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Introduction and Table of Contents

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Introduction and Table of Contents

Abstract

The *Journal of International Agricultural and Extension Education* is the official refereed publication of the Association for International Agricultural and Extension Education (AIAEE). Its purpose is to enhance the research and knowledge base of agricultural and extension education from an international perspective.

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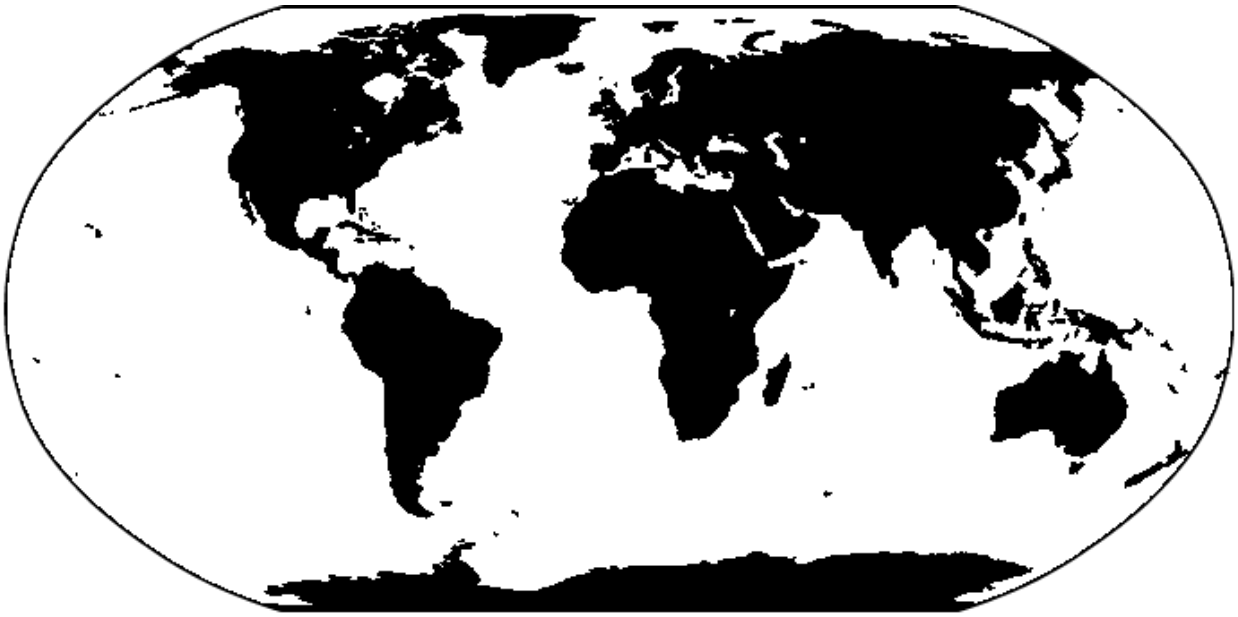

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The *Journal of International Agricultural and Extension Education* (*JIAEE*) is the official refereed publication of the Association for International Agricultural and Extension Education (AIAEE). The purpose of the *JIAEE* is to enhance the research and knowledge base of agricultural and extension education from an international perspective. Acceptance rates for the past 3 volumes are: Volume 18 = 14%, Volume 19 = 20%; Volume 20 = 21%.

Articles intended for publication should focus on international agricultural education and/or international extension education. Articles should relate to current or emerging issues, cite appropriate literature, and develop implications for international agricultural and extension education. **Manuscripts, or portions of manuscripts, must not have been published or be under consideration for publication by another journal**. Three types of articles are solicited for the *JIAEE*: Feature Articles, Tools of the Profession Articles, and Book Reviews.

Feature Articles

Feature articles focus on philosophy, current or emerging issues, and the methodology and practical application of specific research and appropriate technologies, which have implications for developed and developing countries. For publication in the *JIAEE*, feature articles must pass the ***JIAEE's* double blind, referee process**, where peer reviewers evaluate manuscript content and ensure readability. Reviewers are selected from the AIAEE membership. In the double blind, referee process, all references to authors are removed before the manuscript is sent to reviewers. Feature articles may be submitted for peer review a total of three times before they are no longer acceptable for publication in the *JIAEE*. Failure to meet the submission formatting guidelines will result in an automatic first rejection.

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Commentary articles state an opinion, offer a challenge, or present a thought-provoking idea on an issue of concern to international agricultural and extension education, including a published article in the *JIAEE*. These articles are invited by the editors. Tools of the Profession articles report specific techniques, materials, books and technologies that can be useful for agricultural and extension educators in a global context and/or in a country/region. Book Reviews provide insight on current books related to international agricultural education.

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From the Executive Editor

Over the past several months, the Editorial Leadership of *JIAEE* has been working hard to transition the journal from the steady leadership of Dr. Brenda Seevers, past Executive Editor, to a new team of leaders. I will serve as your Executive Editor for the next two years, and am grateful to have the talents of Dr. Robert Strong working with me as our new Managing Editor. Robert and I deeply appreciate the positive stewardship of the journal exhibited by Dr. Seevers during her time as Execuitve Editor.

Transitions in leadership provide a natural opportunity to stop and reflect on what, why, and how we conduct the business of the journal. I encourage you to provide feedback to either me or Robert that will help us make sure the journal meets your needs. You can e-mail us or attend the *JIAEE* meeting at our upcoming conference in Miami. Some of the things we will be considering are the structure and function of our Editorial Board, establishing a Review Board, and providing a credit card payment option for library subscriptions and page fees. We will continue to discuss the issue of open access, a conversation we began at the Editors' Change-over Training in December. Our goal as editors is to provide you with a premier journal that you seek to publish in and find value in reading.

Four feature articles are included in the first issue of Volume 21. The authors examine innovations in extension services in Uganda and Tanzania, reflections on an international fellows program, and Belgium and American college students' awareness, use, and perceptions of biodiesel. A common theme runs through the diverse topics, and that is a theme of international collaboration. All four articles are the direct result of international collaborations. I am strongly encouraged by this trend and I urge each of you to seek opportunities to collaborate with your international colleagues to advance the scholarship of international agricultural and extension education. The annual AIAEE conference, from April 27 – May 1 in Miami, FL, is a great time to connect with future collaborators; I hope to see you there!

Sincerely,

Amy Harder
Executive Editor, *JIAEE*

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Addressing the Challenges of Extension and Advisory Services in Uganda: The Grameen Foundation's Community Knowledge Worker Program

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Abstract

Diffusion of agricultural knowledge is vital to food security and capacity building in the developing world. Many developing world farmers still do not have access to extension and advisory services (EAS), and poor agricultural practices still exist. Diffusion of agricultural knowledge could lead to improved productivity, higher obtained prices, and increased incomes, but it is made more difficult in the developing world by poor infrastructure, high illiteracy rates, and too few extension agents. The rapid spread of mobile phones throughout the developing world has sparked many EAS programs that incorporate mobile technologies. Although they offer great potential for knowledge diffusion, research has not yet identified strong positive impacts of mobile technology-based interventions. The Grameen Foundation's Community Knowledge Worker (CKW) program provides model farmers in Ugandan communities with training and smartphones that are linked to a database with actionable agricultural information. The model farmers (CKWs) interact with their neighbors to share the information in the database. This relatively inexpensive program differs from other EAS initiatives by using a large number of lightly trained "extension agents" and mobile technology that provides those agents with easy-to-access information they share with and help interpret for the farmers in their communities. The program also incorporates ongoing data collection via the smartphones, allowing for a two-way exchange of information and enabling constant monitoring. Two recent studies have shown this program to have positive impacts. An ongoing randomized control trial promises to offer a comprehensive impact assessment.

Keywords: agricultural extension and advisory services, international development, Uganda, information and communication technology (ICT), knowledge diffusion

Introduction

The important role of agricultural extension and advisory services in building capacity among farmers in the developing world is widely known. Throughout Uganda, like in many places, access to and diffusion of agricultural knowledge is critical to improving food security, reducing poverty, and developing sustainable agriculture. Uganda is a country of almost 35 million people, and about 19.3 million (56% of the population) are members of farming households (Uganda Bureau of Statistics, 2011). As a landlocked country, Uganda produces almost all of its own food, and most of its agricultural production is for domestic use (Gollin & Rogerson, 2010). Rural households in Uganda are very poor with a poverty rate (34.2%) almost triple that of urban households (Uganda Bureau of Statistics, 2006).

Most of Uganda's agricultural production occurs on smallholder plots (Uganda Bureau of Statistics, 2003) on which the majority of farmers implement traditional practices that provide low yields. According to a survey by the Uganda Bureau of Statistics (2007), only 1% of agricultural plots used chemical fertilizers, and 6.3% were planted with improved seeds. According to a USAID report on Uganda's rural economy (2008), agronomic best practices such as mulching, proper plant spacing, weeding, and pruning are not widely used in Uganda, and intercropping for higher yields is not properly understood. The report concludes that the "inability to manage pests and disease, together with poor post-harvest handling, often result in substantial crop losses" (USAID, 2008, p. 12). Better diffusion of agricultural knowledge would likely lead to improved yields thereby improving food security and reducing poverty.

As with many developing countries, agricultural extension and advisory services (EAS) in Uganda have traditionally not reached a large portion of the farming population. Poor transportation infrastructure makes travel to remote villages difficult for extension agents, and many government EAS agencies face organizational challenges that limit their reach. Since 2001, Uganda's agricultural extension and advisory services have been implemented by the National Agricultural Advisory Services (NAADS). Unfortunately, NAADS has faced many difficulties including mismanagement of public funds, embezzlement, and policy uncertainty (Naluwairo, 2011). As a result, there is a very high ratio of farmers-to-extension worker in Uganda (Ministry of Agriculture, Animal Industry and Fisheries, 2009). According to the 2008 National Service Delivery Survey, for example, only 14% of all farming households had interacted with an extension worker in the 12 months preceding the survey (Uganda Bureau of Statistics, 2008).

In addition to the poor coverage of extension agents, the diffusion of knowledge among Ugandan farmers is hampered by a high rate of illiteracy that makes the dissemination of written material a less effective option for EAS. The illiteracy rate among Ugandan farmers has been reported to be as low as 31% (Uganda Census of Agriculture, 2011) and as high as greater than 50% (Naluwairo, 2011). Due to the challenges presented by the high illiteracy rate, and without the resources for a large network of field-based extension agents, EAS providers in Uganda and many other countries have looked to information and communications technologies (ICTs) to help facilitate the diffusion of agricultural knowledge. Although ICTs include hardware and software associated with personal computers, fixed-line telephones, televisions, VCR/DVD players, digital cameras, etc., in areas of high poverty and poor infrastructure, the use of ICTs in agricultural knowledge diffusion has typically been limited to radio and, more recently, mobile phones.

For many years, agricultural information has been disseminated via rural radio initiatives, and some studies have shown support for radio's ability to

communicate effectively some agricultural information (e.g., Nazari & Hazbullah, 2010; Svensson & Yanagizawa, 2009). However, radio has several limitations including poor signals, lack of reach to certain areas, one way communication, lack of electricity and financial means needed to consistently operate a radio, and inappropriate programming due to poor communication between farmers, advisors, and researchers (Nakabugu, 2001). Uganda has long used radio broadcasts to disseminate agricultural information (e.g., Radio Uganda); yet, poor agricultural practices persist.

Previous Use of Mobile Phones in Extension

In recent years, much attention in the agricultural EAS field has focused on the potential of mobile phones. Few technologies have experienced as rapid and pervasive adoption as mobile phones, and because mobile communication infrastructure does not require a large and expensive network of fixed wires, the developing world has driven much of this growth (Word Bank, 2012). Although the use of mobile phones has great potential in agricultural EAS and many such programs have been implemented throughout the developing world, impact studies of these mobile phone EAS programs have generally only shown either small impacts or no impact at all.

In a quasi-experimental study on the impact of mobile phones on grain prices in Niger, Aker (2008) found some support that mobile phones increased price dispersion in markets that are more remote and have lower road quality. Fafchamps and Minten (2012) conducted a randomized control trial in 100 Indian villages of an agricultural market and weather service that used mobile phones. Although the researchers found some evidence in the treatment groups of improved practices in a few areas, such as spatial arbitrage and crop grading, the effect sizes in these were small. More importantly, no statistically significant changes were observed in areas targeted by the program such as price received by farmers, crop value added, crop losses resulting from rainstorms, and the likelihood of changing crop varieties and cultivation practices.

In another quasi-experimental study, Muto and Yamano (2009) found that in Ugandan regions that had recently experienced expansion in mobile phone coverage, there was an increase in the sales of banana, but not maize. The researchers in this study concluded that mobile phones seem to increase market participation of farmers in remote areas who grow perishable crops. In another study, Futch and MacIntosh (2009) found no effect of price information on average producer price in a randomized experiment in Rwanda. Other studies that have been unable to identify a positive impact or change in behavior as a result of mobile phone interventions include Camacho and Connover (2010), Cole and Hunt (2010), and Mitra, Mookherjee, Torero, and Visaria (2012). Although the literature on mobile phone-based agricultural programs has yet to show strong impact, many EAS providers recognize that the educational use of mobile phones is in its infancy and offers significant potential for inexpensive knowledge diffusion (Aker, 2010; Jensen, 2007), especially with the advent of smartphones, which dramatically enhance the communication capabilities of mobile phones.

Purpose

A review of the programs evaluated in the studies mentioned above reveals three possible reasons for the weak impact of agricultural EAS programs that use mobile technology. First, most mobile phone interventions rely on one-way, top down communication, which has been identified as a weakness of radio-based EAS programs. Second, many of the EAS programs that use mobile phones include text messages, which are appropriate only for literate farmers. Third, EAS programs

that use mobile phones attempt to reach directly the farmer or someone in the farmer's household, rather than reaching someone who can help the farmer interpret the information from the mobile phone. An agricultural EAS program that addresses these three potential weaknesses might more effectively incorporate mobile phones into agricultural knowledge diffusion. The purpose of this article is to describe the Community Knowledge Worker program, an agricultural EAS program in Uganda that uses a unique extension model to address many of the challenges and weaknesses of other EAS programs, including issues of illiteracy; limited resources for government EAS provision; poor communication between farmers, advisors, and researchers; and lack of hands-on assistance and interpretation of agricultural information sent via ICTs.

Community Knowledge Worker Program

The Grameen Foundation was created in 1997 with the mission "to enable the poor, especially the poorest, to create a world without poverty," relying on the microfinance philosophy of the Grameen Bank (Grameen Foundation, n.d., para. 5). Recently, the foundation created an innovative agricultural extension program in Uganda to help disseminate much needed agricultural information to the most impoverished farmers. Traditional agricultural extension uses a relatively small number of highly trained extension agents who try to reach a large number of farmers. The Grameen Foundation's Community Knowledge Worker (CKW) program reverses the traditional extension model by using a large number of lightly trained, but respected, local farmers (CKWs) to access up-to-date and actionable agricultural information via a smartphone. These CKWs then act as liaisons between their community members and the agricultural information in the database. The database includes: agricultural best practices, weather forecasts, market information and prices, an input supplier directory, and detailed farming information on a wide variety of crops and animals.

Although the use of smartphones is essential to the CKW program, it is secondary to the CKWs themselves, who use the phones to search for needed agricultural information in the database and interpret the information for their neighbors. This immediate access to information allows for the recruitment of less educated "extension agents," and because CKWs are vested members of the communities they serve, they often take an active role in diagnosing their neighbors' farming challenges and encouraging the adoption of recommended farming practices.

Most EAS programs that have used mobile phones to disseminate agricultural information rely on farmers having access to a mobile phone. While the penetration of mobile phones in rural areas is high, it is not complete. Moreover, farmers receiving agricultural information directly may not accurately understand what is being communicated. The Grameen program addresses both of these problems, as only the CKW needs to have access to the smartphone, and they can provide their neighbors with hands-on interpretation of the information accessed from the database.

The use of community members allows the program to reach the most-rural "last kilometer" villages and allows for important agricultural information to reach a larger number of farmers at a relatively low cost. Moreover, the operational costs of the program stay relatively constant even in the most remote villages (Paavo-Krepp, 2012). Another advantage of the CKW program over other mobile phone EAS programs is a two-way exchange of information between farmers and development organizations. The CKW smartphones include software for collecting data from farmers. When the CKWs register a new farmer, they collect basic information, including the size of their plots, their top crops and animals, their primary EAS topics of interest, and poverty indicators. This information facilitates

monitoring of the program. Moreover, when CKWs encounter local remedies (e.g., to common plant diseases), they can submit this information to Grameen. After a vetting process by agricultural researchers, this local knowledge is added to the CKW database for wider distribution. CKWs also act as survey enumerators, collecting information on agricultural conditions for other development organizations that seek to understand emerging agricultural problems in order to inform their own programming. For example, CKWs surveyed farmers in one region to track the spread of baby chicken blight (see Fig. 1). The ability for CKWs to collect information is also the key to the program's sustainability; Grameen uses the revenues from this service to defray the operational costs of the CKW program.

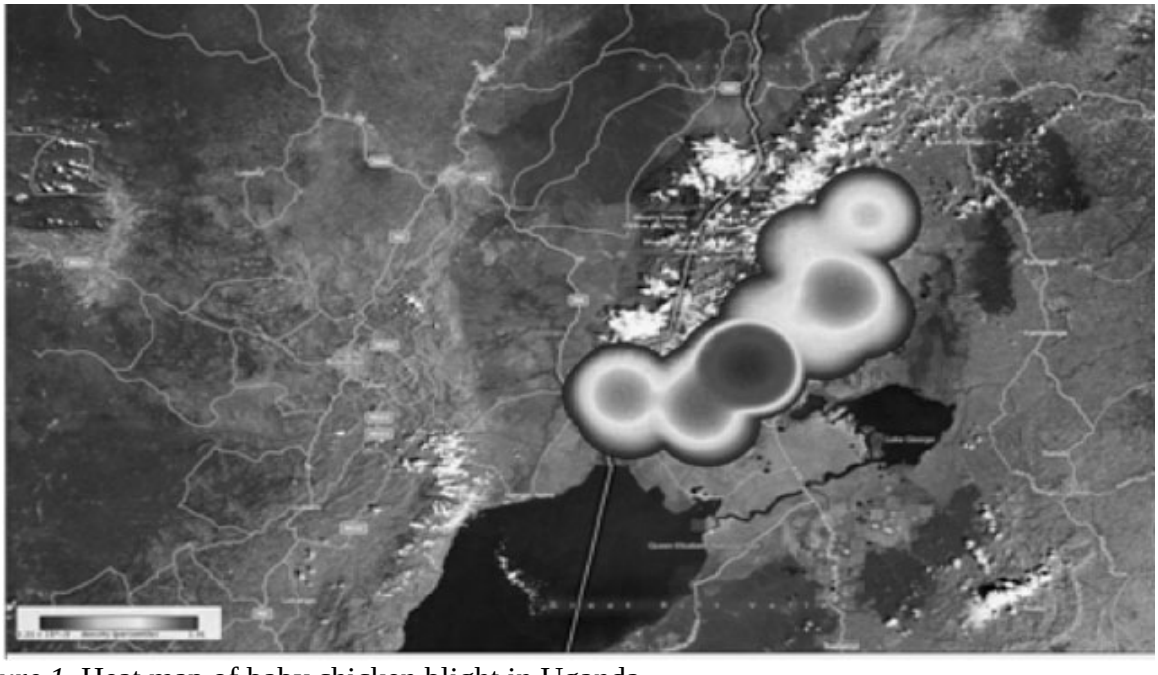

Figure 1. Heat map of baby chicken blight in Uganda.

Program Partners

The Grameen CKW program depends on partner organizations in a number of different areas. To help fund the initial development and test the concept of the CKW program, the Grameen Foundation received financial support from the Bill and Melinda Gates Foundation. When Grameen expands the CKW program to new regions, it does so in consort with regional partners that share the start-up and operational costs of the new roll-out. In return, these partners dictate where the program expansion will take place to ensure their service areas benefit from the CKW program. The quality of the agricultural database is a vital component of the program, as improved agricultural performance depends on accurate, up-to-date, empirical data. As of May 2013, ten different partner organizations provide agricultural information for the database, and a panel of agricultural experts reviews this information.

A number of private sector partners provide technological support for the CKW program. MTN Uganda provides the technology infrastructure over which all CKW applications work. Google donated dozens of Android phones and a thousand solar phone chargers. Salesforce.com donated a number of licenses for its software, which serves as an interface for the program's administrative and survey

database. Atlassian provided the collaboration and project management software that Grameen uses to streamline its operations. These product donations have been vital to Grameen's ability to manage the start-up and operational costs of the CKW program.

CKW Equipment

The CKW mobile platform includes three apps: one for searching the agricultural database, one for conducting surveys, and one for communication with program staff in Kampala. The agricultural database is programmed into the phone's app allowing it to be accessed even in areas with no network coverage. When offline, database searches and survey responses are cached and once the phone comes within range of cell service, the CKW can update the database and submit any collected data to the central server.

Since grid-based electricity is not common in rural areas, CKWs use a solar power system to charge the phones. Upon completion of their training, CKWs must make a deposit of 10,000 Ugandan Shillings (UGX), which is slightly less than US$4, for their equipment package, which includes the phone, a solar charger, a weighing scale, and a measuring band used for livestock girth measurements (to estimate the weight and health for the purposes of nutrition and pharmaceutical dosing). They also agree to have 20,000 UGX withheld from their pay each month for the next two years as part of a rent-to-own program. This arrangement is consistent with Grameen's philosophy to help provide micro-credit to impoverished people throughout the world, and it is important to Grameen that CKWs are invested in their own success. Moreover, Grameen feels that the CKWs are more likely to provide better care for their equipment if they have ownership in it. A monthly airtime allowance is provided to the CKWs for their programmatic and personal use, which CKWs may supplement with airtime they purchase themselves.

CKW Recruitment and Training

Areas are selected to receive the CKW program in cooperation with partner organizations. Grameen only expands the CKW program when it has found a partner to share the costs of the expansion, so the specific communities that receive the program are based on the partner organization's interests, rather than as part of an overall strategy by Grameen. Once an area has been selected, the CKW recruitment process begins. Typically, one CKW covers a single parish (5-10km and 500-700 households), though two CKWs are sometimes selected for larger parishes. CKWs must be farmers, permanent residents of the community, cannot have full-time employment outside the farm, and must be able to read and write in English and speak the local language. Additionally, Grameen aims for half of all CKWs to be women. The recruitment process begins with stakeholder meetings with local officials, farmer cooperative organization leaders, and local technical experts. During these meetings the recruitment team explains the program and the CKW selection process. At a later community meeting, Grameen representatives again describe the CKW program and the desired qualities of CKWs (e.g., trustworthy, leadership skills, and enthusiastic about trying new things), and solicit nominations by the community members present. As candidates are nominated, they undergo a public vetting process, in which their English proficiency and the other qualifying characteristics are checked. All present community members later vote for the nominee they want to be their community's CKW.

CKWs are generally trained in cohorts of up to 50 (2 classes of about 25). During training, CKWs are provided with room and board and receive a travel allowance. Training lasts about 4 days (10-12 hours per day), and is conducted in English. Training begins with the program philosophy and background, a program value proposition, and expectations of the

program. The second module describes how to use the smartphone. The third module introduces the CKW platform (search, farmer registration, etc.), and includes role-playing exercises to practice picking out key words from farmer narratives. Next, CKWs receive training on survey methodology, including survey ethics. Finally, the general training concludes with support functions. At any time during the training, candidates have the option of backing out; otherwise, they sign a commitment to participate upon completion of training. About two in 50 candidates do not complete the training. Refresher training occurs periodically, particularly when there are new partner needs or training is needed for a new survey.

CKW Monitoring and Compensation

Even though CKWs are recruited as volunteers, Grameen provides monthly performance-based financial incentives. Each month, CKWs are expected to register 15 new farmers and complete 48 searches of the agricultural database for farmers. The CKW platform automatically records all searches of the agricultural database, as well as the GPS coordinates where the search, survey, or farmer registration occurred, and these records are used to pro-rate the incentives based on performance. To help manage the performance-based evaluation system, Grameen has developed a dashboard that continuously tracks any number of variables that are programmed into the dashboard. A version of this dashboard can also be customized and provided for a fee to other organizations interested in tracking the data Grameen has collected.

In addition to the pay they earn by performing their expected duties, CKWs are encouraged to earn extra money by using their solar chargers to re-charge their neighbors' mobile phones for a fee. Other benefits include having access to their smartphones and solar charging stations for their personal use. Many CKWs power small electrical devices for their houses, such as lights and radios. Although more difficult to quantify, CKWs also benefit financially by improving their farming practices based on the information in the agricultural database. Nontangible benefits include the intrinsic reward of knowing they are helping to improve the lives of their fellow community members, the increased knowledge they obtain, and enhanced status in the community. For example, many CKWs have reported that their neighbors have bestowed titles of respect upon them, such as "doctor."

Program Sustainability

One of the most challenging obstacles to extension initiatives is sustaining programs over time, especially after initial grant funds have been exhausted. The Grameen Foundation views the sustainability of the CKW program from two perspectives: the sustainability of the CKWs, and the sustainability of the program itself. Regarding the CKWs, Grameen has been developing and piloting several ideas that could potentially incent CKWs to continue to be a resource for the farmers in their communities, while still earning income that does not rely on Grameen and its partners. Most of the ideas include transitioning the CKWs into something Grameen is tentatively calling a "Village Enterprise Service Provider," which is a generic term for any of a number of specialized activities that CKWs would carryout in service of the farmers in their village while earning outside income. These activities include acting as a weighing specialist for harvested crops, organizer of bulked village crops (to obtain a greater price), quality assurance specialist for cash crops, agricultural input agent, and mobile money agent. Additionally, Grameen has been engaging with NAADS, which is exploring adopting the CKW model (in some way) for its extension services, allowing some CKWs to act as hybrid extension agents who continue to provide one-on-one, hands-on extension services while also providing more proactive services

that benefit groups of farmers, such as farmer trainings, demonstration plots, and forming farmer groups. It is unclear what effect such a change in roles would have on a CKW's current responsibility of information dissemination, but over time, it could be that basic information dissemination may become less important than when a CKW is first introduced to a community.

Regarding the sustainability of the program itself, Grameen built some form of sustainability into the initial development of the program when it developed an open data kit surveying app. By training CKWs on such topics as survey gathering procedures and survey ethics, and requiring ongoing survey gathering as part of the CKWs responsibilities, the Grameen Foundation, in addition to having a growing network of extension workers, has also developed a network of enumerators. Grameen uses this network, equipped with its custom-developed mobile survey applications to gather data for research, extension, commercial, and development organizations on a variety of topics, including agricultural practices, livestock numbers, family health, poverty, and education. This service allows client organizations to gather important data more effectively and cheaper that they could on their own. Also because the CKWs are often asked to collect data in their communities, they have local knowledge of the survey area and can therefore collect the data more efficiently, something important in a country such as Uganda where finding homes in rural areas can be difficult. Moreover, survey respondents are reportedly less suspicious of enumerators who are from their community. In addition to these customized surveys, many organizations are interested in the data Grameen CKWs are already collecting as part of their ongoing responsibilities, and have paid Grameen to develop customized dashboards that allow them to track (on an ongoing basis) specific data that Grameen collects.

The revenues that Grameen earns through its data collection services and dashboard development help to supplement the operational costs associated with the CKW program. As of June of 2013, less than four years after it started, the CKW program was 57% sustainable. In addition to helping the program remain sustainable, the opportunity to collect surveys represents yet another possible source of income for CKWs, as they are paid for their work collecting data outside the requirements of their regular duties. Time will tell whether Grameen's data collection services will be able to compete in that market, and whether there will be enough demand for the data the organization collects to fund the program once it is no longer funded by outside organizations.

Future Initiatives

In select areas, Grameen has piloted a program in which CKWs measure farmers' plot sizes by walking the perimeter of farm plots with their phone, using its GPS function to calculate the size of the plot. As of the summer of 2013, the accuracy of the measurements is not perfect (margin of error of about 15%), however, there is hope that new phones being adopted in the Fall of 2013 will perform this function more accurately. One obvious reason to perform this function is to gather objective data on farmer plot sizes. Another is because some of the recommendations that CKWs provide to farmers are tied to their plot size. A third reason for providing this service is to provide better collateral information to lenders and insurers. In the past, farmers have over-borrowed in part because they either exaggerated the size of their land or double-counted their land (for example a farmer may have one acre of land on which he grows banana, and coffee, but may claim to have an acre for each). Over-borrowing is bad for farmers and also bad for the sustainability of a micro-financing environment. If lenders and insurers are willing to accept the margin of measurement

error for the land measurements, Grameen will continue to develop this initiative.

Grameen is also working on a new tool that is based on the Endiisa computer tool recently developed at Makarere University to help farmers formulate livestock diets that yield maximum production at the least possible price. Endiisa means "feeding" in Lugandan, and Grameen is developing an app based on the computer tool that selects the correct amounts of competitively priced feed ingredients to satisfy the nutrient requirements of a specific type of animal at a particular stage of development.

Another new app Grameen is developing focuses on soil fertility. The app will allow CKWs to help farmers make well-informed business decisions about their farms based on the soil available to them. The app will provide prompts about various observable conditions of the soil (color, texture, apparent moisture levels, condition of plants being grown, etc.). Based on the answers to these prompts, the app will provide a recommendation about the best crops for that soil, and information on how to grow and manage each crop (e.g., type and amount of fertilizer to use, where to obtain inputs, etc.). The app will also include market information about the recommended crops (current price ranges, where to sell, etc.) to help to farmer make informed decisions about his or her agricultural mix.

Grameen is currently considering different mobile money solutions, many of which would involve the CKW program. One example involves combining mobile money with mobile financing to provide farmers with credit to buy agricultural inputs. Another initiative would help farmers access credit to manage their annual cash flow. Currently school fees are due around harvest time and many farmers are forced to sell their crops when the market is flooded and prices are at their lowest. One initiative is to have CKWs teach proper storage techniques and take photos of stored crops that would act as collateral on loans that could be used to pay for school fees, and repaid when the farmer sells the goods once prices have risen again.

Program Evaluation and Impacts

Both Grameen and its funders place great importance on monitoring and evaluation. The ability to monitor the CKW program was built in from the beginning by asking the CKWs to collect basic data on the farmers they contact and provide services for. In addition to the data collected by the CKWs, Grameen has the ability to track CKW activity via the customized dashboard it developed. Not only is this information used to evaluate the CKWs, it is also used to better understand the reach of the program. As of June 2013, Grameen had 1,139 CKWs in 39 districts, who had conducted 1,144,771 information searches for farmers in their communities. Repeat users have accounted for 26.71% of the CKW interactions. Additionally, CKWs have completed 69,603 survey interviews for Grameen.

Despite the effective reach in many parts of the country, Grameen and its partners wish to know if the program is having a meaningful impact on the lives of the farmers with whom it interacts. To answer that question, Grameen has partnered with independent outside reviewers to implement a three-phase evaluation of the program: data mining of Grameen's significant base of program administrative data, a quasi-experimental impact study, and a randomized control trial in communities where the program has been recently introduced as a planned expansion.

A team of researchers led by a private sector contractor conducted the data mining effort, which involved detailed analysis of over 650,000 search records, as well as interviews and focus groups with farmers, CKWs, and Grameen staff. The study showed evidence consistent with established patterns for diffusion of innovation (Rogers, 1962), with early adopters driving program use. If the pattern

of diffusion holds over time, there could at some future point be wide adoption of new agricultural practices. Additionally, the study revealed a number of interesting findings including: both the poorest and least poor of the registered farmers accounted for the highest usage of CKW services; information on crops (29%), market prices (25%), and livestock (22%) comprised 76% of all searches; and female CKWs are more successful in meeting with female farmers, while male CKWs are more successful at cultivating deeper relationships with farmers (more repeat meetings). The study also examined CKW performance and found that the median number of searches a CKW conducted met the monthly target, with half of CKWs performing beyond incentivized levels, and in many cases much beyond the financial incentives. A few districts had more CKW meetings than predicted by a regression model. An examination of these districts showed that they tended to have: strong partner involvement, more peer group meetings, and experienced field officers who created an expectation of quality by monitoring CKW performance, holding CKWs accountable, and replacing poor performers.

The second evaluation phase of the CKW program used difference-in-difference methodology to examine the causal effects of the CKW program in a single Ugandan district on farmers' knowledge, attitudes, practices, and outcomes about two years after the introduction of the program (Van Campenhout, 2012). Results from this study suggest significant positive impact of the presence of CKWs on farmer knowledge about farming practices and market prices. The presence of CKWs had no impact on the use of newspapers and radio for price information. There was, however, a significant drop in farmers' use of SMS-based (text message) price information sources, but an increase in reliance on family and neighbors for information. With regard to practices, more farmers in CKW areas switched away from low-risk, low-return crops such as groundnuts, millet, and cassava toward higher risk/reward crops such as maize, beans, and coffee. Additionally, farmers in CKW areas reported using better farming practices such as recommended crop spacing and the use of manure as fertilizer for crops. As for outcomes, the study found that the presence of CKWs accompanied a 34 percentage-point increase in farmers' access to extension services. The study did not show any impact on productivity, possibly because changes in productivity take more time to surface than an outcome such as access to extension services. The study did show, however, that farmers in CKW areas received a significantly higher price for maize.

For the third evaluation phase of the CKW program, Grameen has partnered with Modernizing Extension and Advisory Services (MEAS) to conduct a cluster-randomized control trial (RCT) in communities into which the program was expanded in late 2012. For this expansion, Grameen's roll-out partner was the East Africa Dairy Development (EADD), which establishes and supports the development of dairy farmer associations (hubs) that offer training, milk bulking, and other dairy business services. For this RCT, 12 dairy hubs in the region near Masaka served as the units of randomization. Hubs were randomly assigned to one of three treatment conditions: The first condition consists of EADD dairy hub services alone, and serves as a comparison group for the presence of CKWs. The second condition consists of EADD dairy hub services with the addition of CKWs who serve all farmers regardless of whether they have dairy cattle. The third condition is intended to determine the extent to which the effects of the CKW program can be enhanced by increasing access to needed supplies. In this condition, in addition to CKWs, EADD will help each hub to establish an agro-vet shop that will give dairy farmers greater access to dairy-related inputs.

The survey used for the RCT consisted of over 140 questions, plus a series of repeated items for each crop and animal the farmer has, covering (a) demographics; (b) household characteristics, poverty, and finance; (c) food security and health; (d) agricultural production; (e) agricultural practices; (f) CKW key messages; (g) risk adversity; (h) diffusion of knowledge; (i) household decisions; and (j) extension and advisory services. The survey was administered to a random sample of 1,200 households (100 in each hub) as a baseline in August 2012, and will be administered after one year and then again every six months for up to three years or until pre-established impacts are observed.

Summary

The Grameen Foundation's CKW program is an innovative approach to inexpensively supplement existing EAS efforts in a way that reaches the most rural villages and the farmers who are in the greatest need of EAS. Unlike most EAS programs that use ICT, the program uses the latest ICT (smartphones) not as the main focus of the intervention, but rather merely as a key tool used by a large number of lightly trained extension workers. By doing so, the program addresses some of the greatest challenges facing traditional extension programs (e.g., large extension worker-to-farmer ratios and illiteracy) and ICT programs (e.g., access to technology and one way communication that can be misinterpreted).

More importantly, the Grameen Foundation has wisely placed significant emphasis on monitoring and evaluation to inform program management decisions and to ensure the program is having the impacts it was created to have. Because data collection is a crucial component of the CKW program, Grameen has a tremendous amount of data on rural Ugandan farmers, something quite rare for Africa, which will inform international development efforts for many years. Over time, the amount of data will continue to grow, the ongoing RCT will provide further insights, and the program's promise will likely attract future researchers. Ultimately, the program could not only have a significant positive impact on the lives of Ugandan farmers, but if the model proves to be an effective and sustainable one, people in need of extension and advisory services throughout the world might benefit as well.

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The Companion Village Project: An Extension Education Tool for Improving Crop Production

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Abstract

To address the issue of farmers not knowing or adopting improved crop production practices, the Institute of Agriculture at the University of Iringa (formerly Tumaini University) in Iringa, Tanzania, developed the Companion Village Project (CVP). Working primarily with pastors at local churches, the CVP has 47 demonstration plots highlighting improved production practices and serving as a backdrop for multiple educational presentations for farmers throughout the growing season. Local farmers managed the CVP plots. Local farmers were able to see the results and discuss the improved practices with the pastors and other local leaders as well as with Institute staff. To estimate the impact of the CVP, yields were measured on the plots and surveys were taken of participating and non-participating farmers. Crop yields were greater with the recommended improved production practices compared to conventional practices. The visibility of the improved practices and greater yields has resulted in adoption of the improved practices by more farmers in the region.

Keywords: Tanzania, agriculture, extension, training and visit, farmer field schools, demonstration plots

Introduction and Theoretical Framework

Agricultural extension in Tanzania has been almost entirely provided by the public sector represented by the government through the Ministry of Agriculture and Cooperatives. For years extension programs were implemented by the Ministry's staff from the national level down to the field level (Rutatora & Mattee, 2001). The ministry has been offering conventional extension services, trying to reach a large number of the clients all over the country. However, ministry-based extension has been unable to reach a majority of farmers for economic, socio-psychological, and technical reasons (Food and Agriculture Organization [FAO], 1998).

In 1986, the Tanzanian extension service underwent reforms, and the training and visit (T&V) approach was launched as part of the National Agricultural and Extension Rehabilitation Program funded by the World Bank (Douglah & Sicilima, 1997). The T&V system of extension was considered as an innovative approach in extension organization and management and as having resulted in the streamlining of the government system to make more efficient use of staff resources (Rutatora & Mattee, 2001). The T&V system was found to have a positive impact on farmers' yields especially when there was adequate contact with local extension agents in a participatory manner (Dejene, 1989; Feder, Slade, & Sundaram, 1986; Hussain, Byerlee, Heisey, 1994; Phillips-Howard, 1994). However, the approach also has been criticised as a top-down approach leaving little possibility for participation and initiative both for farmers and village extension workers (FAO, 1998).

In 1996 another reform was initiated in Tanzania with the National Agricultural Extension Program (NAEP) which modified the T&V approach by adopting a more participatory approach. Observations revealed that even with the modified T&V system, the approach continued to assume that knowledge flowed from the source down and lacked communication, participatory problem solving skills, and participatory experiential approaches (Rutatora & Mattee, 2001).

Over the years and with declining resources, reforms have been undertaken by the government intended to limit its role to the core functions of governance and allow more involvement of the private sector in offering public services such as extension education (Rutatora & Mattee, 2001). The Agricultural and Livestock Policy of 1997 in Tanzania stressed the need to promote private sector participation for collaborative efforts, that extension service delivery would no longer be a monopoly of the government, and the private sector would be allowed to own and manage extension services. The need to substitute traditional extension systems with participatory, pluralistic knowledge systems was also recommended by the InterAcademy Council (2004).

In light of these policy changes, the Institute of Agriculture at the University of Iringa (formerly Tumaini University) started the Companion Village Project (CVP) in the Iringa region of Tanzania in 2008. The goal of the CVP was to improve farmers' knowledge and adoption of improved production practices through demonstration, education, and engagement at a local level. To achieve this goal, the CVP aimed to bridge the gap between agricultural researchers and farmers. The program followed the advice of Gemo, Eicher, and Teclemariam (2005) and developed a particular extension model to meet the needs of local farmers and communities in the Iringa region. In addition to using the general model of T&V, the project also utilized principles from Sasakawa Global 2000, and Farmer's Field Schools (FFS).

The T&V approach includes "(a) professionalism, or building of a professional extension service, (b) single line of command, (c) concentration of effort, (d) time-bound work or operating in a regular and timely fashion, (e) field and farmer orientation, (f) regular and continuous training, and (g) linkages with research" (Benor & Baxtor, 1984, p. 39-40). Similar to the Sasakawa Global 2000 projects (Borlaug, 1989), the CVP includes improving productivity in staple food crops, effective use of local extension staff, creating immediate and significant benefits to farmers by using well-managed and large demonstration plots, and supplying the seed and fertilizer needed to run these demonstration plots. The CVP also follows the findings in northern Tanzania on the need for many demonstration plots across the area to account for differences in the biophysical conditions as well as the socioeconomic and environmental conditions of the farmers and focusing on farmer education for influencing technology adoption (Nkonya, Schroeder, & Norman, 1997). The CVP is also similar to Subair's (2002) description of the on-farm adaptive research philosophy and follows Subair's admonition that "farmers will adopt a new technology only if they perceive that it is in their economic interest to do so, and if needed support services are adequate" (p. 90). Farmer's Field Schools have been credited with improving agricultural production elsewhere in the world (Anandajayasekeram, Davis, & Workneh, 2007; Davis, 2008; FAO, 2001).

Farmer's Field Schools, originally associated with promoting integrated pest management, work at the grassroots level to advance the principle of stakeholder participation in program decision-making and eventually giving full responsibility to stakeholders for program development (FAO, 2001). FFS are "a method to educate farmers in an informal setting within their own environment" (Anandajayasekeram et al., 2007, p. 83). The defining characteristics of FFS include discovery learning, farmer experimentation, and group action. The approach is an interactive and practical method of training, and empowers farmers to be their own technical experts on major aspects of localized farming systems (Davis, Nkonya, Ayalew, & Kato, 2009). The FFS elements of discovery learning and group action are especially evident in CVP.

Purpose and Objectives

The purpose of this paper was to describe how the CVP operates and to assess the impact of this participatory demonstration method of extension education. The specific objectives of the impact assessment were to measure the adoption rates of the improved practices demonstrated on CVP plots and to quantify the resulting impact on crop yields.

Background and Operational Framework

The CVP was started in 2008 and was the primary tool of the Institute to address crop production and food security in the Iringa region. The primary approach of the CVP was to establish a series of demonstration plots and educational offerings in the villages of the Southern Highlands of Tanzania. The educational offerings of the "extension network " included issues such as improved crop production practices and the related issues of grain storage, marketing, processing to add value to the crops, etc. The CVP leveraged the role churches and pastors hold as community leaders and their resulting authority and credibility to extend knowledge and recommendations from university research to village farmers adopting principles of T&V, Sasakawa Global 2000, and FFS approaches as previously discussed.

Similar to FFS, the CVP demonstration plot is the primary learning resource where farmers meet for field work and educational meetings and discussions. Training lasts the entire cropping season when researchers from the Institute visit farmers and lead classes and discussions four to six times a year. Demonstration plots of the size of 0.4 hectare (one acre) are established in the villages. The demonstration plots consist of half maize and half edible beans because maize and beans are the main staple crops of the region (URT, 2006, 2012).

The CVP model involved religious organizations as part of the extension delivery model. Churches and, in a few locations, schools in the Iringa region provided land for the demonstration plot, supervised and managed the plot, and organized educational meetings in exchange for funding of the CVP operating expenses provided by churches of the Evangelical Lutheran Church of America (ELCA). Church leaders and members received the maize and beans from the demonstration plot after the final measurements were recorded during harvest. Churches were chosen to be part of the extension model because (a) the integrity of pastors implied credibility of project, (b) regular traffic to and from the church increased the visibility of the demonstration plots, and (c) they increased trust in the data collection. Having churches playing a role in community development is not a new phenomenon in Tanzania. Historically, Christian missions have played an instrumental role in introducing new crops, medicines and technologies in Tanzania (Koizumi, 2007).

The demonstration plots were intended to inform and educate the entire village despite being associated with a particular church or school. In addition to the open invitation for all villagers, specific village officials and local extension officers were invited to (and often did attend) the regular meetings throughout the year.

Farmers were involved in choosing the demonstration location at each village. Each demonstration plot was 0.4 ha (one acre) and was divided equally between beans and maize.

The CVP recommended these farming practices: (a) minimum tillage and residue management practices, (b) high quality seed, (c) optimum cultural practices, (d) improved soil fertility, (e) pest management, and (f) crop rotation. All of these practices were applied together on each demonstration plot. There were no sub-plots showing the effect of the practices separately. These practices were chosen based on university research and experience that showed which practices would improve yields quickly. Minimum tillage and residue management were practiced by retention of stubble. The next crop was sown through the remaining stubble and weed residue. Farmers were instructed to leave the crop residues on the soil instead of the conventional practice of burning the residue.

High-quality seed was promoted because the crop yield and quality parameters are all dependent on the genetics of the seed. There was a wide range of genetics grown among the villages for all crops. While local genetic seed was considered, the usual CVP recommendation was to introduce new genetics that had high production potential for the Iringa region, but these had not been tested in most of the villages. Most farmers were using open-pollinated maize varieties that were harvested from their own fields the previous year. While these varieties can be very well adapted for the village, they may lack the yield potential that a maize hybrid might provide.

The cultural practices being demonstrated included growing the crops separately from each other, planting seeds in

rows to facilitate work in the field during the growing season, and planting seeds at a proper depth and spacing to maximize germination and early vegetative growth potential. Maize was planted in rows 60 cm apart, and 20 cm from plant to plant within a row. Beans were planted in rows 30 cm apart, 10 cm apart within a row.

Soil fertility was managed and enhanced through the use of fertilizer, manure, and compost. Soil samples were collected and analyzed prior to the first growing season to help develop fertilizer recommendations. Weeds were controlled by regular hand weeding starting two or three months before seeds are sown and continuing to harvest. Insects and diseases were monitored and control products applied if warranted. The maize and bean areas within the plot were rotated each year to show the benefit of the legume nitrogen (N) credit from the beans for the following maize and to reduce pest pressure by breaking the life cycles of the pests.

Plot yields were compared with the performance of the farmers fields near the plots, planted on the same date, and whose owners did not use the CVP recommended practices. Yields on both the demonstration plots and the nearby farmers' fields were measured on three 10 meter lines randomly located in each plot or field. These yield results were evaluated at the post-harvest meeting.

As part of the CVP program, the Institute of Agriculture conducted six educational sessions during the first year of the program in each village to educate the farmers through knowledge sharing as well as through hands-on participatory demonstration of promoted practices. A Researcher from the Institute of Agriculture led the instruction and discussion with all those who attended the meetings. The meetings were typically announced a week ahead of time so that the word could spread in the village for those interested in attending. In subsequent years, the first two meetings, which specifically addressed plot location and preparation, were omitted and four field days were held.

The first meeting was held in March (before the initial growing season) and included an introduction to the CVP program and an overview of the farming practices to be used. Soil samples were collected and sent for analysis to determine soil fertility status and fertilizer management recommendations. At the second meeting in August, the plot area was measured and marked and instructions given on minimum tillage and residue management. At the third meeting in November, the maize seed and planting-time fertilizer were delivered to the site. Instruction was given on how to plant the maize at the proper spacing between rows and within rows and how to apply the fertilizer. The seeds and fertilizer delivered by CVP to the sites were used in the demonstration only. Farmers were advised where they could purchase the seeds and fertilizers for their own farms. The fourth meeting in January included the delivery of bean seeds, fertilizer for the beans, and side-dress nitrogen fertilizer for the maize. Instruction was given on making the second application of fertilizer to the maize and how to plant the bean seeds and fertilize them. At the fifth meeting in April or May, instructions were given on how to get ready for harvest and how to determine and record yields. The sixth meeting in June or July involved evaluating the harvest and instruction on storage techniques.

During each of the six meetings, researchers and participants engaged in a joint discussion of the decisions that needed to be made to adopt the recommended practices. A common issue affecting cropping decisions was cash and credit constraints faced by many farmers. Institute personnel discussed what could be done to

accommodate these constraints. For example, while fertilizer can be a good investment, if farmers cannot afford to purchase commercial fertilizer the project encourages them to use alternative methods such as (a) adding compost through utilizing minimum tillage and residue management, (b) using manure whenever possible, and (c) mixing-and-matching compost and manure with fertilizer. Likewise, purchasing hybrid maize or new bean seed is usually a sound agronomic practice; however, if funds were limited, the discussion included how to obtain less expensive but still improved seed.

A secondary goal of the project was to encourage attendance of women at these meetings as women conduct the majority of the field work for the crops on their own small land holdings. To assist in extending the presented information to women, and others that could not attend meetings, most presentations were supplemented with handouts printed in Swahili that could be taken home.

Each village was required to maintain thorough notes of each meeting's presentations and copies of handouts. The villages were given a box file or notebook where they kept copies of the handouts. The box file was left in the village and was accessible to all village members. It also provided a place to record the varieties/hybrids used, the type and amount of fertilizer applied, any pest control products used, and specific events associated with field preparation, planting dates, and harvest dates. In addition, each village was instructed on keeping rainfall data for the entire growing season.

Methods

Data used for the impact assessment study were collected through a survey of meeting attendees in April and May, 2013. These village meetings were part of the extension education program of the Institute of Agriculture and were open to all people even if they had not been involved in the CVP demonstration plots. The survey data were collected using structured questionnaires that were developed and administered by research assistants involved in the program. All meeting attendees, CVP participants and non-participants, were asked to complete a survey on demographic characteristics, agronomic practices, and maize and bean yields. The questions for agronomic practices were specific for maize and beans only the two crops involved in the program. Eight villages that joined the program in 2008 and 2009 were selected for the study because these participants had more experience with the demonstration plots (see Table 1).

Table 1

Villages Participating in the Survey and the Length of Time with CVP

Village	Year joined the program
Ihemi	2008
Ilambilole	2008
Ipogoro	2008
Nduli	2008
Itungi	2008
Kilolo	2008
Lulanzi	2009
Mlafu	2009

Findings /Results

Of the 190 farmers who completed the surveys, 51% were female; 49%, male (see Table 2). Fifty-eight percent of the respondents were between 30-49 years old. Almost 75% of the respondents were married. Over 50% were involved in farming only; 25% also had a small business selling perishable commodities.

Table 2

Characteristics of Respondents

Variable	Category	Frequency	Percentage
Gender	Male	93	48.9
	Female	97	51.1
Age	Below 20	3	1.6
	20-29	23	12.1
	30-39	47	24.8
	40-49	63	33.2
	50-59	26	13.7
	60-69	21	11.1
	70 and above	7	3.7
Marital status	Single	24	12.8
	Married	137	73.3
	Divorced	5	2.7
	Widow	21	11.2
Economic activities	Small business/selling perishable crops	45	24.7
	Employed	9	4.9
	Temporary unskilled laborers	18	9.9
	Farming only	94	51.6
	Others	16	8.8

Seventeen percent of the attendees reported cultivating 0.4 ha (1 ac) or less (see Table 3). Sixty percent farmed 0.8-1.6 ha. Twenty-four percent cultivated 2.0 or more ha. Besides growing maize and beans, many also grew potatoes, tomatoes, and other vegetables.

Based on their answers in the survey, the farmers were divided into two groups. Farmers who had adopted at least one agronomic practice (e.g. planting in rows, systematic spacing of seeds, using commercial fertilizer, using hybrid maize, etc.) taught by the CVP were grouped as adopters. Farmers who did not use any the practices recommended by CVP were grouped as non-adopters. The adopters were further divided into two groups: those who adopted one to three practices (Group 1) and those who adopted four to six practices (Group 2). The non-adopters were asked whether they had attended other farming training and then divided into two groups: those who had attended or were attending or had attended training administered by other NGOs or government agencies (Group 3) and those who had never attended any other farming training (Group 4). The non-

adopters were split into these two groups because participation in other training may have improved their farming methods and yields compared to those who had not attended any training. Twenty-three percent of the respondents had adopted four to six CVP practices and 15% had adopted one to three CVP practices (see Table 4). Thirty-four percent were non–adopters who had attended other training meetings; 28% were non-adopters who had not attended any training.

Table 3

Area Cultivated and Crops Grown by Respondents

Variable	Category	Frequency	Percentage
Area cultivated in maize and beans	Less than 0.4 ha	4	2.2
	0.4 ha	27	14.5
	0.8 ha	32	17.2
	1.2 ha	41	22
	1.6 ha	38	20.4
	2.0 ha	23	12.4
	2.4 ha	7	3.8
	More than 2.4 ha	14	7.5
Crops cultivated (other than maize and beans)	Potatoes	56	38.6
	Sorghum	6	4.1
	Cowpeas	23	15.9
	Tomatoes	50	34.5
	Vegetables	86	59.3
	Others	27	18.6

Table 4

Adopters and Non-Adopters

Group	Frequency	Percentage
Group 1: Adopters (4-6 CVP practices)	43	22.6
Group 2: Adopter (1-3 CVP practices)	28	14.7
Group 3: Non-adopters, attended/attending other trainings	65	34.2
Group 4: Non-adopters, never attended any other training	54	28.4

Adopters were asked to indicate the year they joined the CVP program. To determine whether those who had been engaged in the CVP program for longer periods of time adopted more practices than those who had participated for shorter periods of time, a chi-square test was run. The chi-square was estimated to be 27.45 ($df = 20$, $p = 0.12$). This nonsignificant relationship showed there was no association between the number of practices

a farmer adopted and the year he or she started attending the CVP meetings.

Of the adopters, 59% were male and 41% were female. Thirty-four percent of the adopters had been attending the CVP demonstration meetings for five years, 21% for four years, 24% for three years, 10% for two years, and 9% for one year. In total, 98% of the adopters had been attending CVP meetings sometime during the period of the CVP program. Two adopters did not answer the question on how long they had been attending CVP meetings. Sixty-two percent of adopters said they had been regularly attending the CVP demonstration meetings. Of the non-adopters, 57% were female and 43% were male. The survey was structured so that non-adopters were not asked whether they had attended CVP meetings. Other differences between adopters and non-adopters included 80% of the adopters were married compared to 69% of the non-adopters, 57% of the adopters listed their economic activity as only farming compared to 48% of the non-adopters, and 89% of the adopters farmed 0.8 or more ha compared to 80% of non-adopters (see Table 5).

Table 5

Differences between Adopters and Non-Adopters

		Adopters[a]	Non-adopters[b]
Variable	Category	%	%
Marital status	Single	4.2	18.1
	Married	80.3	69
	Divorced	1.4	3.4
	Widow	14.1	9.5
Economic activities	Business/selling perishable crops	19.1	28.1
	Employed	2.9	6.1
	Temporary unskilled labourers	5.9	12.3
	Farming only	57.4	48.2
	Others	14.7	5.3
Area cultivated	Less than 0.8 ha	11.3	20.0
	0.8 and More	88.7	80.0

Note. Percentages are for each category within each variable: marital status, economic activities, and area cultivated. [a]Groups 1 & 2. [b]Groups 3 & 4.

Adoption of Improved Practices

Adopters were asked to indicate which of the CVP recommended practices they had adopted. The practices listed most often were leaving crop residues and reducing seed spacing as recommended by CVP (both 80%). The practice adopted the least was commercial fertilizer usage, which was stated by 46% of the survey respondents (see Table 6). Minimum tillage and plant spacing were most likely implemented the most because these practices do not require additional resources or expenditures by the landholder. In contrast, fertilizer usage requires resources, and this is a limitation for small scale farmers.

Table 6

Adoption of CVP Recommended Practices

	Adopters[a]
Agronomic practices	%
Leaving crop residues	79.7
Reducing spacing in planting	79.7
Improved seeds	69.6
Minimum tillage	62.3
Pest and diseases control as instructed by CVP	55.1
Applying fertilizers according to soil analysis	46.4

Note. [a]Groups 1 and 2, n =71.

When the respondents were asked what obstacles prevented adoption, 96% said because "inputs were expensive" (see Table 7). This was also revealed by adopters when asked to mention obstacles that prevented them from adopting all the recommendations. Another obstacle mentioned by 28% was agricultural marketing problems (e.g., unreliable market and low prices offered by buyers).

Table 7

Obstacles to Adoption indicated by Farmers

	Adopters[a]
Obstacles that prevent adoptions of all practices	%
Inputs were expensive	95.5
Lack of market	28.4
Poor availability of inputs	6.0
The practices were difficult	1.5
I am waiting to see success from others	1.5

Note. [a]Groups 1 and 2, n =71.

Yield Impact

To determine the impact of adoption of the CVP recommended practices on maize and bean yields, the self-reported yields were compared into two ways: before and after adoption within the adopters group, and between the adopters and non-adopters groups. Because there were no baseline data of the participants of the program in terms of the yield before adoption, the 2013 survey asked the farmers to estimate the maize and bean yields before they adopted the recommended practices and then the yields they currently are harvesting after adopting the practices. Non-adopters were asked to estimate the yields they currently are harvesting.

Maize yields.

Among the adopters, the average maize yield before adoption was 1.0 t/ha (*SD* = 0.7) and 3.3 t/ha (*SD* = 1.6) after adoption of one or more recommended practices. A paired sample *t*-test indicated there was a significant difference between the maize yields before adoption of CVP recommended practices and after adoption of the practices ($t = 13.2$, $df = 64$, $p < 0.001$).

Maize yields were also compared among the "adopters' groups" and the two groups of non-adopters: Group 3 and Group 4 (see Table 8). An ANOVA test showed that average maize yields among the four groups were significantly different overall ($F(3, 177) = 27.88$, $p < 0.001$) The post-hoc comparison using Tukey's lsd indicated that the average yields for Group 3 (non-adopters who attended other training) and Group 4 (non-adopters who had not received any other training previously) did not differ significantly from each other but both differed significantly from the average yield of Group 1 and Group 2, the "adopters." The average yield for adopters of four to six of the recommended practices by the program was slightly higher but not significantly different from those who adopted one to three practices. The average yields of the adopters were higher than the average regional maize yield of 1.5 t/ha in both 2009 and 2010, the latest years available (Ministry of Agriculture, Food Security and Cooperatives [MAFSC], 2012), but the average yields of the non-adopters were similar to the regional averages.

Table 8

Comparison of Maize Yields of Adopters versus Non-Adopters (t/ha)

	N[a]	*M*[b]	*SD*
Group 1: Adopters (4-6 CVP practices)	41	3.28	1.68
Group 2: Adopters (1-3 CVP practices)	26	3.16	1.38
Group 3: Non-adopters, attended/attending other trainings	62	1.81	1.06
Group 4: Non-adopters, never attended any other training	52	1.30	0.77

Note. [a]Some respondents did not report maize yield information. [b]The average yields of groups 1 and 2 are not statistically different but both are significantly higher than the average yields of groups 3 and 4. The average yield of group 3 is statistically different from the average yield of group 4. $p < 0.005$.

Bean yields.

Among the adopters, the average yield before any changes was 0.3 t/ha (*SD* = 1.4) and 0.60 t/ha (*SD* = 2.3) after CVP practices had been adopted. A paired sample *t*-test indicated there was a statistically significant difference in bean yields from before adoption of CVP practices compared to yields after adoption ($t = 7.1$, $df = 20$, $p < 0.001$).

Bean yields among the four respondent groups also differ significantly ($F(3, 71) = 4.60$, $p = 0.005$) (see Table 9). The post-hoc comparison using Tukey's lsd indicated that the average yields for Group 3 (non-adopters who attended other trainings) and Group 4 (non-adopters who had not received any other training previously) did not differ significantly from each other but the average yields of both differ significantly from the average yield of

Group 1 (adopters, who used four to six practices) which was the same result as with the maize yields. Although the average yield of Group 2 (adopters of one to three practices) was higher than of the non-adopters and slightly lower than the yield of Group 1, it was not statistically different from any of the other groups. Because the average bean yields of both adopters and non-adopters were below the average regional bean yields of 1.1 t/ha in 2009 and 0.9 t/ha in 2010 (MAFSC, 2012), the farming conditions (e.g., soil and climate) may not be as conducive to producing beans in these villages as it is elsewhere in the Iringa region. However, the yield advantage of adopting four to six CVP practices was still present in these villages compared to those who did not adopt any of these practices.

Table 9

Comparison of bean yields of adopters versus non-adopters (t/ha)

	N^a	M^b	*SD*
Group 1: Adopters (4-6 CVP practices)	15	0.62	0.26
Group 2: Adopters (1-3 CVP practices)	6	0.56	0.13
Group 3: Non-adopters, attended/attending other trainings	25	0.37	0.28
Group 4: Non-adopters, never attended any other training	29	0.35	0.26

Note. [a]Some respondents did not report bean yield information and not all maize growers grew beans. [b]The average yields of groups 1 and 2 are not statistically different. The average yield of group 1 is statistically greater than the average yields of groups 3 and 4. The average yields of groups 2, 3, and 4 are not statistically different. $p < 0.00$

In summary, the 2013 survey indicated that Groups 1 and 2, the "adopters," had greater average maize yields after they adopted the CVP techniques and in comparison to Groups 3 and 4 (non-adopters). The survey also showed that Group 1 had greater average bean yields than Groups 3 and 4. Since the average bean yields of Group 2 (adopters of one to three practices) did not differ significantly from the other groups, the program was more effective for those who adopted four to six practices that those who adopted one to two practices.

Conclusions and Recommendations

The demonstrated success in improving crop yields through adoption of the CVP recommended practices was seen in the yield differences found in the 2013 survey. Thus, the CVP with its adaptation of T&V, SASKAWA Global 2000, and FFS approaches to local conditions proved to be an effective extension education tool for improving crop production. These dramatic increases in adoption of improved practices and the resulting yield increases show the ability of the farmers to adopt and improve their yields once they had been shown, instructed, and witnessed the impact of those practices. This conclusion mirrors the findings of Owolade and Kayode (2012) for snail farmers regarding information-seeking behavior and adoption of practices to increase production.

The CVP began with the goal to be a three-year education and demonstration program for villages in the Iringa region of Tanzania. This has been accomplished with the support of the administration of the

University of Iringa and financial funding from companion congregations from the St. Paul (Minnesota) Area Synod of the ELCA. Most projects had been extended to a fourth or even fifth year, which were completed in 2012 and 2013. There continues to be a need for education related to agricultural production and subsequent issues related to production such as grain storage, credit, marketing and value-added processing of the crops. As a result of the positive relationships that had been developed through visits to village churches and schools that had participated in the CVP, there was now the potential to establish an educational infrastructure for delivery of education on an expanded array of topics related to agricultural production and the food system separate from the system of demonstration plots. The next phase of the CVP will include the transition to an extension network that will allow the staff to continue providing educational information on agricultural production and the food system to farmers and others in the communities where relationships had been developed.

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African Food Security Fellows' Perceptions of Their Experiences in the United States: Reflective Journaling as a Way to Interpret and Understand an International Experience

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Abstract

The study reports on a reciprocal exchange program funded by the U.S. Department of State. It involved 14 Food Security Fellows, including seven each from Kenya and Uganda, who were community leaders, policymakers, and media professionals. The Fellows experienced a five-week training program on issues of food security and the unique role improved communication networks could play in reducing food insufficiency in their countries. During their exchange, the Fellows were asked to keep reflective journals chronicling their training experiences and interactions with Americans and their culture. The journal entries were transcribed and coded, and emergent themes were identified in concert with the study's purpose and research questions. Established procedures to address researcher reflexivity and enable transferability of the findings were followed. The data analysis yielded 41 codes from which 11 themes were derived. The Fellows expressed a more positive attitude about Americans and the United States at the program's end. They also described an appreciation for the role of youth development in agriculture and the need for extension educators, researchers, and university personnel to work together to ensure a nation's food security. Future exchanges should provide participants with an internship experience instead of only job shadowing opportunities.

Keywords: Africa, food security, international experiences, reflective journaling

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Introduction

The exchange project reported on

aimed to improve the outlook of food security in Kenya and Uganda by providing professional development for three key stakeholder groups whose collaboration stood to amplify their collective impact on food insufficiency: community leaders, media specialists, and policymakers. The project was funded with a grant awarded by the U.S. Department of State, Bureau of Educational and Cultural Affairs during 2011 and 2012. The funding agency designated the participants as *Food Security Fellows.*

Research Setting and Participants

The project was implemented as a four-phase process. The first and third phases brought 26 Kenyans and Ugandans to the United States for two five-week professional development experiences. Twelve Fellows came during April 2011, and the remaining 14 came during September and October 2011. The other two phases of this reciprocal exchange included two groups of Oklahoma State University (OSU) faculty and collaborators traveling to Kenya and Uganda to learn more about the regional food security situation and related challenges of the two nations.

The study's population was the 14 Fellows who participated in the project's third phase. The Fellows were selected based on an application and interview process. After reviewing the applications, it was determined who would receive a face-to-face interview. During the project's second phase, OSU faculty members from the Department of Agricultural Education, Communications, and Leadership interviewed applicants and selected those to invite for participation. Six of the seven Ugandan Fellows were male and included two community leaders, two policymakers, and three media professionals. The seven Kenyan Fellows included three community leaders, two policymakers, and two media professionals with four males and three females.

During the program's first four weeks, the Fellows were housed on OSU's campus, where they received training in food production, education/advocacy, food security/sufficiency, nutrition, and rural vitality. Weekends included activities in which the Fellows experienced American culture. On the program's tenth day, the Fellows began an 11-day internship or job shadowing experience with enterprises similar to their employers at home, e.g., a county Extension office; a National Public Radio affiliate; the Oklahoma Department of Agriculture, Food, and Forestry; and Oklahoma's largest daily newspaper. During the fifth week, the Fellows attended a conference in Washington, D.C., hosted by the U.S. Department of State.

Food Security in Sub-Saharan Africa

According to the United Nation's Food and Agriculture Organization (FAO, 2011), more than 925 million people in the world are hungry every day. Sub-Saharan Africa (SSA) is home to 239 million hungry people (World Hunger Education Service, 2012). "Sub-Saharan Africa . . . is the only region of the world where hunger is increasing" (Sanchez, Swaminathan, Dobie, & Yuksel, 2005, p. 1). "Several biophysical and economic constraints impede sub-Saharan Africa's escape from extreme poverty, including extremely low productivity of food production, heavy burden of infectious disease, and insufficient core infrastructure in water, roads, power and telecommunications" (Sanchez, Palm, & Sachs, 2007, p. 1). Further, Mihalacha-O'keef and Li (2011) reported 39 nations needed outside support to assist with food security emergencies in 2006, of which 25 were African. Nearly four million Kenyans and more than two million Ugandans require food assistance regularly (USAID, 2008,

2009). Improving communications on food security among the key stakeholders groups was the exchange program's central theme.

The Value of Exchange Programs for Professionals

Adult learners may study and learn in a myriad of contexts, including professional exchanges involving internships and job shadowing experiences that are rich with cultural experiences. "A guiding principle behind efforts to achieve greater understanding and mutual respect among the peoples of the world through cultural exchange is the belief that people learn to live together by *living together* [emphasis added]" (Pires, 2000, p. 41).

In terms of the professional development gained from participating in exchange programs, Gallagher (2002) described the benefits of forming collegial partnerships with international peers. International experiences can increase the desire to learn about other cultures and impact an individual's career interests (Rodriguez & Roberts, 2011). "Participation in study abroad programs enhances academic, social and cultural skills of students, makes them aware of transnational issues, and makes them better leaders of tomorrow" (Özturgut, 2007, p. 44).

Participants in a study conducted by Odell, Williams, Lawrence, Gartin, and Smith (2002) not only gained awareness of global issues, but they also modified preconceived notions about their host countries. In addition, exchange programs allow participants to view their own country and culture from a new perspective (Pires, 2000). The understanding of these different perspectives "can be dramatic when the two cultures involved are separated not only by linguistic, social, philosophical, and historical differences, but also by gaping economic disparities such as those that exist between Africa and America" (Pires, 2000, p. 42).

Further, "[w]e should find it disheartening that most Americans continue to have a rather abysmal understanding of the world's second largest continent, on which 12 percent of humanity lives" (Pires, 2000, p. 39). Pires (2000) asserted the need to promote study abroad and cultural exchange programs, specifically in Africa. Moreover, gaining increased cultural awareness can impact the global community as well as local communities (Rodriguez & Roberts, 2011).

Rodriguez and Roberts (2011) concluded the best educational practices for instructors to facilitate during international learning experiences were to ensure that "course structure, community involvement, extracurricular activities, and reflection" occurred (p. 29). Providing opportunities for interaction with host families or local citizens increases the likelihood of more authentic events transpiring (Rodriguez & Roberts, 2011). Myles and Cheng (2003) found that participants who interacted more frequently with people from their host country were quicker to adapt to the new environment. Dooley, Dooley, and Carranza (2008) also described the benefits of personal interactions and relationships with local citizens, including cultural activities such as touring museums, to gain an understanding of the history and heritage of the local community.

This kind of exchange allows participants to experience new cultures and take that knowledge back to their respective countries (Suarez, 2003). It also enables those who host exchange participants to broaden their understanding of other cultures and facilitate future interactions successfully (Pires, 2000). These experiences promote productive communication, allowing for enhanced

social, economic, and political relations among nations (Gallagher, 2002).

Geelhoed, Abe, and Talbot (2003) described *culture shock* as a prominent barrier that prevents people from participating in global experiences. "When students experience the accumulated strains of relating to the challenges of an unfamiliar environment, they experience culture shock" (Boyle, Nackerud, & Kilpatrick, 1999, p. 203). Experiencing an international and unfamiliar environment could easily become overwhelming, especially for novice travelers (Rodriguez & Roberts, 2011). Educators, therefore, should be aware of cognitive overload (Roberts & Jones, 2009) and use guided reflection to mitigate it (Rodriguez & Roberts, 2011).

Reflection and Reflective Journaling

John Dewey is considered an important developer of the concept of reflection as an approach to learning (Hatton & Smith, 1995). "He considered [reflection] to be a special form of problem solving, thinking to resolve an issue which involved active chaining, a careful ordering of ideas linking each with its predecessors" (Hatton & Smith, 1995, p. 33). Boud (2001) defined reflection as "those intellectual and affective activities in which individuals engage to explore their experiences in order to lead to new understandings and appreciations" (p. 10).

Kolb (1984) described reflection as "the way we give meaning to the world" (p. 147). Reflection causes learners to "recapture, notice, and re-evaluate their experience" (Boud & Walker, 1993, p. 99) and it provides a vehicle to transform experiences into knowledge (Roberts, 2002). Thorpe (2002) explained reflection as "a means of monitoring our own learning, both what we know, how we know it, and the process through which we learn" (p. 80).

The most important reflection occurs after the event or experience has transpired. This is partly because the "immediate pressure of acting in real time has passed" (Boud, 2001, p. 13). This involves the individual thinking about the experience, focusing on the feelings and emotions that occurred because of the event, and reevaluating the experience (Boud, 2001). Reevaluation includes "relating new information to that which is already known, seeking relationships between new and old ideas, determining the authenticity for ourselves of the ideas and feelings that have resulted, and making the resulting knowledge one's own" (Boud, 2001, p. 14).

"Journaling in its various forms is a means for recording personal thoughts, daily experiences, and evolving insights" (Hiemstra, 2001, p. 19). Journaling can be used to revisit past reflections, couple them with newly formed opinions and experiences, and further the learning process (Hiemstra, 2001). Professional development can occur through journaling if "dilemmas, contradictions, and evolving worldviews" (Hiemstra, 2001, p. 20) are confronted.

Moreover, "[t]here is considerable evidence of the tremendous benefit possible through a journaling technique" (Hiemstra, 2001, p. 25). Writing tasks often are used as reflection tools because the authors must be specific about what they do or think; in turn, this promotes an attitude of reflection (Hatton & Smith, 1995). "The reflective journal holds potential for serving as a mirror to reflect the student's heart and mind" (Hubbs & Brand, 2005, p. 60). Specifically, journal writing can be "a form of reflective practice, that is, as a device for working with events and experiences in order to extract meaning from them" (Boud, 2001, p. 9). "The advantage available in most journaling formats of being able to review or reread earlier reflections makes a

progressive clarification of insights possible" (Hiemstra, 2001, p. 20).

Prompting is an important part of the process of learning through reflection (Roberts, 2002). "Asking questions beforehand increases the intentionality of the consciousness or the 'orientation of the mind to its object' thus deepening the experience" (Russell & Vallade, 2009, p. 104). One concern with journal writing, however, is students may write differently because they know the instructor will read their entries (Walker, 2006), i.e., "they write what they think the instructor wants to hear instead of writing about what is true to them" (p. 220). Such a concern and its consequences was a limitation of this study.

Conceptual Framework

Learning is "the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience" (Kolb, 1984, p. 41). To that end, this study was guided by Kolb's (1984) theory of experiential learning. Kolb's (1984) four phases include concrete experience, reflective observation, abstract conceptualization, and active experimentation or *testing*. A learner lives through an experience, observes and reflects on said experience, forms abstract concepts or implications regarding the experience, and thereafter uses those implications to guide his or her choices or testing of future experiences. Moreover, reflective journaling allows journal writers to describe and illuminate their understanding at all four stages of the experiential learning cycle (Hubbs & Brand, 2005); therefore, Kolb's (1984) model fit well with this study.

Purpose and Research Questions

The study's purpose was to describe how select Kenyan and Ugandan Food Security Fellows made meaning of their experiences regarding U.S. culture, their internship or job shadowing experiences, the training procedures, and the group activities provided during a professional and cultural exchange program. Three research questions guided the study:

1. How did the Fellows' understanding of American culture and U.S. citizens' change as a result of the program?
2. What were the benefits and challenges as perceived by the Fellows who participated in an internship or job shadowing experience?
3. What were the reactions of the Fellows toward the training experiences and activities that resonated with their professional roles, especially aspects relevant to improving food security in their home countries?

Research Methods and Procedures

Permission was obtained from OSU's Office of University Research and its Institutional Review Board to conduct the study. To gain understanding of how the Fellows made meaning of their experiences, they recorded daily journal entries during their stay in the United States. The Fellows were given a composition notebook for journaling. The journal entries stood to provide rich, thick descriptions of their experiences (Lincoln & Guba, 1985).

Hubbs and Brand (2005) said expectations should be clear and guidance provided when expecting individuals to reflect. In addition, Dunlap (2006) concluded the facilitator of the journaling exercise should "provide students with cues or guided questions to help them focus their journal responses" (p. 22). Therefore, journal prompts were provided to promote reflection and assist in answering the research questions. Preflection questions

were included as journal prompts to help participants ready themselves for the program and reflective questions probed their daily experiences. An example preflection question was, "How do you expect the culture of the United States to be different from Kenya/Uganda?"; one of four daily prompts was, "Describe what you learned today and how that could be applied to your professional life."

At the program's end, the journals were left with the researcher who transcribed the entries verbatim. Thereafter, ATLAS.ti was used to code and store the data. An inductive approach to coding was followed (Hsieh & Shannon, 2005). When using inductive analysis, "qualitative researchers build their patterns, categories, and themes from the 'bottom-up,' by organizing the data into increasingly more abstract units of information" (Creswell, 2007, p. 38).

Journal entries were read prior to transcribing, during the transcription process, and again after all entries were transcribed to ensure complete data immersion and comprehension. While transcribing, the researcher created memos of reactions and possible interpretations of the data. Memoing "could be in the form of preliminary propositions (hypotheses), ideas about emerging categories, or some aspects of the connection of categories" (Creswell, 2007, p. 239). Memos were developed (Creswell, 2007) and captured in the ATLAS.ti program to help define the codes and also to assist in creating inferences based on latent content. The line-by-line or open coding (Creswell, 2007) was done to ensure the reading of each recorded word and to develop unique codes (Hsieh & Shannon, 2005). The level of abstraction of the coded content was one to two sentences. The transcribed entries were converted from Microsoft Word documents to text files and those files were uploaded to the ATLAS.ti program.

After coding three journals, the codes were revised and redefined so the study's research questions could be addressed and justified through the journal entries. This enabled constant comparison of the data; thus, codes and research questions, as codes, were adjusted continually (Creswell, 2007). As more codes emerged, the coded journals were reexamined to maintain coding consistency. The coding yielded 41 codes. Quotes from these codes were sorted into related categories based on the study's research questions. Themes were then developed from the coded data (Creswell, 2007) and used to organize the findings by research question.

Researcher Reflexivity and Trustworthiness

Creswell and Miller (2000) described eight techniques to improve the validity of qualitative research. Creswell (2007) recommended "qualitative researchers engage in at least two of them in any given study" (p. 209). The lead researcher used four of these procedures: reflexivity; member checking; rich, thick descriptions; and peer debriefing (Creswell, 2007).

To show reflexivity, "the researcher comments on past experiences, biases, prejudices, and orientations that have likely shaped the interpretation and approach to the study" (Creswell, 2007, p. 208). To address reflexivity, the researcher kept a daily journal. The journal described the researcher's biases and assumptions that may have influenced the analysis and interpretation of the data. To acknowledge biases, the researcher reports involvement in planning and executing the Fellows' training program as well as daily interactions. Involvement also occurred during a 12-day period when the researcher traveled to Uganda the summer prior to the study.

The Fellows were provided, via electronic mail, transcriptions of their journal entries and were given a week to respond with changes. This allowed them to "judge the accuracy and credibility of the account" (Creswell, 2007, p. 208). Four Fellows responded with corrections that were made. Rich, thick descriptions of the Fellows' views and settings were developed to help the reader determine if the findings are transferable or applicable to other interdisciplinary exchange programs or similar scenarios in the future (Creswell, 2007). Weekly, peer debriefings were also conducted, including consultations with a doctoral candidate from Kenya, two U.S. doctoral students who had traveled to Uganda, and four other qualitative researchers. Finally, to protect the Fellows' identities, aliases were assigned and an extensive audit trail was kept.

Findings

Four themes emerged from the data in regard to Research Question #1.

The Fellows left the United States with a more positive attitude about Americans when compared to their attitudes toward Americans on arrival to the United States. One Fellow provided this comment in his journal:

> I used to think that not many Americans were friendly. What I saw here in the five weeks was different. Although the people I would meet on elevators did not readily show good responses to greetings, those we were meeting in the offices, farms, ranches and other places we visited have been very welcoming and sharing with us. For example, the day I was with the Stillwater City Council, one of the staff was so excited to meet me that he quickly phoned his wife and jointly invited me and hosted me at their home that very evening. I was amazed by this philanthropy and openheartedness. (F3: 909-917)

A Fellow also wrote "this program has changed my view about the American people as anti-social. I found the Americans to be courteous, social and always ready to assist" (F9: 174-176).

The Fellows found citizens of the United States to have a lack of knowledge about geography and worldly issues. For example, one Fellow made this journal entry:

> People of America are ill-exposed. I came to realize that a very small percentage of Americans know the world and what actually goes on. I was surprised that a high percentage of university students actually think Africa is one country, to the extent that they don't even know Uganda exists! (F3: 918-924)

Another Fellow wrote, "American youths do not know much about what is happening outside of their country. Their views on Africa are only guided by sorrow and lies of hunger, disease, poverty and war that is [sic] seen on TV" (F4: 49-51).

The Fellows found citizens of the United States to be generous, helpful, and dedicated to their careers and relationships. "A journalist at *The Oklahoman* surprised me this morning with gifts for my little daughter, and before I had overcame my excitement my two internship hosts had filled my desk with kids stuff" (F15: 171-173). Further, this Fellow was ". . . impressed by the sense of purpose among people who stay on top of their game here" (F15: 220-221).

The Fellows noticed a "sense of community," which left them inspired to do

more. To this end, a Fellow reflected on his work situation at home:

> . . . [M]any of the staff I work with [at home] are not fully committed in serving the community for which they work. They are not very dedicated, evidenced by the need to follow them every time specific tasks are given to them. But also, the general community in the district seems to lack commitment and passion in whatever they do. (F3: 389-393)

However, another Fellow wrote the exchange program "inspired me to be more pro-active in my community work related to food security and with my contacts I can help my village do more in food security. I can be involved in outreach programs" (F14: 146-148). A different Fellow drew this conclusion: "I've learned that service to humanity is the most important mission of every human being. That I can only be relevant to my community if I am of service to it" (F15: 266-268).

Two themes emerged from the data in regard to Research Question #2.

The Fellows welcomed the opportunity to learn from their professional peers and mentors in the United States. For example, one Fellow was excited to "learn how best to do things from Americans who are very successful in so many spheres" (F9: 13-14). Another Fellow explained,"[t]hese experiences are directly linked to my job. I [now] have a wider understanding from a global perspective" (F5: 133-135). And a third Fellow stated:

> Before this internship, I knew my job as a university lecturer was to teach, conduct research and outreach. However, because of the separation of the three functions in Uganda, it is always difficult to connect the three. Experiencing first-hand how the three function at Oklahoma State University improved my understanding of the job I do. (F12: 174-177)

The Fellows desired specific jobs but some were given the task of an observer during their internships; however, learning still occurred. For example, a Fellow indicated his role was more job shadowing or ". . . [as] that of a learner, my task was to inquire how things are done at the respective places, policy implications and challenges faced" (F3: 852-853). The media professionals had more specific tasks during their internships, which provided them the most hands-on experiences among the Fellows. One media professional wrote, "I've been published in *The Oklahoman* [, the state's largest newspaper]! The article, about the Listeria outbreak in cantaloupe, was at one point the most viewed on newsok.com and closed the day at number three" (F15: 145-149). A third Fellow wrote, "I have learned a great deal of lessons from my internship and more so on how to improve the food security situation in Africa, especially through correct policy guidelines and implementation processes" (F7: 542-544).

Five themes emerged from the data in regard to Research Question #3.

If food security and production is to improve, the youth must be involved in agricultural endeavors. To this end, one Fellow elaborated:

> The driving force behind agricultural development in the United States has been youth development programs. One of the greatest lessons I learned out of the interaction with the extension agents and members of American youth development

> programs (4-H and FFA) was that American agriculture students are trained to support agricultural systems in various areas, including agricultural engineering, manufacturing, agribusiness, marketing, communication and leadership. The leadership component of the training is the most attractive element for the students, and they just love it! (F7: 118-127)

Extension services in Kenya and Uganda need to link teaching and research more effectively to be more efficient in sharing best practices with the agriculturists. To wit, two Fellows indicated these positions: "The extension system in the United States is kind of similar with that of Kenya, except for the close collaboration between teaching and research" (F6: 84-85). "There is a need for enhanced collaboration between research, teaching and communications (extension) in my country to improve food security" (F6: 57-58). Another Fellow concluded that,

> [t]he inter-connectedness of extension and research make the farmers get the necessary technologies and advice for improving productivity. As a policy fellow, I take it as a king pin to be adopted and implemented if the necessary change in food security is to be realized by my local government and the central government as well. (F3: 102-105)

Using the media as an ally and being proactive can increase agricultural knowledge. To this point, one Fellow stated "[t]he importance of building relationships with the media should not be overlooked" (F5: 72-73). Another Fellow maintained "[t]here is a need to create trust between agricultural professionals and journalists. If our message is to get to the community, the media will have to be our partner" (F6: 415-417). Another Fellow commented on using social media: "I learned about the use of social media to catalyze communications and I will be more active in Twitter and Facebook to remain in contact with my peers" (F9: 149-150).

Networking is invaluable and should be emphasized. In accord, a Fellow stated, "I can maximize my ability to improve food security in Kenya through improved linkages between media, the communities and the strengths in [sic] policymakers. The network I have established will be very useful in addressing food security in Kenya" (F9: 202-206). Another Fellow maintained the exchange program "has started a long-term collaboration between Gulu University and Oklahoma State University and I look forward to positive outcomes" (F12: 80-81).

The Fellows believed they could make a difference. In support, one Fellow wrote this:

> I feel I am not the same. I have changed a lot. My worldview has dramatically improved. I feel humbled. I feel I have much respect for others and responsible for all my actions. I am excited to bring about change in my organization and society. (F7: 621-624)

Finally, a Fellow made this journal entry: "At times, we do not need political power to make change in our societies, all we need is the courage and vigor to change the world" (F4: 185-187).

Conclusions and Implications

The Fellows were eager to experience the United States, as 12 of the 14 had not been to the United States before, but they were somewhat apprehensive, as well.

Their main concerns included perceptions of Americans being arrogant and unhelpful. During the exchange, however, they enjoyed the generosity of Americans and appreciated their willingness to help them whenever possible. The Fellows also realized Americans tended to lack global knowledge, especially about Africa and their countries in particular. Some of the Fellows' views were based on their interactions with U.S. undergraduates. After the program was complete, many of the Fellows had a different attitude toward Americans, specifically regarding diversity and culture.

In addition, the professional exchange program allowed the Fellows to experience the dedication, passion, and work-related commitment of Americans. They gained an appreciation of the career-mindedness of some Americans. The Fellows' expressions of a new outlook on American culture and people is in agreement with Pires (2000), who stated international experiences allow people to acquire an understanding of other cultures. Misconceptions about countries will be righted and these experiences help to eliminate the "haves and have nots" (Pires, 2000, p. 42) attitude. Providing the Fellows with specific information before their travel, at the beginning of the program, and continually throughout the program may have helped the Fellows gain a sense of security, which allowed them to overcome the negative aspects of culture shock (Boyle et al., 1999; Geelhoed et al. 2003).

The Fellows appreciated the opportunity to complete training experiences related to their professional positions. This echoes Rodriguez and Roberts (2011) who concluded students placed a high value on applied learning activities while undergoing international experiences. Similar to Boyle et al. assertions (1999), the Fellows gained knowledge and experience from U.S. experts and increased their professional network. As a result, the Fellows perceived they had gained a solid foundation for impacting food security in their home countries. That viewpoint supports Kolb's (1984) posit about individuals *testing* their understanding of a concept by undertaking new experiences. The media Fellows were given specific tasks or jobs during their internships; however, the policymakers and community leaders indicated they had more of a job shadowing experience, which, for some, was less specific or job task-oriented.

The Fellows also realized the importance of involving youth in agricultural endeavors. According to the Fellows, careers in the agriculture sector are not popular choices for many students in Kenya and Uganda. For example, one Fellow wrote that "as a university lecturer, I have taught students who are either forced to do agriculture by their parents or do it as a last resort because they have failed to be taken for either human medicine, [or] pharmacy" (F12: 62-64). Therefore, the Fellows were impressed with how the agricultural education/FFA and 4-H programs they witnessed led youth willingly and enthusiastically toward agricultural careers.

The Fellows perceived a need for close links between research, Extension, and the farmer because this approach to communication allows best practices to be shared with local farmers to help improve their efficiency and effectiveness (Mutimba, Knipscheer, & Naibakelao, 2010). In support, a Fellow indicated the "need [existed] for enhanced collaboration between research, teaching and communications (extension) in my country to improve food security" (F6: 57-58).

The Fellows identified using media outlets as a method to share agricultural information proactively with the public. They planned to use the networks developed

through this grant-funded program – African counterparts and new American colleagues – to enhance their impact on food security in SSA and also indicated a desire to increase commitment to their respective careers. However, the Fellows expressed an awareness of the challenges and obstacles they would face as change agents for improved food security in their home countries.

Recommendations for Practice and Additional Research

Similar exchange programs should be offered that include learning opportunities for preflection, reflection, and post-reflection by the participants. In addition, other U.S. institutions of higher education should seek funding to host exchange programs that promote scholarship, professional fellowship, and cultural understanding for the international visitors and the U.S. citizens who participate. Participants in future programs should be provided the opportunity to experience internships with actual *hands-on* job roles instead of only shadowing experiences.

Exchange programs calibrated to improve food security should continue with an increased emphasis on agricultural education and extension programs that feature youth development. Agricultural professionals from developing countries should learn about agricultural education/FFA, 4-H, and other youth organizations in agriculture and how they encourage individuals to pursue agricultural careers. Communication networks should be established in other developing countries to assist in creating opportunities for youth development in agriculture. More U.S. students should take part in learning experiences, including study abroad or cultural exchange programs, involving African countries (Pires, 2000).

The opportunity exists to *triangulate* this study's findings with post-reflection interviews collected after the Fellows returned home and the project's external evaluation report to obtain a more complete understanding of the project's impact. Moreover, a follow-up study should be conducted to examine communication behaviors among the Fellows throughout time to ascertain lasting impacts on their networking, especially in regard to improving food security. In addition, more research is needed to understand better the benefits and challenges associated with mid-career professionals participating in international exchanges. Inquiries also should be done to describe the qualitative differences between internships and job shadowing experiences.

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Awareness, Use, and Perceptions of Biodiesel by Belgian and American College Students

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Abstract

Biodiesel is a renewable liquid transportation fuel with potential to extend petroleum supplies and reduce tailpipe emissions of particulate matter, unburned hydrocarbons, and carbon monoxide (CO) and reduce life-cycle carbon dioxide (CO_2) emissions relative to petroleum diesel. However, little is known about how various groups, either internationally or domestically, view biodiesel. This study examined Belgian and American college students' awareness, use, and perceptions of biodiesel. A higher percentage of Belgian students versus American students reported driving diesel automobiles (60% and 17%, respectively) and being aware of biodiesel (100% and 86%, respectively). However, only 4% of either Belgian or American students had purchased biodiesel. Belgian students were undecided and American students slightly agreed there were renewable and environmental benefits of biodiesel use. Both Belgian and American students were undecided about biodiesel quality, with Belgian students being more uncertain. Belgian and American students were also undecided if there were negative externalities associated with biodiesel. Both groups tended to agree that continued long-term reliance on fossil fuels is not sustainable; however, Belgian students agreed more strongly than American students. While there were significant differences between Belgian and American students, both groups were largely undecided about biodiesel quality and the food and economic consequences of biodiesel production and use; differences were primarily in the degree of uncertainty. Both groups (especially Belgian students) were concerned about continued reliance on fossil fuels. Given the low level of use and the high degree of uncertainty, efforts should be made to educate Belgian and American college students about biodiesel.

Keywords: Biodiesel, Perceptions, Survey, Belgium, United States

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Introduction

Worldwide biodiesel production increased from 17.8 billion liters in 2009 to 21.4 billion liters in 2012, a four-year increase of 20.2%. In 2011, the United States ranked first in biofuel (ethanol and biodiesel) production by country, with a total of 57.4 billion liters produced (REN21, 2012). Of the total, 3.2 billion liters were biodiesel. Belgium was the 11th highest biofuel-producing country, totaling 0.8 billion liters. Biodiesel use increase has occurred because of energy mandates put into place in both countries, to reduce fossil fuel dependency and improve Green House Gas (GHG) emissions.

This renewed interest of liquid biofuels among the public, government, and industry was largely caused because of diminishing petroleum supplies, increasing energy demands, the geographical concentration of known petroleum reserves, and concerns about the environment (Koonin, 2006; Rojey & Monot, 2010). The U.S. Energy Independence and Security Act of 2007 mandated that 136 billion liters of renewable biofuels be in use by 2022 (Schnepf & Yucobucci, 2010). Likewise, in 2009, the European Union (EU) adopted the Renewable Energy Directive setting a target of 10% biofuels for all transportation fuels by 2020 (Böhringer, Rutherford, & Tol, 2009). U.S. biofuels policy has been mandate-driven and there is minimal pressure to change that position while the European Union (EU) is verging toward more reliance on mandates (Ziolkowska, Meyers, Meyer, & Binfield, 2010).

Commercially available liquid biofuels are considered to be first generation biofuels, because they are produced primarily from food crops (cereals, sugar crops, and oil seeds) using mature technologies (Sims, Mabee, Saddler, & Taylor, 2010). Although there is strong political and agricultural industry support for first generation biofuels, not all critics have been convinced of the net benefits of increased production and use. Some question the performance (Skipper, Van de Velde, Popp, Vickery, Van Huylenbroeck, & Verbeke, 2009), environmental consequences (Lehrer, 2010), economic impacts (Pimentel, 2009), and food availability and cost effects of first generation biofuels (Naik, Goud, Rout, & Dalai, 2010). While there is a great deal of scientific interest and on-going research concerning second generation biofuels (produced from non-food feedstocks, such as lingo-cellulose and algae), commercialization is estimated to be a decade or more in the future (Sims et al., 2010).

Ulmer et al. (2004) examined Oklahoma consumers' attitudes toward ethanol-blended gasoline. A majority (59.2%) of respondents indicated that reduced U.S. dependence on foreign oil was the greatest benefit of ethanol-blended gasoline. No significant relationship was found between consumers' willingness to purchase an ethanol blend and the demographic variables of gender, education, income, age, or urban versus rural residence. These results partially conflict with previous research indicating that females (Zelezny, Chua, & Aldrich, 2000) and younger adults (Gronhoj & Thogersen, 2009) have more pro-environmental attitudes than males and older adults. A study to assess consumers' perceptions related to biofuel use in transportation, conducted in the northwestern part of Romania, noted that participants believed biofuel was cleaner and caused less pollution to the environment (Mariasiu, 2013). Of the 1036 respondents, 55.6% agreed they would be willing to pay more for biofuels to ensure less pollution and a cleaner environment. Research comparing Belgian and American consumers noted similarities and differences

between the two groups (Popp, Van de Velde, Vickery, Van Huylenbroeck, Verbeke, & Dixon, 2009). Consumers in both countries ranked fuel economy and purchase price as highly important factors in deciding whether to purchase a gasoline, diesel, or biofuel automobile.. High income Americans were less concerned with fuel economy. American consumers, having both higher fuel taxes and average annual miles driven, were more concerned than Belgian consumers over fuel prices.

A recent study assessing Greek university students' perceptions of energy and the environment noted that students are "overwhelmingly positively disposed towards the environment" (Charisiou & Goula, 2012, p. 9). Students believed protecting the environment should take precedence over economic consideration and 82% believed bioenergy was an acceptable method to reduce global warming. Halder (2011) studied the importance of bioenergy knowledge, perceptions, and attitudes among young citizens. The study found three influential dimensions of bioenergy perceptions and attitudes: (a) practical, (b) motivation, and (c) critical. The study identified critical perceptions of bioenergy among the younger generation and noted distinct differences between American and Belgium students; namely Belgium students did not have positive perceptions toward bioenergy, but were interested in learning more, and American students knew little of bioenergy but were excited to use it.

Previous comparative research on the acceptance of genetically-modified organisms (GMOs) in the food supply provided evidence that American and Belgian students may differ in their perceptions and acceptance of other innovations such as biodiesel due to cultural factors (Gaskell, Bauer, Durant, & Allum, 1999; Wohlers, 2010). Differences in perceptions may also be influenced by increased urbanization and decreased agricultural land in Belgium. While these trends are also occurring in the U.S., concerns may be more muted due to the lower population density and greater availability of arable crop land in the U.S. as compared to Belgium (Central Intelligence Agency, 2013; Tempels, Verbeek, Pisman, & Allaert, 2012).

Understanding consumers' perceptions, attitudes, and knowledge about energy and environmental technologies and programs can provide a framework for educational strategy and policy development (Segon, Stoer, Domac, & Yang, 2004). Public opinion surveys about renewable energy sources have become increasingly important. These surveys have been used to assess awareness, attitudes, and knowledge, and have provided a springboard to overcoming social barriers toward renewable energy sources (Segon et al., 2014).

Knowledge of current levels of GHG emissions and the prediction of a 50% increase in population on Earth by 2050 has reached consumers worldwide. Today, consumers are increasingly more aware of their purchasing behaviors with regards to the environment (Van de Velde et al., 2009). Biofuels give consumers an opportunity to purchase a transportation fuel that reduces harmful emissions to the environment; however, some consumers question other potential consequences of the use of biofuels. A consumer survey that assessed American and Belgian citizens' perceptions determined that respondents with heightened awareness towards the environment felt that renewable fuels could potentially result in higher food costs (Skipper et al., 2009). However, both American and Belgian consumers preferred low food prices over low fuel prices. The research noted that environmental concerns were largely the same between respondent groups.

Acker (2008) noted the importance of educating students, consumers, and policymakers about renewable energy, including biofuels. The research further noted that education was one of three primary needs necessary to expand the renewable energy market. Specifically, Acker recommended educational programs target industry personnel, school groups, and the general public. Additionally, Wingenbach, Boyd, and Lindner (2003) noted the importance of understanding students' knowledge and attitudes about international agricultural issues to prepare them for the workforce. College students will play an important role in the development and use of biodiesel as citizens, consumers, teachers, business leaders, voters, policy makers, and scientific and technical experts (Acker, 2008; Cortese, 2003). Yet, little is known about how these students view biodiesel production and use (Zyadin et al., 2012). Thus, the purpose of this study was to determine and compare Belgian and American college students' use, awareness, and perceptions of biodiesel in an effort to determine educational needs for the future.

Research Objectives

This study was used to:

1) Determine and compare the awareness, use, and perceptions of biodiesel among retail fuel consumers in America and Belgium; and
2) Determine if there were significant relationships between awareness, use and perceptions of biodiesel and selected consumer demographic characteristics among American and Belgian fuel consumers.

Research Methods

The population for this study was comprised of students enrolled in an introductory agricultural economics course at the U.S. University (University of Arkansas) and an introductory chemistry course at the Belgian University (University of Ghent) during fall 2011. The survey was administered in each class during the fall semester of the 2011-2012 academic year. Prior to administering the survey, a brief statement was read to students describing the purpose of the study and assuring students their participation was voluntary and responses would be anonymous. At the U.S. University, 90 of 105 (85.7%) students enrolled were present and provided usable responses; at the Belgian University 119 of 120 (99.2%) were present and provided usable responses. The anonymous nature of responses precluded follow-up of absent or non-responding students.

The survey instrument was developed by the researchers based on a review of the literature related to consumer awareness, use, and perceptions of biofuels (Halder et al., 2011; Kinsey, Peterson, & Haines, 2003; Skipper et al., 2009). The completed instrument contained three sections. Section one had three items to determine if the respondent owned or drove a diesel-fueled vehicle, had ever heard of biodiesel, or had ever purchased biodiesel. (The second item was used as a screening question; respondents indicating they had never heard of biodiesel were directed to proceed directly to the demographic items.) Section two contained 34 items on a 1 to 5 Likert-type scale (1 = *strongly disagree* and 5 = *strongly agree*) designed to determine respondent perceptions about biodiesel. To prevent response set, 11 of these 34 items were negatively worded. Section three contained three demographic items related to gender, age, and type of area where the student was raised [farm, rural - nonfarm,

town (≤ 10,000 population), or city (>10,000 population)].

The test-retest procedure was used to determine instrument reliability (Gall, Gall, & Borg, 2006). The survey was administered twice, at a 14 day interval, to seven American undergraduate students not included in the main study. The coefficients of stability were 1.0, 0.81, and 0.99, for sections one, two, and three, respectively. A panel of six individuals with expertise in survey methods (n = 3), biofuels research (n = 1), biodiesel marketing (n = 1), and Belgian university teaching (n = 1) reviewed the instrument and judged it to possess face and content validity.

Data were analyzed using descriptive and inferential statistics. Principal components analysis was used to identify the number and nature of the underlying factors responsible for covariance in the 34 items designed to measure perceptions of biodiesel (section two). Following principal components analysis, negatively worded items were reverse-coded and factor scores were constructed for each identified factor, factor reliabilities were assessed, and the resulting factor scores were used as criterion variables in subsequent multiple regression analyses (Hair, Anderson, Tatham, & Black, 1998; Hatcher, 1994). The 0.05 alpha level was selected *a priori* for all tests of statistical significance.

Findings

The typical Belgian student (N = 119) was male (65%), grew up in a town (38.5%) or city (26.5%), was majoring in engineering (87%), and was 19.0 (SD = 0.72) years old. The typical American student was also male (58.6%), grew up on a farm (35%) or in a rural area (21%), was majoring in agriculture (80%), and was 19.9 (SD = 3.3) years old.

A majority of Belgian students, but less than one in five American students, reported owning or driving a diesel automobile (see Table 1). Awareness of biodiesel was high for both Belgian and American students, but, at 100%, was significantly higher for Belgian students. Only about 4% of either Belgian or American students had ever purchased biodiesel. Among those owning or driving a diesel vehicle, 7% of Belgian and 27% of American students reported they had previously purchased biodiesel.

Table 1

Vehicle Fuel Type and Awareness and Use of Biodiesel for Belgian and American College Students

Statement	Belgian %(*f*)	American %(*f*)	χ^2
I own or drive a diesel automobile	60.3(70)	16.8(15)	39.25****
I was aware of biodiesel prior to this survey	100.0(117)	85.6(77)	18.03****
I have purchased biodiesel or a biodiesel blend	4.3(5)	4.4(4)	0.01

Note. **** p<.0001.

Data from the 34 biodiesel perception items were subjected to exploratory factor analysis, using the FACTOR procedure in SAS Version 9.3 (SAS Institute, 2013), to identify latent factors. The principal factor method was used to extract the factors,

followed by a promax (oblique) rotation. Based on the scree plot of eigenvalues, the proportion of variance explained, and the interpretability of the factors (Hatcher, 1994), four factors: (a) Renewable and Environmental Benefits, (b) Negative Externalities, (c) Low Quality Fuel, and (d) Lack of Concern; were identified and named (see Table 2). These four factors explained 100% of the variance in the original 34 items.

Table 2

Factors, Loadings, and Scale Reliabilities for Student Responses to the Biodiesel Survey

Item	Factor loading
Factor 1: Renewable and Environmental Benefits ($\alpha = 0.77$)	
Biodiesel can significantly reduce dependence on foreign oil	0.67
Biodiesel produces fewer harmful exhaust emissions than petroleum diesel	0.67
By buying biodiesel I can contribute to a cleaner environment	0.64
It is better to use biodiesel since it is made from renewable resources	0.62
The Belgian [U.S.] government should support biodiesel research	0.52
Increased use of biodiesel will decrease global warming	0.49
I am willing to go out of my way to purchase biodiesel	0.45
Factor 2: Negative Externalities ($\alpha = 0.71$)	
Increased use of biodiesel will cause a shortage of food	0.73
Increased use of biodiesel will cause an increase in the cost of food	0.67
Increasing biodiesel production will decrease food production	0.62
Most new jobs resulting from increased biodiesel use will be low-paying jobs	0.46
Increased use of biodiesel will increase farmers' income	-0.46
Factor 3: Low Quality Fuel ($\alpha = 0.74$)	
Using biodiesel results in increased engine repair and maintenance costs	0.71
Diesel engines will not run properly on biodiesel	0.66
I would never use biodiesel in a diesel engine	0.63
If I had a diesel car or truck, I would use biodiesel	-0.55
Biodiesel is better for my engine than petroleum diesel	-0.52
Factor 4: Lack of Concern ($\alpha = 0.66$)	
Emissions from automobiles have no effect on average global temperatures	0.77
I believe that average global temperature is increasing	-0.67
There are sufficient oil resources to meet Belgian [U.S.] petroleum needs for the foreseeable future	0.47

Items with negative factor loadings were reverse-coded and individual factor scores were calculated by summing all responses within a factor and dividing this sum by the number of items (Hatcher, 1994), resulting in factor scores that retained the original 1 to 5 scaling. The real limits for the scaled responses were defined as 1.00 to 1.49 =

strongly disagree; 1.50 to 2.49 = *disagree*; 2.50 to 3.49 = *undecided*; 3.50 to 4.49 = *agree*; and 4.50 to 5.00 = *strongly agree*.

Based on the nature of the factors, care must be used in interpreting factor scores. Higher factor scores for the Renewable and Environmental Benefits factor represent more positive perceptions of the benefits of biodiesel use; conversely, higher factor scores for the Negative Externalities, Low Quality Fuel, and Lack of Concern factors represent more negative perceptions of biodiesel.

Based on mean scores (see Table 3), Belgian students were categorized as undecided about the Renewable and Environmental Benefits, the Negative Externalities, and the Low Fuel Quality biodiesel factors. Belgian students disagreed with the Lack of Concern factor, indicating they had concerns about the supply and environmental aspects of continued reliance on fossil fuels. The mean scores for American students indicated they agreed with the Renewable and Environmental Benefits factor, disagreed with the Lack of Concern factor, and were undecided about the Negative Externalities and Low Fuel Quality Factors.

There was no statistically significant difference between Belgian and American students on perceptions of the Renewable and Environmental factor, with the mean for Belgian students near the upper limit of the undecided category and the mean for American students near the lower limit of the agree category. Both Belgian and American students were undecided about the Negative Externalities and Low Quality Fuel factors and disagreed with the Lack of Concern factor. However, there were statistically significant differences between Belgian and American students on the Negative Externalities (lower mean for American students), Low Fuel Quality (lower mean for American students), and Lack of Concern (lower mean for Belgian students) factors. The difference between means for the Negative Externalities factor was relatively small (Δ= 0.18); however, the differences for the Low Quality Fuel and Lack of Concern factors were larger (Δ = 0.53 for each). Using Cohen's (1988) effect size descriptors, the difference between the means for Belgian and American students was small (Cohen's d = 0.30) for the Negative Externalities factor, and large for the Low Quality Fuel (Cohen's d = 0.76) and Lack of Concern (Cohen's d = 0.80) factors.

Table 3

Comparison of Belgian and American *College Students' Perceptions of Biodiesel Factors*

	Belgian		American		
Factor	*M*	*SD*	*M*	*SD*	*t*
Renewable and environmental benefits	3.48	0.50	3.57	0.64	1.09
Negative externalities	2.96	0.57	2.78	0.59	2.05*
Low quality fuel	3.10	0.52	2.57	0.58	6.51****
Lack of concern	1.87	0.56	2.40	0.81	4.97****

Note. $^{****}p < 0.0001$, $^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$.

Among Belgian students there were significant negative correlations between student age and level of agreement with the Low Quality Fuel (r = -0.26) and Lack of

Concern (r = -0.24) factors; older students tended to perceive biodiesel as higher in quality and were more likely to have concerns about continued reliance on fossil fuels. There was also a significant negative relationship (r = -0.20) between the size of community in which the student was raised (dichotomized as farm/rural or town/city) and their level of agreement with the Negative Externalities factor; students from towns or cities tended to be less concerned about potential negative effects of biodiesel production and use. However, no demographic characteristics explained more than 7% of the variance in Belgian students' perceptions of any biodiesel factor. There were no significant relationships between gender and any of the four biodiesel factors.

Among American students there was a significant positive relationship (r = 0.25) between gender and level of agreement with the Negative Externalities factor, with females tending to have stronger concerns about potential negative consequences of biodiesel use. There was also a significant negative relationship (r = -0.27) between the size of community in which the student was raised (dichotomized as farm/rural or town/city) and level of agreement with the Lack of Concern factor; students from towns or cities tended to have higher concerns about continued reliance on fossil fuels. Both demographic characteristics explained less than 8% of the variance in the level of agreement with either biodiesel factor.

Conclusions and Implications

Belgian students were more than three times as likely to own or drive a diesel vehicle and, at 100%, were more likely to be aware of biodiesel than were American students. Despite this greater use of diesel vehicles and greater awareness of biodiesel, Belgian students were no more likely to have previously used biodiesel than were American students (4.3% and 4.4%. respectively). This finding was interesting because Belgium has had a B4 blending mandate since 2009; do students not consider "blends" to be biodiesel? Additional research should be conducted to answer this question. This research also noted that among only those driving diesel vehicles, American students were actually more likely to have purchased biodiesel than Belgian students.

The results of principal components factor analysis indicated 100% of the variance in responses to the 34 items measuring perceptions of biodiesel could be explained by four factors: (a) Renewable and Environmental Benefits, (b) Negative Externalities, (c) Low Quality Fuel, and (d) Lack of Concern. Belgian and American students were undecided about the Negative Externalities and Low Quality Fuel factors and disagreed with the Lack of Concern factor. The mean scores for the Renewable and Environmental Benefits factor placed Belgian students near the upper real limit of the undecided category and American students at the lower real limit of the agree category.

When comparing mean scores, there were significant differences between Belgian and American students on three of the four factors. Belgian students rated the Negative Externalities and Low Quality Fuel factors higher (less positively) than did American students. Conversely, American students rated the Lack of Concern factor significantly higher (indicating less concern) than did Belgian students. However, given that the real limits for the levels of agreement with each factor did not differ by group, one must conclude these are differences along narrow continuums. There was no significant difference between Belgian and American student means on the Renewable and Environmental Benefits factor. Both Belgian and American students had relatively "soft" perceptions of

biodiesel. Overall, Belgian students tended to be more negative toward the performance, food, and economic effects of biodiesel use. Both Belgian and American students had somewhat positive perceptions of the environmental effects of biodiesel. The finding that students maintain positive attitudes towards biodiesel and environmental concern supports previous research by Charisiou and Goula (2012) and Halder (2011). Further investigation should determine Belgian students' relatively negative perceptions of biodiesel performance.

Among Belgians, older students and those from towns or cities tended to be more positive about selected aspects of biodiesel production and use. Among American students females tended to be more concerned than males about the potential negative aspects of biodiesel use and students from towns and cities tended to have more concerns about continued reliance on fossil fuels. Demographic characteristics were not particularly robust predictors of perceptions of biodiesel for either Belgian or American students. This was also true for research completed by Ulmer et al. (2004).

Belgian and American students were largely uncertain about important aspects of biodiesel production and use. Thus, increased efforts are needed in both countries to better educate students about a variety of technical, economic, and societal issues related to biodiesel. Because of the vital role these students will play as consumers, citizens, opinion leaders, voters, and, in some cases, technical experts, increased educational efforts are essential. Additionally, research is needed to understand the basis for students' positive attitude towards environmental aspects of biodiesel. These attitudes may reflect generalized "positive bias" toward perceived "green technologies".

Understanding consumers' awareness, use, and perceptions of biodiesel is the first step in creating educational strategies to increase consumer acceptance. With fuel concerns and new global mandates, international agricultural and extension educators are in a unique position to educate consumers globally about biofuel production and use. This research should serve as in initial investigation into the needs for biofuel education internationally. Efforts should be made in the U.S. and the EU to educate consumers about biofuel production, use, and benefits. This research should serve as a catalyst for these efforts.

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