Teaching and Educational Methods

Undergraduate Research in the Andes: Overcoming Barriers to Developing-Country Farm-Household Focused Analysis

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Abstract

This paper provides a qualitative description of a long-term engagement of undergraduate students in an immersive research experience in Ecuador. We describe and analyze factors related to operation under common challenges to field research in developing countries. We address issues of incentives and barriers to faculty and students interested in pursuing international undergraduate research. Our program has engaged students at Virginia Tech eight times since 2007, including a total of 50 U.S. undergraduates, and was designed to attract students of all socioeconomic strata. It begins with a Spring semester three-credit class on research methods, household survey administration, and data analysis and inference. During this time, partners in Ecuador are introduced through remote meetings and joint work on the survey. In mid-May, we fly to Quito, where students take language and culture lessons, finalize the survey, and gain exposure to the various institutions involved in the research. After two weeks, the group travels to the remote survey location, currently near Riobamba in Chimborazo Province. Four weeks of data collection paired with local students follow. Finally, data are analyzed, and a report is prepared and presented to an advisory group in the subsequent Fall semester.

The programmatic goals were to (1) provide undergraduates with a substantive research experience in a developing country; and (2) provide useful data for the project as to the attitudes of Ecuadorian farmers toward adoption of environmentally friendly agricultural practices. The program is built around several principles: (i) end-to-end student engagement from problem identification through presentation of findings to stakeholders; (ii) financial accessibility—all participation costs are covered; (iii) primary data collection from farm-households in the study area; (iv) full partnership with host-country researchers and students; and (v) supportive and complementary past and ongoing agronomic research in the study area. Lessons include challenges related to program structure; administration—the Institutional Review Board (IRB) clearance, travel approvals, and financial matters; technical challenges—questionnaire design, CAPI surveying, teaching, and programming data analysis; and field supervision, language, and cultural awareness. Linkages to high-quality ongoing agronomic research allow the socioeconomic research to focus on technology adoption and technology-relevant factors such as profitability, risk, and access to inputs. These themes are well-addressed through socioeconomic research.

1 Introduction

We designed an international research program to address three critical deficiencies related to the preparation of undergraduate students in social sciences for careers in agricultural sciences and graduate studies. First, undergraduate students in agricultural social sciences often lack meaningful research experience linked to an agricultural policy question of interest. Second, research experiences for undergraduates tend to be narrowly focused and do not engage future scientists in the full range of the research experience. Third, undergraduate students in agriculture often lack international

experience beyond short-term faculty-led travel abroad courses, limiting their abilities to build a deep understanding of another country's language, culture, and institutions (Bruening and Frick 2004; Heinert and Roberts 2016; Bletscher, Gould, and Qu 2022).

The international student research program developed builds on Virginia Tech faculty's research experience and strong partnership with Ecuadorian colleagues, and focuses on measuring obstacles to widespread diffusion of conservation agriculture (CA) practices. The programmatic goals were (1) to provide undergraduates with a substantive research experience in a developing country; and (2) to provide useful data for the project as to the attitudes of Ecuadorian farmers toward adoption of environmentally friendly agricultural practices. In the Spring semester, students enroll in a three-credit class on research methods in applied economics. The course covers the whole research process from literature review, research question formulation, the development of survey instruments, and data analysis. Students also interact with faculty and students in Ecuador to learn about CA principles and the language and culture of Ecuador.

Following the end of the Spring semester, students travel with faculty to Ecuador for six weeks. The first two weeks are spent in language/culture classes in the mornings, while visiting local institutions and piloting field methods in the afternoons. Virginia Tech students partner with Ecuadorian students and embark on four weeks of data collection, interviewing farm households. The program ends with a one-credit research class in the following Fall semester during which students work in groups to address their research questions using the data they collected. The final outputs are a written report and presentation of research findings to a faculty committee.

The objectives of this paper are to provide a qualitative description of the evolution of this undergraduate research program and the factors leading to its ease of operating under common challenges to field research in developing countries. The description is supported by a qualitative survey of former participants. We begin by presenting program background, the features that have made the opportunity enjoyable for students and faculty, and the features that have made it sustainable. We then move to the structure of the program and how that structure has been adjusted over time to strengthen its educational content. We discuss program barriers and opportunities and how barriers were overcome. We then provide perceptions of student participants.

2 Background

The first phase of the Ecuador undergraduate research program began in 2007 in response to strong student demand. Many undergraduate students in the Department of Agricultural and Applied Economics (AAEC), and elsewhere in the College of Agriculture and Life Sciences, had expressed interest in hands-on experience in international agricultural development. The department's faculty conducted international research, supported by external funding, that included graduate students, but provided few engagement opportunities for undergraduates. The faculty thought that it was important to make the research experience accessible to undergraduates.

To address this shortfall, AAEC faculty leaders created an undergraduate research program within a well-established research project. The Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program (SANREM CRSP) sub-project in Ecuador (and Bolivia) led by AAEC engaged a multidisciplinary team of U.S. researchers and host-country scientists from the Instituto Nacional de Investigaciones Agropecuarias (INIAP) in Ecuador. The project focused on agronomic and economic feasibility and adoption of CA in a small-scale, highly fragile, farming system in the Ecuadorean highlands. Extremely steep slopes, irregular rainfall, and the use of aggressive tillage led to important erosion-related soil loss, declining yields, and overall stress on the system (Barrera, Alwang, and Cruz 2010; Monar et al. 2013). The SANREM project examined agronomic factors including fine-tuning known CA practices; effects on input use; and impacts on yields, soil loss, and soil health. Researchers concluded that CA held significant promise (Barrera, Alwang and Cruz 2010a, 2010b). The

technical feasibility and agronomic attractiveness of CA stimulated interest in examining production costs, economic returns, and an eventual strategy to disseminate the results to potential beneficiaries.

The United States Agency for International Development (USAID)-funded Collaborative Research Support Programs (CRSPs, now named Innovation Labs) run by Virginia Tech had participation from graduate students who experienced a productive research environment in Ecuador. They found that local scientists were fully invested in ongoing research. In addition, safety, often a concern in developing countries, stability, and access to services made Ecuador a favorable environment for student fieldwork. The research itself offered several topics amenable to survey research, such as field experiments, on the cost effects associated with CA practices, willingness to adopt CA practices, and measurement of adoption and its impacts (Alwang et al. 2013; Monar et al. 2013; Barrera et al. 2020). Within this established research program, AAEC faculty created an end-to-end research experience for undergraduates. The experience consisted of design and testing of a survey questionnaire and enumeration of surveys to farm-households as the go-to data-generating experience. Data analysis and reporting completed the undergraduate research experience. The faculty thought that it was important to make the experience accessible to all students regardless of their financial resources or lack thereof. By tying the program to ongoing grant resources, financial barriers to participation were lowered. Spanish language proficiency was emphasized, and we strived to recruit at least some participants with strong language skills.

3 Program Description

3.1 Initial Undergraduate Engagement and the Evolution of the Program

The first groups of undergraduates to participate in this international research program were known as "SANREM Research Interns." The program was built into the SANREM CRSP project plan and held every other year. These groups (eight students in 2007, five in 2009, seven in 2011, and six in 2013) were exposed to a limited research experience, including Spring meetings, two weeks of language training in Quito, and four weeks of data collection in Bolivar Province. Later as described below, the program was expanded to produce a more complete research experience.

In the Spring semester, the first intern group (2007) participated in regular two-hour informal biweekly classes whose content mainly covered findings from the agronomic research, the cultural context, and some Spanish agricultural vocabulary. While at least minimum Spanish language proficiency was a pre-requisite for participation in the program, only a few students were proficient speakers. Students in 2009 and later would have stronger language proficiency. Students were split into two-person teams and asked to develop small-scale research projects that could reasonably be completed in four weeks.

This first attempt at an international research internship produced important observations, which led to changes in the way subsequent SANREM internships were organized. First, we discovered that the entire group should address a common set of objectives rather than encouraging small teams to investigate separate research themes. The program did not have sufficient capacity to supervise multiple teams, and our partners were overextended by requests for transportation to different research locations. For example, one two-person team in 2007 planned to visit health centers and local water utility offices to understand how poor water quality affected farm families, particularly children. Another team conducted research on costing CA practices by interviewing farmers about time spent in different on-farm activities. INIAP researchers specialize in agriculture and were neither prepared nor excited about supervising data collection in the water and health sectors.

Second, we recognized that a large part of the research experience is to bridge the gap between the data and the potential to make inferences about the larger population. We decided to increase rigor and ensure data collected were of sufficient quality and quantity to support statistical analysis. This

decision made it necessary to cover additional topics during the 2009 and subsequent Spring semesters. Added topics included hypothesis testing, sample size (and randomization), and its relationship to statistical representativeness, and questionnaire design. We also introduced programming statistical software for data analysis. While many of the interns had coursework on statistics, they had never employed the techniques in a research context. These additions led to more instructional time as the course credits were increased from one to three hours.

Third, we observed the importance of physical fitness and team building. The Andean highlands are a particularly challenging environment due to high elevations, 2,800–3,800 masl (meters above sea level); walking from household to household during survey enumeration was physically challenging and led to student burnout. We subsequently introduced an exercise regime during the first two weeks of language training in Quito and spent more time during evenings interacting with student groups to understand and help deal with the challenges they faced. Teamwork is also fostered by increased interactions during subsequent Spring semesters with INIAP colleagues.

The four groups of SANREM Research Interns (2007 to 2013) conducted their fieldwork in Bolivar Province and stayed in the town of Guaranda (see Figure 1). They traveled up the mountain into indigenous communities and down the mountain into mestizo communities to interview farmers about the technical and economic potential of CA (Barrera et al. 2016; Barrera et al. 2020). Guaranda was an excellent location for the students because the town was small enough to be safe and large enough to have restaurants and adequate medical care. When SANREM ended in 2014, INIAP research on CA moved to Chimborazo Province in areas around the small city of Riobamba.

3.2 Current Program

Following completion of the SANREM project, AAEC faculty decided to focus on an enhanced opportunity by providing an end-to-end research experience. The idea was to build on the lessons learned from the past Ecuador research internships, and with external funding from the United States Department of Agriculture (USDA) Research Experience for Undergraduates (REEU) program, five years of engagement began in 2019. Lessons learned through the SANREM phase included the need for additional training in research methods, programming for data collection, analyzing survey data, and preparing reports, as well as an understanding of research and the research context.

Structurally, the new program consists of a three-credit course taught during Spring semester, six weeks in Ecuador (two weeks in Quito and four weeks of data collection in Chimborazo Province, current home of ongoing CA research) and a single-credit Fall course on data analysis and reporting (Figure 2). Faculty and students from the Escuela Politecnica de Chimborazo (ESPOCH) participate during the Spring. These students are then teamed with Virginia Tech students during field interviews in June. ESPOCH students use the experience to complete an undergraduate thesis necessary for the degree in Agronomic Engineering and partnering benefits U.S. students through enhanced exposure to Spanish and local context, and by facilitating enumeration.

The Spring class covers research methods and research administration issues, and formally engages partners in Ecuador. The course syllabus conveys expectations for students as well as the content and intensity of the field research. Lectures and exercises in research methods include problem identification and a literature review, an overview of quantitative and qualitative methods, hypotheses and the role of falsification, and questionnaire design and its link to the concepts related to the hypotheses. We require written output at different stages, and the content of the lectures is specifically tailored to the program at hand. Students appreciate the exposure of a “total” research project, and one anonymous participant stated: “Getting experience working through ‘all the steps’ of a large research project helped me to better understand the research process, and this understanding made the concept of research much less overwhelming.”

Figure 1: Map of Ecuador with Study Locations.

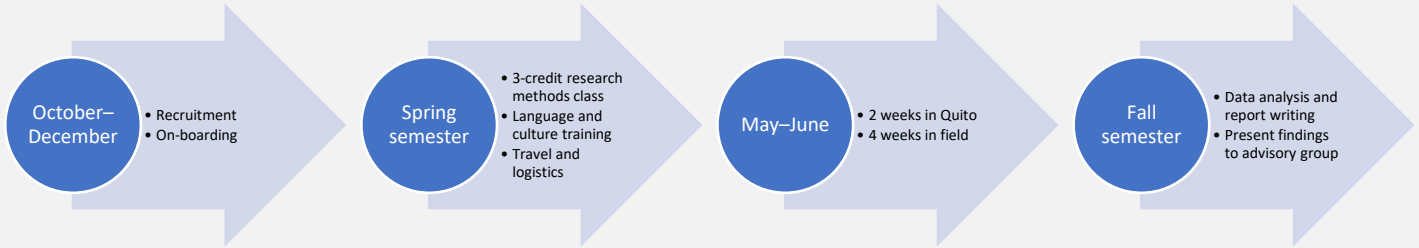

Figure 2: Timeline for Ecuador Undergraduate Research Internship Class.

Prior to 2019, our household surveying had been done using paper questionnaires. This led to heavy burdens on students to input the data into a digital format, a time-intensive activity for which few rewards were received. We decided to switch to a computer-assisted person interview (CAPI) process, whereby questionnaires are entered into a tablet-based format, and software is used to program the survey. Training in CSPro (www.census.gov/data/software/cspro.html), the software used for tablet-based enumeration, was introduced in the Spring semester course. This training helps students think about the links between concepts, the questionnaire, and the structure of the data they will later use for their research analysis. Students are introduced to basic survey fundamentals, such as using matrix formats for themed groupings with scales, skip patterns, and the appropriate use of open-ended questions. The CAPI process introduces an entirely new field experience. Instead of keeping paper copies dry and ensuring that the handwriting was legible, data are immediately available, and the main concern is to keep the tablets dry and well-charged. Modifications to a CAPI-based survey can be made in real time, and there is no need for printing multiple questionnaires.

Students design the questionnaire in partnership with INIAP scientists and ESPOCH students. These interactions help our students to strengthen their Spanish skills and better understand how to communicate the concepts. They are challenged to justify the inclusion of questions and to explain the wording and the information generated from each of the questions. The Ecuadorean students tend to have expertise in bio-physical sciences, but limited knowledge of social sciences, and not all are knowledgeable about farming practices in the communities where the surveying takes place. As CSPro programming is taught, students are forced to consider the ultimate utility of specific questions, the flow of the interview, and how to translate their research concepts into the Andean context. Issues such as what constitutes a household and who might be considered the household head lead to deeper consideration of the cultural context. Interactions with Ecuadorean students and researchers facilitate this process. One participant commented: “It was fun and interesting to work with and learn from the Ecuadorian extension agents and students involved in the project.”

During the Spring semester, the students are also exposed to sampling considerations, research ethics, and best practices for interviewing farm families. Sampling is a key consideration, as the sample and its properties determine the relationship between the household data set and the research questions. A few hours are spent on statistical representativeness and inference, followed by coverage of how sampling affects this relationship. Issues such as optimal sample size and the role of clustering are also covered. The timing is important because we rely on the Ecuadorian partners to generate the random sample. This process, including obtaining village populations, and gathering names and contact information of potential respondents, requires time. We also introduced ethical and administrative considerations such as obtaining approval for human subject research (Institutional Review Board (IRB) clearance), privacy, and how privacy considerations are related to use of software, and regulations related to safety such as the Clery Act.

The first two weeks in Ecuador are used for morning language and cultural training at a Spanish school in Quito, while afternoons are used for visits to INIAP and other research partners, further refinement of the survey instrument, and a physical exercise regime. Rigorous training in CSPro is essential as survey piloting in communities around Quito provides information requiring revisions to the questionnaire. ESPOCH students participate in questionnaire revisions and work with the U.S. students to improve the logic, structure, and flow of the questionnaire.

After two weeks in Quito, our INIAP partners transfer the students to the research site, currently in the communities outside of Riobamba. The first couple of days in Chimborazo are spent meeting the ESPOCH administration, introducing the research idea to the communities, and further refining the questionnaire with local partners. Virginia Tech students are paired with ESPOCH students. Supervision in the field is provided by INIAP, local agricultural extension agents, and Virginia Tech Faculty (Alwang, Bosch, Chen, Larochelle, and Norton).

Two important considerations govern the field research: cost and faculty time. First, cost of surveying in developing countries largely depends on the capacity of vehicles used to transport enumerators to target villages. In our case, paired teams with a single (INIAP or other) field supervisor means that three teams can be transported in a single vehicle; since we are constrained to two vehicles, the optimal number of Virginia Tech students is six—three per vehicle when paired with an ESPOCH student. While in other environments a small bus or minivan might change this calculus, given the roads in our study area, four-wheel drive vehicles are necessary.

The second consideration is faculty time. To manage the burden on individual faculty, we team teach during the Spring semester, and a single faculty member accompanies the student group for two weeks in Ecuador—we rotate participation, so that over the whole of the six-week in-country research, three different faculty members supervise for two weeks each. Our experience tells us that Spanish proficiency is important, and on one occasion when a faculty member was not fluent in Spanish, we engaged a Spanish-speaking graduate student as a research associate.

Following four weeks of surveying, the undergraduate team presents basic descriptive statistics to the communities where the surveying occurred. This exercise is important because it is a way to give back to the communities. The presentations also facilitate ongoing interactions between INIAP and local actors whose participation is needed to continue the agronomic research. The exercise also teaches our students about the value of collaboration and provides some structure to discussions of data analysis. The benefits of CAPI surveying also become obvious as the data are immediately available in a digital format. Since the students programmed the CAPI survey, they are already familiar with the data structure, making it easier to provide descriptive analysis for these presentations. Before we used CAPI (during the SANREM portion), we had students digitizing data and error checking at nights. CAPI eliminated this very burdensome requirement and allowed students to focus on analysis themes for the community presentations as well as subsequent write-ups of the research results.

During the following Fall semester, more rigorous analysis is conducted. Students are exposed to data cleaning and quality control, the value of structured data sets, and hands-on programming for statistical analysis. At the end of the semester, we convene an academic and professional advisory board to review the work and provide suggestions for students and the program. Participant feedback has been an important source of information about successes and failures of the experience. Research themes as well as a brief description of data collection are shown in Table 1.

3.3 Impacts of COVID-Related Travel Restrictions on the Program

In early 2020, the growing COVID-19 pandemic required suspension of the field research. At the time, meetings with our Ecuador partners and students and faculty from ESPOCH were attenuated. While INIAP personnel still worked remotely, the university was closed, and students were not reachable.

Considering our options for Summer 2021, we decided to continue with the program with some modifications. There was no question of the possibility of getting information from the research communities because exposure to the pathogen could have had extremely dire effects on the relatively isolated population. To provide students with the full research experience, the Spring 2021 course included (i) a semester-long project using student interviews to measure the influence of COVID-19 on student educational experience at Virginia Tech, and (ii) an introduction to agricultural conservation practices in the Chimborazo region in Ecuador. The interview project focused on research methods, from formulating a research question to data collection and presentation of findings. The summer involved a six-week paid research internship on data analytics using the Ecuador data set collected by the 2019 cohort. Early in the day, faculty delivered instructional material and went over tasks for the day. Faculty remained available throughout the day to address questions. We concluded the day with students giving an overview of the progress made and challenges faced. The internship started with data cleaning and formulation of research questions. We then focused on more elaborate statistical modeling, data visualization, and steps in preparing a written report.

Table 1: Undergraduate Research Internship: Participants, Research Topics, Survey Descriptions, and Analytical Techniques.

Year	Students Females	Males	Research topic (Location)	Survey description	Analysis
2007	8	1	Effects of water quality on child health, knowledge of causes of erosion, and dairy production costs (Bolivar)	Water and health: 60 household responses; dairy study: 50 respondents interviewed. All data were transcribed from paper.	Descriptive statistics, some multivariate analysis
2009	4	1	Baseline survey (Bolivar): family and farm characteristics, cropping patterns, labor use, and income	Multi-purpose farm-household survey 286 observations with responses recorded on paper.	Descriptive statistics, farm typology creation, gender-specific analysis
2011	4	3	Costs of conventional farming and conservation agriculture (Bolivar)	Paper survey of 88 farm-households interviewed in two watersheds. Input prices collected in market centers.	Descriptive statistics on costs of production and net revenues
2013	6	1	Determinants of adoption of conservation agriculture practices (Bolivar)	Short survey and discrete choice exercise among 233 farmers.	Descriptive statistics on farmer concerns about CA and the value of soil conservation
2019	5	2	Baseline survey (Chimborazo): family and farm characteristics, cropping patterns, labor use, and income	CAPI survey of 392 farm households. Household conditions, farming practices, and attitudes about CA.	Descriptive statistics, multivariate analysis of access to credit, and determinants of CA adoption
2020			Determinants of adoption of CA; attitudes toward environmental damage	*Used data generated in 2019 (Chimborazo).*	Multivariate discrete choice models
2021	4	1	Special project: impressions of COVID-19 impacts on undergraduate learning	*75 telephone surveys of undergraduate students. Short, 10-minute interview.*	Descriptive statistics evaluating alternative learning experiences under COVID-19
2022	4	2	Follow-up survey (Chimborazo): intention to adopt CA, actual adoption	190 surveys completed; data collection suspended due to uprisings in the area.	Multivariate statistical models linking farmer and farm attributes and intention to adopt CA

During 2022, we reinstated the complete in-country program for Virginia Tech students. No problems with COVID-19 were experienced.

4 Barriers and Opportunities

Much of what we learned about running the program is due to the durability of the program over eight research cycles. This durability facilitates learning by doing and the quality of the research experience as it has improved substantially over time. A core group of faculty advisors was maintained throughout the eight cycles, and we put a heavy emphasis on debriefing the students after the program to address problems. The durability owes to faculty success in obtaining external funds to support the program as well as positive feedback from early student participants that helped motivate efforts to continue and improve the program. For further information on the coursework, please see the syllabus in Appendix A.

4.1 Cost

An important barrier for many students is cost. Obtaining a rigorous international field research experience with professional supervision by national experts and U.S. academics would be prohibitively expensive—approximately $3,500 per student. Our project resources paid the bulk of the costs, but in years where funding was limited, students have been encouraged to seek and have received internal funding from Virginia Tech sources, including the AAEC department, the College of Agriculture and Life Sciences, and the University Honors program. The involvement of INIAP in joint research projects has also allowed us to lower costs—project personnel are paid and vehicles are made available through the research funding. This funding, in turn, provides the motivation for the questions addressed by undergraduate research. INIAP has also negotiated favorable rates for accommodations and lunches for the students. To keep costs low, Virginia Tech faculty donate their time; no project funding has been used to pay faculty salaries. As a result, the out-of-pocket cost for each undergraduate participant over the life of the program has been close to zero, except for the tuition paid for the three-credit Spring semester course and one-credit Fall semester course.

4.2 Recruitment

We advertise the program through undergraduate advisors and student listservs. We emphasize the uniqueness of the program and that students formally receive credits for courses taken in the Spring and Fall semesters. We highlight differences between our international research internship program and typical study abroad experiences by stressing its rigor and immersive elements. A six-week immersion in undergraduate research in the Ecuador highlands is both physically and mentally challenging. Early in the program, we learned it is important to select students who are willing to (1) endure full days of rigorous physical and mental exertion, (2) prepare for and adapt to expected minor health issues, (3) work closely with others in a group setting over several weeks, and (4) adjust to nuances of working in another culture with patience. We receive many applications and screen applicants based on coursework, Spanish ability, motivation as demonstrated by a statement of interest, and letters from referees. We generally short-list about ten candidates and conduct short interviews to make final decisions. During the interviews, we stress the physical and mental difficulty of the program and try to gauge Spanish-speaking ability. We seek a gender-balanced group of about six students. Description of participants by gender and year is shown in Table 1.

4.3 Consistent Research Themes

The importance of the research topics cannot be overstated. Our program is unique in that it builds on ongoing biophysical research in the area. Student interns are introduced early in training to the CA practices and the motivation for examining costs, constraints, and mechanisms for diffusion. We learned that, since CA requires a fundamental rethinking of the role of crop residues and tillage operations, farmers are reluctant to adopt without clear evidence of its advantages (Barrera et al. 2016; Delgado et al. 2021). Students learn that public agricultural extension is limited in Ecuador so that information on incentives and barriers to adoption and successful low-cost tools for extension are of critical interest to policymakers. The evolving focus on tools for dissemination helps clarify the practical value of our research. This value motivates participants; they too want answers to these questions.

Continuity in research reinforces the idea that research is an incremental process, and the best researchers build on the shoulders of their predecessors. While we introduce the importance of the literature review, we expose students to the findings of earlier intern groups and challenge them to push the findings further.

4.4 Research Skills and Language/Cultural Training

Since our early efforts, we have modified procedures to enhance student preparation. While learning-by-

doing is a major theme of the program, we found that students lacked practical training in research methods covering the gamut from problem formulation to results reporting. The Spring semester class was necessary to provide a sufficiently broad view of the research enterprise. Introduction of programming and data analysis creates a bridge between quantitative coursework and its practical application. Fieldwork in developing countries requires special skills, and the semester-long course enabled technical, language, and cultural training to provide these skills. We have increased the degree of interaction with our Ecuadorean partners during the Spring semester preparation phase in order to emphasize context-related vocabulary and build cultural awareness. When available, we have incorporated Spanish-speaking graduate students into the Spring class; their own experiences tend to resonate with the interns. The COVID-19 pandemic had an interesting impact on this skill training. COVID-19 made remote meetings more widely acceptable and accessible, enabling students to have more exposure to language and culture via joint meetings with INIAP and ESPOCH students.

4.5 Administrative Burden

Since program inception in 2007, much has changed in terms of university and other requirements for socioeconomic and overseas research. These include student/participant safety, human subject protection in interviewing, and privacy considerations related to data collection and management.

Safety regulations, including adherence to the Clery Act, have not directly affected student participants, but indirect effects have emerged. We adhere to all relevant university and governmental regulations in this regard. Virginia Tech now requires careful consideration of safety (including reports of crimes in relevant areas) prior to approval, and any safety-related issue encountered in the country needs to be reported. These requirements have led us to request information from our partners. The indirect effect on students has come via sensitization to safety concerns. For example, a student reported an issue of harassment during the program. We discussed the issue and why it was a problem with our INIAP partners who have changed their decision-making to mitigate such concerns.

The human subjects review has had a direct impact on how our instruction is structured. We initially sought to minimize the IRB approval process by keeping it in the background; faculty handled the IRB review without engaging students. Over time, we decided to include students in the process for two reasons. First, all research participants are now required to undergo IRB training through an online course, so it became natural to include the subject during coursework. Second, and more fundamentally, as faculty, we decided that research ethics constituted an important consideration in socioeconomics research. In the Ecuador context, subtle questions emerged about who to interview in the households, what types of questions might be sensitive, and how to protect the agency of the respondents. For example, a basic principle of survey research ethics is that the response has to be voluntary. Survey respondents need to give informed consent, researchers should avoid coercion, and the process should respect the people and their autonomy. These considerations now form an important part of our instruction on research ethics, and preparation of a consent script is an important learning opportunity.

Software approval has recently become more burdensome at Virginia Tech for several reasons. One of these is that software users need to be aware of the importance of privacy. When we conduct survey research, we need to communicate that in addition to being voluntary, information from an interview will be anonymous. Approvals for software use require an assurance that individual-specific information will be protected. We use the software approval process to generate discussions about the importance of anonymity and dangers that might result from failure to protect participant privacy. These actions have converted administrative dicta from barriers into opportunities for learning, and we believe that these considerations are an important part of an ethical research process.

4.6 Cultural Considerations and Competencies

The first two weeks in Quito are especially important. Quito provides a gentle introduction to the developing country research experience. The language school does an excellent job at a reasonable cost to the project. In addition to individualized instruction (tailored to student needs), the school provides initial exposure to Ecuadorean culture and history. Afternoons and evenings in Quito provide an opportunity for revisions to the survey and programming in CSPro. More generally, two weeks in a new environment where the food and rhythm of life are different (at an elevation of 2,850 masl) provide a solid introduction to the challenges yet to come. This immersive experience has long-term impacts. One participant said: "My experience in Ecuador motivated me to continue studying Spanish which has opened doors to me personally, professionally, and in my community. Farmers' generosity in responding to my broken Spanish was humbling and motivated me to continue studying the language…the ability to communicate in Spanish has allowed me to engage with farmworkers advocating for workplace safety in my professional role, adult English-language learners as a volunteer English teacher…"

Differences in culture between the United States and Ecuador can be difficult to adequately convey to the U.S. students before the trip. For example, fieldwork can start rather slowly each day, and time needs to be taken for pleasantries with our INIAP colleagues. Time also needs to be taken to introduce enumerators to interviewees. Students are often anxious to get on with the survey and can become frustrated with the pace, but usually adjust after a few days of experience and discussions with faculty leaders. As one participant noted: "The pace at which we did our work was much different from what I'm used to. We spent a lot of time waiting without using that time productively. It was not necessarily a problem, but an adjustment for sure."

Learning to work collaboratively with Ecuadorian students can also take time. Faculty leaders try to facilitate the process by carefully matching U.S. and Ecuadorian students based on their personalities, Spanish skills, and agricultural backgrounds, so each student pair has complementary skills. Joint sports activities usually spontaneously occur, which also helps with acculturation. Exchange of simple gifts is a useful means of showing appreciation by the Virginia Tech students. Most of the student groups enjoyed a joint U.S.-Ecuadorian karaoke night as well. A participant noted: "The opportunity to work one-on-one with students in Riobamba as well as shoring up Spanish in Quito was extremely enriching in understanding what life looked like in another part of the world. When you work with someone for hours each day, you're going to exchange many ideas, nuances, sayings, jokes, stories, and traditions. From walking through the rural highlands to sitting around a fire at night, we learned an incredible amount from the students and faculty we worked with (including the Virginia Tech faculty!)."

4.7 Keeping the Program Fun for Students Despite Its Intensive Pace

We also learned how to structure daily and weekly activities so students could sustain their physical and mental energy, while remaining focused both on the objectives of the research and on enjoying their international experience. For example, we learned that the optimal time to leave the hotel for the field each day is 8:00 a.m. and to leave the field to return to the hotel is 3:00 p.m. so the students are back to the hotel in time for downloading data from tablets, discussing issues arising during the day, and calling friends and family before dinner. The students eat together as a group, and they select as a group where to dine when eating outside the hotel.

With help from our Ecuadorian partners and considering student desires, we select special weekend activities to give the students a flavor of Ecuador beyond their work and routine interactions with the Ecuadorian scientists and students. For example, most groups have climbed the Chimborazo volcano, visited the falls and baths of Baños, and toured local markets. We schedule one day of rest per week when students are free to do what they please alone or together. They shop, sightsee, play sports, sleep, and so forth.

4.8 Preparing for Health Challenges and Other Risks

Any group of students living and working in Ecuador for six weeks will encounter gastro-intestinal and other health problems. Students and faculty follow medical advice on shots before leaving the United States and bring medicines for expected routine health issues while abroad. Faculty leaders obtain information on medical facilities near the hotel in Ecuador and communicate with local partners and hotel staff to obtain advice when special problems arise. It is almost certain that the faculty leader will need to assist one or more students with a health issue during the six-week program in Ecuador. Usually, it is a foodborne illness, often striking late at night. Once it was a gallbladder problem that required surgery. It is most difficult if the faculty leader is the one who is ill, but we have been fortunate over the years not to have a debilitating problem arise for the leader. If that had occurred, the backup plan was to rely on our Ecuadorian partners for assistance.

Health problems are the most common type of risk, but student behavior that requires correction, culture shock for a student, street crime, and political protests are others. In 2022, four and a half weeks into our in-country program, a nationwide protest occurred. Roads were blockaded by protesters forcing gas stations, stores, and restaurants to close and most transportation to shut down. Our survey ground to a halt, and options were assessed with the help of our Ecuadorian partners, project faculty in Blacksburg, and the Global Education Office at Virginia Tech.

We could continue to shelter in place, but food sources were dwindling. We could not drive to Quito to catch our flights back to the United States because of the roadblocks and lack of fuel for ground transport. Domestic flights were stopped. Although the international terminal was open in Quito, the challenge was to get there. Our Ecuadorian colleagues felt that even though the strike was unlikely to last more than another week or two, the situation could worsen.

We decided to charter a small plane to take the seven of us from Riobamba to Quito. Our risk insurance taken out for the trip covered the cost. We held a closing event with the ESPOCH students and INIAP partners, and the next day they dropped us off at the tiny airstrip near our hotel in Riobamba. A man came out and unlocked the chain to the gate to let us in. When the small Beechcraft plane arrived from Quito, the pilot looked at the seven of us and our luggage and shook his head; there was both a space and weight issue. First, while the plane seated seven, only six of the seats were for passengers, so one of us needed to ride in the co-pilot seat. Second, we had too much luggage and needed to leave some of it behind. Another party had contracted for a later flight, so the pilot offered to bring us the extra bags. We boarded, took off, and landed forty minutes later in Quito. We all made our flights home without a hitch. It is hard to plan for everything, so insurance is your friend for research-abroad programs as we discovered on that trip and the previous one when it paid for gallbladder surgery.

4.9 Value of Local Partnerships

An ongoing close partnership with host-country researchers ensured that socioeconomic research topics were consistent with ongoing agronomic research (technology validation and outreach). Through this consistency, our research interns saw the utility of their work. Their study findings have provided important information for the design of an outreach strategy for INIAP. Partners' motivation was strengthened by the allocation of external funding to short- and long-term training, resources for field technicians, and enhancing visibility of the program within Ecuador. Throughout the international undergraduate research program, the projects supported short-term training to build capacity for soil health and productivity analysis. Through the early linkage to the CRSP, project funding also supported degree training for INIAP partners. Mutual benefits from engagement in the projects led to strong support from the INIAP administration.

The undergraduate research program introduced or institutionalized standard socioeconomic research tools into INIAP. In particular, the use of CAPI for household surveys is now the norm. Evidence of the power of this form of data gathering came from their observations of the ease with which the

questionnaire is programmed into CSPro, the time savings in the interview process as electronic skip patterns are followed, time and cost savings from streamlining the data entry process, and data security as data are loaded onto secure online portals within a few hours of survey enumeration.

5 Research Participant Reflections

A brief anonymous survey administered to past participants provides insights into how the program met its goals to train undergraduate students with skills the agricultural sector needs and prepare them for graduate studies. The survey included six open-ended questions, and respondents were asked to select and respond to one or two questions that resonated the most with them. The questions are provided in Appendix B. Some of the comments are integrated (above) into the text, but additional reflections are useful.

> *"It allowed me to expand on and use critical-thinking skills, learn how to problem solve, and encouraged me to not only ask questions but really think about how to ask those questions."*

> "*I learned about survey creation, how to avoid false or skewed data, how to analyze data, and more*."

> "*Interest in pursuing graduate studies was stimulated."*

> "*This experience was the first real opportunity I had to work in a research environment, and it made me feel capable of navigating graduate studies*."

> "*The idea of one day organizing and going through the steps of my own research project became exciting and is a large reason why I did go to grad school. I don't think I would have had the same eager attitude towards research/grad school if I had not been involved in this project*."

While the focus was on research skills, participants indicated that the experience has also solidified interpersonal and soft skills, such as flexibility, humility, teamwork, collaboration, and leadership. Most participants valued the language and cultural immersion, which for some was possibly more impactful in their career trajectory than the research skills they gained.

> *"I had done some traveling before my trip to Ecuador, but never to developing countries. It truly opened my eyes as to both how different my upbringing was as compared to the people in the communities that we visited—the access to education and financial ease, but also how much we had in common—the importance of family and community and hard work. After graduation, I went on to law school and began working in international project finance where I spent most of my career to date working on renewable energy projects in Latin America. I'm now joining the General Counsel's office at the International Development Finance Corporation. I think my experience in this program really solidified my desire to help others and particularly in communities that were the most in need. I still have a picture of the mountains in Ecuador on my desk!*"

6 Conclusion

This paper provides a qualitative description of the evolution of an undergraduate research program in international agricultural development. It identifies factors enabling operation of similar programs under common challenges to field research in developing countries. Fifty undergraduate students have been engaged in an immersive research experience in Ecuador. It begins with a Spring semester three-credit class on research methods, survey administration, and data analysis and inference. Ecuadorian

partners are introduced through remote meetings and joint work on the survey. Students travel to Quito, where they take language and culture lessons, finalize the survey, and gain exposure to the various institutions involved in the research. After two weeks, the group travels to the remote survey location, currently near Riobamba in Chimborazo Province. Four weeks of data collection paired with local students follow. Finally, data are analyzed, and a report is prepared and presented to an advisory group in the subsequent Fall semester.

The program is built around several principles: (i) end-to-end student engagement from problem identification through presentation of findings to stakeholders; (ii) financial accessibility—all participation costs are covered; (iii) primary data collection from farm-households in the study area; (iv) full partnership with host-country researchers and students; and (v) supportive and complementary to past and ongoing agronomic research in the study area.

The program has successfully overcome several challenges including the need for IRB clearance to protect the rights of survey respondents. Program funding ensures that the program is accessible to students from varying socioeconomic backgrounds. Valuable survey information is obtained by questionnaire design and surveying conducted by students supported by faculty and staff from Virginia Tech and our Ecuadorian partners. Students receive language and cultural awareness training to support their survey activities. Linkages to high-quality ongoing agronomic research allow the socioeconomic research to focus on technology adoption and technology-relevant factors such as profitability, risk, and access to inputs.

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Appendix A: Example Syllabus

Agricultural and Applied Economics 4984
Methods and Planning for Ecuador Research Internship
Syllabus and Course Description
Spring 2020

Instructors: Jeffrey Alwang, 215I Hutcheson Hall, Tel: 231 6517, Email: alwangj@vt.edu
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Office hours: Students are welcome to stop by at any time or make an appointment by emailing one of us.
Class time/location: Wednesday 4–6 p.m., 302 Hutcheson

I. Course Description

This course is intended as preparation for a 6-week research internship in Ecuador during May–June 2020. Topics include: (i) Overview of the sustainable agriculture research in the Chimborazo region in Ecuador; (ii) history, culture, and geography of Ecuador and the Chimborazo region; (iii) research methods, including the scientific method, questionnaire preparation, sampling, and IRB approval; and (iv) Spanish practice with agricultural vocabulary (3H, 3C).

II. Learning Objectives

Students completing the course should be fully prepared to undertake the research internship with a clear idea of responsibilities and expectations.

a) Learn to conceptualize multidisciplinary research problems and design a research plan appropriate for a solution to the problem.
b) Convert the conceptual plan into reality by: (i) designing a questionnaire and data collection plan; (ii) creating a sampling plan to make the data representative of the desired population; and (iii) coding the questionnaire into tablet computers.
c) Understand how statistical analysis is used to link the household data to the research questions.
d) Learn about the culture and institutions in the internship project area.

III. Texts and Special Teaching Aids

Required textbook:

Doing Survey Research: A Guide to Quantitative Methods, 4th ed., by Peter M. Nardi (Note: The 3rd edition is good enough and much cheaper).

Additional readings:

Nyariki, Dickson M. 2009. "Household Data Collection for Socio-Economic Research in Agriculture: Approaches and Challenges in Developing Countries." *Journal of Social Sciences* 19(2):91–99.

Devereux, Stephen, and John Hoddinott. 1993. "The Context of Fieldwork. Chapter 1." In Stephen Devereux and John Hoddinott, ed. *Fieldwork in Developing Countries*. Boulder CO: Lynn Rienner Publications.

IV. Course Organization and Expectations for Students

The course will involve interactive discussions and presentations by faculty and students. It is expected that students complete reading assignments prior to the class in question. Readings will be assigned one period ahead. Homework assignments will be specific to each topic, but will include readings, preparation for class presentations, and preparation of a research plan, including questionnaires for data collection. Students are encouraged to complete their homework assignments in groups, unless otherwise specified.

This course is designed to prepare students to conduct research in Ecuador in the Summer of 2020. Students will be evaluated on their eligibility for the program based on their course grade, participation, and attendance in this course. To remain eligible, students are allowed to miss two classes, to remain in good academic standing (overall 3.0 GPA for the semester), and to attain a grade in this course of at least a C or above. A student's final eligibility will be determined following the midterm (3/18). Any student who fails to meet these criteria will not be eligible for the summer portion of the research internship.

V. Syllabus

Topics and readings:

1. **1/22: Introduction to the research project. *Instructors:* Norton (lead), White**
2. **1/29: Overview of prior year research. *Instructors:* Chen, Garber**
3. **2/5: Research methods. *Instructors:* Alwang, Chen**
   Readings: Chapters 1 and 2 in text.
4. **2/12: Research methods & questionnaire. *Instructors:* Chen, Alwang**
   Readings: Chapter 3 in text; Nyakari.

   2/19: Research methods & questionnaire design. *Instructors:* Larochelle, Norton
   Readings: Chapter 4 in text.
5. **2/26: Research methods – Questionnaire design cont'd. *Instructors:* Norton, Larochelle**
6. **3/4: Research methods – Questionnaire. *Instructors:* Chen, Larochelle**
7. **3/18: Research methods – IRB. *Instructors:* Larochelle, Alwang**
   Mid-term exam
   Readings: Chapter 5 in text; Review paper by Nyakari.

8. **3/25: Research methods – Sampling and statistical representativeness. *Instructors:* Norton, Chen**
9. **4/1: Research methods – Data analysis. *Instructors:* Alwang, Garber**
10. **4/8: Research methods – Data analysis. *Instructors:* Chen, Alwang, Garber**
11. **4/15: Finalize data analysis plan – Methods for data analysis. *Instructors:* Larochelle, Norton**
    Readings: Chapters 6–8 in text
12. **4/22: Finalize details of research internship plan. *Instructors:* White, Norton**
13. **4/29: Finalize details of research internship plan. *Instructors:* White, Alwang**
14. **5/6: Finalize travel plans. *Instructors:* Shelton, White**
    Reading: Devereux and Hoddinott.

VI. Evaluation Procedure

Mid-term exam (3/18):	30%
Class participation:	40%
Graded homework assignments:	30%
Total:	100%

VII. Disability Statement

Reasonable accommodations are available for students who have a disability. Students should contact the Services for Students with Disabilities (SSD): http://www.ssd.vt.edu/registering/students_disabilities/students_disabilities.html.

To be eligible for services, students with disabilities are responsible for self-identification.

VIII. Honor Code

The Undergraduate Honor Code pledge that each member of the university community agrees to abide by states:

"As a Hokie, I will conduct myself with honor and integrity at all times. I will not lie, cheat, or steal, nor will I accept the actions of those who do."

Students enrolled in this course are responsible for abiding by the Honor Code. A student who has doubts about how the Honor Code applies to any assignment is responsible for obtaining specific guidance from the course instructor before submitting the assignment for evaluation. Ignorance of the rules does not exclude any member of the University community from the requirements and expectations of the Honor Code. For additional information about the Honor Code, please visit: https://www.honorsystem.vt.edu/

Appendix B: Undergraduate Research Program in Ecuador – Survey of Participant Perceptions

Please consider the six questions below. Select and respond to one or two questions that resonate the most with you.

Survey Questions

Q1. How did your undergraduate research experience in Ecuador influence your decision to attend graduate school?

Q2. How did your experience in Ecuador stimulate your interest in doing international development work?

Q3. In what ways did your research experience in Ecuador strengthen your research skills?

Q4. In what ways did your experience in Ecuador shape your perspective on working in another culture?

Q5. What did you most gain from your experience in Ecuador?

Q6. What changes to the program would have improved your experience?

References

Alwang, J.G., W. Norton, V.H. Barrera, and R. Botello. 2013. "Conservation Agriculture in the Andean Highlands: Promise and Precautions." In S. Mann, ed. *The Future of Mountain Agriculture*. Berlin: Springer-Verlag.

Barrera, V.H., J. Alwang, and E. Cruz. 2010a. "Análisis de la viabilidad socio-económica y ambiental del sistema de producción papa-leche en la microcuenca del río Illangama-Ecuador." *Archivos Latinoamericanos de Producción Animal* 18(1–2):57–67.

Barrera, V.H., J. Alwang, and E. Cruz. 2010b. *Experiencias de manejo integrado de recursos naturales en la subcuenca del río Chimbo, Ecuador*. Quito: Editorial ABYA-YALA.

Barrera, V.H., M. Barrowclough, J.M. Dominguez, J.A. Delgado, R. Stehouwer, R. Gallagher, and J. Alwang. 2016. "Conservation Agriculture on Steeps Slopes in the Andes: Promise and Obstacles." *Journal of Soil and Water Conservation* 71(2):91–102.

Barrera, V.H., J. Delgado, J. Alwang, L. Escudero, J. Arévalo, and Y. Cartagena. 2020. "*Prácticas de agricultura de conservación que promueven la productividad y sostenibilidad del sistema de producción papa-pastos en la microcuenca del río Illangama, Ecuador.*" Boletín Divulgativo No. 448. Quito, Ecuador: Editorial ARCOIRIS Producción Gráfica.

Bletscher, C., M. Gould, and S. Qu. 2022. "The Exploration of Undergraduate Attitudes and Knowledge about International Agricultural Issues and U.S. Agricultural Policy." *Journal of International Agricultural and Extension Education* 29(2):7–23.

Bruening, T.H., and M. Frick. 2004. "Globalizing the U.S. Undergraduate Experience: A Case Study of the Benefits of an International Agriculture Field-Based Course." *Journal of International Agricultural and Extension Education* 11(1):89–96.

Delgado, J.A., V.H. Barrera Mosquera, J.R. Alwang, A. Villacis-Aveiga, Y.E. Cartagena Ayala, D. Neer, C. Monar, and L.O. Escudero Lopez. 2021. "Potential Use of Cover Crops for Soil and Water Conservation, Nutrient Management, and Climate Change Adaptation Across the Tropics." *Advances in Agronomy* 165:175–247.

Heinert, S.B., and T.G. Roberts. 2016. "Globalizing the Undergraduate Experience in Agricultural Leadership, Education, Extension, and Communication." *Journal of Agricultural Education* 57(1):42–55.

Monar, C., A.K. Saavedra, L. Escudero, J.A. Delgado, J. Alwang, V.H. Barrera, and R. Botello. 2013. "Positive Impacts in Soil and Water Conservation in an Andean Region of South America: Case Scenarios from a USAID Multidisciplinary Cooperative Project." *Journal of Soil and Water Conservation* 68(1):25A–30A.

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