properties impact soil characteristics. Students will identify how the climate, weather, and environment impact the soil properties, and will examine the role erosion plays in soil science. Students will collect soil samples from a variety of sources, and will use industry methods to determine the chemical composition of the soil and how this composition affects its physical and chemical characteristics. Students will connect to prior knowledge of life science by looking at how biotic factors impact soil type, composition and texture through investigation and experimentation. Students will use the results of their soil testing and the locations from which they took their samples to create a soil map of their local area. Students will compare their map to existing soil maps and analyses, and analyze the similarities and differences with the previous research.

Unit 2: Key Assignments

1. Sedimentary Rock Lab
In this activity students will model how sedimentary rock is formed by simulating weathering and erosion. Because sedimentary rock is the parent material for major components of many high quality soils, students will investigate the physical and chemical processes which create sedimentary rock. In this lab, students will use brown sugar to simulate the effect of water on soluble rock, show how water can dissolve various minerals, show how freezing water can crack porous rock, show the effects of water's impact by pouring water on sand, and use a hairdryer and sand to simulate wind erosion on copper sulfate crystals. Students will turn in a lab report that details the results of the lab and that identifies which processes are examples of physical change (water expanding in cracks to break rocks, sand particles wearing away rock, etc.), and which processes are examples of chemical change (slightly acidic water dissolving limestone, oxidation of minerals to create metal oxides, etc.).
(http://www.rsc.org/education/teachers/resources/jesei/weather/home.htm)

2. Collect and Test Soil Samples: Physical Properties (figure out what elements might be in them based on chemical properties)
In this lab, students will learn how to test the physical characteristics of soil, so that they can learn how these characteristics affect a soil's capabilities in later units. They will be able to assess and amend a soil to achieve a specific agricultural application. Students will collect soil samples from a variety of locations around their community. After receiving instruction in lab safety protocols, students will choose appropriate lab testing and safety equipment, and will carry out a battery of industry standard tests to determine what physical characteristics the soil samples possess. After receiving instruction in what physical properties of matter are measured in soil testing, students will use the ribbon test, and also look at physical factors such as soil texture, composition, and particle size. Students will examine the soil for presence of living organisms, such as nematodes. Based on these properties, students will hypothesize what chemical elements are present in the soil. Students will research what chemicals are prominent in the soil in their test areas, and check their hypotheses against this research. Students will turn in an annotated bibliography detailing the major findings of their research. Students will give a presentation on their annotated bibliography, and give details on where their soil came from, the lab tests they performed, the results of the tests, their data analysis, and how that analysis compared to their research.

3. Background Scholarly Research and Forming a Hypothesis
As they begin work on their semester-long research project, students use skills in research and forming hypotheses developed in the previous units to develop a hypothesis for their agriscience research project. Students will use credible sources to conduct background research on the agricultural issue they are investigating by reading and deconstructing scholarly journal articles to identify the key components of their agriscience research project. They will use this research to generate a testable hypothesis related to the scientific problem they have identified. The hypothesis developed by the student will be constructed with the independent and dependent variables in mind, and ultimately reviewed by the instructor.

4. Test Soil Samples: Chemical Properties
In this lab, students will learn how to test the chemical characteristics of soil, so that as they learn how these characteristics affect a soil's capabilities in later units, they will be able to assess and

amend soil to achieve a specific agricultural application. Students will test the soil samples that they collected for the previous lab to determine the chemical properties of the samples. After receiving instruction in lab safety protocols, students will choose appropriate lab testing and safety equipment. After learning what chemical characteristics of soil are commonly tested, what reactions occur in the testing process, and how these tests are performed, students will carry out a battery of industry standard tests to determine chemical characteristics, such as pH, nitrogen levels, potassium levels, phosphorous levels and presence of micronutrients. Students will use their chemical tests to compare what chemical elements they found in the soil with what they hypothesized based on physical characteristics, and what they found in their research. Students will turn in a lab report which details where their soil came from, the lab tests they performed, the results of their tests, and the analysis of their results as compared to their findings in the previous assignment.

5. Experimental Design and Conducting Experimentation
Students continue work on their semester-long agriscience project by constructing an experimental design to test the hypothesis they developed in earlier in this unit. A written experimental design should be constructed consistent with scientific protocols using the systematic approach outlined in the previous units. Students will have their experimental designs reviewed by professional contacts (industry experts, agricultural instructors, local growers/producers, researchers or university representatives). After validating the design using the peer review process, students will move to the experimentation phase of their research. Experimental designs should include replicates, control groups, and determine the variables to be controlled and how. Additionally, a determination should be made as to the type of data that will be collected and in what ways, with the emphasis placed on quantitative data or quantifying data that is qualitative in nature. Students will use their experimental design to test their hypothesis. Raw data should be recorded using a field book or electronic device.

6. Creating Soil Maps
Students will take the soil analysis results from the previous assignments to construct a soil map of their local area. Based on the physical properties, such as soil texture, composition and particle size, the chemical properties, such as pH, nitrogen levels, micronutrient levels, etc., and the specific location from which the soils came, students will categorize the soil samples and the class will construct a comprehensive soil map of the local area. Students will then compare their map to existing soil maps, and analyze the similarities and differences with the previous USDA-NRCS maps.

7. Soil Management Project
The soil management project, which students begin in unit 2, will be ongoing throughout the length of the course. The teacher will procure samples of soil from a variety of local farms and these samples will be kept as individual soil plots, or can be kept in plastic containers. Students will perform a variety of tests on these soil samples throughout the course in order to determine the characteristics that the individual samples possess, to analyze how these characteristics impact agricultural outcomes, and how amendments can be made to the soil samples in order to achieve a desired outcome. In this unit students will use the skills they learned in the previous labs to test and record the physical and chemical characteristics of the soil, and identify organisms living in the soil. Students will keep ongoing records of the data they collect during

each of the units learning labs. This data will include information about the physical and chemical characteristics of their soil sample, results from testing pH, moisture, nutrient levels, water holding capacity, ability to grow target crops, and other factors in subsequent units.

Unit 3: Water and Soil Management

Using knowledge accessed from previous units on the physical and chemical properties of soil, students will analyze how the water cycle impacts soil based on its soil type (sand, silt, clay) soil location (geographic and topographic), vegetative state and natural slope of land. In order to understand how water becomes available for plant growth, students will explain the movement of water through soil with respect to how intermolecular forces impact percolation, capillary action, pore size, cohesion and adhesion. Furthermore, students will address how the concentration of organic matter in soil impacts the movement of water. Students will explain the impact that soil has on the quality of their water and will use water analysis tests to determine the safe and appropriate levels for potable water. Students will also be able to provide solutions to possible contaminations and/or toxic levels of residues/nutrients in the water samples. Students will determine how different irrigation, tillage and planting practices will impact the soil and surrounding area by testing water quality, pH and checking for possible contaminants due to leaching. Students will determine proper and efficient irrigation practices based on the chemistry behind the soil and the way water moves through the soil particles. Students will use GPS to enable students to more accurately analyze watersheds in their area and rationalize how the drought can impact both water quality and quantity as well as soil composition.

Unit 3: Key Assignments

1. Soil Erosion and Runoff Lab

Using soil plots from the previous labs, students will analyze how soils with vegetation (including organic matter) have a greater water holding capacity and less runoff than soils without vegetation by collecting runoff water from each plot and testing not only the amount of water collected from each plot, but also the percent of solids collected from runoff from each of those plots. Students will complete their lab write up to emphasize their understanding of these key concepts. Students' lab reports should include qualitative and quantitative observations of the composition of runoff from the soil plots. They should analyze this data to draw conclusions about the water holding capacity of the soils and should discuss the intermolecular interactions which allow soil to hold water at the molecular level. This assignment prepares them for decisions that will be made in their capstone project of creating a soil management plan.

2.Water Quality Testing

Students will begin by examining properties of subatomic particles and will create models to illustrate bonding of hydrogen and oxygen, accounting for the polarity of the water molecule. The focus of this unit will continue to develop an understanding of how hydrogen bonds give water a number of properties that allow it to percolate through soil, adhere to pollutants and transpire through plants.

https://www.lcmm.org/education/resource/on-water-ecology/worksheet-water-quality-testing.pdf

Above is the link to the lab where students will test water samples from various sources throughout their community to determine the quality of the water. They will test and record data on pH, phosphates, nitrates, dissolved oxygen, and turbidity. Students will then analyze this data

to draw conclusions on what can be done to improve the quality of the water. Students should also indicate what steps can be made in agriculture to protect water quality and ensure a safe water source for the community. Students will make a presentation to the class that summarizes their lab procedure, results, and conclusions. To extend learning, the group that has the most thorough presentation can present their findings to the School Board, local Farm Bureau, or any other local organization.

3. Analyzing data, interpreting data and forming conclusions.
Students will determine the best methods for organizing the data from their semester-long Agriscience Project by creating data tables. The skills in analyzing and interpreting data used during Key Assignments One and Two in this unit will be applied to the final agriscience research project. Students will make similar determinations on their Agriscience research. Students will use mathematical principles to synthesize their data, calculating a mean. Furthermore, a statistical analysis of the data will help the student determine if the results are due to chance or the independent variable that was tested. Students will choose the best way to present their data using graphs they believe will most effectively demonstrate their findings, and will further summarize what each graph shows. Finally, students will interpret the data and formulate conclusions based on the results. In the written conclusion, students will use their data to either accept or reject the original hypothesis. Conclusions should be directly supported by the data and by previous research. Students will also identify the limitations of their research, improvements that could be made to the experimental design, as well as future studies that may be conducted that relate the study at hand.

4.Tillage Practices and the Impact they have on Runoff, Erosion and Soil Chemistry
Students will explore how chemical bonding, chemical reactions and chemical equilibrium are demonstrated through the relationship between tilled soil and water runoff. Students build upon their knowledge of atomic structure to explore the various forms of chemical bonding that takes place between atoms of different elements as well as the role of valence electrons. To deepen understanding of chemical interactions, students will investigate both the physical and chemical changes that take place during tillage.

Students will utilize locally sourced soil samples at both pre-tillage and post-tillage intervals to compare the effects of tillage on the physical and chemical nature of soil. Ideally, multiple tillage types will be examined including conventional tillage, deep ripping tillage and conservation tillage. Soil pH, effective cation exchange capacity, soil organic carbon, and soil nutrient levels will be measured in addition to an analysis of the physical structure of the soil. Examination of the physical structure can allow students to predict potential erosion and runoff issues.

Students will then develop suggestions for best tilling practices by using GPS and topographic maps to determine the natural slope of a given plot of land. They will be asked to design the most efficient “tillage” for this plot to conserve water, prevent soil erosion and cause the least disturbance to soil and water bonding. Students must explain in a written report, including a detailed diagram, why they selected the design they did and how it will be the most beneficial for the environment using conservation techniques for the soil and water as learned in this unit. They will also explain why the alternative designs would be poor choices.

5. Ground Water Contamination and Aquifer Lab
Students will demonstrate how aquifers filter different contaminants by constructing a model of an aquifer and testing how groundwater contamination occurs by using common agricultural contaminants. They will analyze two different types of aquifers and determine which type they would want to place a well into and why. Students will explain how the size of the pores affects the intermolecular interactions between contaminated water and the rock, and how this in turn impacts how well an aquifer can filter out contaminants.

Students will examine how the pH of different solutions is directly affected by soil type and aquifer porosity. Students will model this by capturing water that comes through their aquifer model. Students will then determine the concentration of this type of solution through a standardized titration experiment.

Once they have used their models as a means of understanding how easily groundwater can be contaminated, they will complete their conclusion and create a multimedia production in the form of a TED talk or Infomercial that educates their community on what agriculturists do and can do to improve water quality in their local area. They will present their productions to a panel of judges and the winners will have their video/multimedia presentation broadcast school-wide.

6.Irrigation Practices in Agriculture
Students will understand how evaporation (due to temperature) and soil type plays a huge role in the irrigation methods and practices employed in the agriculture industry. Students will be given 3 different soil types. Students will divide these 3 soil types into 9 different samples; 3 of each in a different setting, but they will receive the same amount of water to simulate "irrigation". Students will hypothesize what they think will happen based on soil type and temperature with regard to moisture retention and how this will impact decisions in irrigation selection. In the control group the 3 soil samples will be placed outside. In test group #1, 3 samples will be placed under a heat lamp to simulate an environment with a hotter ambient temperature. In test group #2, 3 samples will be placed in a location cooler than your outside temperature. In all 3 of the test locations students will water all of the samples with equal amounts of water. The following day students will test the moisture content of all soil samples using a Kelway Soil Acidity and Moisture Meter to determine the effects that temperature and soil type had on moisture retention. Using this data, students will then complete the lab write up and finish a conclusion by summing up how this lab impacts irrigation practices.

7. Semester One Capstone Project
Students will submit their agriscience research in a written paper, and it will include the following components: problem/purpose, background research, hypothesis, methodology, results/data, and discussion/ conclusion. The paper will be written using skills associated with technical and scientific writing, for example, refraining from the use of personal pronouns or keeping discussion limited to what the research and data suggest rather than personal opinion and bias. APA format will be utilized to reference and cite sources. The project and its findings will be shared with the class in an oral presentation.

Unit 4: Plants and Soil Management

Building on knowledge acquired from the previous units on the physical and chemical properties of water and soil, students will begin to determine the effects of plant, soil and water interactions with respect to maintaining or restoring environmental health and structure. Students will model how nutrients cycle through the environment, analyze how pH affects nutrient availability by changing chemical equilibrium, determine water holding capacity with respect to water availability for plant growth, and identify possible nutrient deficiencies based on plant observations. Students will apply this learning to developing knowledge of soil nutrients and their role in the environment by testing and analyzing soil samples for optimal soil structure, nutrient value and availability and determining possible soil amendments and practices to improve soil quality.

Unit 4: Key Assignments

1.Plant Requirements from Soil Lab

Students will demonstrate their knowledge of plant growth requirements by creating a controlled experiment to compare the difference between natural and synthetic fertilizers on plant growth. Students will make qualitative and quantitative observations of plant growth and analyze their data in order to draw conclusions regarding the availability of nutrients and the practical application for crop growers. Fertilizers are identified with particular isotopes and as part of the assignment, students will describe nuclear processes and radiation, describing their methods of use in determining fertilizer application in commercial agriculture. Students will then create a written recommendation to a local crop producer regarding which type of fertilizer to use for their farm in order to achieve production goals, highlighting chemistry concepts as a fundamental part of the assignment.

Optional extension: Students can analyze the amounts of fertilizers needed in order to reach the desired amount necessary for plant growth and determine whether the addition of fertilizers is cost effective.

2. Soil Management Project

Students will analyze their data collected from unit 2 and determine which crops can be grown based on the current physical and chemical properties of the soil. Students will make recommendations for soil amendments which would increase the nutrient availability of the soil in order to grow a desired crop. Students should consider how pH, and chemical equilibrium will impact the availability of nutrients in the soil in their recommendations. Students will then plant a crop from a given list of cover crops (clover, grasses and legumes) in their soil test plot, allow it to grow and then retest the soil to see if there is a difference in the nutrient concentrations. Students will incorporate their knowledge of biogeochemical cycles into their lab report and will provide an explanation of how nutrients are being transferred from the soil to the plants. The research and experimentation conducted in this project will be added to their Soil Management Capstone Project.

3. Plant and Soil Interactions

Students will compare their nutrient values from the previous project with other groups during a classroom discussion. Students will analyze the data and develop explanations for why there is a difference in the amount of nutrients the plants extracted from the soil. Students will then revisit the Soil Erosion and Runoff Lab from Unit 3 and measure the amount of runoff and soil erosion

that occurs on each of the cover crops and compare the data to the data collected from Unit 3. Students will communicate their results in a lab write up.

Unit 5: Animals and Soil Management
Using knowledge from previous units about soil nutrient content, students will identify the key macrominerals and microminerals necessary for normal livestock growth and reproduction. The students will correlate the minerals present in soil with the nutrient content of typical livestock concentrate and roughage feeds. Using local resources, the students will identify mineral deficiencies or toxicities in the soil and relate the deficiencies or toxicities to livestock health. Students will identify crop and range management practices to improve the nutrient content of soil, and will explain what reactions take place at the molecular level to improve nutrient content. Students will identify various methods of using animal waste and the environmental impacts including the use of animal waste as soil amendments and fertilizers. Students will relate the units of concentration used in agriculture practice to units used in chemistry labs, as they identify problems and contaminants associated with livestock waste disposal and related health and safety regulations.

Unit 5: Key Assignments
1. Nutrient Deficiencies in Livestock
Students will examine the correlation between soil and plant nutrient levels with health problems in livestock. Using their knowledge of solutions and concentration, students will identify soil nutrient deficiencies in a geographic area. They will relate the nutrient deficiencies with livestock diseases. For example, if an area has a deficiency in selenium, students will identify problems such as white muscle disease in calves and lambs. Working in groups, the students will analyze a case study on selenium deficiencies in cattle and offer a solution and/or design a system to prevent or correct a mineral deficiency in livestock caused by a soil deficiency. Their analysis will be presented in a written report.

Optional extension to this assignment could include testing other nutrient deficiencies, such as copper toxicity, and reporting these findings in a group oral presentation using the case study as an example.

2. Livestock and Water Quality
Students will examine the nutrients present in animal waste and identify possible environmental contaminates in the waste. To examine the effects of water runoff from livestock facilities, students will design a controlled experiment to test water samples from soils exposed to livestock for nitrates, phosphate, heavy metals, pH, dissolved oxygen and other factors. Students will utilize their previously collected soil samples or soil plot and design a model to simulate water run off from a livestock production facility. Alternately, students will test water runoff samples from existing livestock facilities. At the conclusion of the experiment, students will provide a written recommendation to a county land use commission with a protocol for the optimal use of the animal effluent.

3.Livestock Waste Management
Students will examine the challenges involved with livestock waste management. The problems may include ammonia emissions, phosphorus runoff, nitrate leaching and heavy metal runoff.

The instructor will provide a problem and scenario that relates to livestock waste management from an agricultural operation. Students will research the problem and design a system or solution. For example, if a school builds a school farm and raises 10 head of cattle in confinement, how will the waste be handled? The students will consider factors such as environmental concerns, health and safety regulations, amount of waste produced, reactivity of the waste products, uses for the waste, possible cost and labor requirements.

4. Soil Management Project
The soil management project, which students begin in unit 2, will be ongoing throughout the length of the course. In this unit, students will identify the nutrient deficiencies or toxicities present in the soil samples that might influence livestock production. Students will develop a written proposal for the tested soil, including soil amendments, fertilizers and application of animal waste or changes in livestock management practices to address these deficiencies or toxicities. As part of the recommendation process, students will examine the use of animal waste as a method of enhancing soil quality, using background knowledge of nuclear processes to describe variability in nutrient availability in uptake. For any toxicities present, students will examine the chemical profiles of the elements and recommend strategies for resolving agricultural issues for those elements. Students will use these soil management profiles as a component of their final course project as well as use them for subsequent units.

Unit 6: Soil Sustainability
Based on the accumulation of knowledge, examples and research conclusions from throughout the year, students will develop an understanding of sustainable agriculture by employing a Sustainability evaluation tool, "The 3-Pillars of Sustainability, economic, environmental and social impacts" of agriculture. Students will critically evaluate and justify perspectives and determine benefits/concerns based on research and credible information. Students will investigate and evaluate the sustainability of agricultural practices. Students will design and conduct a phytoremediation lab to analyze the efficacy of salt tolerant accumulators to remove saline from the soil. Students will formulate potential solutions using the three pillars of sustainability to soil and land management problems based on agricultural scenarios and debate agricultural issues.

Unit 6: Key Assignments
1.Phytoremediation Lab
Students will learn the about the remediative effects of plants in the uptake of soil contaminants, in this example, reducing soil salinity. Students will research saltwater intrusion causes and implications, research phytoremediation, develop a hypothesis, design an experimental procedure, identify safety procedures specific to this experiment, collect and analyze data, and formulate conclusions. Through these steps, students will determine which types of plants are best in phytoremediation of saline ("halophytic" or salt loving plants) and the maximum amount of saline which can be removed from the soil in this way.

Possible extension: Compare efficacy of procedure with different soil types
Students will complete a formal lab write-up.

2.Tillage Protocols: Impact on Soil Structure and Soil Sustainability Lab

The purpose of this lab is to determine the effects of tillage practices on soil sustainability and plant growth. Using a prepared mini-plot with all three tillage examples (conventional, no-till, and low till) soil structure, students will measure and compare soil fertility, water holding capacity,and percolation. Students will analyze and graph their data, explain the implications of the each of these tillage systems with respect to soil and water sustainability and extrapolate those results to the effect of tillage practices affect on plant health. Students will create a poster to illustrate the benefits and drawbacks of each tillage system with respect to Soil-Plants-Water.

3.Land Use Planning Model

Student groups will make soil/land management decisions based on specific agriculture and land use restrictions on pieces of land such as large urban gardens, range management, forest management, and farmlands. Students will use their knowledge of physical and chemical properties of soil in regards to plants, animals and water to highlight the importance of sustainable agriculture. Getting a land use plan approved and in place with multiple interest groups is complicated and relies on the checks and balances to determine the success of the project. Each student in the group needs to take on a specific role in order to determine their Land Use Plan (such as conservationist, developer, owner, law enforcement, Department of Public Works, Anthropologist, City Planner, etc.). Groups will then prepare a presentation to present their plan. This presentation could be presented to the class and instructor or even community/local industry members.

4.Agriculture Issue Debate and Policy Proposal

Students will begin by conducting secondary research using industry journals into the global use of methyl bromide as a chemical soil sterilant. Students will examine the pros and cons of the use of methyl bromide in terms of manipulations to the chemical profile of soil, microbiology, effects on groundwater, runoff challenges and effects on agricultural productivity. Research should highlight chemical reactions as the primary point of focus. Students will then be assigned a perspective related to the methyl bromide investigation (runoff or microbiology, for example) to represent in the debate, using their list of chemistry- and agriculturally-focused pros and cons to inform their contributions. Students will end the debate with a comprehensive analysis of the issue of methyl bromide use in agriculture from multiple angles in order to develop a model policy for their county regarding the possible use of methyl bromide in agricultural applications.

5. Soil Management Project

The soil management project, which students began in unit 2, has continued throughout the length of the course. At the end of Unit 6, students will incorporate knowledge gained from all previous labs, and the conclusions drawn from the Phytoremediation and Tillage Protocols: Impact on Soil Structure and Soil Sustainability Labs to test, analyze, treat and/or modify soil structure and fertility for specific usage/in order to achieve desired outcomes. This work will be used as evidence in the Soil Management Capstone Project and will also aid in drawing the final conclusions of the year long research and experimentation.

Capstone Project and Portfolio

1.Soil Management Capstone Project

As the final course capstone project, students will be given a scenario and soil sample designed around their local agriculture industry. The given scenario will provide students with specific

information about the topography and climate/rainfall data of the location where the soil sample was collected. Students will use knowledge and skills learned in previous units to physically and chemically analyze the soil sample.Their soil analysis should include the composition and nutrient, pH, and salinity levels.The data collected from their soil sample analysis and the provided land information should be included in the soil management plan that the students create. The student's Soil Management Plan will recommend soil amendments, proper tillage practices, optimal irrigation methods, crop recommendations, and animal use suggestions.Their recommendations and suggestions should be justified in terms of the 3-pillars of sustainable agriculture.

2. Course Portfolio
The course portfolio will provide evidence of real-world agriculture application of scientific research done throughout this course. The portfolios will highlight student work from throughout the course to show a progression of learning, experimentation, and application of course content. Items that will be included in the portfolio are student lab reports, the Agriscience Research paper, and their Soil Management Plan.

STANDARDS ADDRESSED:

Course 1: Integrated Agricultural 1 (Physical Science Emphasis)			
NGSS Standard	**Description**	**Agriculture Standard**	**Description**
PS1A.1-1	Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.	B9.1	Define metallurgy principles, including distortion, hardening, tempering, and annealing.
PS1A.1-2	Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.	B7.1/1.2-1L	Explain the role of heat and oxidation in the cutting process; Integrate accepted shop management procedures and a safe working environment.
PS1A.1-3	Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces	B9.O SECTION/1.2	Assimilate metallurgy principles and fabrication techniques; Integrate accepted shop management procedures and a safe working environment.

	between particles.		
PS1A.1-4	Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.	5.90 SECTION/5.5	Assimilate metallurgy principles and fabrication techniques; Complete a cold metal project, including interpreting a plan, developing a bill of materials, selecting materials, shaping, fastening, and finishing.
PS1B.1-5	Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.	B9.7/1.2	Construct a welding project using any electric welding process, appropriate products, joints, and positions, which will include interpreting a plan, determining proper assembly sequence, developing a bill of materials and cutting list, selecting and acquiring materials, and developing a clear and concise fabrication contract.
PS1B.1-6	Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.*	B7.0 SECTION	Understand oxy-fuel cutting and welding.
PS1B.1-7	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.	B5.O/B7.0/1.1.10-15	Understand agricultural cold metal processes; Explain the role of heat and oxidation in the cutting process.
PS1A.2-1	Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.	B11.0 SECTION/1.0.8 MATH	Understand the principles and applications of various engines and machinery used in agriculture.
PS2A.2-2	Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.	B11 SECTION/1.O.8 MATH	

PS2A.2-3	Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.*	B11.5/B9.7/B6.3	
PS2B.2-4	Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.	B4.3.3-4/B11 SECTION/1.0 SECTION	
PS2B.2-5	Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.	B3.0 SECTION/1.2 SECTION	
PS2B.2-6	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.*	B3-B7/B9/B11/2.4	
PS3A.3-2	Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).	B10/B3/B11	
PS3A.3-3	Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.*	B3	
PS3B.3-1	Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the	B3/B11/B10	

	other component(s) and energy flows in and out of the system are known.		
PS3B.3-4	Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).	B10/1.2	
PS4A.4-1	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.	B3/B9/2.0	
PS4.2	Evaluate questions about the advantages of using a digital transmission and storage of information.	B12/B1/B1/1.2	
PS4.3	Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.	B12/B1/B1/1.2	
PS4.4	Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.	B12/B1/B1/1.2	

PS4.5	Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.*	B12/B1/B1/1.2	
LS2.2-1	Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.	E4.4-4/D10/D7/1.2/E2	
LS2.2-2	Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.	E5.5-2/E10.3/1.1.10-15	
ESS1B.1-4	Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.	None POSSIBLY E11	
ESS2B.2-1	Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.	NONE POSSIBLY E11/E12.1/G7.2-3	
ESS2B.2-3	Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.	NONE	
ESS2C.2-5	Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.	E.1.1/G.8/F.5.4	
ESS3A.3-2	Evaluate competing design solutions for developing, managing, and utilizing	E10.4/E2.1/E12.3/E.3	

	energy and mineral resources based on cost-benefit ratios.*		
ETS1A.1-1	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.	5.0/7.0	
ETS1B.1-3	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.	4.0/10.2	
ETS1B.1-4	Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.	ALL B SECTIONS	
ETS1C.1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.	5.0/7.0	