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Editor

Jason Bergtold,
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Research Articles

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Research Article

Evaluation of Learning Outcomes from Participation in a Student-Managed Commodity Investment Fund

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JEL Codes: A20, G11, Q02

Keywords: Commodities, experiential learning, finance, futures, investing

Abstract

Students in agricultural and applied economics are expected to develop skills and knowledge allowing them to perform tasks in agribusinesses and related industries. Skills range from technical abilities in the discipline to soft skills, such as communication ability or leadership performance, which may be more broadly applicable. We present results of a survey of undergraduates and graduate students participating in a student-managed commodity investment fund. The fund provides an experiential learning opportunity for undergraduate students and allows them to learn about commodity markets (futures, options, and other derivatives) while simultaneously improving technical, communication, and leadership skills. Students consider soft skills to be an important factor determining their participation and improve both soft and hard skills through participation.

1 Introduction

Experiential learning is an increasingly prevalent method of teaching in agricultural economics as well as other disciplines. Experiential learning is a process—or philosophy—of learning where learners take experiences and transform them into knowledge. As noted by Kolb and Kolb (2005), experiential learning is not simply an experience provided to the learner, but a process by which the student experiences, reflects, thinks, and acts to gain new knowledge. Each of these concepts (experiencing, reflecting, thinking, and acting) is equally important in the philosophy of experiential learning and supports understanding and retention of material introduced through this approach. The appeal of experiential learning has continued to grow since being conceptualized by Kolb (2014). The importance of experiential learning as a core component of higher education and a supplement to classroom teaching is now widely recognized (Bransford, Brown, and Cocking 2000).

Many of the earliest formalized experiential learning opportunities in agricultural economics involved the use of games or computer simulations to recreate a real-world experience (Koontz et al. 1995b). More advanced experiential opportunities are now available to students including opportunities that marry all three missions of the land grant university (Curtis and Mahon 2010). These opportunities enhance student acquisition of the disciplinary and soft skills required of the well-rounded agricultural and applied economics graduate. Increasing numbers of agricultural graduates are employed outside the traditional agriculture sector (Artz, Kimle, and Orazem 2014). For instance, demand for graduates with a solid understanding of finance and agriculture has only grown with the development of new commodity-based investment instruments. Commercial and financial firms are an important source of employment for students with experience in risk management, commodities, and financial derivatives.

Risk management, commodities, and derivatives education are some of the most common areas of experiential learning in agricultural economics (Spencer and van Eynde 1986; Koontz et al. 1995a; Dolan and Stevens 2006; Dolan and Stevens 2010; Riley 2019). Often, course concepts are illustrated in a game format or through the use of a simulated portfolio (Trapp 1989; Koontz et al. 1995a). A natural

progression from investment and hedging simulators toward a more realistic environment is an investment fund. Unlike typical university courses or investing games, the student-managed investment fund (SMIF) provides students with real money that is invested according to rules set by the organization (Lawrence 1990). In this sense, a student-managed investment fund closely mimics the operations of an investment firm and provides an experiential learning activity that requires students to use and develop knowledge of commodity markets while improving the soft skills demanded by industry. Peng, Dukes, and Bremer (2009) indicate that the majority of SMIFs invest in equities. Even though investing in commodity markets is very different from investing in stocks in both approach and investment horizon, a recent study by Isengildina-Massa and Ramsey (2019) demonstrates that the SMIF provides an excellent model for incorporating experiential learning in agricultural and more general commodity price analysis programs. Student-managed commodity investment funds provide an environment for students to engage in all four stages of Kolb's (2007) experiential learning cycle as they participate in fund activities throughout the course of the semester.

In spite of widely recognized benefits for students, there has been little evaluation of student experiences and outcomes from participation in student-managed investment funds. One exception is Clinebell and Murphy (2016), who surveyed alumni of a student-managed investment fund and found evidence that participation in the fund improved student knowledge and soft skills. Alumni overwhelmingly reported that participation in the fund increased communication, writing, and presentation skills. Moreover, they reported that participation in the experiential learning opportunity increased their knowledge of investing concepts more than learning without the experiential component. Sixty-three percent of respondents to the survey were influenced in their choice of career by participation in the fund. In other studies, students have reported strong preferences for experiential learning over more passive approaches (Hawtrey 2007).

The goal of this study is to assess learning outcomes of students participating in a student-managed commodity investment fund. It builds directly on earlier work by Isengildina-Massa and Ramsey (2019), which describes the fund creation, procedural details of fund operation, and the costs and benefits of operating such funds. This article advances their earlier research by specifically examining student assessment of the benefits of fund participation. Outcomes are measured through self-assessed improvement in several areas related to this experiential learning program. We first review important factors determining student participation. Second, students consider a number of knowledge criteria and skills and rate their confidence in being able to perform related tasks. They also rate perceived improvement in task performance resulting from participation in the fund. We find that soft skills are important factors determining student participation and improve with participation. Possible improvements to fund operation to enhance soft and technical skill sets are also discussed.

2 Learning Outcomes, Student-Managed Commodity Investment Fund, and Outcome Survey

Our survey was designed to capture key learning outcomes associated with participation in a student-managed commodity investment fund described in more detail by Isengildina-Massa and Ramsey (2019), as well as student motivations for joining this fund. The key learning outcomes are specific areas of knowledge or skills that students can be expected to obtain due to their participation. The survey divided these outcomes into technical and soft skills. The outcomes identified in the survey are expected outcomes based on the structure and operation of the fund as detailed below.

The fund is composed of undergraduate and graduate students at all levels of study. The fund originally operated only as an extracurricular activity, but students participating in the fund now receive two hours of course credit per semester in a pass/fail format. In general, the majority of participants are undergraduate students (greater than 90 percent of all members). Although the fund is housed in an agricultural and applied economics department, students from all majors can apply to participate.

Students are recruited to the fund through a general recruitment effort that generally occurs in the fall semester of each year, but is also sometimes conducted in the spring as well. Acceptance to the fund is determined by a formal interview process provided that the candidate has a minimum grade point average of 3.0 and at least three semesters of study remaining. The interview process consists of submission of a resume, a technical interview, and a behavioral interview. In the most recent recruitment cycle, 159 students applied to the fund, and 30 students were admitted after formal interviews.

After training, students take the role of a commodity analyst and are responsible for a specific part of the fund's overall portfolio. To simplify operation of the fund, the portfolio is composed of exchange traded funds (ETFs) and exchange traded notes (ETNs), rather than futures contracts, that would require margins calls and the possibility of physical delivery. The students in this fund invest in a total of 15 commodities in three sectors. There are the agricultural commodities, such as cotton, corn, a livestock index, coffee, sugar, wheat, and soybeans; the energy commodities Brent crude oil, gasoline, natural gas, and U.S. oil; and the metal commodities copper, gold, nickel, aluminum, and silver.

Analyst performance is determined not on an absolute basis, but on performance relative to a benchmark fund: the Bloomberg Commodity Index in this instance. Students meet roughly twice a week to take part in activities related to the fund. These include training meetings—typically a lecture, outside speaker, or group activity—and the weekly trading meeting. Analysts on a commodity make a trade proposal at the trading meeting, and all fund members then vote on the proposed trade. The trading meeting aligns with the operation of real firms and provides the greatest opportunity for students to develop their soft skills.

If an analyst is submitting a trade at the trading meeting, the bulk of the work occurs before the trade proposal is presented. Analysts follow a template in constructing their proposal that includes information on the position they would like to take, analysis of market fundamentals, and potential exit strategies. In constructing the trade proposals, junior and senior analysts must work together in a team to arrive at a single proposal. During the proposal pitch itself, the analysts both present the proposal to the entire membership as well as defend their position. Whether the proposal is accepted depends on the quality of the analysis presented and the ability of the analysts to clearly communicate their position to the group at large.

In addition to the act of trading, students involved in the fund are also engaged in personnel management activities including the selection of fund management. Management take an active role in leading various aspects of the fund. All fund members are also involved in recruiting and interviewing potential members. Charlton, Earl, and Stevens (2015) report that a management position in a student-managed fund can be as important as trading activities, again highlighting the importance of soft skills gained through these learning opportunities. The acquisition of soft skills is an important element of many experiential learning opportunities (Marsh et al. 2016). Soft skills broadly encompass any interpersonal or behavioral skills that are not usually included in disciplinary or technical knowledge. Crawford et al. (2011) identify seven soft skill clusters including experiences, team skills, communication skills, leadership skills, decision-making skills, self-management skills, and professionalism skills. In a nationwide survey of 31 universities and 282 employers, they found that soft skills were ranked more important than discipline knowledge, technical skills, and technology skills by employers. Traditional lecture formats provide little opportunity for students to improve in these areas, but experiential learning tied to traditional coursework can result in significant improvement in students' ability to develop soft skills (Good, McIntyre, and Marchant 2013).

Even the most basic responsibility of a participating student—to place and evaluate trades—encompasses all aspects of an effective experiential learning experience. Students are placed in the new experience of making a trade using real money. They are then asked to reflect on their trade, whether successful or not, by reporting trade outcomes to the group and in regular performance reports. Students learn new concepts when their reflection gives way to new ideas or ways of thinking. And as their participation in the fund is ongoing, students then act on new ideas and knowledge. Thus, the student-

managed commodity investment fund provides experiential learning in various technical and soft skill areas by incorporating all four aspects of Kolb's (2014) experiential learning cycle.

We measure the outcomes from participating in the fund using the self-efficacy and improvement approach because measuring student performance in soft skill areas can be difficult. Moreover, attempting to set performance standards in these skill areas could ignore aspects of learning that students feel are important. Self-assessment requires students to reflect on their own outcomes and assists in monitoring progress, in addition to the information it provides to faculty (Walser 2009).

The outcomes were measured through a survey of 23 students administered at a routine trading meeting of the fund and with 100 percent participation rate. The survey was anonymous, and participants recorded demographic and educational information (such as major, graduation year, etc.) before proceeding to the second section. Participants were then presented with several possible factors influencing their decision to participate in the fund and asked to rate the relative importance of each factor. Students were then presented with a list of skills and asked to rate how confident they were in being able to complete the task and how the fund has improved their ability to complete the task. The tasks in the survey (and shown in Figures 4 and 5 presented later) are related to the expected student learning outcomes described above. Last, several open-ended questions about future careers paths were also recorded.

3 Results and Discussion

The sample includes students from nine different academic majors with varying levels of time spent in the group, from one to seven semesters. Only one fund member and survey participant at that time was a graduate student, eight students were seniors, nine were juniors, and five were sophomores. Freshmen had not been admitted to the fund at the time the survey was conducted. As shown in Figure 1, most students were from agricultural economics, business information technology, or finance backgrounds. Figure 2 shows the sample by semesters of participation. One student participated in the fund for seven semesters by transitioning directly into a graduate degree and continuing their involvement.

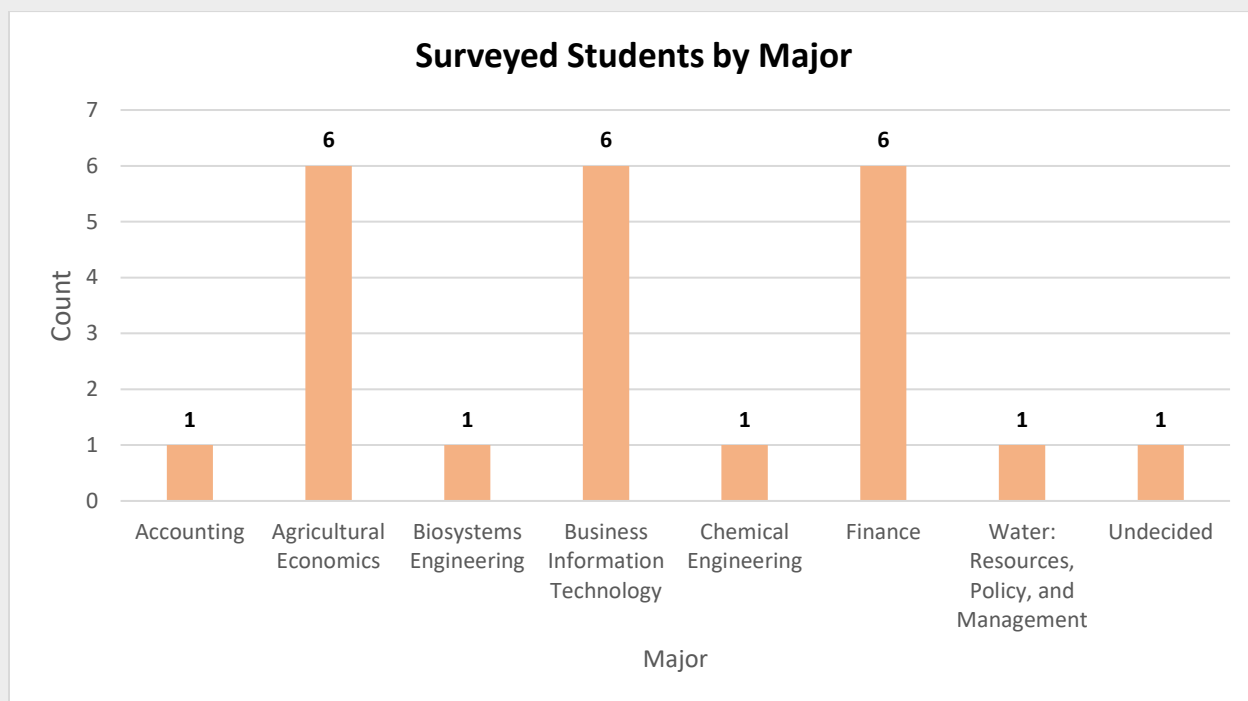


Figure 1. Surveyed Students by Major

Note: The agricultural economics category includes majors in agribusiness and applied economic management

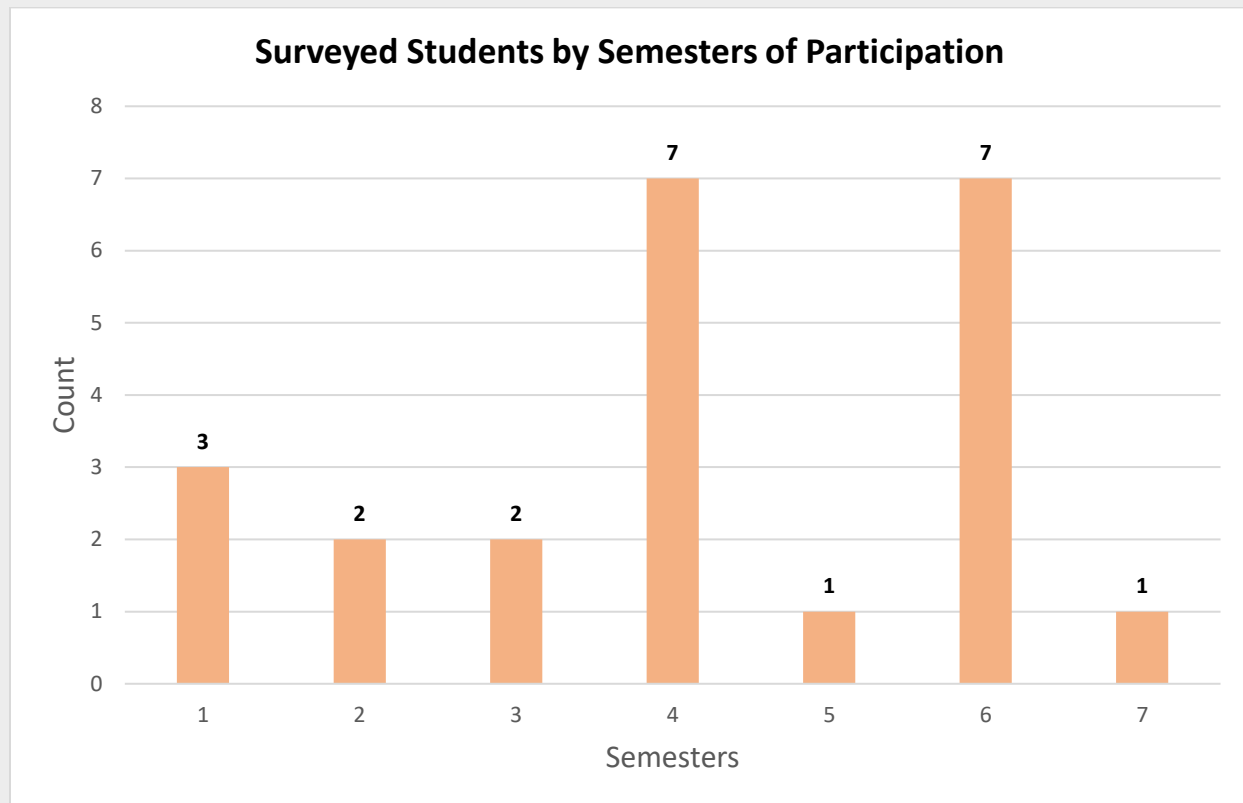


Figure 2. Surveyed Students by Semesters of Participation

3.1 Motivation

Students were first asked to rank 13 different possible factors motivating their participation in the fund. These ranged from employment and internship opportunities to the acquisition of technical skills and soft skills. Importance of the factors was measured using a Likert scale with students responding with either “Not Important,” “Somewhat Important,” or “Very Important.” The responses were assigned numerical values (1–3) and then ranked based on relative importance across the entire sample. While some of the factors are not related to skill acquisition, we categorize “knowledge of investment markets,” “software and/or data analysis training,” and “improved academic performance” as linking to technical skills and knowledge. We consider “public speaking” and “hands-on learning” to most closely link to soft skill acquisition.

As seen in Figure 3, the five most important factors in determining participation were “hands-on learning,” “knowledge of investment markets,” “employment/internship opportunities,” “professional development opportunities,” and “leadership opportunities.” The five least important factors, from least important to most important were “social opportunities,” “interdisciplinary membership,” “improved academic performance,” “the fund as a supplement to academic courses,” and “software/data analysis training.” In general, these results indicate a high amount of importance being placed on employment, soft skills, and opportunities that can boost employment prospects. Less weight is given to technical skills and links between fund participation and academic courses. Research has shown that soft skills can be an important predictor of future success (Heckman and Kautz 2012). Students may be viewing the fund as an avenue for acquiring such skills to complement traditional classroom education.



Figure 3. Importance of Different Factors in Determining Participation in a Student-Managed Commodity Investment Fund

Note: Score is sum of individual member rankings using 3-level Likert scale. Maximum score is 69

3.2 Technical Skills

Students also completed a self-efficacy and improvement questionnaire, which included 11 items denoted as “Knowledge/Technical Skills,” 7 items denoted as “Communication Skills,” and 5 items denoted as “Leadership Skills.” Efficacy and improvement were both assessed using a 5-point Likert scale. In the case of self-efficacy, 1 corresponded to “Cannot do at all,” 3 to “Moderately can do,” and 5 to “Highly certain can do.” For improvement, the scale was 1 meaning “Has not improved,” 3 indicating “Has moderately improved,” and 5 indicating “Has greatly improved.”

Figures 4 and 5 show students’ self-assessment of improvement in 8 knowledge/technical skills and 8 communication/leadership skills. The figures show that the greatest improvement was in what might broadly be termed commodity market knowledge. That is, 100 percent of the sample reported at least moderate improvement in understanding mechanics of futures, options, ETF, and ETN markets. This includes the fundamental economic analysis that market participants use to guide their investment decisions. Fewer students reported strong improvement in understanding portfolio approaches to investing.

Students found less improvement in their ability to use statistical software, complete statistical analyses, or conduct price forecasting. This may not be surprising given that, while students in the fund are encouraged to include data-driven analyses in trade proposals, this is not a requirement. At the time this survey was conducted, training of junior analysts did not include structured training in software or statistical analysis. However, a new online course now accompanies new member training with modules



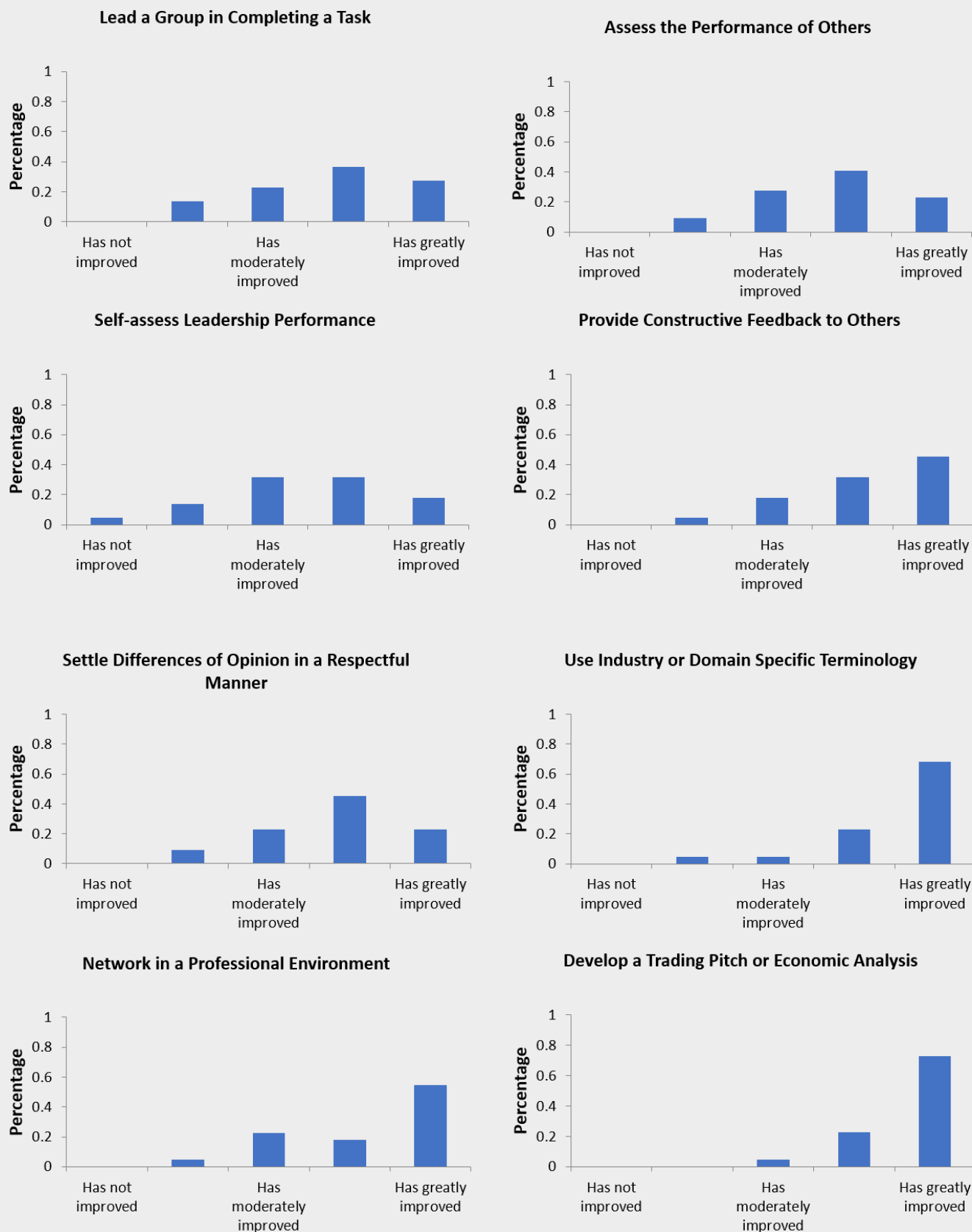


Figure 5: Self-Assessment of Improvement in Communication and Leadership Skills from Participation in a Student-Managed Commodity Fund

in these areas. Successive implementations of this survey may provide evidence that structured software and price analysis modules result in improved efficacy.

3.3 Soft Skills

In terms of communication and leadership, the most improvement was in the use of domain-specific terminology and development of a trading pitch. These skills are necessary to function in a professional finance environment. Fewer members felt that they improved in leadership performance and leading a group. While all members of the group have a hand in selecting leadership, only a few members of the group will be in leadership roles. However, as members advance through the group, they generally take on at least one leadership role as senior analyst for a commodity. Two out of three students that gave a 2 on improvement in leading a group had been in the group for two semesters or less.

3.4 Heterogeneity in Self-Assessed Improvement

We also examine whether there are any clear differences in student self-assessed improvement by major. There are three majors represented in sufficient amounts in the sample to justify exposition: finance, agricultural economics, and business information technology. Average scores for self-assessed improvement are shown in Table 1. Improvement in most knowledge/technical skills is largest for finance majors. In comparison, agricultural economics majors generally report the least improvement. Although, we cannot make any definitive statements about the causes of these differences, we hypothesize that agricultural economics majors may have more familiarity with, and understanding of, commodity markets compared with their peers in business-related majors, which typically focus on corporate finance or equities and bonds as investment instruments. Improvement in nonagricultural economics majors suggests that the student-managed commodity investment fund is a useful tool for bringing the benefits and strengths of the agricultural economics department to the wider student body.

3.5 Limitations

Given the limitations of the sample, the results of this survey provide some evidence that the student-managed commodity investment fund helps students improve a range of soft skills. Several improvements to fund operation have now been implemented and may result in improvement in both technical knowledge and skill acquisition. These include structured training programs in price analysis and basic statistics. Analysts are also required to give market updates at training meetings even if they don't have a trade proposal. This ensures that members speak in front of the entire membership at least biweekly.

We note that the results of this assessment only apply to students who actually apply and participate in a student-managed commodity investment fund. Because students participate in the fund voluntarily, we are cautious about making any general statements about outcomes because of issues of selection bias. Students applying for the fund may have a stronger drive for extracurricular enrichment. As well, students accepted into the fund may have stronger baseline technical and soft skills given that they successfully navigated the interview process. A logical next step in assessing the educational outcomes from the student-managed commodity investment fund is to establish a control group of students who did not enter the fund and provide more comprehensive measurement of skill improvement.

Table 1. Average Score for Self-Assessed Improvement in Knowledge/Technical Skills by Major

Question	Agricultural Economics	Finance	Business Information Technology
Academic Performance in University Courses	2.83	3.66	3.00
Identify Relevant Information and Data on Commodity Markets	4.33	5.00	4.83
Understand Futures Markets and Their Operation	4.83	5.00	4.66
Understand Markets for ETFs and ETNs and Their Operation	4.33	4.83	4.66
Conduct Statistical Analysis and Price Forecasting	3.83	3.83	4.17
Use Software for Analysis	3.16	4.16	3.66
Understand Portfolio Approaches for Investing	2.83	4.33	4.00
Identify Fundamental Economic Drivers of Commodity Markets	4.5	5.00	4.66

4 Conclusions

Graduates of agricultural and applied economics programs have a diverse skill set that allows them to work in a number of professions. Employers place emphasis not only on discipline-specific knowledge, but also on graduates' soft skills. While traditional academic coursework provides limited opportunities for developing such skills, experiential learning classes, such as student-managed investment funds are an excellent venue for gaining and applying such skills. Commodity-focused funds allow for creating such venues within a field of agricultural and applied economics.

The student-managed fund provides opportunities for students to experience the role of a fund manager. Properly structured, the fund also provides opportunities for students to reflect on their experiences, think about the experiences or conceptualize them abstractly, and then actively experiment. This reflection is analytical and rigorous, collaborative, and ultimately an important part of knowledge creation and skill acquisition. While classroom instruction can be designed to provide a similar environment, the student-managed fund offers a holistic approach for the incorporation of experiential learning in the agricultural economics curriculum.

Results of a survey of students participating in a student-managed commodity investment fund indicate that many students join the fund for a hands-on learning opportunity, to improve knowledge of commodity markets, and to improve employment opportunities. Students reported improvement from participation in the fund in both technical skills and almost all soft skills. Reported improvement was broadly consistent with student motivations for joining the fund. This is encouraging that, at least thus far, the benefits of the fund have aligned with student expectations. Moreover, the soft skills improved by participation are important criteria for employment.

Successive iterations of student surveys will allow for a more detailed examination of reported student improvement in the future. Furthermore, they will provide a larger sample from which statistical differences in student subpopulations can be determined. In addition to self-assessment of outcomes, pre- and post-tests could be developed to measure technical knowledge. Given that participation in the fund also involves management and leadership skills, peer evaluation is another avenue for future research. These improvements are left for later work.

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Teaching and Educational Methods

Teaching about Diversity and Racism in Food Systems: An Example for Agricultural Economics and Related Departments

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Keywords: Agriculture, food systems, race, racism, undergraduate education

Abstract

This paper presents curriculum and metrics for a course titled *U.S. Food, Social Equity & Development*, taught since 2015. The course meets a race and racism diversity course requirement at the University of Vermont. Departments affiliated with AAEA have an obligation to teach and inform our students about racism in the food system: individual and systemic, intended and unintended, institutional and structural. This has been reinforced by the June 3, 2020, AAEA statement condemning racially motivated acts of violence, police brutality, and overreach of military action, and committed to pledging positive action toward diversity, equity, and inclusion. By understanding the opportunity associated with our obligation, we will graduate future professionals and scholars who understand the importance of including issues of racism in their research; future food producers who will better recognize and attend to the issue of racism; and future consumers who understand how their consumption decisions impact racism.

1 Introduction

On June 3, 2020, the AAEA drafted a statement condemning racially motivated acts of violence, police brutality, and overreach of military action, and committed to pledging positive action toward diversity, equity, and inclusion. The statement went on to say:

As an organization, our responsibility is to remain a platform for rigorous research on a breadth of societal issues, engaged public discourse across a diverse set of stakeholders, and to inform discussions and policies that can help refine and strengthen the frayed social fabric. . . . Let us pledge ourselves to these principles and rededicate ourselves to the mission of striving toward a just society that needs engaged, empathetic, and intelligent education, science-based and community-driven research, and engaged scholars more than ever (Agricultural and Applied Economics Association Executive Board 2020).

To adhere to this responsibility, we contend that we have an obligation to teach our students about the historical injustices on which the current food system is built, analyze (impacts of and potential solutions to) current manifestations of racism in the food system, establish an ethical orientation around the pursuit of an antiracist food system, and equip our students with skills to pursue social—and specifically racial—justice in the food system. Our students, after all, will be employed by, conduct research about, and promulgate policies for our food system from basic science through production, consumption, and disposal.

Our commitment as educators and researchers to an antiracist food system (see Kendi 2019 for a full discussion on antiracism) is based in the explicit recognition that racism exists in our agricultural and broader food system, as individual and institutional racism (un)intentionally reinforces each another and

generates racial disparities (Alberta Civil Liberties Research Centre n.d.; Inter-Institutional Network for Food, Agriculture, and Sustainability 2018). Even a cursory examination reveals racism is deeply embedded in the food system. Violence and manipulation sanctioned by the federal government resulted in Native Americans being forcibly moved from their ancestral lands and relocated in the West, providing white Americans with large swaths of land to build an agricultural economy reliant on slave labor (Dunbar-Ortiz 2015). After slavery was abolished, Blacks began to acquire plots of land until the early twentieth century when institutional racism enacted through a myriad of ways (e.g., Black Codes, Jim Crow laws, heirs' property, discriminatory lending practices) contributed to the dispossession of up to 90 percent of Black-owned farmland over the course of the twentieth century (Gilbert et al. 2002; Hinson and Robinson 2008; Figueora and Penniman 2020). In addition to the current racial disparities in land access, labor exploitation in the agrifood system is racialized. People of color disproportionately experience dangerous working conditions, lower pay, and barriers to enact basic labor rights across the food chain, including in farm work, meatpacking, and restaurant work (Pfeffer 1983; Perea 2011; Jayaraman 2013; Miraftab 2016). And racial disparities are apparent in the outcomes of the food system as well, with people of color more likely to experience food insecurity and obesity (Odoms-Young and Bruce 2018; Petersen, Pan, and Blanck 2019).

These current manifestations of racism in the food system are inherently, though not exclusively, economic. They are fundamentally tied to questions of access to and distribution of resources. It is therefore imperative for us to include education that covers this material as it relates to agricultural economics and the other disciplines we increasingly find in our departments, including rural sociology, applied and consumer economics, and community development. Indeed, this shift toward combining several disciplines in former agricultural economic centric departments has occurred since the 1970s and intensified in the 1990s (National Research Council 1995; Agricultural and Applied Economics Association n.d.). Despite the tumult that these types of mergers have caused, they also provide opportunity to ask and answer more nuanced questions about food systems generally and the role of race and racism in them specifically. As a dynamic social construct, investigating the mutual effects between racism and agricultural economics will benefit from interdisciplinary perspectives. It was, after all, the rural sociological work of W.E.B. Du Bois that established an "emancipatory empiricism," which interrogated prevailing racist assumptions, identified race as a social category, and pointed to policy options pursuing social equity (Jakubek and Wood 2018).

Expanding our teaching to earnestly engage in issues of race and racism will expand our scholarship on these issues, a need based on a relatively quick search of the *American Journal of Agricultural Economics* on Oxford Academic. The Oxford Academic database contains 9,658 AJAE research articles and 1,890 AJAE discussion articles in total. The first search was narrowed to refereed journal articles. In the history of the journal, there are 0 articles with the word *racism* in the title; 11 articles with racism mentioned anywhere in an article, and 5 articles with the word *race* in the title. Neither *race*, *racism*, nor *racial discrimination* appeared in keywords, and only 5 discussion articles mentioned racial discrimination, with a search starting in 1959. The moment, and more importantly the moral imperative, demands that we, the producers and reproducers of agricultural economics as a discipline, take race and racism more into account in our work, contributing an agricultural economics perspective on the manifestations and impacts of racism within the food system.

Of course, we recognize that isolating racial categories is precarious work that risks reductionism and distortions. We concur with the insights of feminist theory (e.g., Crenshaw 1989), methods (e.g., Naples 2003), and empirical work (e.g., Quisumbing et al. 2014) that human identities and experiences with the world result from the intersection of a multitude of identities. To this point, we also assessed the prevalence of gender issues within our literature search, while also acknowledging that many other identities (e.g., age, disabilities, sexual orientation, etc.) also mediate power and privilege. There are 5 articles with *gender* in the title and 4 with *gender discrimination* in the title. A keyword search of gender discrimination produced zero discussion articles. As a reflection of our research, it is clear that race and gender are not at the forefront, despite their importance in mediating access to and distribution of

resources. Complex and dynamic as these social categories are, they require our scholarly attention, as well as explicit acknowledgments of the limitations of our research, but demand that we do not eschew them.

As we are well aware, the applied research that we collectively conduct lends itself to integration with teaching. Teaching issues of race and racism may yield productive inroads into the disciplinary contributions of agricultural economics to issues of racism in the food system in multiple ways. One likelihood is that agricultural economists committed to teaching about racism in food systems identify new research questions. Another, likely even more impactful, is that we train the future generation of scholars and practitioners who are even better poised to address social injustice. In our teaching moving forward, future scholars will understand the importance of including these issues in their research, future food producers will better recognize and attend to the issue of racism, and future consumers will understand how their consumption decisions impact racism.

The National Academies Press publication by the Institute of Medicine and National Research Council (2015) includes an entire chapter on “Social and Economic Effects of the U.S. Food System.” It includes what they consider three broad classes of social and economic effects. Racism is embedded in each. The categories include:

1. Levels of income, wealth, and distributional equity;
2. Broader indicators of quality of life, such as working conditions, job satisfaction, and freedom of choice to pursue taste and lifestyle preferences; and
3. Associated impacts on worker health and well-being (167).

The goal of this paper is to provide an overview of a course developed to teach about racism through the lens of the food system. The objectives of this commentary are to: (i) describe our approach to teaching about racism in the context of the food system, (ii) present information on enrollments, and (iii) provide course materials used in a class taught eight times since 2015 at the University of Vermont (UVM) in the Department of Community Development and Applied Economics (CDAE) in the College of Agriculture and Life Sciences (CALS). *U.S. Food, Social Equity & Development* is a three-credit introductory level course that meets a diversity requirement at UVM.¹ The course description explains that it “provides an introduction to gender, race, class, and ethnicity with particular emphasis on food, population, economic, and ecological issues in sustainable agriculture, food systems, and community development. The geographical focus emphasizes the United States.”

2 Course Approach

U.S. Food, Social Equity, and Development has been taught as a lecture-based and hybrid course. The overarching purpose of this course is summarized to students in the syllabus:

Structural racism and injustice are defining attributes of our society and so are inherently embedded within our food systems. As a Diversity course, the content of this course describes how and why structural racism shapes the U.S. food system and the ways that this system contributes to (or, in some cases, seeks to address) structural racism and inequity.

Because topic areas range, for example, from production through consumption, historical and

¹ All undergraduate degree students matriculating in Fall 2008 or later must successfully complete the university-approved diversity courses: one three-credit course from Category One (Race and Racism in the United States), and a second three-credit course from either Category One or Category Two (the Diversity of Human Experience). These requirements will apply as well to undergraduate transfer students receiving bachelor's degrees from May 2012 onward (uvm.edu).

current economic policy (e.g., the Farm Bill), agricultural labor, and industrial organization in the agricultural (and other) value chain(s), it is not difficult to place this course in a agricultural economics related department.²

During Spring 2020, because of COVID-19, the course became online only after spring break (with half the semester remaining). The course can be relatively easily adapted to a remote learning format in either a synchronous or asynchronous online format. Our description focuses on the hybrid approach, which adapted the lecture-based course. At UVM, our teaching platform is Blackboard and incorporates universal design for learning principles (UDL) that are built into that platform. “UDL is an educational approach based on the learning sciences with three primary principles—multiple means of representation of information, multiple means of student action and expression, and multiple means of student engagement” (Center for Applied Special Technology n.d.b.). UDL explicitly means that the course is accessible. Accessibility includes all aspects of the course, from the way material is presented to the way students are assessed. And, for a course in which 75 percent of the material is related to racism, accessibility also includes aspects of emotional learning, student comfort, and social learning (Center for Applied Special Technology n.d.a.). In the case of this course, accessibility also means meeting the needs of students from first year through seniors, even though the course is entry level. We often quip to the students, “this course is a mile wide and an inch deep.” The course covers a lot of material, as seen in the course modules in the online supplementary Appendix A. Part of UDL is that the material is presented in a variety of ways. In each unit/module, students have a reading, typically one more “popular” and one more “academic,” often with an audio clip and a video clip. We follow the idea of read, listen, view, but not necessarily in that order. There are 21 short online quizzes that follow the modules. Students can take the multiple choice/matching quizzes more than once and up to three times (depending on quiz length). These are automatically graded in Blackboard, and students receive immediate feedback. The lowest three scores are dropped. There are six varied assignments due throughout the 15-week semester. While these are all writing assignments, they cover a variety of writing types and include reflection, annotated reference, movie critique, and opinion editorial. As a blended course (hybrid), in-class time incorporates some lecture and typically an in-class group assignment designed around a current event. Online supplementary Appendix B provides a list of assignments, and online supplementary Appendix C provides examples of in-class assignments.

The learning goals of the course are provided at a general and more specific level. Assignments, in-class exercises, and exams are designed to assess these goals.

Course Learning Goals

General

At the end of this course, students will have:

1. Developed an awareness of the diversity of individuals, cultures, communities, and process issues as they relate to U.S. food systems;
2. Developed an awareness of race and racism in the United States at the individual or systemic levels including historical and/or contemporary issues in the U.S. food system;
3. Analyzed arguments, processes, and debates including conflicting and multiple perspectives related to race and racism in U.S. food systems; and
4. Demonstrated the ability to apply theoretical knowledge to recognize and name dynamics and/or problem-solve in specific cases related to race and racism in the U.S. food system.

² Each of the examples above has a *Journal of Economic Literature* code. Examples include D-Microeconomics (e.g., household behavior and family economics, production and organizations, distribution and market structure, pricing, and design), I-Health, education, and welfare (e.g., health and inequality), J-Demographics, labor economics, labor policy (e.g., wages, compensation, and labor costs and mobility, unemployment, vacancies, and immigrant workers), I-Industrial organization, N-Economic history, and of course, Q-Agricultural economics.

Specific

At the end of this course, students will:

1. Understand and be able to actively participate in a variety of debates related to poverty, race, and sustainable development. These include politics surrounding the food system, hunger in the United States, food justice, consumer ethics, food and identity, working conditions on farms, jobs in the food industry, and public health concerns;
2. Understand how societies shape food and agricultural systems and how food and agriculture shape societies; and
3. Have exposure and an entry level understanding of current policy, events, and published literature in food systems.

While the course employs principles of universal design and can be taught in a variety of formats, from lecture-based to hybrid to fully online (as we experienced during the Spring 2020 COVID-19 pandemic), the course utilizes a variety of other pedagogies to engage students. These additional pedagogies are especially important given the complexity and challenges that are inevitable when engaging in issues of race and racism. In-class, small group discussions were a part of several of the lecture sessions. These discussions introduced students to their “neighbors” and provided a safer place for interaction in a large class. The quizzes were structured for assessment and continued learning, as students were permitted to take the 21 quizzes more than once, online. The questions were randomized to decrease memorization of answers given the multiple choice and matching format. The semester began with an introduction to systems thinking. While students found much of the material to be difficult and emotionally draining, the course ended with a module on change making, which brought a more upbeat ending to the semester. Two assignments were reflective. Students explored their place in the food system, both using a family history and “where they are now” approach. The course provided information in both historical and contemporary contexts, including a history of agricultural labor and immigration. Overall, using a variety of pedagogies and providing a safe space to discuss unsettling material appears to provide students with a positive learning experience, based on student assessments in class and student evaluations of the course.

3 Course Metrics

CDAE piloted U.S. Food, Social Equity, and Development in Spring 2015. The course obtained a permanent number in 2016 and has remained the *only* permanent “Diversity 1” (D1) course taught in CALS since that time. Figure 1 shows the trajectory of enrollments. The course fills at capacity or above, regardless of how many seats are provided. The first year the class was capped at 50. The next three years had a cap of 75. We increased the cap to 90 in 2019. That has been increased to 120 for Fall 2020, and as of publication enrollment is now 130. Across the eight offerings, 683 students enrolled in the course. Students are interested in the material.

While we do not share student evaluation comments, the majority of students were hungry to read, see, listen to, and discuss the material. Taught by 4 different faculty members, student evaluations were numerically higher (4+ out of 5 on a 5-point Likert Scale), but not statistically different, than the CDAE course average across all courses taught, ranging from communication design to introductory and intermediate microeconomics, and introduction to entrepreneurship to research methods.

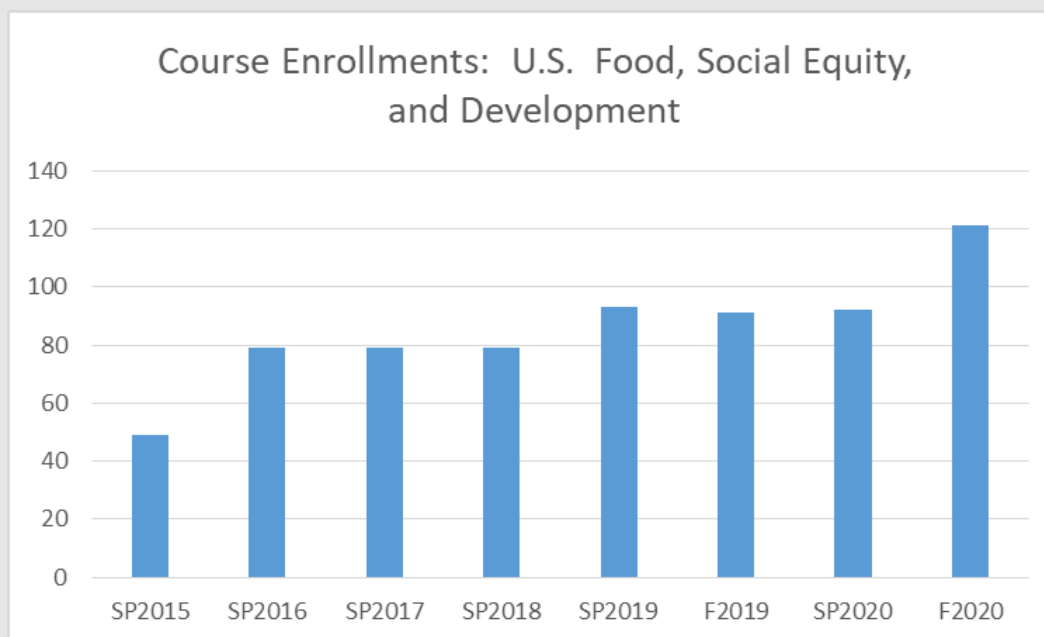


Figure 1. Course Enrollments over Time

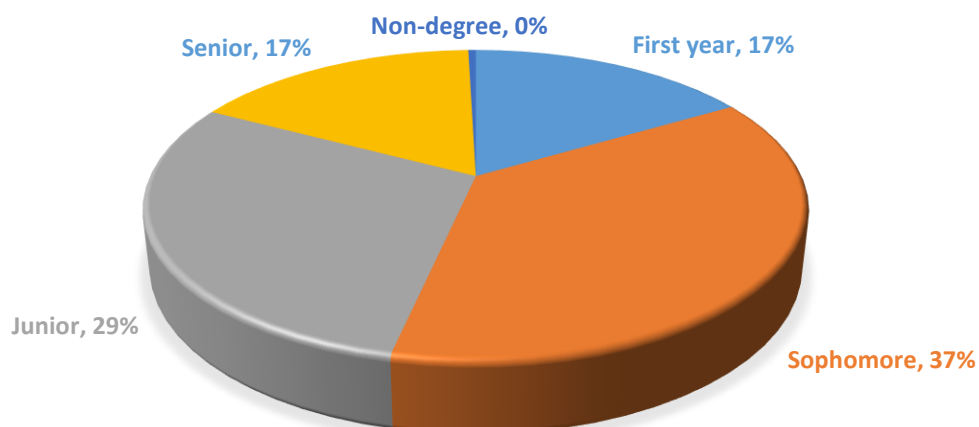
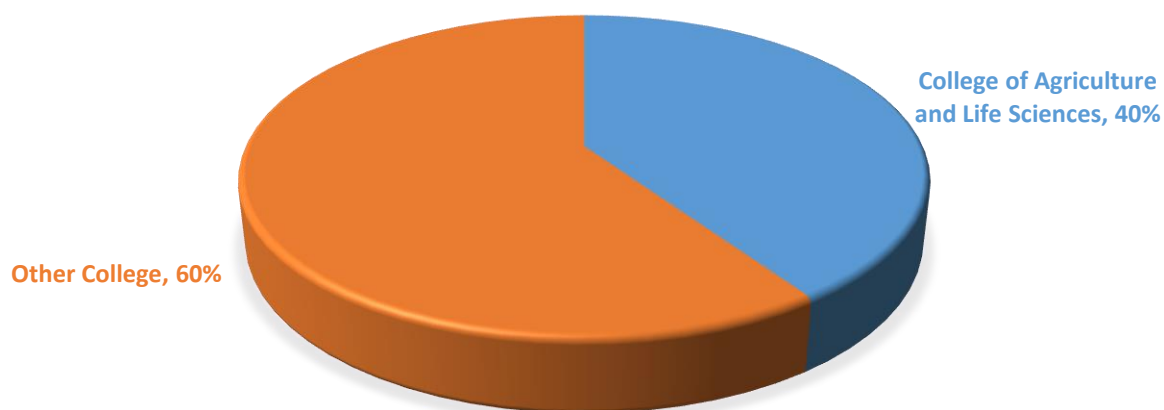
The first TA for the course was compelled to write an article about her experience and the need for such courses in any curriculum that addresses the food system (Peña 2015). A quote is powerful:

I was engaged in the class as an empowered learner. With the knowledge gained subsequently, I see myself taking the next steps as an empowered doer. In diversity courses offered by land-grant universities, an emphasis on empowerment and change will encourage white and minority students to examine both their own and others' personal barriers (Pena 2015, p. 124).

Who enrolled in the course? The course is required for food systems majors. Food systems is a transdisciplinary major offered in CALS and sits at the college, not department level. For all other students, CDAE 004 is a choice that meets the D1 university-wide requirement.³ The university has offered between 48 and 59 D1 courses per year since 2014. Although this is an introductory level class (00 level at UVM = introductory), the majority of students enrolled were either sophomores or juniors, followed by equal numbers of first-year students and seniors (see Figure 2).

Although offered in CALS, the majority of enrollees were from other colleges (60 percent; see Figure 3). Enrolled students came from every college with undergraduate major offerings at UVM (see Figure 4).

³ UVM's diversity requirement is intended to provide undergraduate students with the awareness, knowledge, and skills necessary to function productively in a complex global society, by fostering an understanding of and respect for differences among individuals and groups of people. A D1 course addresses race and racism in the United States.

ENROLLMENTS BY CLASS YEAR (N = 683)**Figure 2. Student Enrollments by Class (2015–2020)****ENROLLMENTS—COLLEGE OF AGRICULTURE AND LIFE SCIENCE VS OTHER (N = 683)****Figure 3. Enrollments: College of Agriculture and Life Sciences versus Other Colleges (2015–2020)**

ENROLLMENTS BY COLLEGE (N = 683)

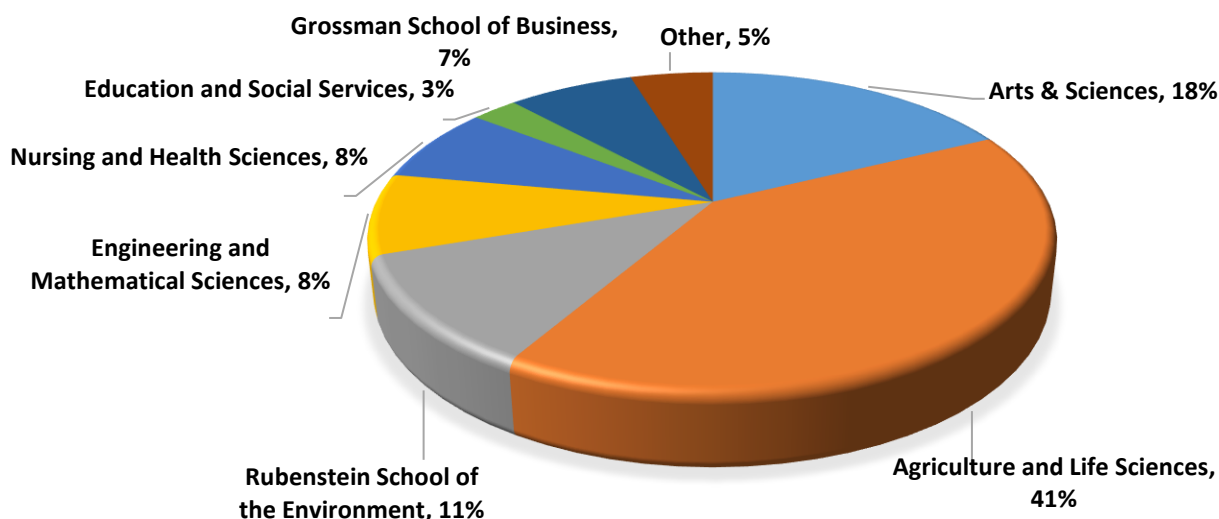


Figure 4. Student Enrollments by College (2015–2020)

MAJORS IN THE COLLEGE OF AGRICULTURE AND LIFE SCIENCES (N = 276)

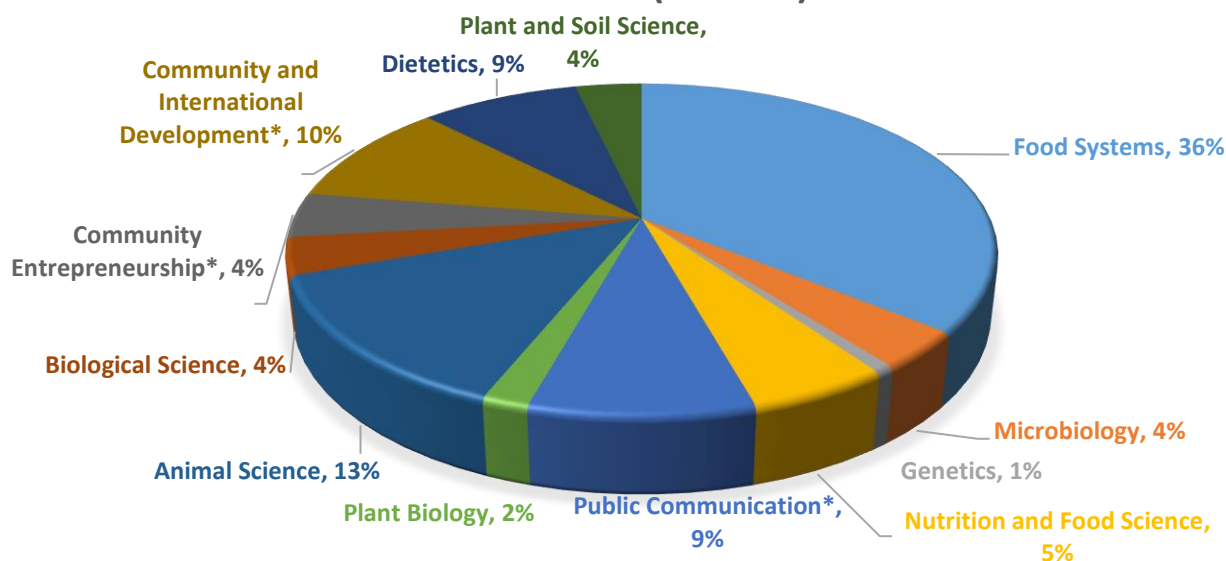


Figure 5. Majors within CALS (2015–2020)

*Majors in the offering department (Community Development and Applied Economics-CDAE)

Because CDAE 004 is a required course for food systems majors, these majors had the highest representation of enrollees (36 percent; see figure 5). Twenty-three percent of students enrolled were majors in the offering department most closely associated with AAEA—CDAE. Every major in CALS was represented, ranging from basic to applied natural, life, and social science.

4 Discussion and Conclusion

Education in our now expanded disciplines go beyond traditional agricultural economics and now include rural sociology, consumer economics, and community development, to name a few. The potential for interdisciplinarity that is housed in our departments provide us with key tools to effectively respond to the statement that the AAEA has made about our organization's and discipline's obligations regarding race and racism. If we are to take action based on the written statement, it is important that we face agriculture's involvement in individual and structural racism, incorporate teaching about racism in our curricula, and not to rely on departments in other colleges in our universities to carry the load. We believe that to heed this call, educators must construct and instruct these types of courses from a position of co-learning, by which the instructor makes clear that they, along with their students, are in a constant process of self-reflexivity and improvement. Kendi (2019) asserts, being racist or antiracist is not a static status but an ongoing pursuit. Of course, faculty are responsible for building their own courses and materials. The focus of this commentary is how one university, in CALS, in one AAEA-affiliated department developed and delivered a course on race and racism in the food system.

While outside some of our teaching toolboxes, there are more opportunities than barriers to incorporating such a class into our department offerings. First, we can provide students with knowledge and the opportunity to reflect. Second, we can reach a wide variety of students from majors across our campuses who may otherwise not be familiar with our field or the concept of agricultural and food systems. Third, we can open the door to open discussions with students as well as with our colleagues. Fourth, we may find that more students are interested in our field.

We can advance our disciplines by facing individual and structural racism that has impacted agricultural historically and in contemporary society. There is more to agriculture and food systems than simply efficient production. It is through actions such as teaching about racism in the food system that will help us reach "our responsibility is to remain a platform for rigorous research on a breadth of societal issues, engaged public discourse across a diverse set of stakeholders and to inform discussions and policies that can help refine and strengthen the frayed social fabric" (Agricultural and Applied Economics Association Executive Board 2020).

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Teaching and Educational Methods

Educating the Next Generation of Interdisciplinary Researchers to Tackle Global Sustainability Challenges: A Graduate Course

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JEL Codes: A23, Q11, Q20, Q30

Keywords: Teaching applied economics, global economic analysis, interdisciplinary coursework, sustainability

Abstract

This paper describes an innovative graduate course in agricultural economics that has evolved over the past decade and attracts students from across the Purdue University campus. Its novel combination of guest lectures on key sustainability topics, and intensive, computer-based lab assignments with the SIMPLE model of global food and environmental security, prepares students to undertake innovative projects. These independent projects are presented to the class, written up, and submitted in lieu of a final exam. The topics covered are quite diverse and range from the impacts of women empowerment on food security, to the consequences of heat stress on farm workers, and the impact of reducing food waste. The course has spawned two dozen published journal articles, inspired MS and PhD theses, and facilitated a number of important interdisciplinary projects. The complete syllabus, lab assignments, and detailed course design are made available for others to use and adapt to their own circumstances. Future versions of the course will seek to incorporate explicitly spatial analysis of agriculture, land, water, and environmental quality outcomes.

1 Introduction

Effective functioning of the global food system is critical to human well-being on the planet—providing nutrition, employment, other ecosystem services, as well as an important source of income for hundreds of millions of people, including a majority of the world's poorest households. However, this same food system is transforming our natural environment. These stresses have recently been conceptualized as risks to the “safe operating space” within the earth's planetary boundaries (Steffen et al. 2015).

Exceedances of these planetary boundaries represent potentially irreversible alterations of the earth system. Conversion of natural lands to farming and loss of biodiversity, pollution from excess nutrient applications in agriculture, the depletion of groundwater stocks, and the emission of climate-altering greenhouse gases all pose significant risks to the planet (Hertel 2011). Balancing the critical role of the food system in feeding the world's growing population while respecting these planetary boundaries is one of the grand challenges faced by society today, and solving this challenge requires collaboration across many diverse disciplinary boundaries (Springmann et al. 2018).

This article describes a graduate course offered at Purdue University that teaches students how to analyze and find solutions for this suite of sustainability challenges within an economic framework, but drawing on a wide range of disciplines. The course is based in the Department of Agricultural Economics and is titled: “AGEC 528: Global Change and the Challenges of Sustainably Feeding a Growing Planet.” It allows students to explore the trade-offs and synergies arising out of the competing demands on the planet's finite land and water resources, for which agriculture is the dominant user (Molden et al. 2007; Ramankutty et al. 2008). Identifying potential pathways for sustainable development in the coming decades will inevitably require transformation of the world's food systems (FAO 2018). Analysis of these trade-offs and potential transformational changes is undertaken within the context of an economic

modeling framework nicknamed SIMPLE: a Simplified International Model of Prices Land use and the Environment (Hertel and Baldos 2016). This framework keeps the economics as simple as possible in order to allow the model to be widely accessible to non-economists. SIMPLE has proven amenable to integrating insights and knowledge from a variety of different disciplines, including agronomy, climate science, ecology, hydrology, engineering, nutrition, as well as a variety of social sciences (Hertel, Ramankutty, and Baldos 2014; Liu et al. 2017; Lopez Barrera and Hertel 2020; Lobell, Baldos, and Hertel 2013; Baldos and Hertel 2014).

Students learn about the global drivers underlying the evolution of the food system and associated sustainability challenges—focusing specifically on land, water, and natural ecosystem services. Students also explore how infringement on the planetary boundaries, as evidenced through water scarcity or climate change, for example, may alter the functioning of the food system.

2 Course Design

This is a 3-credit class, meeting twice a week for a full semester (15 weeks). The first meeting of each week introduces a new dimension of the food system and its interaction with the natural environment (Table 1). We initiate the week's activities with two contemporary readings on the topic, as well as a chapter in the textbook (Hertel and Baldos 2016). Articles are typically drawn from recent issues of top interdisciplinary journals such as *Nature*, *Science*, *Proceedings of the National Academy of Sciences*, and *Global Environmental Change*. Students are required to post two questions based on each of the readings in a shared directory (we use Dropbox). This provides an added incentive for timely submissions, as everyone, including the instructor, can see who has offered questions for the week. The submissions are compiled and structured into a coherent set of topics/themes by one of the students who then leads the discussion following the guest speaker's presentation.

Guest lectures are provided by domain experts drawn from relevant fields, including: agronomy, climate science, demography, ecology, economics, engineering, geography, hydrology, nutrition, and political science. They speak for 45 minutes (time limit is strictly enforced), leaving 30 minutes for student-led discussion. This format has proven to provide a good balance between delivery of new content and student engagement. Speakers are provided with the curated list of questions in advance. Students come from the Colleges of Agriculture, Engineering, Liberal Arts, Management, Science, and Technology, so the questions are wide-ranging and typically engage the speaker in a variety of (often unexpected) ways. As a result, the speakers have found this to be a rewarding experience, and, to date, they have always accepted return invitations!

Table 1. Topics Covered in the Course

- Planetary Boundaries and the Food System
- Population Growth and Global Food Demand
- Yield Growth and Yield Gaps
- Total Factor Productivity Growth
- Potential for Cropland Expansion
- Water Availability: Constraints and Opportunities
- Globalization
- Consumer Preferences for Food
- Nutrition and Food Security
- Post-Harvest Losses
- Linking Biodiversity and Agricultural Production
- Environmental Impacts of Agriculture: Water Quality
- Environmental Impacts of Agriculture: Greenhouse Gas Emissions
- Climate Change as a Factor Influencing Global Agriculture

Table 2. Lab Assignments in the Course

Assignment 1: Simulate the impact on global and regional food demands in 2050 of varying assumptions about population growth and the income responsiveness of food demand.

Assignment 2: Analyze the impact of population growth projections on world food markets under varying assumptions about the price responsiveness of the extensive and intensive margins of supply, as well as consumer demand.

Assignment 3: Examine the impact of economic growth and climate change on crop productivity, global land use, agricultural prices, and undernourishment globally and by major world region.

Assignment 4: Examine the consequences of international economic integration for the effectiveness of sustainability policies.

Assignment 5: Gridded analysis: Explore the consequences of changing irrigation efficiency for aggregate water withdrawals across a range of grid cells in the continental United States.

The second meeting of each week is “lab day.” Using graphical exercises, mathematics, computer simulation, and numerical analysis, we explore the economic dimensions of the weekly theme and how it relates to the global food system, resource use, environmental quality, and nutritional outcomes. The core economic concepts are developed in the context of five lab assignments (Table 2). These lab assignments are based on the SIMPLE model (Figure 1) and are designed to allow students to obtain a hands-on assessment of the relative importance of the forces bearing on the long run supply and demand for food and natural resources, key economic mechanisms mediating these adjustments, and the implications for food security and the environment. Labs are implemented in the GEMPACK software (Harrison and Pearson 1996), which was developed explicitly for solving and analyzing economic equilibrium models. Because the model is expressed in linearized form (i.e., in terms of elasticities, cost, and quantity shares, etc.), it is straightforward to analyze. Analysis is greatly facilitated via the extremely useful

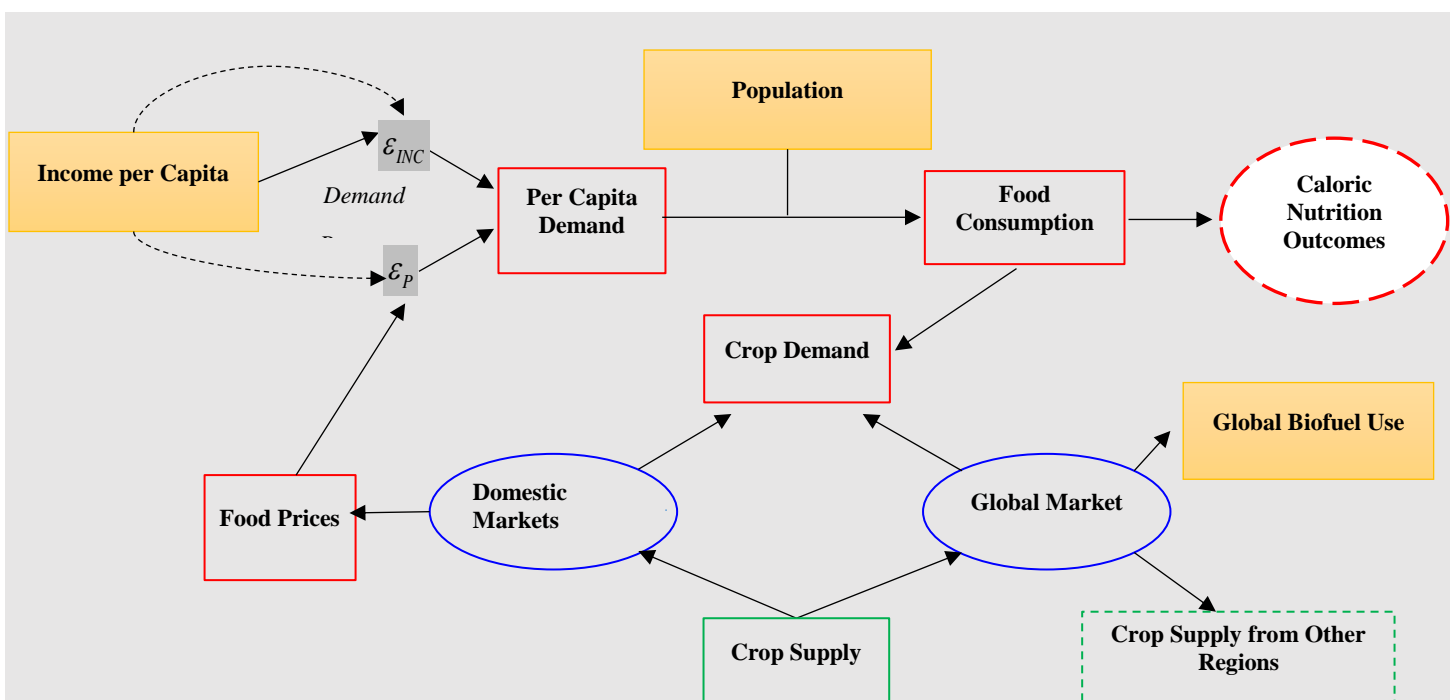


Figure 1. Overview of the SIMPLE Model

AnalyseGE interface that assembles in one place the: model equations, model solution, initial data (and shares), and also the parameters. A series of mouse clicks allows the user, for example, to decompose the intensive and extensive margins of supply response and analyze why this might differ across regions. Furthermore, since the underlying nonlinear model is solved in such a way as to allow the shares and elasticities to vary over the course of the simulation (e.g., the income elasticity of demand for food products declines as households become richer), students can undertake large change experiments, such as projecting the global food economy to 2050.

The labs begin by focusing on key demand drivers: population and income, bringing in the supply side in the second lab assignment. Global food supply is governed by three factors: the extensive margin of supply (cropland expansion), the intensive margin of supply (increasing the intensity of nonland input usage), and total factor productivity growth (introduction and adoption of new technologies). A caloric nutritional attainment module is introduced in the third lab assignment, along with climate change scenarios. The fourth lab focuses on the theme of globalization and explores how global market integration alters sustainability outcomes. The fifth, and final, lab uses the gridded version of SIMPLE to explore issues related to irrigation and groundwater sustainability in a spatially explicit manner.

The capstone event in this course is the student project, which involves the application of SIMPLE to a problem of the student's choosing (Box 1 provides some recent examples). Most students come into the course with some specific ideas about sustainability and potential solutions to the environmental and food security issues facing the world today. We begin discussing their ideas in the first week and continue these informal discussions throughout the first half of the semester. As they undertake the lab assignments, these ideas typically evolve and become more refined. After spring break (halfway through the semester), I meet with the students individually—or in some cases in pairs—to finalize their project concept (There are typically about sixteen students in the class.)

Box 1. Topics Addressed in Previous Course Projects

1. *Food Waste and Post-Harvest Losses*: The UN-FAO estimates that one-third of global food production is lost or wasted so that only two-thirds of production is actually consumed. What are the implications of such losses for crop prices? How would a reduction in post-harvest losses affect nutritional outcomes?
2. *Changing Nutrition Guidelines*: The USDA is in the process of formulating a new set of nutrition guidelines. For the first time they are considering adding environmental impacts to these guidelines. How would such considerations change the pattern of food consumption? How would changing consumption patterns alter the pattern of global land use and greenhouse gas emissions?
3. *Regulating Nonpoint Source Pollution from Agriculture*: Arguably the most important environmental problem surrounding agricultural production in the midwestern United States is the run-off of excess nutrients into streams, rivers, and coastal ecosystems. The resulting incidence of hypoxic “dead zones” has led to calls to greatly restrict nutrient use in agriculture as well as investing in conservation policies. How will such regulations affect production, prices, and food security? Which are the most effective policies?
4. *Empowerment of Women: Implications for Global Food Security*: Women comprise a large share of the agricultural labor force, and female-headed farms represent a large share of agricultural enterprises worldwide. Women are also key decision makers when it comes to household nutrition and fertility. As such, they are in a unique position to influence local, regional, and global food security outcomes. However, lack of education and limited access to credit and other inputs currently limit the impact that women can have on these outcomes. How would greater empowerment of women change the global food security landscape?
5. *Migration and Global Food Security*: The migration of individuals across national borders is a global phenomenon that is currently on the rise. It affects for the supply of, and the demand for, food. What is the net impact on global food security of trends in international migration?

Box 1 Continued

6. *Virtual Trade in Water:* Scientists have recently identified “virtual trade in water” as an important element of the global sustainability puzzle. Virtual water exports arise when one country exports water intensive goods to another country. The water embodied in the production of this commodity for export is termed “virtual water,” and recent studies have documented the extent of such “trade.” In light of the trends in population, income, productivity, and biofuels, will the pattern of virtual water trade be altered between the present day and 2050?
7. *Constraints on Irrigated Agriculture:* Almost 40 percent of the world crop production is coming from irrigated lands. However, growing scarcity of water threatens to limit the potential of irrigated agricultural production to feed the world. Excessive water withdrawals also threaten to increase soil salinity and soil productivity. What are the potential impacts of constraints in irrigated agriculture on the global farm and food system?
8. *Africa as the Sleeping Giant of Agriculture:* In 2009, the World Bank published a report suggesting that the Guinea Savannah Zone of Africa could become the next breadbasket for the world. What would be the implications of such a development?
9. *Urbanization:* In one of our lab discussions, we explored urbanization’s impacts on demand for land. However, one could dig deeper by looking at the quality of land that is being displaced. What are the implications for global land use, food security, and the environment?
10. *REDD:* Similar to urbanization, students could explore the impact of efforts to dedicate additional land to the production of environmental services. This would be implemented through adjustments to the regional conversion factors of land in environmental services to cropland.
11. *Climate Change:* We also explore in our lab discussions the impacts of different types of climate shocks on agricultural productivity and land use. A deeper dive might entail converting existing studies of the impacts of climate change into shocks or parameter adjustments within our own model and exploring the results. It is also possible to consider the impact of elevated heat and humidity on labor capacity in agriculture and the consequences for food prices.
12. *Jevon’s Paradox:* The Angelsen reading discusses Jevon’s paradox—a situation in which yield growth might lead to extensification. A deeper exploration of the conditions under which we might expect such a result would be interesting. What is the demand elasticity required to generate this outcome? How do yield differentials across regions affect the likelihood of this outcome? Can these results tell us anything about the probability of experiencing Jevon’s paradox in the real world?
13. *Impacts of Shifting Population and Income on Global Demand Elasticity:* Regional differences in demographics and income growth will shift the balance of global demand. How do these shifts change the aggregate global demand elasticity? How does this compare to shifting demand elasticities within regions? What impact does this have in moderating/amplifying the extensification impacts of biofuels mandates?
14. *Biophysical/Economic Interaction:* Relative yields (local yields versus the global maximum) might be indicative of how close a particular region is to the biophysical limits of intensification given current technologies. To understand how such biophysical limits interact with the economics governing the crop market, we might want to consider a linear relationship between relative yields and our intensification parameter. By plotting different regions on this linear relationship, one could determine whether such a biophysical limit, through its impact on the economic parameters, changes the outcomes of crop expansion scenarios.
15. *Impacts of Different Types of Technology Growth:* In our model, we can simulate land augmenting, land disaugmenting, and technology neutral productivity growth (through af_{land} , af_{nland} , or both simultaneously). What are the realistic ranges of these types of productivity growth going forward? If yield growth outpaces nonland technology growth, what would be the impact on prices and extensification? Under different scenarios, does the clear relationship between land prices and extensification begin to break down?

Box 1 Continued

16. *Globalization*: We have spent relatively little time in the labs relating global processes to local outcomes. However, it can be shown analytically that the *effective* elasticity of demand for a local market depends on the rest of the world's supply elasticity, the local production's share of the global market as well as the global demand elasticity. Among other possibilities, an analysis of globalization's impact might compare the extensification impacts of productivity changes in small markets (share of world supply is small) to large markets.
17. *Changing Productivity of Livestock and Food Processing*: We've spent a fair amount of time evaluating the impacts of changing agricultural productivity. However, one could also assess the implications of changes in the total factor productivity of livestock production or food processing. Contradictory effects of these downstream productivity changes (less crops required to produce a good, but demand is now increasing) may lead to interesting results depending on the assumed parameter values.
18. *Market Mediated Responses*: Hertel (2011) highlights the importance of considering economic factors when estimating the land use implications of changes in biofuels demand. A similar analysis could assess to what scale biophysical estimates of the impacts of demand shocks (e.g., population growth, income expansion) are moderated through economic processes such as intensification and demand reduction.
19. *Economic Impacts of Biodiversity Loss*: Cropland expansion and intensification have been shown to result in biodiversity loss. One source of biodiversity that is important for agriculture is the presence of natural pollinators. What are the impacts of pollinator loss on agricultural yields, and hence the need for further cropland expansion?
20. *Cost-Benefit Analysis of Productivity Growth*: Several papers provide estimates of the cost and scale of historical TFP growth. Using these estimates, one could estimate the consumer surplus generated by the yield growth to evaluate the cost effectiveness. Similarly, estimates of the cost per hectare saved would be possible for land-sparing technologies.
21. *Water Quality Trading in the Chesapeake Basin*: We have examined the impact of fertilizer use in agriculture, as well as the consequences of excess nutrients for water quality. This is a particularly important problem in the Chesapeake Bay region. Using the gridded version of SIMPLE-G, it is possible to develop nitrate leaching mitigation cost curves to explore the potential for profitable pollution trading with industrial and municipal point-sources of pollutants.

Throughout the second half of the semester, students submit weekly updates on their projects, starting with an outline and then progressing from experimental design to results and analysis. Students typically use one of the lab assignments as a starting point for their project and introduce changes to production technology, consumer preferences, or public policies for subsequent analysis. By keeping tabs on the students each week, it allows me to head off unproductive and possibly erroneous lines of work while also keeping the students motivated (see Supplementary Table S1 for the project rubric and schedule). In the final week of classes, students make a short presentation focusing on the problem motivation, experimental design, and a few key findings. Their final task is to write this up in a short paper (10 pp. maximum text, unlimited figures, and tables permitted), which is submitted in lieu of a final exam. Grading is based on class participation, lab assignments, and the final project.

3 Evolution of the Course

When this course was first initiated in 2011, the world was in the midst of a food price crisis (Abbott, Hurt, and Tyner 2011). I had recently given an AAEA Presidential Address on a related topic: "The Global Supply and Demand for Land in 2050: A Perfect Storm in the Making?" (Hertel 2011), and was headed for a sabbatical with the Center for Food Security and the Environment at Stanford University where I co-taught, together with my host, David Lobell, an interdisciplinary seminar in the Department of Earth Systems Science. This course was advertised across campus and open to all graduate students as well as

advanced undergraduates. We ended up structuring the course around the AAEA Presidential Address, with each week tackling a different theme. This was my first introduction to teaching an interdisciplinary course, and we utilized a number of key elements that I still employ—nearly a decade later. The first is the idea of inviting a different domain specialist to speak each week. The second is to follow the lecture with student-led discussion, with one individual in charge of leading this discussion each week. The idea of class projects was a natural outgrowth of this format and had proven success in prior classes.

The SIMPLE model was born during this period. Based on my previous experience with the Global Trade Analysis Project (GTAP; Hertel 1997), I recognized the power of having a standardized computational framework for teaching applied economics. The GTAP model was released in 1993 in conjunction with the annual short course in Global Trade Analysis and that course has subsequently been offered on a continuous basis for nearly three decades. The content cross-fertilized with a PhD course in applied general equilibrium analysis. Following this example, for the new interdisciplinary course, my collaborator Uris Baldos and I developed a global, partial equilibrium model that was a disaggregated, numerical expression of the theoretical model introduced in the presidential address. Based on my positive experience with the GEMPACK software package (Harrison and Pearson 1996) for teaching the GTAP courses, we adopted that software suite for SIMPLE as well. Our strategy was to keep the model as simple as possible—eliminating “nice to have” flourishes in favor of a stripped-down analogue to the theoretical model—since the latter could be solved analytically and therefore was a useful source of insight and intuition into the model simulations. This allowed the students to quickly grasp the key economic mechanisms at work and begin to exercise them in the context of their own projects.

Influenced by the climate scientists around me at Stanford, the first major exercise we undertook with SIMPLE was to run it backward over time. Given our interest in projecting forward 45 years (2006–2050), we decided to backcast from 2006 to 1961, which also happened to be the starting point for the FAO data series upon which we relied for much of our data. This resulted in a novel paper critiquing the literature on global land use change projections (Baldos and Hertel 2013). In particular, we found that the tendency of the prominent Integrated Assessment Models at the time to predict massive land conversion for agriculture in the 21st century was a direct consequence of their failure to incorporate key economic margins of response—most notably the potential for endogenous intensification of production in response to rising land prices. By using the 1961–2006 historical period as our laboratory, we were able to show how such an assumption resulted in far more land conversion than had been historically observed. This was our first indication that SIMPLE could be an effective vehicle for advancing interdisciplinary research. Indeed, after witnessing the development of increasingly complex models, journal reviewers at the time welcomed the use of a model that they could actually understand!

From an initial focus on food and resource scarcity, the course has evolved to focus on the agriculture-environment interface and planetary boundaries. This evolution has mimicked the changing interests and publications in the top interdisciplinary journals such as *Science* and *Nature* (Steffen et al. 2015; Springmann et al. 2018). Each year, the syllabus is updated, and periodically some topics are dropped (e.g., biofuels) in favor of emerging topics (e.g., biodiversity; consumer-driven sustainability). In this way, the course has remained relevant to students across campus.

4 Course Impacts

The course has been well-received by students with recent overall course ratings (as opposed to instructor ratings) of 5.0, 4.5, and 5.0 where 5 denotes excellent. In preparation for writing this article, I sent out a request to recent graduates of the course, asking them to describe how the course influenced them—in particular their outlook on economics (for the non-economists) and interdisciplinary work. Excerpts from these responses are provided in Box 2, along with the major field of study of the graduate student responding. From these comments, it is clear that, for scientists with an aversion to economics, this can be a good entry point to learning the value of economic thinking. And for the economists, the most important feature of the course seems to be the opportunity to think about the “big picture,” as well as the exposure to new research ideas.

Box 2. Impacts on Students (Major Field of Study in Parentheses)
Comments from Non-Economists

"I thoroughly enjoyed AGECE 528 this semester. I learned a great deal about Agricultural Economics, and the strong link it has to my field of study (applied climatology). I enjoyed that the course was open to all majors, as it provided insightful discussion and different viewpoints on reading assignments for the course. I like the inclusion of lab assignments with SIMPLE, as it helped me breakdown economics in a manner I am familiar with (modeling of complex systems) leading to a deeper understanding of the intricate nature of the agricultural-economic system. I have struggled with economics in the past, but after taking the course, I have developed a much greater appreciation and deeper understanding of the science, especially since I was able to make economics applicable to my own field of study." **(Climate Science)**

"Because Ag Econ was outside of my discipline, I found this class very helpful. I learned a lot about economic modeling, it's strengths and weaknesses, how the models are made, what kinds of assumptions go into them, and how to interpret the results. Of course, I was not an expert upon finishing the class, but the introduction was very valuable. In addition, seeing the interconnectedness of different variables in the unique study of Global Land Use was very helpful in following the news." **(Agricultural Engineering)**

"I really enjoyed this class. I felt like I was able to grow in a direction I would have not otherwise been able to explore. I had joined the Ecological Sciences and Engineering program to explore interdisciplinary work, but I still had a barrier setup, and it felt like economics was on the other side of that barrier. After taking the class, I would say that changed. I initially felt very comfortable with the lecture and discussion portion of the class, as I thrive learning in that format. However, I felt uncomfortable with the labs (once again the barrier). However, I became invested in my project, and that is what really changed my perception about my ability to incorporate economics into future research or at least to identify the need to do so. My career goal is still to eventually work on interdisciplinary teams focused on wicked environmental problems, so I think that this class really benefited me." **(Agricultural and Biological Engineering)**

"I am not an economics person. I believed more in production to solve the world's food problem. Taking this class changed that view. It exposed me to the deprivations I would suffer from if I do not pay attention to economic activities that directly impact my immediate environment as well as the world view too. I got exposed to many challenges that exist in agricultural productivity and the multidisciplinary approach to solving them. I got more interested in world trade and learned to foresee the implications of my activities and decisions on the poor and rich at the national, continental, and world level." **(Agronomy)**

"Prior to the course, I had a very limited view of agricultural and applied economics. Now that I understand that there's a lot of good work being done in the area, and now that I have a better appreciation for what's possible with state-of-the-art economic modeling tools. I expect to apply insights from economic modeling or even leverage models from the economics literature as I continue to pursue a research career in natural hazards mitigation. I'm currently working on expanding my final project into something publishable and policy-relevant with the assistance of my advisor as well as Professor Baldos. Additionally, the course provided an excellent networking opportunity; I connected with several interesting and capable fellow researchers who I now consider friends." **(Industrial Engineering)**

Box 2 Continued

"In my case, AGE 528 made me realize how the agricultural challenges that we face impact in the world economy and the people. The kind of analyses that we did in the class made me think how we can model and replicate different situations in order to develop better policies for the common welfare. My masters program is in Horticulture combined with Agricultural Economics, and this class made me eager to look for a PhD in Agricultural Economics." **(Horticulture)**

"AGE528 class changed my perspective and helped me answer important aspects of post-harvest losses which I later adopted in my thesis. Coming from a non-economics background, I had very little idea about how can one apply economics to study the impact of environmental factors in agriculture. I believe that AGE528 (irrespective of academic background) provides everyone with an opportunity to see the world of agriculture from an entirely different economic lenses and focus more toward our contribution toward sustainability and food security for our future needs." **(Engineering Technology)**

"I really enjoyed the AGE 528 class and learned a lot about agricultural economics concepts and how they relate to solving the problems in agriculture production sustainably. I have an Industrial Engineering background. However, I found it quite easy to learn and understand the concepts. I think the simulation software (SIMPLE) that we used in the class helped to apply the concepts and analyze the problem in greater depths. The final team project that we did helped me to understand the relationship between economic factors (TFP, labor productivity) in agricultural production with environmental factors (heat stress, malnutrition) in different regions of the world." **(Industrial Engineering)**

"The FAO estimates over 2 billion people do not have regular access to safe, nutritious, and sufficient food. There are very few issues that our generation face more important than this one. AGE 528, in conjunction with my program in Ecological Sciences and Engineering, has broadened my horizons to the positive impact that interdisciplinary work has, especially in the world of food security. I really enjoyed learning and reading about a different topic each week. The issue of food security is so complex, and it seems this is the only true way to teach the subject. I really appreciated how applicable the readings of this class were to current events. As a non-economist, the course opened my eyes to the world of ag-econ and its quintessential importance for global food security. I am not a naturally strong student in the area of coding and computing, but this course taught me in a way that I could understand and create a final project based on a computer modeling system. I never thought I would say that!" **(Ecological Sciences and Engineering)**

Comments from Students in Agricultural and Applied Economics

"The best and simplest way I can describe my experience from this class is that it allowed me to think 'bigger picture.' As students of economics, we can often get consumed in microenvironments/micro-interactions that sometimes we forget that any small change in an economy can have ripple effects on many different sectors, within supply chains, and trade between nations. This class allowed me to think through many of these potential impacts, even before running any simulations. Better yet, once simulations had been run, I could reason through why the results may have come out the way they did because of these simple thinking exercises. The interdisciplinary nature of the course reinforced my views that the study of human action and interaction with the natural world is the sum of many different disciplines. Using the combined tools of the natural sciences and social sciences help us form a better understanding of the 'bigger picture.'" **(Agricultural Economics)**

Box 2 Continued

“AGEC 528 has been an eye-opener to me in many ways. I joined Purdue in 2019 aspiring to become an applied microeconomist and always dreaded complicated macro theories or anything to do with macroeconomics in general, until I took this course in Spring 2020. I have never been in a class before where a complex modelling technique was introduced with so much simplicity and made even more interesting by complementing the technical lab sessions with interdisciplinary guest lectures and making us apply the model to pressing real-world issues. It was also a great networking experience, interacting with peers researching in other interdisciplinary areas.” **(Agricultural Economics)**

“This class allowed me to find my passion within the field of applied economics and agricultural economics, and it made a huge impact on my academic trajectory. In this class, I became fascinated with the tradeoffs and synergies arising out of the competing demands on the planet’s finite resources, as well as potential pathways for sustainable development in the coming decades. The topics, the dynamics of the course, and the methodology applied really triggered my interests. But most importantly, it widened my perspective on how economics could contribute to other disciplines. I have been developing a big portion of my PhD dissertation around extensions of the nutritional module in SIMPLE. Since Spring 2019, I have been serving as TA for this course, and I have seen the same effect on many other students. Looking back, the impact of this course on my career has been tremendous. After finishing my PhD, I plan to stay in academia hoping that my research helps achieve a sustainable future as well as helping to educate students with an interest in these topics. And all of that was inspired by the AGECON 528 course.” **(Agricultural Economics)**

“AGEC 528 in essence changed my career from financial management to agricultural economics. I was impressed by the multidisciplinary design of the course. Frankly, it was my first experience with multidisciplinary course. Sitting in this class was a great chance to look at the big picture of a critical challenge, which is feeding the world in 2050. Speakers from different disciplines were sharing their views and articles relating to this issue. It was really informative how tradeoffs appear between different disciplines like economics and environment.” **(Agricultural Economics)**

“As a graduate student, it’s very easy to get absorbed in the importance of our own (usually narrowly focused) research projects and forget that it doesn’t exist in isolation. While every research problem is still important, other problems also exist and are often related and embedded within more complex “wicked problems” like food security. AGECE 528 was a good reminder of this and helped me put my own research topic (storage loss) in perspective. I think that it’s important and humbling for any grad student to see how their research fits into the bigger picture, and that research can be much more impactful by thinking beyond just one narrow question or issue. Even as an economist, I appreciated the simplicity of the economics discussed in the course. It allowed me to focus more on the modeling, and how the interdisciplinary topics are applied and measured in the model. The modeling helped me understand these topics from a more macro perspective, rather than at the micro-level approach I use in my own research.” **(Agricultural Economics)**

One of the biggest benefits of teaching this course has been the impact it has had in shaping my research, greatly enhancing my interdisciplinary collaborations. This course has directly, or indirectly, spawned two dozen journal articles as well as a textbook. Most of these have been born out of discussions—sometimes heated debates—with students and guest speakers on topics such as Jevons’ paradox (Hertel, Ramankutty, and Baldos 2014). Others have emerged from an attempt by the visiting lecturer and myself to forge a synthesis between our respective fields—for instance economics and ecology (Seppelt et al. 2020). By inviting a rotating group of scientists to speak in the course, I have also been able to forge productive interdisciplinary collaborations. If not well-matched, such collaborations can prove frustrating and costly—both in time and resources. The trick to successful interdisciplinary collaboration is to identify like-minded individuals whom one enjoys engaging in discussion and inquiry. By sharing the syllabus with guest speakers in advance, settling on a couple of recent readings, listening to the guest lecture, and observing how these individuals interact with the students, I have found it is possible to form a reasonably accurate assessment of the likelihood for a successful collaboration emerging.

The core group of lecturers whom I identified at Purdue University in the first few years of the course also became the foundation for two successful campus-wide interdisciplinary competitions. The first was sponsored by the Mellon Foundation and emphasized the communication of interdisciplinary research around the “grand challenges” facing the world today. Our project focused on the long run sustainability of U.S. agriculture and culminated in an event at the National Press Club in September 2018.¹ The second was a research competition attracting submissions from nearly 50 competing interdisciplinary groups across campus, focusing on Big Ideas—in this case related to sustainability.² We would not have been successful in these competitions (typically announced with just a few months’ lead time) if we had not identified like-minded collaborators in advance and begun fleshing out the themes for these projects in the context of our interactions through this graduate course. One of the most satisfying impacts of the course has been to see student projects evolve into thesis topics, and later into journal articles. More often than not, these students have introduced me to new areas of inquiry, thereby broadening my horizons and lending an interesting dynamic by which the course content evolves over time. Two notable examples of such student-led initiatives are: the role of food waste in global food security and environmental sustainability (Lopez Barrera and Hertel 2020), and the impact of heat stress on agricultural labor capacity (Lima et al. 2020; Hertel and de Lima 2020).

5 Challenges and Future Opportunities

The foremost challenge facing those offering such a course is to keep it fresh and exciting! As this is an elective course, demand can quickly dry up if students no longer find this to be sufficiently innovative. Also, there is continuing competition for “global food security” types of courses offered elsewhere in the university. The differentiating factor in this course is that it is model-based, and students learn how to use this model through a systematic series of labs. This is what gives them the capacity to ultimately bring the SIMPLE model to bear on an issue of particular interest to them. It is this last step which the students find most meaningful. This is quite different from a readings-based course—which typically culminates in a readings-based term paper. Such courses are valuable, but often leave students wondering how they can apply this newfound knowledge to address the world’s food and environmental security challenges.

A second challenge is the labor-intensive nature of the course. We are teaching economics at the same time we are teaching students how to generate and analyze results from a global economic model, in addition to introducing specialized material on a wide range of sustainability topics. In the first few years, the course was co-taught with Uris Baldos, my co-author and collaborator in development of the

¹ <https://mygeohub.org/groups/glass/npc2018>

² <https://www.purdue.edu/discoverypark/initiatives/big-idea-challenge/>

SIMPLE model. This collaboration launched the course and also gave rise to the textbook which we co-authored. For each chapter/sustainability topic, Uris developed a computational example using the SIMPLE model. After Professor Baldos moved on to a new position, I recruited a PhD student from our department who had excelled in the previous year's course. Iman Haqiqi assisted with the labs and projects for several years, gaining valuable teaching experience and contributing to new pedagogical material for the lab assignments and associated tutorials. Dr. Haqiqi has subsequently used the SIMPLE model in his own research (Haqiqi et al. 2018; Baldos et al. 2020). The most recent PhD teaching assistant for AGECE 528 is Emiliano Lopez Barrera. Emiliano has invested a great deal of time and energy in pedagogy for teaching economics to non-economists and helping to guide student projects. Emiliano Lopez Barrera has also adopted the SIMPLE framework for exploration of issues related to nutrition and food waste (Lopez Barrera and Hertel 2020). This course would not have been possible without the collaboration of these three excellent teachers.

I see a number of future opportunities related to this course and the associated materials. First, the development of an explicitly spatial (gridded) version of SIMPLE (SIMPLE on a grid or SIMPLE-G; (Baldos et al. 2020) opens interesting new avenues for teaching and research. Many of the scientists and engineers enrolling in the course have strong geographical information system skills, and the issues in which they are interested (e.g., water scarcity, climate impacts) are inherently geospatial. (It is not interesting to think about water scarcity at the national level—on average the United States, for example, has plenty of water!) Allowing the students to use the gridded model opens the door for more meaningful projects and greater opportunity for subsequent publications. However, this does add another layer of computational and analytical complexity to the course. (One of the SIMPLE-G-US models disaggregates the United States into 75,000+ grid cells.) Finding new ways to teach economics with such a gridded modeling approach is a high priority.

There are two promising approaches to using the gridded model in a classroom context. The first involves running the model and mapping results on the NSF-funded GeoHub.³ This is an open science platform designed to allow users from anywhere in the world to access and run models using NSF's high-performance computing systems. We experimented with this in September 2019 when we ran a short course for an NSF-funded interdisciplinary project.⁴ This allowed participants to run the high resolution SIMPLE-G model and map results without downloading extra software and without access to special computers. They were able to do all this on the GeoHub simply via an internet browser. In this case, we had participants go through the AGECE 528 labs (non-gridded model) online before coming to campus for the course.

The second novel approach, which we have been exploring is aimed at facilitating economic analysis of results from the gridded model. When producing results for 75,000+ grid cells, one can draw attractive maps, but it is hard to analyze why impacts in one region of the country differ from those in another. Toward this end, we have developed a "mini-model." This is a small collection of grid cells (perhaps 10 to 20) for which the impacts are found to differ in interesting ways based on the map of results. Once prices for national outputs and inputs are made exogenous, the individual grid cells in SIMPLE-G no longer communicate with one another, and it is possible to independently solve for grid cell level changes in land, water, fertilizer, and other input use, as well as for crop output. If national boundary conditions (i.e., prices in this case) are appropriately "shocked" when solving the mini-model, then the solution for the grid cells will be the same as for the full model. This means that a careful analysis of results and why they differ across grid cells can be undertaken. This is the essence of lab 5 in Table 2 which focuses on the differential impact of changes in irrigation efficiency. In some grid cells, the response to improved irrigation efficiency is to increase water usage while in others, water use for irrigation falls.

³ <https://mygeohub.org/>

⁴ https://mygeohub.org/courses/sustainability_shortcourse

Over the next five years, in conjunction with a new NSF project (GLASSNET), we will be offering SIMPLE-G short courses for young scientists across a range of disciplines. For these courses, we plan to employ the GeoHub to facilitate online learning as well as online preparation for an onsite course and for computational purposes. We will also endeavor to teach participants the basic principles of economics as they pertain to addressing the global sustainability challenges related to food, land, water, and climate. It is my hope that these experiences will feed back to the graduate classroom, thereby enhancing the learning opportunities for students enrolled in AGE 528.

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Teaching and Educational Methods

Flipping Together: A Collaborative Approach to a Flipped Class

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Abstract

The flipped classroom approach has been cited as a method for increasing student engagement, enhancing content comprehension, and integrating practical application of concepts. Opponents note its complex nature as a barrier to successful integration. To mitigate this limitation, a faculty member in agricultural economics worked with a faculty member in agricultural education to create and present an upper-level agricultural sales course with flipped and traditional instructional components. The purpose of this study was to assess the impact of delivery methods on student confidence. Impacts of the two approaches were assessed through a pre/post course survey of student perceptions of content topics and confidence in knowledge of individual course topics. Although grades were similar to previous semesters, students had varying degrees of change in confidence and knowledge for information presented through the flipped or traditional methods. The instructor benefited by a reinvigorated approach to a topic that had suffered from stagnation. The benefits to students' confidence and knowledge, and the reinvigorated energy the instructor gained outweighed the costs to the effort of creating the flipped components, and a collaborative approach is recommended for those content experts uncertain of their ability to flip a classroom.

1 Introduction

Emphasis on high quality teaching at the postsecondary level has increased over the last two decades (Fry, Ketteridge, and Marshall 2008; Muijs and Reynolds 2017). Researchers have cited high-quality teaching as a factor contributing to increased undergraduate retention levels, graduate school aspirations, and student self-efficacy (Loes and Pascarella 2015). The increased focus on teaching has led many instructors in higher education to look outside traditional lecture-based classroom formats to enhance their teaching methods (Bryson 2016). One of the approaches used commonly as a supplement to lecture-based instruction is a flipped classroom. Flipped classroom methods first gained recognition in secondary education (Bergmann and Sams 2012), and use of them increased in higher education over the course of the last decade (Conner et al. 2014; O'Flaherty and Phillips 2015). The flipped classroom approach can be defined as the design and implementation of blended instruction that moves content learning largely outside of class time and directs students toward active learning and application of knowledge during face-to-face meetings (Lage, Platt, and Treglia 2000; Bergmann and Sams 2012). Most commonly, instructors present asynchronous content via videos, readings, and explanations to students in a digital format available prior to application-based course sessions (Lage, Platt, and Treglia 2000).

Whereas some studies have found positive impacts of this method on student learning (Strayer 2007; Fulton 2012; Honeycutt and Garrett 2013; Mason, Shuman, and Cook 2013; Conner et al. 2014), others have found no impacts (Herreid and Schiller 2013; O'Flaherty and Phillips 2015). Critics of the method point to the amount of work required (Honeycutt and Garrett 2013) and the complexity of the method, and note that only trained experts should attempt it. Compounding the problem is the finding by Smith and Thapa (2017) that many content-area instructors, like agricultural economists or animal

scientists, have little background related to developing curriculum or delivering instruction using sound pedagogical principles. Researchers note the most likely reason for limitation of instructors is that while in graduate school future instructors put their attention to studying their field rather than becoming experts in pedagogy or curriculum development (Jensen, Kummer, and Godoy 2015). One potential solution is to match a content-area expert with a pedagogical expert to overcome the knowledge barrier. Pedagogical experts can be found in education-focused colleagues or in centrally supported resources for teaching excellence (e.g., standalone Centers for Teaching Excellence at many universities).

The purpose of this study was to test the impacts of flipping a classroom on student confidence on course topics, while removing the knowledge barrier of the content-area expert. Course design and topic content development in an introductory agricultural sales course (which had significant application focus in learning outcomes) were crafted for this study through collaboration between faculty members in agricultural economics and agricultural education. To meet the purpose, the study had the following objectives: (1) determine the changes in student confidence in course topics from the beginning to the end of the semester; and (2) compare changes in student perceptions for topics taught using traditional instructional approaches versus topics taught using flipped-classroom instructional approaches

2 Background

Using a flipped classroom approach to instruction alters the sequence of information presented and application from the traditional lecture format; lectures and interactive lessons are made available to students to allow them to learn core concepts before class, while classroom time is reserved for students and teachers to work through the application of learned concepts (Barkley 2015).

Previous research reveals large-scale benefits to the use of a flipped classroom for both students and instructors (Donovan and Lee 2015). There are noted student benefits to using a flipped classroom approach, including increased student engagement (Fulton 2012); increased confidence in content mastery and student self-perception of their efficacy to apply content topics (Honeycutt and Garrett 2013; Conner et al. 2014); improved student course satisfaction (Fulton 2012; Strayer 2012; Mason, Shuman, and Cook 2013); and improved student grades (Wilson 2013). The literature base related to high-quality teaching in postsecondary settings highlights the importance of student engagement for critical learning (Coates 2006; Barkley 2009). Having students engage with the material and peers before class time benefits student learning and primes students to be ready for applying concepts (Owen and Dunham 2015). In a flipped classroom, students are responsible for initiating the learning process, as they bring in content through their own efforts prior to class sessions (Honeycutt and Garrett 2013). Honeycutt and Garrett (2013) outline important concepts for successful integration of a flipped classroom model, including communication strategies, collaboration during pre-work, group clarification for out of class elements, and active student collaboration during class sessions. As a result, the Honeycutt and Garrett (2013) model of flipped classroom design used in this study yields significantly more opportunities for student engagement than traditional instruction (Fulton 2012). Another noted engagement benefit for students in flipped classroom courses is the opportunity to engage with the content at their own pace with flexibility to revisit content. The freedom of consuming instruction without the time limitations of a class session provides more processing time when completing higher-order cognitive tasks (Sousa 2011).

Educational researchers cite student connection, responsibility, and increased efficacy in completing tasks as benchmarks for learner-centered instruction (Owen and Dunham 2015). These concepts are embedded at the core of the flipped classroom approach (Honeycutt and Garrett 2013; Owen and Dunham 2015). Flipped classrooms are often taught at higher cognitive levels than traditional instruction (Gallagher 2014). Instruction delivered at higher cognitive levels can have marked impact on the efficacy gained by students in the learning process (Conner et al. 2014). Students in a flipped classroom are also more likely to participate in active learning strategies (Phillips and Trainor 2014). The design of a flipped classroom allows the opportunity for students to work collaboratively during class

sessions if the instructor chooses (Barkley 2015). If done, these student exchanges may yield increases in overall understanding, especially for complicated concepts (Barkley 2015). Because of the embedded components related to learner-centered instruction, proponents of a flipped classroom approach argue the model provides a simple method for shifting instruction from teacher-centered to learner-centered (Fulton 2012; Strayer 2012; Owen and Dunham 2015).

Several studies have been conducted in which students participating in the flipped model have knowledge gains significantly higher than students in traditional sections of the same course (Wilson 2013). Researchers at Capital University in Ohio used a flipped approach in two of four statistics courses. Although there were no differences in pretest scores between groups, there were significant differences in posttest scores. Students enrolled in the flipped class averaged 6.73 points higher on test grades and 9.99 points higher overall in the class than students enrolled in the sections with traditional instruction (Wilson 2013).

The impact of a flipped classroom model on instructors has also been investigated. Using a flipped approach has been found to give instructors more time during class sessions to address misconceptions about content, and more time to build rapport in their classes (Honeycutt and Garret 2013; Barkley 2015). In addition, instructors employing a flipped classroom model have also reported spending more time with individual students, which could help foster positive student-teacher relationships and increase overall student engagement and interest in the subject (Phillips and Trainor 2014). Many universities advocate using a flipped classroom as an economically viable option for delivering student-centered instruction with existing resources (O'Flaherty and Phillips 2015).

Not all views of a flipped classroom approach to learning are positive. Those who caution against the use of a flipped classroom share three main concerns with this type of instruction. First, there are many who believe that the shift of lecture to outside of class does little to further engage students in the learning process (O'Flaherty and Phillips 2015). Second, although instructors note additional time in class when using a flipped classroom model, preparing content for students to learn outside of class can increase the overall time instructors need to prepare for class each day (Kim et al. 2014). Finally, without proper student motivation, there is no guarantee students will expend the time and effort required to learn the content before each class session (Abeysekera and Dawson 2015).

In contrast to studies highlighting student knowledge gains, other studies have been conducted in which little or no differences were found in the knowledge gains between students in traditional and flipped sections (Herreid and Schiller 2013; O'Flaherty and Phillips 2015). Student perceptions of flipped classroom instruction have also been mixed. Some students have noted an appreciation for the structure that comes with organized pre-class materials typical of flipped classrooms (Sohrabi and Iraj 2016), while others have cited difficulty learning content when there is not an instructor present to clarify their understanding (Sohrabi and Iraj 2016; Yilmaz 2017).

Flipped classroom teaching approaches are complex (Honeycutt and Garrett 2013). Opposition to using flipped classroom approaches in higher education often cite a lack of instructor knowledge related to educational theory and pedagogical principles as a barrier to successfully flipping postsecondary courses (Jensen, Kummer, and Godoy 2015; Sohrabi and Iraj 2016; Yilmaz 2017). The initial setup of a flipped style class can be very time consuming as instructors must develop lectures and interactive materials related to core understanding for students to access before class (Owen and Dunham 2015). Quizzes, readings, and activities also require more thoughtful construction for many instructors compared to delivering a lecture (Bishop and Verleger 2013). The time commitment is so prominent that some experts estimate development of quality material for a flipped classroom can take years of instructor time to perfect (O'Flaherty and Phillips 2015). Instructors in higher education already struggle to maintain a healthy work/life balance, and the extra time needed to initiate a flipped class can create additional stress (Owen and Dunham 2015).

A common limiting factor to the development of a flipped class is having enough support for instructors (Owen and Dunham 2015). Institutions with larger numbers of support staff related to instructional design had shorter lead times to implement a flipped class than those with fewer support

members (O’Flaherty and Phillips 2015). Owen and Dunham (2015) found there can be differences in learning outcomes designed for students and the goals of a teacher for a given course. For example, a student learning outcome might be for students to be able to define a concept or focus on awareness or application of a concept while a goal of the instructor may be to improve electronic access of content. A lack of pedagogical background in higher education can amplify challenges in implementing a flipped classroom approach, as development of flipped classrooms typically requires a large amount of pedagogical knowledge (Owen and Dunham 2015). Kanuka (2006) stated the importance of incorporating strong concepts of instructional design into higher education courses. Enlisting the help of a pedagogical expert can help to merge both content with instructional design (Kanuka 2006).

3 Methods

Successfully executing the flipped classroom approach to instruction method relies heavily on combining educational technology and active learning strategies to enhance student learning (Strayer 2007). Yet many content-area instructors have little background in pedagogy or curriculum development (Smith and Thapa 2017). To overcome this barrier, course design and topic content development for this study were conducted through collaboration between faculty members in agricultural economics and agricultural education. This pairing was designed to take advantage of content-area and pedagogical expertise in designing flipped components for a class. The paired faculty members followed Strayer’s (2007) model for flipped classroom instruction (shown in Figure 1). Strayer’s (2007) model includes the contributions of both educational technology and active learning to the overall learning environment. The study design allowed us to examine the increase in student confidence from individual topics when flipping some topics and presenting others in traditional instructional methods.

This study was conducted using descriptive survey methods. The population for this study included a census of students ($N = 53$) enrolled in the Spring 2017 section of an introductory sales course at University of Idaho. The course is included as one option of four courses of which agribusiness students must select two. It also meets the requirement for an elective in many College of Agriculture and Life Sciences degree plans, as well as an elective in the College of Business and Economics’ marketing minor. Project setup included obtaining Institutional Review Board approval for this research.

The agricultural economics faculty member was the sole instructor of the course but worked with the faculty member in agricultural education to provide expertise in the pedagogical setup of course instruction. The faculty team determined which components would be taught using a flipped approach (content delivered outside of course sessions) and which would be taught using a traditional approach (content delivered during class sessions). Decisions on which topics to flip were made by selecting an even distribution of topics that students in previous semesters found easier or more difficult, to create a balance of easy and difficult topics presented in both flipped and traditional methods. Methods for assessing student completion of the outside of class components, formative assessments of learning, and course dates and deadlines were also determined and carefully designed to meet the learning outcomes of the course with attention to rigorous content and strong adherence to sound pedagogical principles (i.e., matching learning outcomes to assessment, course pacing, timely feedback). The result of course planning included the identification of eleven specific course topics, and a determination that six topics would be taught using a flipped approach and five would be taught with a traditional approach. Topics were taught intermixed throughout the timeline of the semester, to prevent topics in one approach from being more likely retained due to proximity to the post-survey at the end of the semester. Course topics and their method of instruction are shown in Table 1.

The survey instrument used in this study included four sections. Section one included items to gather demographic information including gender, major, and time left in degree program. The second section allowed respondents to share their background in sales and agricultural sales. Section three included questions about course decision and overall sales perceptions, and section four asked students to rate their level of confidence in their knowledge for each of the eleven topics covered in the course on

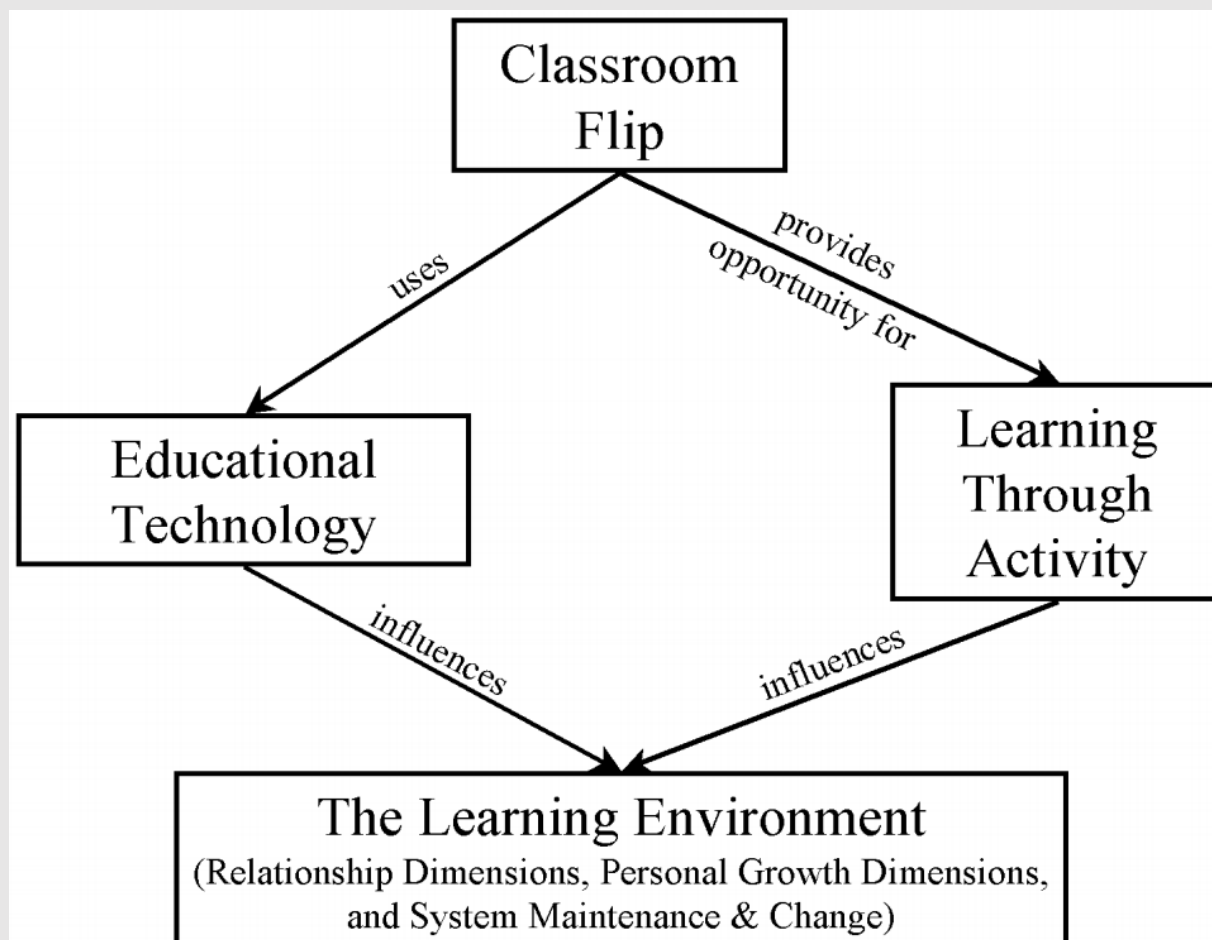


Figure 1. Theoretical Framework for Flipped Classroom Design (Strayer 2007)

a Likert-type scale from 1 (not confident at all) to 4 (completely confident). A four-point scale was deemed appropriate because the confidence of students was likely initially low and the use of narrower ordinal scales in confidence can prevent respondents from falsely inflating scores (Sullivan and Artino 2013). Although scores on tests and quizzes arguably offer a great measurement of learning, without a standardized test that mitigates all other factors (including the difference in the nature of any given two topics) that can be used consistently across semesters, assessment scores from one topic to the next may

Table 1. Content Areas and Method of Instruction

Topic Area	Chronological Order	Method
Sales Eras	1	Flipped
Marketing vs. Sales	2	Flipped
Prospecting	5	Flipped
Understanding Customers	4	Flipped
Probing	7	Flipped
Communicating Value	8	Flipped
Strategy & Planning	3	Traditional
Opening a Sales Call	6	Traditional
Closing the Sales Call	10	Traditional
Customer Satisfaction	11	Traditional
Dealing with Resistance	9	Traditional

or may not reflect mastery of content but other factors such as student aptitude. Lacking such a standardized test, student confidence in their knowledge was chosen as the measurable outcome.

Sections one through three of the instrument were piloted in the Spring 2016 semester. The instrument was evaluated for face validity by a panel of experts in both agricultural sales and agricultural education and deemed to be appropriate as a measure of student self-reported content area confidence. The instrument was administered online using Qualtrics survey software. Distribution practices were guided by the tailored design method, including five points of contact as prescribed by Dillman Smyth, and Christian. (2014). Contact points included: prenotice, survey initiation, and three follow-up reminder notifications. Students were notified about the option for participation during the initial class section and sent individual survey links to access the instrument. Two reminder emails were sent to nonresponders. Participants who completed the survey were incentivized with five extra credit points toward their total points earned in the class, which equates to approximately 0.5 percent of the overall grade in the course. Participants completed the instrument twice; as a pretest in the first week of the course and as a posttest in the final week of the course. Of the 53 students in the course, 50 completed both the pre- and post-surveys, yielding a 94 percent response rate.

Results were compiled from the Qualtrics software and analyzed using IBM SPSS v 23 to determine descriptive and comparative data. Student changes in confidence were calculated from the beginning to the end of the semester for each of the eleven course topics, and a matched pairs *t*-test was conducted to determine if changes were observed between topics taught using a flipped approach and those taught using a traditional approach.

An additional component of this study included the analysis of comments from the University of Idaho mandated student evaluations of instruction for the course used in the study. Comments were provided by students anonymously the last three weeks of the course and were analyzed to determine the frequency and percentage of topics.

4 Results

The first objective of this study was to determine the changes in student perceptions of course topics from the beginning to the end of the semester. To accomplish this objective, we calculated the descriptive information from pretest and posttest surveys for each of the eleven course topics. Results of this analysis are shown in Table 2. The topic with the largest change in student confidence was Probing ($M = 1.44$, $SD = 1.14$), while the topic with the least change in student confidence was Understanding Customers ($M = 0.48$, $SD = 0.95$). Overall, students reported increases in confidence for all topic areas, with a mean increase of $M = 0.99$ ($SD = 0.76$) across all topical areas. Of the eleven topics under consideration, six showed less than one-point movement between pre- and post-surveys. The six topics include: Understanding Customers, Customer Satisfaction, Communicating Value, Closing the Sales Call, Marketing vs. Sales, and Dealing with Resistance.

The next objective of this study was to compare changes in student perceptions of course topics taught using traditional and flipped-classroom instructional approaches. The descriptive information for change in confidence based on type of instructional approach is shown in Table 3. Based on the descriptive information, change scores appeared similar between topics taught in a flipped content approach and those taught using a traditional approach. To further examine potential differences between student confidence scores based on the method of instruction, a matched pairs *t*-test was conducted. Results of that analysis revealed no differences in student confidence for course topics based on instructional approach ($t = 4.23$, $p = .08$). Further, differences were tested using a two-step cluster analysis. Results of the cluster analysis yielded one homogenous group, indicating no pattern of change in confidence differences across the students.

Table 2. Descriptive Statistics for Student Confidence in Topic Areas

Topic Area	Method	Pre-Survey		Post-Survey		Change	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Sales Eras	Flipped	1.52	0.61	2.80	0.76	1.28	0.99
Marketing vs. Sales	Flipped	2.28	0.73	3.24	0.59	0.96	0.88
Prospecting	Flipped	1.94	0.79	3.10	0.71	1.16	0.96
Understanding Customers	Flipped	2.74	0.75	3.22	0.79	0.48	0.95
Probing	Flipped	1.68	0.79	3.18	0.64	1.44	1.14
Communicating Value	Flipped	2.48	0.89	3.30	0.61	0.82	1.04
Strategy & Planning	Traditional	2.06	0.62	3.16	0.65	1.10	0.79
Opening a Sales Call	Traditional	2.08	0.88	3.30	0.73	1.22	1.11
Closing the Sales Call	Traditional	2.16	0.73	3.08	0.60	0.92	0.94
Customer Satisfaction	Traditional	2.82	0.69	3.40	0.57	0.58	0.86
Dealing with Resistance	Traditional	2.08	0.70	3.06	0.71	0.98	1.02
Overall		2.16	0.83	3.16	0.68	0.99	0.96

Note: Confidence scores were collected on an ordinal scale as follows; 1 = not confident at all, 2 = somewhat confident, 3 = fairly confident, 4 = completely confident. *M* = mean, and *SD* = standard deviation.

Table 3. Means for Change in Confidence Based on Instructional Method

Topic Area	<i>M</i>	<i>SD</i>
Flipped Content Areas	1.02	1.04
Traditional Content Areas	0.96	0.97

Note: *M* = mean, and *SD* = standard deviation.

5 Discussion

This study focused on the changes in student perception and confidence in a partially flipped agricultural sales class. Despite student confidence for course topics increased across the board with a mean increase of nearly one point on a four-point Likert scale, there was no statistically significant change between the confidence increases based on either a traditional or flipped instructional approach. This finding was consistent with other studies on this topic (Herreid and Schiller 2013; Jensen, Kummer, and Godoy 2015; O'Flaherty and Phillips 2015). Although not statically significant, every topic area had an increased confidence score, and some, like Opening a Sales Call, showed practical significance in the increased score. Therefore, we believe the positive results from student confidence scores indicate including flipped components in a class does not negatively impact the student learning.

Besides, some experts argue that flipping any component in a class can have positive influences on all other instruction (Honeycutt and Garrett 2013). The exposure to flipped classroom material arguably can produce a positive externality on the overall student learning experience in a course. Perhaps flipping a portion of the course for this group of students was enough to carry increases in confidence throughout nonflipped subjects. This possible explanation adds to the argument for teaching portions of courses in the flipped modality while noting the limited risk to making the change.

As for individual topic areas, there are six topics that had less than one-point change from pre- to post-course evaluation (less than 25 percent given a four-point Likert scale). With the exception of Marketing vs. Sales, these topics are complex and have a degree of subjectivity in determining the application. For example, students are required to make contextual judgments as to which closing method is best for a given scenario. This judgment is based on perception and feel, leaving many students

wanting more concrete decision tree style application. This contextual judgment requirement is certainly different than the more formulaic activity in other topics like Strategic Planning (which has a clearly defined process) and Prospecting (which has a strict process that includes a formula for assessing the potential of prospects).

Beyond the statistics, positive impacts for flipping the class were found. First and foremost, students commented on evaluations that they appreciated the interactive class sections and felt as though they were more engaged than they were in a traditional lecture. For the instructor, the opportunity to engage in pedagogical discussions where theory and practice were discussed in depth provided great insight and furthered the instructor's understanding of instructional design and delivery. In addition, the changing of activities in the class helped to refresh some of the content. This resulted in a refreshed engagement and enthusiasm for the course by the instructor. Ultimately, the instructor had greater job satisfaction and arguably more frequent and better quality engagement with students one on one.

Because the flipped mode of teaching content was shown to be at least as impactful as traditional lecture mode, the potential compounded impact on the overall student experience, and the benefit to the instructor from engaging the material differently, we recommend a continued use of the flipped classroom approach in courses for instructors in higher education settings. By combining a subject-matter expert (agricultural economics faculty member) with a faculty member who has the training to properly design flipped content (agricultural education faculty member), students were delivered a course which embodied the expertise of both faculty members. In addition, given that this study shows the combined effort does no harm, properly flipping a course may be a way for instructors to refresh their approach for teaching a subject for which their previous approach may have become stale or around which they have mental fatigue. This new perspective might reinvigorate their excitement for engaging students.

Through our work, we noted additional areas that could warrant future research efforts. We followed the recommendation of Honeycutt and Garrett (2013), who suggested looking for opportunities to flipping components of classes as an alternative to flipping all content in a course. Based on the results of this study, we recommend further research into the use of "partially-flipped" courses to help examine the impact that flipping some portions of a class could have on the overall learning in the course. For example, are there characteristics of topics or concepts that make the flipped instruction method more or less effective? Further research should also be conducted to determine if the flipped content had impact on the adjacent nonflipped content area. More research should also be conducted to establish whether some topics more easily integrate into a flipped approach than others, or if there are differences between courses that are partially flipped and those taught exclusively with traditional or flipped instructional approaches. Of course, the expansion of this research over a longer period of time and across institutions and instructors would add to the validity and generalizability of the findings.

Finally, confidence in the concepts presented in the course is only one area of concern; additional aspects of student benefits should be considered. Student engagement might be a factor of conformance (e.g., "I will learn it to gain the desired grade even if it kills me") or a factor of genuine interest (e.g., "I really am curious about this content and want to know more"). Factors like interest in the content lead to further pursuits in that field, maybe to the point of influencing students' careers. Future research could allow an examination of all student benefits stemming from flipped or partially flipped courses. The specialized content in this study without a standardized assessment is noted as a limitation to this study. While outside the scope of this study, we recommend implementing this process within a course where preexisting pre- and posttest data is well established to examine the effectiveness of a flipped classroom on knowledge factors.

Student performance, in addition to confidence, should also be considered. In this study, student overall course scores for the semester where the flipped curriculum was delivered were approximately 35 percent higher than in previous semesters, even though the point values and assignments for the course stayed the same. Additional research could help to determine the cause of the grade increase. It is

possible that the attention given in the setup of this class resulted in an improvement to the overall quality of instruction for all components over previous semesters. This improvement in instructional quality could have masked any differences between instructional approaches, as focusing on improving curriculum to meet the demands of research can often improve the overall quality of all instruction related to the study (Creswell 2017). We also recommend studying the effects of flipped curriculum embedded in a sequential degree plan, within multiple classes, as a way to examine the effectiveness of a flipped classroom when systematically implemented.

Research should be conducted to realize if purposeful planning is important to students and can help them to increase their engagement. The study did highlight the importance of integrating active learning with the flipped style class in order to increase both knowledge and confidence in a topic. The pairing of faculty members with content knowledge and pedagogical expertise was a success in this situation. Both faculty members noted ease in designing the class and the improvement in overall student engagement in the course from previous semesters. In practice, we recommend future collaborative efforts between instructors in higher education who are content-area specialists and those who have a background in instructional design and planning to overcome many of the challenges associated with designing a flipped course, or any course for that matter. By flipping the course together, students experienced the expertise of two faculty members, engaged more with the content topics, and had more opportunity to apply their newfound knowledge to real-world situations.

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Case Study

Consolidation in the Farm Credit System: The Case of AgCountry and United

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JEL Codes: Q13, Q14

Keywords: Agricultural finance, agricultural lending, consolidation, Farm Credit System, merger

Abstract

Agricultural lenders provide an important service in America's agricultural economy. In recent years, consolidation has occurred in many aspects of agriculture, including agricultural lending. This educational case study examines consolidation in the Farm Credit System (FCS), which is a system of cooperatively owned agricultural lending associations. The merger between AgCountry Farm Credit Services and United FCS illustrates some drivers of consolidation in the Farm Credit System and provides opportunities to consider the advantages and disadvantages of a merger. The perspectives of the associations' leaders, member-owners, and employees are explored, allowing students to offer tactical and strategic advice to these stakeholders. This case study is intended for undergraduate students taking courses in agricultural finance, agricultural lending, or cooperatives.

1 Introduction

In fall 2016, farmers across the upper Midwest were busy harvesting their crops and preparing for the next growing season. At the same time, leaders at AgCountry Farm Credit Services and United FCS were also reflecting on past efforts and planning for the future. Bob Bahl, the chief executive officer (CEO) of AgCountry, and Marc Knisely, the CEO of United, had identified and evaluated strategic opportunities throughout their careers in the Farm Credit System (FCS). Now they were considering another key question: whether AgCountry and United should become a single association. If a merger were to occur, the new association would conduct business with approximately 18,000 borrowers in 65 counties in eastern North Dakota, western Minnesota, and north central Wisconsin (Vinje 2017). A merger had the potential to alter the business relationships of thousands of borrowers and the work lives of hundreds of employees.

FCS associations make loans to farmers, ranchers, and other entities related to agriculture. In recent years, many FCS association mergers have occurred. For example, AgCountry expanded its lending territory through a 2008 merger with its neighbor to the north, Farm Credit Services of Grand Forks. Likewise, United was formed through a 2002 merger of Farm Credit Services of Minnesota Valley and Farm Credit Services of North Central Wisconsin. Both Bahl, who worked for Grand Forks and then AgCountry, and Knisely, who worked for Minnesota Valley and then United, learned valuable leadership lessons during these mergers. Yet other lessons were learned by AgCountry and United's borrowing customers—member-owners who elect their association directors. These customers experienced the benefits and challenges presented by FCS mergers.

Initial merger discussions within a working group of select directors from AgCountry and United highlighted the two associations' important similarities. Specifically, both associations were committed to paying patronage to member-owners, both embraced operating in a strong agricultural region, both maintained strong balance sheets and credit quality, and both supported offering a wide range of services to member-owners. Given their experiences with previous mergers, stakeholders from AgCountry and

United understood that the advantages of merging would be weighed against several disadvantages of merging. Skillful guidance was needed as AgCountry and United searched for the best path forward.

2 Agricultural Lending in the United States

The agricultural lending industry serves farms, ranches, and other businesses related to agriculture. America's farms and ranches have more than \$400 billion of debt (U.S. Department of Agriculture 2020). Borrowed funds are critical because agricultural output is reduced in the absence of adequate credit (Briggeman, Towe, and Morehart 2009; Nadolnyak, Shen, and Hartarska 2017). Farms and ranches use operating loans for purchases of crop and livestock production inputs and term loans for purchases of assets such as machinery, equipment, and farmland. In addition to lending directly to farm and ranch operators, agricultural lenders make loans to agricultural cooperatives and a host of other agribusinesses.

Commercial banks, FCS associations, the Farm Service Agency, implement dealers, credit unions, and individuals all make loans to agricultural producers. These lenders are not always competitors because the agricultural lending market is somewhat segmented by borrowers' characteristics and needs (Dodson and Koenig 2004). Although there are many sources of agricultural credit, commercial banks and the Farm Credit System currently hold the vast majority of U.S. farm debt.

Commercial banks hold roughly 40 percent of U.S. farm debt (Figure 1). These institutions use customer deposits and other funds to make loans to many individuals and businesses, including those in agriculture. Commercial banks are familiar to the many Americans who use bank products or services on a daily basis. In 2019, Wells Fargo had a greater volume of agricultural loans than any other commercial bank (American Bankers Association 2019). Although Wells Fargo and several other major banks have retreated from this area in response to a weakening agricultural economy (Bunge and Maltais 2019), the loan portfolios of hundreds of small rural banks remain highly concentrated in agriculture.

The Farm Credit System commands an agricultural lending market share similar to that of commercial banks. The system is comprised of 68 associations that focus on lending to specific territories

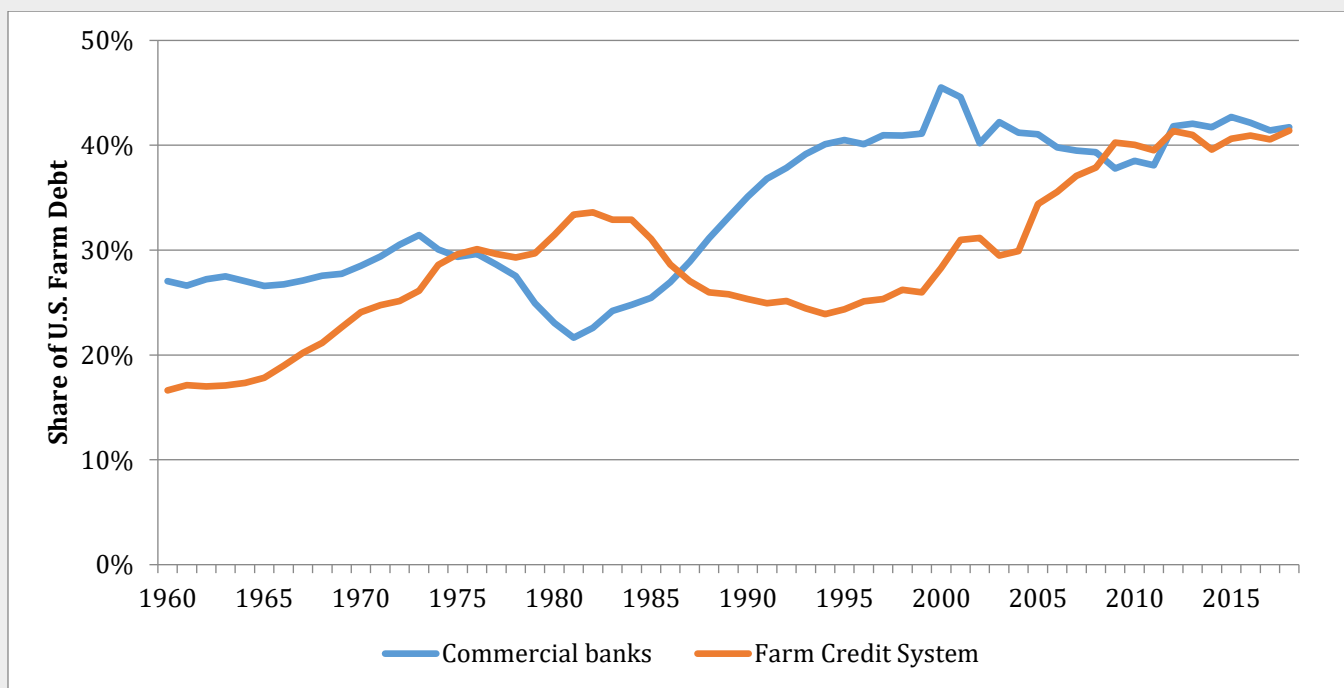


Figure 1. Share of U.S. farm debt held by commercial banks and the Farm Credit System

Source: United States Department of Agriculture, 2020.

within the United States (Farm Credit Administration 2020a). In addition to making loans, many associations offer other services, including crop insurance, farm record keeping, succession planning, and tax accounting. However, FCS associations do not accept deposits or offer many other traditional banking services offered by commercial banks. Associations acquire loanable funds by borrowing from their district bank, which is owned cooperatively by the associations it serves. The four district banks acquire funds from the Federal Farm Credit Banks Funding Corporation, which generates capital for the Farm Credit System by selling debt securities to investors. In total, the system has more than \$300 billion in assets and serves more than 500,000 borrowers (Farm Credit Administration 2019a).

Farmers, ranchers, agribusinesses, utility companies, and rural homebuyers are all eligible to borrow from the Farm Credit System. Table 1 shows that real estate loans to farmers and ranchers are a large portion of the system's combined loan portfolio. Historically, the system has made more real estate loans than commercial banks. Although it lags behind commercial banks in non-real estate lending, it makes many production loans and intermediate-term loans to farmers and ranchers. Loans to cooperatives, ethanol plants, and other agribusinesses are a growing part of the FCS loan portfolio.

3 History and Structure of the Farm Credit System

The Farm Credit System serves a unique and important purpose. In the early twentieth century, credit for agricultural real estate purchases was generally available in limited supply or at unreasonable terms (Farm Credit Administration 2019b). The Federal Farm Loan Act of 1916 addressed this problem by establishing a government-sponsored system of agricultural real estate lenders. The Farm Credit Act of 1933 added short-term and intermediate-term lenders to this system, which would become known as the Farm Credit System. The Farm Credit Administration was also created in 1933 to regulate FCS associations and banks. The Farm Credit System eventually included hundreds of federal land bank associations (FLBAs) and production credit associations (PCAs) that operated in distinct geographic territories. All told, the FCS has long been a "reliable source of credit to finance agriculture and rural America" (Farm Credit 2019a).

FCS associations have always been owned cooperatively by their borrowers. Cooperatives are defined by several principles related to the users of the business' goods or services. In the case of FCS associations, the users of the business are its borrowing member-owners. One principle of cooperatives is user ownership, which means that associations are owned by their member-owners. In order to borrow from an association, member-owners are required to own association stock equal to the lesser of \$1,000 or 2 percent of their loan amount. This ownership gives member-owners a claim on the association's profits, which are redistributed to member-owners through patronage dividends that are paid in proportion to a member-owner's loan size.

Another principle of cooperatives is user control, which means that an association's stockholders elect a board of directors to govern each association. Each stockholder is entitled to one vote, regardless

Table 1. Gross loans outstanding for the Farm Credit System (in millions of dollars), 2014–2018

Loan type	2014	2015	2016	2017	2018
Long-term real estate	100,811	107,813	114,446	119,450	124,876
Production and intermediate-term	46,305	49,204	50,282	51,724	53,447
Agribusiness	32,935	36,595	39,628	42,210	46,113
Rural utility	21,568	25,798	27,440	27,965	29,160
Rural home	6,754	7,117	7,148	7,261	7,308
Other	8,681	9,363	9,824	10,167	11,040
Total	217,054	235,890	248,768	258,777	271,944

Source: Farm Credit Administration (2019a).

of that stockholder's volume of business with the association. The board of directors hires a CEO and supports that person in developing organizational strategy. Compared with investor-owned firms, many of which have a narrow focus on creating returns for stockholders, cooperatives are more likely to craft strategy around other goals of their member-owners (Boland, Hogeland, and McKee 2009). In fact, many cooperatives were designed specifically to satisfy unique needs in an industry or geographic region.

A final principle of cooperatives is user benefit, which means that users should benefit from an association's services and benefit financially from the redistribution of profits. Although associations are for-profit businesses that retain some earnings to fund business operations, other association earnings may be shared with member-owners through patronage dividends. Patronage dividends effectively lower the interest rate paid on loans.

4 Consolidation in Agricultural Lending

Consolidation is occurring across many industries. For example, large agricultural operations have become increasingly important to U.S. agriculture. Farm and ranch consolidation may be caused by technological advancements or more efficient labor use (MacDonald, Hoppe, and Newton 2018). Likewise, the number of agricultural cooperatives in the United States has declined markedly, causing the remaining cooperatives to do more business than before (U.S. Department of Agriculture Rural Development 2018). In addition, several major input supply companies have merged in recent years.

The financial industry is also characterized by consolidation. From 2003 to 2018, the number of U.S. commercial banks decreased by 41 percent (Federal Deposit Insurance Corporation n.d.). Over the same period, the number of U.S. banks with over one-quarter of their loan portfolio devoted to agriculture decreased by 24 percent. Commercial bank mergers have been spurred in part by relaxed regulations on activities such as interstate bank branching (Barry and Ellinger 2012).

Consolidation has happened throughout the Farm Credit System in recent decades. The Agricultural Credit Act of 1987 allowed FLBAs and PCAs in the same territory to merge into a single agricultural credit association (ACA). In addition to this consolidation across association types, considerable geographic consolidation has transpired within the Farm Credit System. Although 1,000-plus associations existed as recently as the early 1970s, there have been fewer than 100 associations for the past 15 years (Farm Credit Administration 2019b). Consequently, the typical association has changed from a relatively small organization that served just a few counties to a much larger and more sophisticated organization.

Mergers have also occurred among FCS banks. There are now just four district banks: AgFirst, AgriBank, CoBank, and Farm Credit Bank of Texas. CoBank is an agricultural credit bank (ACB) with authority to fund associations in its district as well as to make loans to cooperatives and other specified entities. The three other district banks are FCBs.

5 Drivers of Consolidation

Consolidation often occurs when one or more of the merging organizations is at a crossroads. Recent or anticipated changes in leadership may influence consolidation. According to Featherstone (2017, 80), "generational transitions provide an impetus for consolidation, whether it be in production agriculture, agribusinesses, or lending." Because mergers are inherently a time of transition, they may be used to initiate operational or cultural change efforts. These efforts can help organizations that wish to build on recent successes as well as those looking to reverse poor performance.

In a variety of industries, increasing returns to scale and economies of scale are among the most common reasons for consolidation. Many banks exhibit increasing returns to scale because outputs such as revenue and profits increase more rapidly than inputs such as assets when expansion occurs (Wheelock and Wilson 2018). Similarly, large FCS associations tend to operate more efficiently than smaller associations (Dang, Leatham, McCarl, and Wu 2014). As financial institutions grow in size, they

may become more efficient in their spending on corporate overhead, information technology, and data processing (Kovner, Vickery, and Zhou 2014). Mergers may also allow for cost reductions stemming from the elimination of some duplicate positions or business locations (Kowalik, Davig, Morris, and Regehr 2015).

Consolidation may diversify an organization's business activities. Financial institutions are interested in diversifying both their loan portfolios and their other business activities in order to make their profits resilient to downturns in particular geographic areas, industries, or business lines. Diversification achieved through a merger is most successful when the merging institutions' income streams are uncorrelated or negatively correlated.

6 Challenges of Consolidation

Despite the possible advantages of organizational changes sparked by consolidation, there are several obstacles to creating change. Even well-intended change efforts frequently fall short of expectations (Kotter 1995). The efforts may be particularly difficult if the acquired organization's employees are resistant to the acquiring organization's culture (Nahavandi and Malekzadeh 1988). Leaders with strong communication and change management skills can navigate employees' sensitivities to change and cultivate positive employee attitudes regarding new cultural or operational emphases (Kavanagh and Ashkanasy 2006). Furthermore, because change typically occurs through a long process, leaders can increase the likelihood of success by clearly identifying the benefits of the change and by instilling receptive attitudes among the next generation of stakeholders in their organization (Kotter 1995).

New leadership may be unsettling to some employees or customers who appreciated an organization's previous direction. Furthermore, when a merger occurs, leaders' responsiveness to individual concerns may be reduced due to the demands of representing an enlarged constituency. Representation is a key issue in the Farm Credit System because member-owners cooperatively own each association. Freshwater (1997, 225) notes that, eventually, "the incremental benefits of larger scale may be more than offset by losses in loyalty and shared values." Maintaining a shared strategic vision is particularly important in cooperatives with heterogeneous membership (Boland, Hogeland, and McKee 2009).

Although eliminating staff or business locations after a merger may reduce costs, customer loyalty can be damaged if customers are forced to interact with unfamiliar staff or to travel to inconvenient locations after a merger. Indeed, loan volume is negatively associated with the distance between borrowers and agricultural lenders (Witte, DeVuyst, Whitacre, and Jones 2015). Efforts to counteract these challenges and retain customers may create new or unforeseen costs.

Finally, diversified income streams are desirable from a risk management perspective, but expanding geographically or across business lines may expose shortcomings in a firm's existing knowledge, services, or products. The acquiring institution must understand the risks of the new areas in which it is becoming involved (Kowalik, Davig, Morris, and Regehr 2015). To maintain or gain expertise in a wide variety of areas, an organization may need to make investments that mitigate cost savings realized elsewhere in a merger.

7 Comparison of AgCountry and United

AgCountry and United were neighboring associations located in the AgriBank district. In 2016, AgCountry had more than 12,000 customers and 400 employees, roughly doubling United in these categories. AgCountry had 27 offices and United had 12 offices. Table 2 shows that AgCountry's balance sheet was more than three times the size of United's balance sheet.

Due to their different lending territories, which are illustrated in Figure 2 and Figure 3, the associations had lending activities concentrated in different upper Midwest states. These varied geographies meant that AgCountry's member-owners and United's member-owners were influenced by different conditions. Associations have a limited authority to originate or purchase loans from outside of

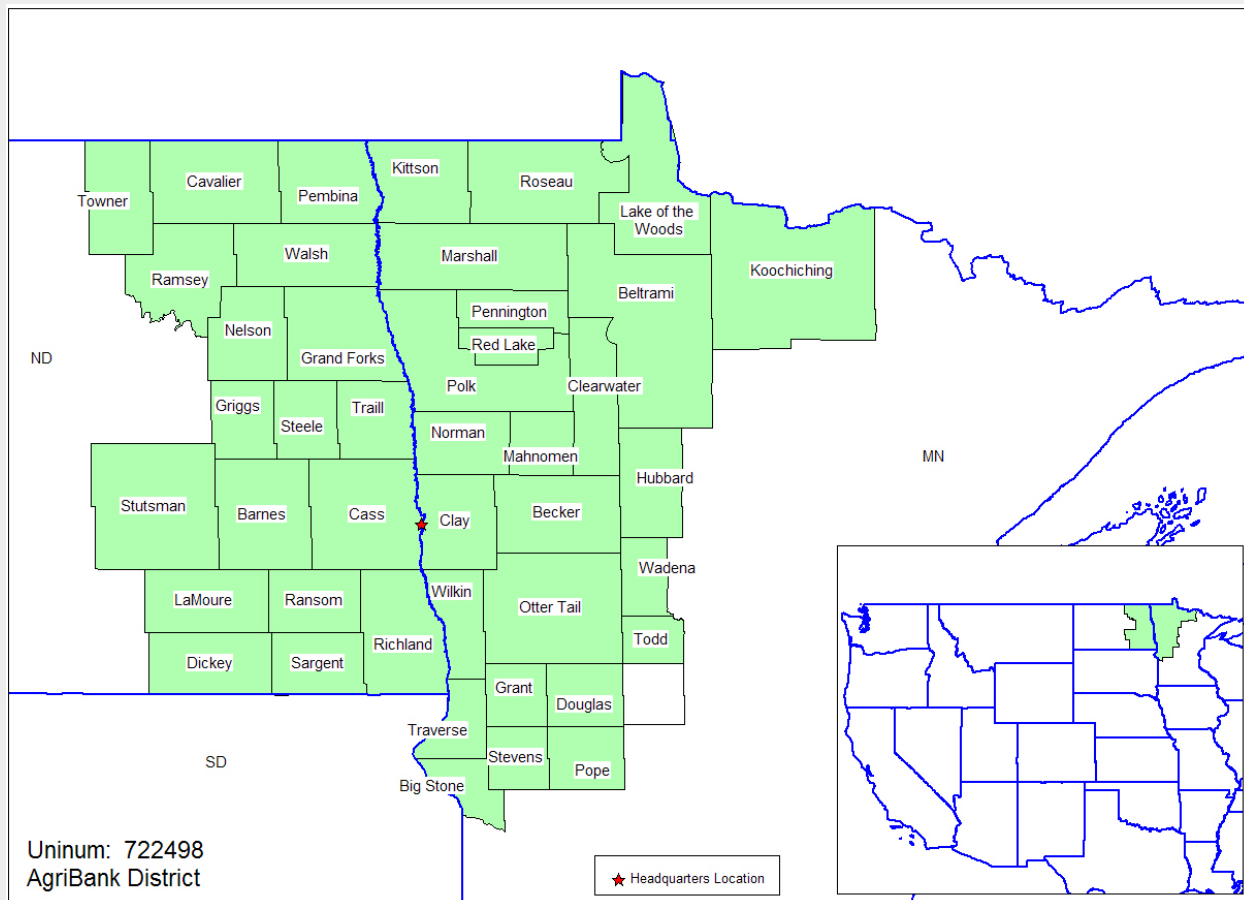
Table 2. Financial summary for AgCountry and United (in thousands of dollars), 2016

	Total assets	Total equity	Net interest income	Return on assets	Return on equity
AgCountry	\$5,462,470	\$1,168,716	\$131,193	2.00%	9.40%
United	\$1,727,586	\$305,474	\$44,090	1.40%	8.10%

Sources: AgCountry Farm Credit Services (2017); United FCS (2017).

their territory, so both associations made roughly one-fourth of their loans to member-owners outside their lending territories.

As described in Table 3, AgCountry and United also had different loan concentrations. Although both AgCountry and United made many loans to fund cash grain operations producing corn, soybeans, and wheat, these loans were a larger part of AgCountry's loan portfolio than of United's loan portfolio. In contrast, United's presence in Wisconsin resulted in many loans to dairy farms. Both associations made loans for sugar beet production, which is a relatively uncommon enterprise in other areas of the United States. However, many of the smaller lending concentrations for AgCountry and United were very different; AgCountry was highly involved with the ethanol industry, whereas United was involved with unique crops such as cranberries.


Figure 2. Lending territory of AgCountry, 2016

Source: Farm Credit Administration (2020b).

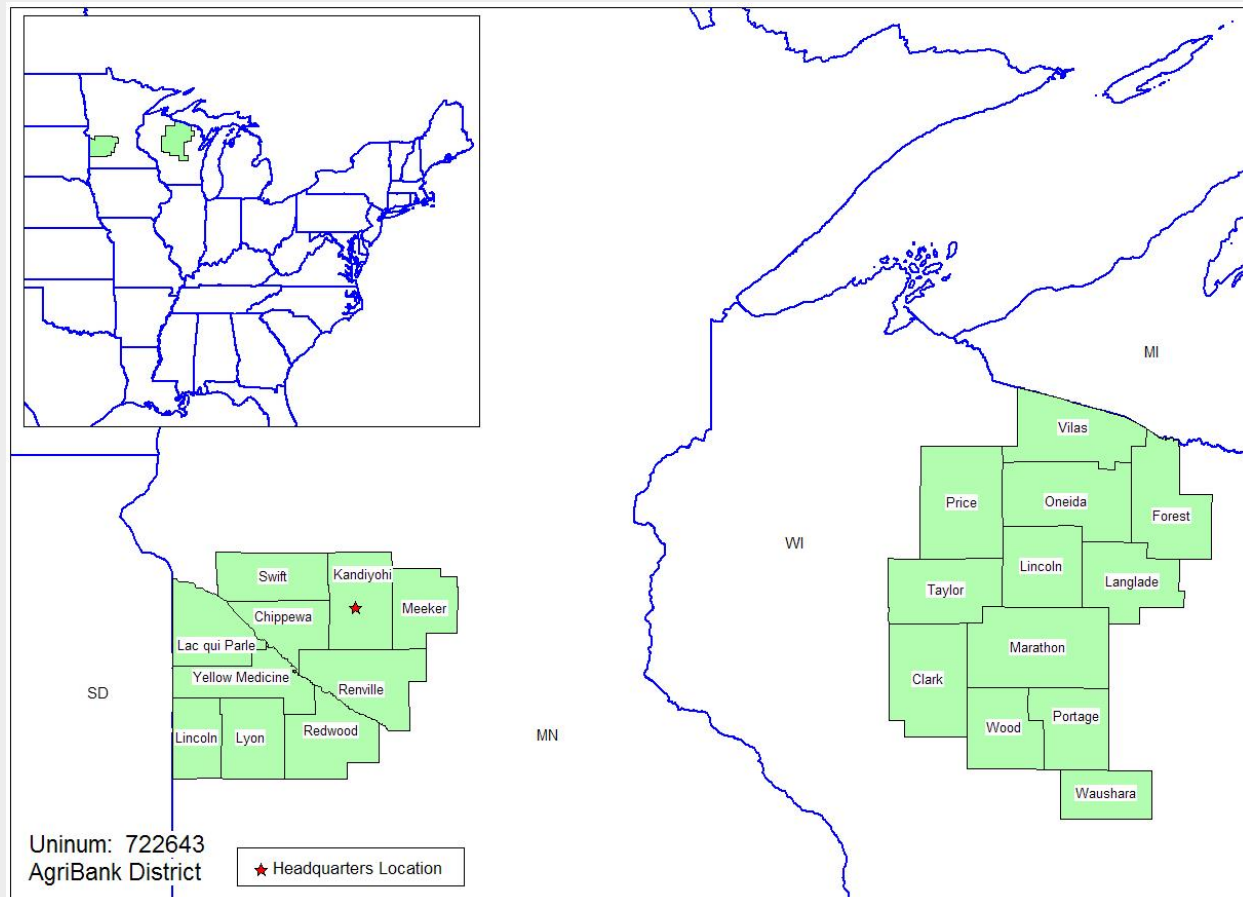


Figure 3. Lending territory of United, 2016

Source: Farm Credit Administration (2020b).

Table 3. Loan portfolio concentrations, 2016

	AgCountry	United
Cash grains	52.7%	36.5%
Sugar beets	11.5%	6.0%
Livestock	6.1%	5.7%
Ethanol	4.1%	0.3%
Dairy	3.9%	12.4%
Other	21.7%	39.1%

Sources: AgCountry Farm Credit Services (2017); United FCS (2017).

Note: Percentages are based on share of loan volume.

8 Details of the Merger

Several approvals would be required to merge AgCountry and United. First, the directors of both associations would need to vote to recommend a merger. Then, AgriBank and the Farm Credit Administration would both need to approve the proposed merger. The associations' member-owners would also need to vote on the proposal. Therefore, for a merger to occur, the concerns of many different stakeholders would be acknowledged and addressed by those crafting merger plans.

If the merger was approved, AgCountry would acquire United, making the new AgCountry the eighth-largest FCS association (Meersman 2017). The merged association would be headquartered at AgCountry's existing headquarters in Fargo, North Dakota. The initial merger plan recommended that all

existing business locations for both associations remain open after the targeted implementation date of July 1, 2017. Furthermore, association leaders believed that most of the associations' employees, particularly customer-facing employees, could be retained after the merger.

Future leadership was a key topic during merger talks. Because merging all of the existing directors from AgCountry and United would have created a large board, the associations planned to merge their existing 12-director boards into a new 18-director board. On the new board, nine of the elected directors would represent the former AgCountry territory, six of the elected directors would represent the former United territory, and three outside directors would be appointed. A CEO transition was also part of the proposed merger plan. Bahl would maintain his role as AgCountry CEO from the July 1, 2017, merger date until his planned retirement at the end of 2017. Knisely would then become CEO at the beginning of 2018.

9 Key Questions

On November 11, 2016, Bahl and Knisley were scheduled to attend a joint board meeting with the directors from AgCountry and United. At that meeting, the potential merger would be discussed, and the directors of both associations would vote on whether to recommend the merger. As the CEOs and directors prepared for the board meeting, they had many opportunities and challenges to consider. For the merger to be successful, the CEOs would need to offer sound guidance to the associations' directors as they solidified their strategic plan. Moreover, the CEOs and directors would need to balance the concerns of member-owners and employees from both associations as the merger process unfolded.

Although optimism pervaded many of the initial discussions surrounding the merger, important questions were sure to emerge as stakeholders seriously considered the merger for the first time. These questions would reflect different goals and concerns. The direction of the merger would be determined by leaders' answers to questions such as the following:

1. From an economic perspective and a strategic management perspective, what are the main motivations for approving and main reservations for opposing the merger?
2. What concerns may AgCountry member-owners have with the proposed merger?
3. What concerns may United member-owners have with the proposed merger? Are these concerns similar to or different than those of AgCountry member-owners?
4. How does the proposed plan manage the change created by a merger? Are there additional steps that may ease the transition to a merged organization?

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