2021

AGRO 366: Soil Nutrient Relationships — A Peer Review of Teaching Benchmark Portfolio

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BENCHMARK PORTFOLIO

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AGRO 366: SOIL NUTRIENT RELATIONSHIPS

ABSTRACT:
Soil Nutrient Relationships serves juniors and seniors with a major or minor in Agronomy. I originally cotaught this course with another professor and was in charge of just the lab portion. Now that I am the sole instructor I had goals of developing new content learning resources and better integrating lab and lecture content. The course was reorganized in 2021 into weekly modules with independent learning, lab time to work on calculations, using NebGuides, and other skill content, and then end of week discussion for relevant case studies or discussion of application and interactions. Students also conducted a group project outside of class time as a performance task activity. One new assessment group was developed in 2021 to test that students could independently do lab skills and to practice developing nutrient management plans on a smaller scale than the performance task activity. Students responded to course surveys that they had gained knowledge in all learning objectives and that the lab activities helped them complete the unit wrap-up assignments and group project. Changing lab meetings to a time to emphasize using the content, and developing assessments where students independently used content increased learning and the new model will be used again. There were further adjustments to the course as a result of COVID but I am looking forward to increasing the amount of time spent with students on face-to-face learning in the future.

KEYWORDS:
Lab Integration. Soil Science. Problem Solving.

Table of Contents

Memo 1, Description of Course

Course Background

Soil Nutrient Relationships (AGRO 366) is a junior-senior level course at The University of Nebraska-Lincoln required by most options of the Agronomy major and minor (minors are typically majoring in Agricultural Business/Economics or Mechanized Systems). The content focuses on understanding the chemical cycling of nutrients to better address practical nutrient management situations and builds on concepts from Introductory Soil Science (100 level, prerequisite to this course) and 200 level departmental courses on crop and soil management. The course addresses many of the departmental Student Learning Outcomes.

The course is offered once a year and averages 65 students. It is a 4-credit course scheduled as three 1-hr large group sessions used for lecture, discussion, example problems, and case studies as well as one 2-hr session of 20-24 students to work on relevant skills (e.g., soil sampling, soil test interpretations) per week. A flipped model of teaching was developed by the prior instructor and continues in practice. Students watch videos on course concepts prior to attending lecture and then focus on application of content through discussion and case studies when in person.

I originally joined this course with responsibility for lab portions only. The prior instructor had developed a lab model which I have been slowly adapting. The lab schedule has been completely separated from lecture content with little overlap in content. The course has a semester project and I have often thought of the labs as building the skills to do the project. The course has a large number of assessments and I have cut quite a few from lab over the years focusing primarily on quizzes and 2-3 other assignments to practice skills (e.g., develop a soil sampling plan).

In general, the course has used a weekly online quiz over lecture videos, a weekly in person quiz over lab activities, 5-6 assignments over specific tasks, attendance at case study discussions, 4 exams, and the semester project for graded assessments. The exams and the projects were each 30% of the course grade leaving 20% each for lab activities and lecture activities (which includes quizzes).

Course Goals

The overarching goal of this course is for students to leave ***able to formulate an evidence based nutrient management plan that considers economics and the environment***. Which means we want the students to be able to use and apply course content in the real world. The course objective is tied to a performance task activity. Within the broad goal, specific course learning objectives include developing and mastering the ability to describe:

- nutrient cycling and the factors affecting availability of each nutrient,
- limiting factors for various nutrients in various environments,
- how to obtain appropriate data and science-based recommendations for nutrient management,
- integrating nutrient management as a systems approach,
- use of the 4R scientific approach, and,
- how socio-economic factors affect nutrient management decisions.

Nutrient management is the 2nd largest production expense (after seed) and mismanagement is the number one way that agricultural production affects the environment, which casts a negative light on agriculture. Our students need the skills to pinpoint recommendations so that return on nutrient investment is maximized without harming the environment. Both under applying and over applying can be costly and damaging. Many course examples include an economic analysis as an important motivator for producers to change management approaches. We also spend quite a bit of time discussing the various nutrient management philosophies and the scientific data supporting the Universities position. Students from farms have many experiences that make classroom discussion richer but also can be hard to overcome when encouraging decisions that apply less nutrient than they are used to.

Why Review this Course

AGRO 366 has been through peer review of teaching with the prior instructor and in coordination with the Center for Transformative Teaching was redesigned as a flipped course in 2017. At that time, I was a junior partner in the course and my part was not reviewed/transformed. Since then, I have become the sole instructor for the course and find myself struggling to use the lecture materials left to me efficiently and to integrate lecture and lab content. Given the ongoing pandemic, I would like to convert more of the course online and redo many of the lecture items as my own work. This course typically has ~10 students who are not from eastern Nebraska and has done a poor job serving their broader interested by focusing on production examples from irrigated corn on silt loam soil. More examples from diverse crops, diverse soils, and diverse production systems are needed. Doing so could increase enrollment (horticulture & turf majors) and make the course more desirable for international and true distance students.

My main focus at this time is redesigning the course delivery as weekly modules that include both lecture and lab. I envision that all content delivery will be done independently and then students will meet in person or via Zoom to work on example calculations and example nutrient management problems. This effort emphasizes the integration of lab and lecture as "lab" is the only time I will see students in person most weeks. Surveys and assessment will be designed to test if lab activities improved overall understanding of weekly topic. I would like for this review to address the course and its organization broadly rather than focus on specific content or activities.

MEMO 2, SUMMARY OF TEACHING METHODS

Course Design

The course was updated for the Spring 2021 semester. This involved shifting from reliance on the former instructor's video lectures to using a textbook for content delivery outside of class. I continued to offer one lecture per week dedicated to application (recorded video this year due to COVID) and continued to use one 50-min meeting per week to focus on problem solving activities in small group discussion (via Zoom this year due to COVID). There was minor tweaking of the course topics and major changes to the activities and assessments. The course syllabus suggested students plan on the following weekly schedule:

- 2-3 hours reading textbook and watching videos on your own (Monday to Tuesday)
- 2 hours in lab (Wed or Thur)
- 1 hour discussing application via Zoom (Friday)
- 1 hour working on the Nutrient Management Project with your group
- Additional time for studying, quizzes, and assignments
- Totaling about 9 hours each week

This course used a flipped design where students review basic concepts on their own and worked on problems during class time. Work in the first part of the week was independent with the basic concepts obtained from the Soil Fertility and Fertilizers text, some weeks instead used a NebGuide on fertility management practices as the assigned reading. A 15-25 minute video lecture and a pdf of lecture slides was also prepared for student use each week (I was the lecturer in all videos for 2021). A quiz over the assigned content was taken before the first meeting of the week and was designed as 60% recall and 40%

comprehension. Because of the change in content source, all quizzes were written new in Spring 2021. Any concerns observed from the quiz statistics were then reviewed in person in lab.

In the middle part of the week, students met for lab activities. Three labs were offered in-person and one lab met via Zoom for 8 students who took the course fully online. Activities that involved calculations or other skills where instructor help would be useful were repackaged from prior labs and prior lecture case studies for use in lab. Lab skills were assessed via a short quiz in the following week's lab and because they contributed to both small assignments and the larger performance task activity.

At the end of the week, students typically discussed practical problems in small groups to develop solutions. The emphasis of this work was first, on identifying complicating or unknown factors (e.g. appropriate Sulfur application rate varies with soil properties) and second, on justifying the decisions made. Each of these were miniature versions of achieving the course goal (developing an NMP) for a specific situation where I control the inputs. Students were placed with the same groupmates each week and those were also the groups for the semester project (the performance task activity). Some weeks were used for project activities such as peer review and check-in with instructors instead of problem sets. By working on smaller problem sets and presenting justification regularly, students were better equipped to justify their overall project at the end of the semester. Additionally, these discussion activities helped with reflection questions on the smaller assignments that students developed as summary to each unit of the course.

On their own time, students work together in small groups (3-4 ppl) to develop their Nutrient Management Plan (NMP) as the performance task activity that addressed the course learning goal. The group work was almost entirely conducted outside of class time with only occasionally meetings with instructor to discuss progress and issues. The students were provided with written directions and a detailed rubric. Portions of the assignment are due each month of the semester. These drafts are reviewed by instructors and peers to provide feedback that improves the final product.

Course Materials

The students used a textbook as their primary source of basic soil fertility concepts. I expected they would take some notes of key concepts they want to remember and use their reading for the weekly quiz. I chose this textbook because it explains the science in a relatively easy to understand way and it includes practical information as well. The text was new this semester.

I also teach using question sets designed to step students though the processes of understanding how each concept is linked to prior knowledge and other course content so that they can see the application of content as well as variability in the knowledge (i.e. in our field, what is the correct answer to for one situation would not necessarily be the correct answer for another situation – just like teaching methods). It usually helps to talk out some of the ideas on the question set with peers or instructors to generate new ideas or alternative applications/solutions so these are used in lab and discussion settings, not as independent work.

Course Assessments

Content knowledge (e.g., ideal pH, P cycle) was assessed with weekly reading quizzes and on exams. Skills (e.g., writing a soil sampling plan, calculating P rate) were assessed with unit assignments and weekly lab quizzes. Problem solving was assessed with unit assignments and the project. The syllabus described assessments thusly:

- Nutrient Management Project (25%): This project is a summative nutrient management project where you apply the soil fertility concepts and skills you have learned in this course. 20% is the written report and 5% is the oral presentation.
- Hour Exams (30%): 3 exams will be given during the lecture period. The format will include multiple choice, essay questions, matching, and calculations. Exam administered online; open

book is fine but do note that canvas time limits will be enforced and large question banks are used. Exams are independent work.

- Weekly Quizzes (20%): These quizzes will include that week's content from reading and videos as well as lab content and calculations. Content quizzes are online and due Tues. Lab quizzes taken during lab.
- Unit Assignments (15%): Summative assignments would include questions replicating in-class activities for independent work. Assignments will include sketches, reflections, and developing smaller scale nutrient management plans.
- Case Study Reports (10%): Work with a team to assess a situation. Summarize findings in a brief oral report. Points are for attendance and participation at Friday Zoom.

The assessment that was new for 2021 was the Unit Assignments. These independent assignments were used to have students replicate lab activities on their own in a way that showed their understood the content and also to build smaller plans that were assessed prior to the larger group nutrient management plan. Two of the unit assignments were planned as reflection activities (value of fertility planning, and managing environmental loss), one was a summary of common soil misconceptions/points of confusion and the other four were smaller plans. Students developed a sampling plan, a lime application plan, a nitrogen application plan, and a manure application plan. Each plan required then to replicate lab skills and justify problem solving decisions.

Justification of Teaching Methods

There are some basic facts that students need to learn (e.g. nutrient chemistry) but the course overwhelmingly is actually about systems thinking and problem solving as each and every time that they will determine nutrient plans in their future will be a unique situation for which I cannot provide a prescription. They need to know what questions to ask and what data to gather so even providing them with all the questions is not effective, they must develop some questions on their own. We practice with case studies in class, and they do smaller plans where I provide inputs, but they must find all inputs and develop field goals themselves for the performance task activity of developing a nutrient management plan.

Link to the Broader Curriculum

Students taking this course should already have introductory soils (the prereq, which I also teach) and typically also already took crop management and soil management at the 200 level. The main course following this is their capstone which develops an entire farm plan (while we just do the nutrient management plan). In addition to soil nutrient content, this course is also expected to address learning objectives for teamwork, stewardship, systems thinking, data gathering, data interpretation, presenting science, and writing for our majors. Due to the rigor of the course, enrollees who are not agronomy majors or minors are rare.

MEMO 3, DOCUMENTATION THAT STUDENTS MET THE LEARNING OBJECTIVES

This review documents learning in two ways. First, I surveyed students and report on their self-assessments. Second, the course uses a performance task activity and can report assessment scores and ranges. Some of the learning data that will be discussed are problem solving, repeatability of activities done in lab, and how the course addresses greater learning in the department.

Data Indicating that Students Achieved Learning Objectives

Over 89% of survey respondents agreed or strongly agreed that the course improved their knowledge or confident in all 8 objectives that they were surveyed over (Table 1). Additionally, students were asked about how the course increased their knowledge or confidence for the 18 departmental learning objectives (as this course is required of all majors). Over 90% of respondents agreed or strongly agreed that the course addressed six of the objectives with the lowest scoring objective still being addressed in the mind of 78% of respondents. The course syllabus specifically claimed that this course would address seven departmental objectives and the student's appreciation for those was strong (Table 2).

Table 1: Percent of respondents who agree or strongly agree that AGRO 366 improved their knowledge or confidence in the following **course** learning objectives. Thirty-six of 42 students completed survey.

Formulate an evidence based nutrient management plan that considers economics and the environment	97
Describe nutrient cycling and the factors affecting availability of each nutrient	97
Describe limiting factors for various nutrients in various environments	97
Describe how to obtain appropriate data and science-based recommendations for nutrient management	94
Describe integrating nutrient management as a systems approach	89
Describe use of the 4R scientific approach	97
Describe how socio-economic factors affect nutrient management decisions	92
Work in groups to analyze agronomic situations and solve agronomic problems	92

Table 2: Percent of respondents who agree or strongly agree that AGRO 366 improved their knowledge or confidence in the following **departmental** learning objectives. Thirty-six of 42 students completed survey.

Demonstrate stewardship and accountability in decision-making processes that transcend fiscal parameters	81
Understand that plant and soil systems are embedded within complex social-ecological networks that interact across a range of spatial and temporal scales	92
Demonstrate understanding and problem solving based on the concepts and applications of their area of study	94
Be able to acquire scientifically derived information, assess its reliability, and write appropriately about scientific knowledge and discovery	86
Interpret graphs, charts, and tables and communicate results through written and oral reports	86
Lead and contribute to diverse teams to propose and implement solutions to complex plant and soil system problems	86
Educate and persuade stakeholders (e.g., consumers, policymakers, growers, etc.) to action using evidence-based and technically sound oral, written, visual and multimedia communications	86

A knowledge survey was given at the beginning and end of the course. Students would mark 1 for content they knew, 2 for content they thought they could find or figure out, and 3 for content they were unfamiliar with. Of 42 students, 34 took the initial knowledge survey and 31 took the final knowledge survey. Responses were summarized such that each question was given a score (e.g., 1 = all students knew the content) based on survey responses. In the final survey, the 4 questions with scores closest to 1 scored

1.065. Their initial survey scores were higher, indicating that this content was learned in this course. The questions were:

- Explain the concept of the 4R scientific principles to nutrient management. Initial Score: 2.128
- Describe to a producer why two seemingly similar fields would actually have different nutrient recommendations. Initial score: 1.795
- Explain the primary loss pathway (if any) for nitrogen. Initial score: 2.000
- Explain what the different tests measure and indicate on a soil test report. Initial score: 2.000

The initial and final surveys could also be compared for improvement. There were two questions with very little change in response between the initial and the final survey. In each case, both scores were low indicating students entered the course knowing this information (identify nitrogen deficiency symptoms, explain why micronutrients rarely need to be applied).

There were 15 questions (of 66) where the improvement from initial to final survey was over 1.0. The two with biggest improvement were very promising as they represented the overarching course goals of applying soil information to make management recommendations. The question were:

- Calculate lime rate based on soil test information and lime quality data (initial: 2.564, final: 1.290)
- Develop a nutrient management plan using the 4R scientific principles for nutrient management. (initial: 2.487, final: 1.161)

Data Indicating that Students Solved Complex Problems

The course specifically targets problem solving and 92% of respondents agreed or strongly agreed that they were more confident in analyzing agronomic situations and solving agronomic problems while 97% were more confident in formulating an evidence based nutrient management plan (Table 1). The concept of learning level was explained to students and then they were surveyed on their perceived level of learning (1=learning facts, 3=applying facts to new situations, 5=combining facts to solve complex problems). The mean student rating for the course overall was 4.06 while the performance task activity (formulating a nutrient management plan) rating was 4.46. These data points indicate that students believe they have been learning in a way that involved complex problem solving in this course.

A primary measure of student learning and problem solving is the completion of the performance task activity. In 2021, there were 11 project groups (nine groups of 4 and two groups of 3, 10 groups worked with a farm field from one group member's family and one group worked with a community garden). The average score for the project was 85.2%. The project average is usually 87-88%. This year, one group had a project that was just barely passing (I actually rounded them up to 60%). This has never happened before and I would attribute this to the reduced contact time with students (and reduced opportunity to view past year's work) as result of shifting the course online for COVID. Also, past years had 5-6 weeks of the lab meeting time for emphasis on developing the project while this year the lab time was used for calculation help as our only weekly face-to-face meeting. About 3 weeks of the Friday discussion were dedicated to developing the project instead. I would argue that individual content learning was increased and teamwork or writing skills were less developed in the online format. This will hopefully pass with COVID but will be monitored in future semesters.

Qualitative assessments from the project grading also provide insights on student learning and problem-solving skills. Some highlights include:

- All groups used appropriate input data (e.g., real field data, referenced correlation sources) in making their recommendations.
- Only one of 11 groups recommended an inappropriate level of nutrients to apply. Their recommendation was too high due to poor logic on nutrient need, not due to process or math errors.

- Students were asked to justify their recommendation in writing. Six of 11 groups provided high scoring justification of recommendations, while 4 provided sufficient justification, and one group provided inadequate justification. Example work from justification section of high pass, medium pass, inadequate projects is in Appendix 2.
- Students were asked to evaluate the recommendation. Two of the 11 groups provided only vague information, two groups commented that the recommendation matched producer goals, four groups addressed producer goals and economics, and the last three (highest scoring) addressed producer goals, economics, and environmental factors such as climate, soil, or nutrient loss potential.
- In general, the lower scoring projects were a result of not completing all sections listed on the rubric.

Students were provided with project directions and rubric at the beginning of the semester, draft deadlines for portions of the paper with feedback on drafts using the rubric (there are 4 due dates such that they turn the paper in in stages, eventually submitting all sections as drafts prior to final submission), and two project discussion meetings (one with peers in March and one with instructors in April) as well as the opportunity to ask questions during any class meeting. Therefore, students simply chose to not do all sections.

Data Indicating that the Course was well Integrated

One goal for 2021 was to better integrate lab activities into the course as a whole. Historically, the lecture and lab were led by separate instructors (I just did the lab until 2019). Furthermore, as the course was rearranged for COVID, lab was the only face-to-face meeting with students. Three in-person lab sections were offered (I led one and graduate students led the other two) with 34 enrolled in-person. One lab section was offered via Zoom and 8 students enrolled that way (I led the Zoom lab). There does not appear to be any difference in the survey responses between the various lab sections.

One way that we monitored student learning was by asking the students to reproduce concepts from lab activities in new situations as independent assignments. In the course survey, 94% of respondents agreed or strongly agreed that lab activities were useful to their learning and 97% agreed or strongly agreed that lab activities helped them complete those assignments. Scores on assignments were very high. The overall course average for these types of assignments was 85.2. Nine students did not submit one or more of the assignments; if those students are removed, the average jumps to 93.1. Another way that we reproduced lab activities was with story problems on exams. These questions typically had high discrimination indexes and approximately 80% success rates.

In general, the course was completely overhauled in 2021 with lab activities that coordinated to assigned textbook reading as the focus on each week and thus, the labs were integrated. The key will be to keep that weekly integration intact next year when the course has more opportunities for face-to-face learning activities.

SUMMARY AND REFLECTION

Lucky for me, students come into this course desiring to learn material that they view as being important to their future work. In fact, 89% of students reported that they plan to use course content in their future work and 81% believe they will use course content on their or their family's farm. For this reason, all assessments are framed as applied learning that both connects back to textbook learning and ahead to real world work. I feel that the updates made to the course this year allowed students better understanding of course content than prior years without diminishing the application component that the course has always had. The primary way that the course teaches and assesses application of content is through the performance task activity of developing a nutrient management plan and this will continue to be an emphasis of the course.

The updates made this year addressed my goals of taking more ownership of course (after switching from co-teaching to fully teaching the course) and better integrating all meetings for the week (specifically making lab activities more closely aligned with content and case studies for the week). The reorganization of weekly topics and integration of lab and lecture topics will continue in future iterations of the course.

The course works well with a flipped design and weekly case study and discussion activities. It will be nice to meet with students more next year to focus more on connecting content from one week to the next and to have more time to work on the group project together. While I look forward to meeting with the students more, this experience has also shown me that it is possible to make the course fully online.

Appendix 1 – Course Syllabus for Spring 2021

AGRO/SOIL 366 SOIL NUTRIENT RELATIONSHIPS – SPRING 2021

COURSE DESRIPTION:
Explores nutrient behaviors in soil and factors affecting nutrient management. Students work on developing fertilizer plans for complex plant production systems that follow the right place, right amount, right source, right time philosophy and ensure production of healthy and nutritious plants, improve profits and enterprise sustainability, fulfill legal requirements, and protect soil and water quality.

WHY THIS COURSE:
Nutrient management is the 2nd largest production expense (after seed) and mismanagement is the number one way that agricultural production affects the environment, which casts a negative light on agriculture. You will need the skills to pinpoint recommendations so that return on nutrient investment is maximized without harming the environment. Both under applying and over applying can be costly and damaging. Many of our course examples will include an economic analysis as fluctuating market prices of crops and increasing cost of fertilizers have heightened the interest of farmers, crop consultants, government, and industry to improve efficiency and augment practices to improve production quantity, quality, and profitability. The course will address principles of soil-plant nutrient relations, fertility evaluations for nutrient management, soil testing and recommendations, fertilizer sources, soil acidity, and nutrient sources.

LEARNING GOALS:
The overarching goal of this course is for you to leave ***able to formulate an evidence based nutrient management plan that considers economics and the environment***. Within this, specific course learning objectives include developing and mastering the ability to describe:

- nutrient cycling and the factors affecting availability of each nutrient,
- limiting factors for various nutrients in various environments,
- how to obtain appropriate data and science-based recommendations for nutrient management,
- integrating nutrient management as a systems approach,
- use of the 4R scientific approach, and,
- how socio-economic factors affect nutrient management decisions.

This course addresses several student learning outcomes for the Department of Agronomy and Horticulture, including:

- Demonstrate **stewardship** and accountability in decision-making processes that transcend fiscal parameters (1B)
- Understand that plant and soil **systems** are embedded within complex social-ecological networks that interact across a range of spatial and temporal scales (2A)
- Demonstrate understanding and problem solving based on the concepts and applications of their **area of study** (3A)
- Be able to **acquire** scientifically derived information, to assess its reliability, and write appropriately about scientific knowledge and discovery (3B)
- **Interpret** graphs, charts, and tables and **communicate** results through written and oral reports (4C)
- Lead and contribute to diverse **teams** to propose and implement solutions to complex plant and soil system problems (6A)
- Educate and **persuade stakeholders** (e.g., consumers, policymakers, growers, etc.) to action using evidence-based and technically sound oral, written, visual and multimedia communications (6C)

Success on above will require the following knowledge/skills, that you will be able to practice in this course:

- How soil nutrients interact with biotic, abiotic, and management factors
- Basic math (including unit conversions), chemistry, and writing concepts
- Understanding that crop production is a complex system of interconnected practices and decisions

TEACHING TEAM:

Team Member	Email address
Professor	
Meghan Sindelar	msindelar3@unl.edu
Graduate Student Teachers	
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Alyssa Kuhn	akuhn2@huskers.unl.edu
Classroom Assistants	
Micah Erickson	micah.erickson@huskers.unl.edu
Jean Niwenshuti	jniwenshuti2@unl.edu

Please email any team member with questions or to schedule appointments.
We are available to help via email, phone, Zoom, or in-person meetings.

COURSE MATERIALS:

1. Soil Fertility and Fertilizers. 7th or 8th Edition. Havlin, Tisdale, Nelson, and Beaton. Pearson.
   ISBN-13: 978-0135033739. E-Reserve at http://ereserves.unl.edu/contents/agro366/agro366.html
2. Nutrient Management for Agronomic Crops in Nebraska. 2014. (Ed. Tim Shaver). University of Nebraska Extension: EC 155.
3. Calculator, computer, good internet connection
4. Other content disseminated through Canvas

AGRO 366 SCHEDULE:

Week	Course Topic	Important Assessment Dates
1	What is Soil Fertility	
2	Soil Nutrient Sources and Cycling	
3	Nutrient Management Issues	1st Project Draft Deadline
4	pH & Liming	
5	Data Collection	Exam 1: Mon 2/22 9am-7pm, Canvas
6	4R Planning	2nd Project Draft Deadline
7	4R Planning	
8	Nitrogen	
9	Nitrogen	3rd Project Draft Deadline
10	Phosphorus	Exam 2: Mon 3/29 9am-7pm, Canvas
11	Potassium	
12	Manure	4th Project Draft Deadline
13	Sulfur	
14	Micronutrients	Final Written Project
15	Finals Week	Exam 3: Mon 5/3 9am-7pm, Canvas

COURSE ACTIVITIES:
This is a 4 credit course – imagine it as one credit for each of the following activities

A. Content Learning:
Textbook reading assignments, video lectures, university extension guides, and other content will be explored on own as an independent, online lecture. Assignments and other material will be disseminated through Canvas. Follow-up quizzes due Tuesday, end of day.

B. Lab Activities:
Attend one weekly meeting for questions on content and to work on calculations and other technical skills related to weekly topic with the assistance of instruction team. Follow-up quizzes in the next week's lab.

Wednesday	1:00-2:50 pm (sec. 152);	275 Plant Science Hall
Wednesday	3:00-4:50 pm (sec. 154);	Online via Zoom
Thursday	1:00-2:50 pm (sec. 153);	275 Plant Science Hall
Thursday	3:00-4:50 pm (sec. 151);	272 Plant Science Hall

C. Case Studies & Discussions:
Attend one weekly meeting (via Zoom) to discuss application of weekly content and practice nutrient management planning in small groups. Various types of assignments will be due from this.

Friday	9:00 - 9:50 (sec. 150);	Online via Zoom
Friday	11:00-11:50 (sec 155);	Online via Zoom

D. Nutrient Management Planning:
Work in small groups on a real field to assess prior management, set goals for improvement, and develop a nutrient management plan. This groupwork will be done outside of course meeting time and culminate in both a written and oral report.

ASSESSMENT
Nutrient Management Project (25%): This project is a summative nutrient management project where you apply the soil fertility concepts and skills you have learned in this course. 20% is the written report and 5% is the oral presentation (to be presented remotely, i.e. via zoom). Detailed guidelines for this activity will be provided later.

Hour Exams (30%): 3 exams will be given during the lecture period. The format will include multiple choice, essay questions, matching, and calculations. Exam administered online; open book is fine but do note that canvas time limits will be enforced and large question banks are used. Exams are independent work.

Weekly Quizzes (20%): These quizzes will include that week's content from reading and videos as well as lab content and calculations. Content quizzes are online and due Tues. Lab quizzes taken during lab.

Case Study Reports (10%): Work with a team to assess a situation. Summarize findings in a brief report.

Assignments (15%): Due via Canvas, would include questions representing in-class activities and independent work competed throughout the week. Assignments will include short write ups, sketches, guidance documents, and other demonstration of learning.

LETTER GRADE SCALE

%	**Grade**		%	**Grade**		%	**Grade**
≥ 92	**A**		80 – 81.9	**B-**		68 – 69.9	**D+**
90 – 91.9	**A-**		78 – 79.9	**C+**		62 – 67.9	**D**
88 – 89.9	**B+**		72 – 77.9	**C**		60 – 61.9	**D-**
82 – 87.9	**B**		70 – 71.9	**C-**		Below 59.9	**F**

COURSE POLICIES AND PROCEDURES

As instructors of this course, we set a classroom atmosphere that nurtures critical thinking and provides opportunities for students to not only ask questions but practice critical thinking. Specifically, our responsibilities include:

- Respecting of all points of views.
- Creating a stimulating environment for the exchange of ideas and for questioning of ideas.
- Prompting you with additional questions or hints/tips to help you answer your own questions.

Each student must take responsibility for their own learning. You should be actively involved in the course, first by setting your own goals for this course. Specifically, your responsibilities include***:***

- Attend all scheduled sessions.
- Read and review the syllabus so you know the course expectations.
- Come to class prepared; ask questions in class and challenge your thinking.
- Check email and Canvas for message and/or announcements from the instructors and TAs.

<u>Attendance:</u> Attendance (in person or virtually) at all scheduled class sessions (lab and discussion) is expected and required. The student is responsible for contacting the instructors or assistants for missed work. If possible, attend a different lab session (or the online session W3-5) if you need to miss lab.

<u>Grade Appeals:</u> Appeals must be made in writing no later than 24 hours after the activity was returned to the student. Written appeal should include rationale or justification.

<u>Penalty for late assignments:</u> 10% reduction in grade each day for five consecutive days after the due date. Work submitted after 5 days or more will be entered as zero in the grade book.

<u>Groupwork:</u> Each group will develop their own contract. There will be regular opportunities to assess groupmates. Please ask for help sooner, rather than later, if there are any difficulties with your group's dynamics.

<u>Disabilities:</u> Students with disabilities are encouraged to contact the instructor for a confidential discussion of their individual needs for academic accommodation. If you anticipate or experience barriers based on your disability (including mental health, chronic or temporary medical conditions (e.g. pregnancy)), please let me know immediately so that we can discuss options. To receive accommodation services, students should be registered with the Services for Students with Disabilities (SSD) office, 117 Louise Pound Hall Bldg, 472-3787.

<u>Emergency Actions</u>: http://emergency.unl.edu/doc/Emergency_Procedures_Quicklist.pdf
UNL Alert: Notifications about serious incidents on campus are sent via text message, email, unl.edu website, and social media. For more information go to: http://unlalert.unl.edu

The following are essential information for all Buildings and Classrooms.

- *Fire Alarm* (or other evacuation): In the event of a fire alarm: Gather belongings (Purse, keys, cellphone, N-Card, etc.) and use the nearest exit to leave the building. Do not use the elevators. After exiting notify emergency personnel of the location of persons unable to exit the building. Do not return to building unless told to do so by emergency personnel.
- *Tornado Warning*: When sirens sound, move to the lowest interior area of building or designated shelter. Stay away from windows and stay near an inside wall when possible.
- *Active Shooter*
    - Evacuate: if there is a safe escape path, leave belongings behind, keep hands visible and follow police officer instructions.
    - Hide out: If evacuation is impossible secure yourself in your space by turning out lights, closing blinds and barricading doors if possible.
    - Take action: As a last resort, and only when your life is in imminent danger, attempt to disrupt and/or incapacitate the active shooter.

INTEGRITY AND CONDUCT

Each student is expected to heed the UNL Student Code of Conduct for all matters including academic honesty and minimizing the impact of COVID-19.

Academic Honesty: Cheating and/or plagiarism will not be tolerated; the Department of Agronomy and Horticulture Academic Integrity Statement reads as follows:
"Academic integrity is an essential indicator of the student's ethical standards. For this reason, students are expected to adhere to guidelines concerning academic honesty outlined in Section 4.2 of University's Student Code of Conduct, which can be found at http://stuafs.unl.edu/ja/code/three.shtml. Students are encouraged to contact the instructor to seek clarification of these guidelines whenever they have questions and/or potential concerns."

Breaches of Academic Integrity for AGRO/SOIL 366:

1. For quizzes and tests, if the instructor observes behavior other than that allowed for through the instructions given, the student will receive a zero (0) for that occasion and will be warned that a second offense will result in a failing grade for the course.
2. If the instructor suspects that completed projects and written papers are not those uniquely created by the individual student, a meeting will be held between that student, the instructor and teaching assistant to discuss the content in question. The student may be asked to present supporting documentation or proof of their resources for the information in question. Students who fail to validate their work will receive a zero (0) for the item in question.
3. If the student is still dissatisfied with the consequences imposed, he/she may appeal to the Department Head or his/her designee within 14 days of the incident.
4. If the student is dissatisfied with the results of his/her appeal to the Department Head, then he/she may appeal to the Dean of the College of Agricultural Sciences and Natural Resources within 21 days of the incident.
5. Further appeal may be pursued with the University Judicial Officer as described in http://stuafs.unl.edu/ja/code/three.shtml.

The course instructor will inform the student's academic advisor of the final disposition of the breach of academic integrity immediately after the final decision

Required Use of Face Coverings for On-Campus Shared Learning Environments:

As of July 17, 2020 and until further notice, all University of Nebraska–Lincoln (UNL) faculty, staff, students, and visitors (including contractors, service providers, and others) are required to use a facial covering at all times when indoors except under specific conditions outlined in the COVID 19 face covering policy found at: https://covid19.unl.edu/face-covering-policy. This statement is meant to clarify classroom policies for face coverings:

To protect the health and well-being of the University and wider community, UNL has implemented a policy requiring all people, including students, faculty, and staff, to wear a face covering that covers the mouth and nose while on campus. The classroom is a community, and as a community, we seek to maintain the health and safety of all members by wearing face coverings when in the classroom. Failure to comply with this policy is interpreted as a disruption of the classroom and a violation of UNL's Student Code of Conduct.

Individuals who have health or medical reasons for not wearing face coverings should work with the Office of Services for Students with Disabilities (for students) or the Office of Faculty/Staff Disability Services (for faculty and staff) to establish accommodations to address the health concern. Students who prefer not to wear a face covering should work with their advisor to arrange a fully online course schedule that does not require their presence on campus.

Students in the classroom:

1. If a student is not properly wearing a face covering, the instructor will remind the student of the policy and ask them to comply with it.
2. If the student will not comply with the face covering policy, the instructor will ask the student to leave the classroom, and the student may only return when they are properly wearing a face covering.
3. If the student refuses to properly wear a face covering or leave the classroom, the instructor will dismiss the class and will report the student to Student Conduct & Community Standards for misconduct, where the student will be subject to disciplinary action.

Instructors in the classroom:

1. If an instructor is not properly wearing a face covering, students will remind the instructor of the policy and ask them to comply with it.
2. If an instructor will not properly wear a face covering, students may leave the classroom and should report the misconduct to the department chair or via the TIPS system for disciplinary action through faculty governance processes.

Required re-entry testing for access to campus in Spring 2021

To protect the health and well-being of the University and wider community, UNL has implemented a policy requiring all people, including students, faculty, and staff, to submit to re-entry testing. Be prepared to show "Access Granted" status in the Safer Community App following a negative test for Coronavirus. Testing will begin the week of January 19-24 for the initial round of tests. It is very important that you take the earliest test possible in this window to help ensure access to campus when the semester starts on January 25. A list of testing locations and more information is now available on the COVID-19 website, https://covid19.unl.edu/

Appendix 2 – Examples of Written Justification from Student Projects

Rubric Reads:
Section C.5. 60 pts. This is the proposed 4R management plan.

- Provide a summary table to recommend source, rate, timing, and placement for all needed nutrients (and lime, if applicable) for at least two crop years (10)
- Summarize and interpret table in writing (5 ea R)
- Provide justification for recommendations and any differences between proposal and current management (5 ea R)
- Expand on recommendations as needed (10)
  - State why there is no recommendation for some nutrients
  - Describe integration of 4Rs as part of the justification for above recommendations.

Example of Strong Work: Student Group A

4R Fertilizer Recommendation

Recommendation Justification

Philosophy of Recommendations:
The producer is taking an economic approach to this field. This includes using the most efficient resources that maximize yield potential. Every decision that is made will take into account the point of diminishing returns to get the most yield for the least amount of inputs. The producer chose this approach because this particular field is not all irrigated. The reason this is so important is because this field will not have as much yield potential as other fields, so the producer does not want to use as much resources here.

All these recommendations are for corn for the upcoming year. When the rotation is soybeans, no nutrients will be recommended for the field since nitrogen can be produced by the soybeans and all the other nutrients are sufficient in the field.

Liming Plan:

Irrigated: Lime Rate = (7 – 6.75) x 5 = 1.25 tons/acre
Application Rate of Ag Lime = 1.25 x 60 / 54 = 1.39 tons/acre Ag Lime
($15 x 1.39) + ($5.50 x 1.39) = $28.50 / acre for Ag Lime + application

Dryland: Lime Rate = (7 – 6.4) x 5 = 3 tons/acre
Application Rate of Ag Lime = 3 x 60 / 54 = 3.3 tons/acre Ag Lime
($15 x 3.3) + ($5.50 x 3.3) = $67.65 / acre for Ag Lime + application

Table 3. Liming Table

Source	Timing	Rate	Placement
Ag Lime (Irrigated)	Directly after soybean harvest in fall.	1.39 ton/acre	Broadcast with tillage to incorporate.
Ag Lime (Dryland)	Directly after soybean harvest in fall.	3.3 ton/acre	Broadcast with tillage to incorporate.

Recommended Source:
The recommended source will be Ag Lime to correct the soil acidity on this field. First of all, according to the calculations of the options given, Ag Lime is the cheapest option per acre including application. In addition to this, Ag Lime is very easy to apply because it can be applied through a dry spreader. Also, Ag Lime will be active in the soil by the time soybeans are planted the following year. The only downside to

using Ag Lime is that sometimes it is more difficult to spread and doesn't become active as fast as other sources because of the lower ECCE.

Recommended Time:
The lime should be applied in the fall after soybean harvest (October/November), prior to corn the next summer; however, since this plan was made in the spring, it is recommended to apply now. This is done because corn is more tolerant to acidic conditions. Since it is known that lime takes time to correct soil acidity, the soil pH will not be corrected the first summer after application. With the soil still being acidic this first summer, corn should be planted so that the crop is not negatively impacted by the acidic soil. However, after this one year of corn, the Ag Lime will be activated in the soil, and soybeans can be planted the year after corn. With the pH being corrected by that lime, the soybeans will have access to all the nutrients they need and the soil organisms will be functioning again, allowing the soybeans to form nodules and fixate nitrogen.

Recommended Placement:
When it comes to placement, the producer should broadcast spreading the Ag Lime. The producer should also till the lime into the soil. Tilling the lime into the soil encourages faster incorporation and allows the lime to correct soil acidity quicker and more efficiently than if it were just lying on the surface in a no-till system. In no-till systems lime only moves downward ½ inch each year. With this in mind, it makes sense to incorporate the lime into the soil via tillage because it would take years to correct the soil profile's pH issue with only ½ inch of downward movement each year in a no-till system. In addition to this, some lime can be blown away in the wind if it is not incorporated into the soil.

These 4R choices are the correct choices for this field and situation. Ag Lime is the best source for this field because it is cheapest, will become active quick enough, and easy to spread. 2.2 tons/acre of Ag Lime. Applying lime in the fall or ASAP, after soybeans are harvested from this field, gives the lime time to correct the soil's pH before soybeans will be grown in this field again. Since corn will be planted the year after soybeans, the lime will have all summer to correct the soil pH before soybeans are grown the following year. Spreading the lime and tilling it into the soil is the best placement option for this field and most fields. Incorporating the lime into the soil allows the lime to correct soil acidity faster and more efficiently than if it were lying on the surface of the soil in a no-till system.

Nitrogen Plan:

Table 4. Nitrogen Recommendation for Irrigated Acres

Fertilizer	Time of Application	Amount Applied in lbs N/acre	Placement
UAN (32-0-0)	Planting	83	Trickle over soil, on top of row
Urea (46-0-0)	V5	80	Broadcast through spreader
UAN (32-0-0)	V10, Tassel, R3	40 (about 13 lbs N each time)	Pumped through pivot via fertigation

Table 5. Nitrogen Recommendation for Dryland Acres

Fertilizer	Time of Application	Amount Applied in lbs N/acre	Placement
UAN (32-0-0)	Planting	47	Trickle over soil, on top of row
Urea (46-0-0)	V5	80	Broadcast through spreader

Recommend Source:
The sources of nitrogen being applied to this field are UAN and urea. UAN is a great source because of its availability as a liquid source, which will make it easy to apply during planting through the planter and

in-season through the pivot during V10, tassel, and R3. Urea will also be used as a source of nitrogen due to its ability to be broadcasted over the field during V5 and then be incorporated into the soil by the pivot.

Recommended Timing:
The producer is going to put on UAN at planting as a starter for both dryland and irrigated. The producer is putting this on as the first nitrogen application because it will reduce leaching and put on the right rate for this time in the growth of the corn crop. The producer will then put on urea at V5 for both dryland and irrigated. This timing was chosen because this is when the corn crop really starts to take off in the vegetative stages and starts to use more nitrogen. At this point the producer will have reached all the nitrogen he is putting on for the dryland. Around tassel, the producer will put on UAN through the pivot on the irrigated only to meet the higher rate recommended for the irrigated zone. This is when the last amount of nitrogen for the irrigated zone will be applied. This time has been chosen because this is when the crop needs the most water so it makes it easy to know that this is a guaranteed time the producer will be irrigating. At this time the producer will also want to get nitrogen applied to help grain fill.

Recommend Placement:
Urea will be broadcasted by a dry spreader over the field during V5. This is the best way to apply urea as it is the most cost-effective method of application and the rate can be adjusted easily by the applicator in the machine. UAN will be applied by the planter during planting and through the pivot at V10, tassel, and R3. These ways were chosen because during planting, the most efficient way to apply nitrogen is right behind the planter by trickling the UAN into the soil right by the seed. For the application through the pivot during V10, tassel, and R3, this method makes the most sense because the pivot is able to cover most of the field and is cheaper than Y-dropping nitrogen right along the rows.

Integration of 4Rs:
UAN best fits application via starter at planting because it provides the seed with access to adequate nutrients immediately during the growing season in order to get it growing quickly. Urea best fits broadcast application at V5 because it is an affordable way to apply nitrogen to both the dryland and irrigated acres during the growing season. The producer only has a dry spreader, so this also played a role in choosing urea. Finally, UAN best fits application through fertigation because it provides the irrigated acres with the extra N it needs during the growing season and it is a liquid so it can be pumped through the pivot.

Example of Medium Work: Student Group K

Nutrient Management Strategy

For this field a zone variable rate application would be the best fit for our spatial management strategy. If you separate your field into zones based on the soil type, this allows you to diagnose the amount of nutrients needed per zone rather than applying a constant rate across the entire field. Variable rate application allows you to apply the specific level of the nutrient to a particular area of the field based on the needs of the zone or soil type. This would be a good fit for this field because we have four different soil types that all respond to nutrient application differently. If we use zone variable rate application, it will allow us to apply the necessary amount of nutrients to maximize the output of this field while saving the producer money by not overapplying nutrients to areas of the field that may not utilize them. For a nutrient strategy sufficiency or deficiency correction is the best fit for this field. Deficiency correction is when a nutrient should be applied only if there is an expectation of a crop response. This means that you only apply nutrients when the levels are deficient and by applying a nutrient you expect to see some kind of improvement. This is the best approach for this field because it is economically and environmentally sound. It will save the producer money by only applying nutrients when there is an expected response from the crop which will help prevent overapplying a nutrient and harming the environment.

Source

Complete recommendations for source, rate, time and placement can be found in appendix 4 below. Sources include 10-30-0-3-.5 and 28-0-0-5 for both corn and soybeans. These liquid sources are being used because the producer has the capability to perform all liquid applications by themselves without a Coop's assistance. The producer also has a large liquid facility that has the capability to store the different liquid sources on site. Due to this bulk capacity the producer can get these sources for cheaper rates when compared to other producers in the area. One difference between our plan and the past is that nitrogen stabilizers will be used along with micronutrient blends to help increase the boron and manganese levels.

Rate

Rates are varying across the different applications to ensure that the application is time efficient and allows for the herbicide application rates to be accurate. In corn the rate is 9 gal/acre of 10-30-0-3-.5 at strip till and is applied along with 6 gal/acre of 28-0-0-5. During planting 9 gal/acre of 10-30-0-3-.5 is applied and then 10 gal/acre of 28-0-0-5 is broadcasted after planting. Throughout the growing season six fertigation applications are made at 10 gal/acre of 28-0-0-5. This results in 256 pounds of nitrogen per acre, 63.2 pounds of phosphorus per acre, and 48.13 pounds of sulfur per acre. The difference in rates between the producers' plan and ours is that we are also adding in 2 quarts per acre of boron and manganese along with 1 gallon per acre of humic acid at strip till. During planting 1 quart per acre of microblend is added along with 2 quarts per acre of humic acid. At the fertigation applications 1 quart per acre of humic acid is added to every single application, but only 2 quarts of boron per acre are added to only 2 of the 6 fertigation applications. For the soybean crop, the rates between the producer's plan and our plan were the same. In the soybean plan 10 gal/acre of 10-30-0-3-.5 is broadcasted and disked in before the soybeans are drilled. The only other application to the soybeans is one fertigation during the reproductive stage and this application consists of 10 gal/acre of 28-0-0-5.

Placement

Placement also varies by the application method, but what makes this field special is that 186 pounds of nitrogen per acre is fertigated in the corn year. This is over 70% of the total nitrogen that is applied to the field. By fertigating it minimizes the risk for leaching since the fertilizer is being applied while the plant is actively growing and taking up nutrients and water. Other placement methods are knifing during strip till and 2 x 2 during planting. The last placement method is broadcast with a floater before the corn emerges. For soybeans the only placement methods are broadcast with a floater and through fertigation. Placement methods were not changed between the producers plan and our plan because we felt the producers plan was the best way to prevent the loss of nutrients through the different processes.

Time

The timing of these applications were also not changed because we felt that avoiding fall applications and front loading would be the best preventative measures to avoid nutrient loss in this sandy soil. By spoon feeding the corn with applications at strip till in mid March and at planting in early May we felt that nutrients would not be lost, especially if nitrogen stabilizers were used. To split up the applications even more we felt that the broadcast application at pre emerge would also help reduce the loss of nitrogen through the system. By using a nitrogen stabilizer at this application we can reduce the loss to leaching and volatilization. Fertigating also helps reduce the loss of leaching by applying when the plant is actively growing and using nutrients. To prevent volatilization with the water application a nitrogen stabilizer will be used to prevent this from occurring. For the soybeans we felt the one broadcast application was necessary to provide easy access to nutrients for the soybean plants. By working in the application we reduce the risk of volatilization, but the risk for leaching can still occur. The only nutrient that would leach from this system is the nitrogen which soybeans do not typically need anyway because of the nitrogen the plants produce themselves. Nitrogen is added to this system because the producer shoots for 100 bu/acre which requires more nitrogen than the plant can produce. One more application through fertigation is made at soybean bloom to help push the soybean plants to the finish line and provide any additional nutrients that are needed to achieve this yield goal.

Example of Low Pass Work: Student Group D

Recommendations

Based on the soil test, there are not many nutrients that need to be added for corn or sorghum other than nitrogen. For soybeans, there will be no fertilizer needed, however, with a pH of 5.5, there will be lime needed to help raise the pH of the soil. According to the recommendations for corn, soybeans, and sorghum from the University of Nebraska-Lincoln, there is no potassium, sulfur, phosphorus, or any other micronutrients that are going to benefit the crops. When creating this 4R nutrient management plan, deficiency correction is the recommended philosophy.

The farmer does not have the ability to do variable rate fertilization. There is only the option to broadcast the fertilizer, therefore, urea is an optimal source. The rate was calculated using the UNL N Algorithm with corn and was figured that 100 lbs per acre will need to be applied to meet yield goals. There were credits from past soybean growth. Due to the source that is going to be used, the application will be done at planting and will be broadcast. For this source, this is the only way to apply it, and planting application is the best option to prevent losses over the winter. There will also be a urease inhibitor added to the urea.

The nitrogen calculations for sorghum were created using the N Algorithm for Sorghum following Corn. There will need to be 160 pounds of nitrogen applied per acre to meet the yield goal according to the formula. The sorghum will be following the same rate, source, placement, and timing as the corn. Due to the crop rotation that there is of corn, soybeans, grain sorghum, it would make sense for the producer to use cover crops to continue to add nitrogen and organic matter back into the soil.

Table C.1. Recommendation for Nitrogen Application: Corn

Nutrient	Amount/Acre	Form	Urea/Acre	Time of Application	Method
Nitrogen	100 lbs	46-0-0	218 lbs	Planting	Broadcast

Table C.2. Recommendation for Nitrogen Application: Grain Sorghum

Nutrient	Amount/Acre	Form	Urea/Acre	Time of Application	Method
Nitrogen	159 lbs	46-0-0	345 lbs	Planting	Broadcast

Example of Inadequate Work: Student Group I

Nutrient Recommendations

This field is under a corn-soybean rotation, with this year being planted corn. By using the current equipment we have on hand that is owned and operated by XXXX, for applications of N every year, and then applying P and K every other year. In table 6 you can see the economics of the recommendations. The average pH in our field is 6.6 and the average BpH in the field is 7.52, so our levels are pretty good during this soil test. Lime will have a blanket application in years that it is needed based on soil test reports.

Application	Rate	N credit	P credit	K credit
32-0-0 injected near seed furrow before planting	40.3 gal	142.7 lbs	0 lbs	0 lbs
11-52-0 broadcasted in the fall	11.5 lbs	1.27 lbs	6 lbs	0 lbs
0-0-60 broadcasted in the fall	2.5 lbs	0 lbs	0 lbs	1.5 lbs