

Graduate STEM-Based Agriculture Education and Women Agriculturalists: An Agency Perspective

Matthew M. Mars¹ & Jeni Hart²

Abstract

In this paper, we explored the academic and professional aspirations, experiences, and perspectives of 11 women pursuing graduate degrees based in the science, technology, engineering, and mathematics (STEM) fields within research-intensive agriculture colleges at three land grant research universities in the United States (U.S.). Using principles drawn from the theories of human agency (Bandura, 1989, 2001; Emirbayer & Mische, 1998; Locke, 1978; Lukes, 1973; Sewell, 1992; Terosky, Campbell, & O'Meara, 2014) and gendered organizations (Acker, 1990, 2012) as our conceptual guide, we explored the conditions and contexts that influence the academic experiences and professional trajectories of emergent women agriculturalists who are enrolled in STEM-based graduate programs. We were particularly attentive to how such experiences and trajectories aligned with agricultural environments that have been shown to be masculine (i.e., large-scale farming and agribusiness, STEM-based agricultural research, Extension). The study developed a deeper understanding of the institutionalized conditions that influence the participation and leadership of women in solving the agricultural problems that confront society and the human condition. Implications for graduate STEM-based agriculture education are discussed and recommendations for both practice and future research are proposed.

Keywords: graduate STEM-based agriculture education, human agency, gendered organizations

Introduction

Women have been central to food and fiber production and consumption since civilization's shift from nomadic lifestyles to agrarian communities and economies some 10,000 years ago. Recent estimates have indicated that the work of nearly half (48%) of all economically active women worldwide in some way involves agriculture (Doss, 2014). Within developed economies, the role of women agriculturists has been mostly understood in the narrow contexts of small-scale farming activities aimed at sustaining families (Brasier, Sachs, Kiernan, Trauger, & Barbercheck, 2014; Flora, 1985; Rosenfeld, 1985; Sachs, 1988) and, more recently, alternative food production models (e.g., farmers' markets, community-support agriculture) (Allen & Sachs, 2007; Jarosz, 2011; Little, Ilbery, & Watts, 2009; Sbicca, 2012; Trauger, et al., 2008; Trauger, Sachs, Barbercheck, Brasier, & Kiernan, 2010; White, 2011). Consequently, there is a paucity of research that examines the pursuit and participation of women, and especially those with scientific and technological expertise, in large-scale agriculture (i.e., *mainstream agriculture*). The few studies that do exist on gender and mainstream agriculture have indicated that within this sector men control the large majority of natural, economic, and industrial resources (Pande, 2000; Phillips,

¹ Matthew M. Mars is Assistant Professor of Agricultural Leadership and Innovation and Director of Graduate Studies in the Department of Agricultural Education at The University of Arizona, 205 Saguaro Hall, Tucson, AZ, 85721, mmars@email.arizona.edu

² Jeni Hart is Professor of Higher Education in the Department of Leadership and Policy Analysis and Associate Vice Chancellor for Graduate Studies at the University of Missouri, 210 Jesse Hall, Columbia, MO 65211, hartjl@missouri.edu.

2006). Moreover, the scientific and technological fields that generate the research that sustains the competitiveness of mainstream agriculture also favor men (Meinzen-Dick et al., 2011).

Little is also known about the aspirations, experiences, and perspectives of women enrolled in graduate-level science, technology, engineering, and mathematics (STEM) degree programs in agriculture colleges. These graduate programs represent strategic entry points to careers in mainstream agriculture, as well as to other agricultural domains that have been shown to favor men and masculinity (e.g., agricultural research, Extension) (Barbercheck, Brasier, Kiernan, Sachs, & Trauger, 2014; Trauger et al., 2008). As such, research that considers graduate STEM-based agriculture education (GSAE) in the context of gender is warranted.

Our study aimed to fill the preceding gap by exploring the academic and professional aspirations, experiences, and perspectives of women pursuing STEM-based graduate degrees in agriculture (e.g., animal sciences, microbiology, plant sciences) within land grant research universities. Similar to mainstream agriculture, research has shown that graduate STEM education, as a field, has a gender bias in favor of men (Ferreira, 2002, 2003; Fox 2001; Griffin, Gibbs, Bennett, Staples, & Robinson, 2015; Herzog 2004). For example, De Welde and Laursen (2011) identified informal patterns of gendered-based exclusion in STEM doctoral programs. Studies have also indicated the masculinity of collegiate STEM education extends to the professional experiences and lives of women professors who must devote excessive time and attention to overcoming gender-based barriers to their success as university scientists (Bilimoria, Joy, & Liang, 2008; Howe-Walsh & Turnbull, 2016; Kaminski & Geisler, 2012; Xu, 2008). Here, we extended the preceding research through an exploration of the conditions and contexts that influence the academic experiences and professional trajectories of women enrolled in STEM-based graduate programs located in research-intensive agriculture colleges.

Literature Review

The roles and status of women within agricultural communities in developing countries have been of particular interest to researchers and policy advocates (Doss & SOFA Team, 2011; Quisumbing et al., 2014). Indeed, a range of economic, political, and socio-cultural conditions have been identified that both contribute to and challenge the capacity of women to productively engage in agricultural development and enterprise (Horna, Smale, & Von Oppen, 2007; Upadhyay, 2005). In particular, limited access to land, equipment, regulated markets, and technological support continue to stifle the overall productivity of farming women in developing regions (Peterman, Quisumbing, Behrman, & Nkonya, 2011; Quisumbing & Pandolfelli, 2010; von Holy & Makhoane, 2006). Recruiting women agriculturalists with advanced scientific and technological training to work in such regions is one proposed strategy for overcoming the preceding challenges (Meinzen-Dick et al., 2011). This recommendation presumes that there is a critical mass of women agriculturalists with advanced STEM backgrounds, as well as assumes these women agriculturalists would be interested in development work (and other feminized agricultural work).

The work of women agriculturalists in developed countries has been considered primarily within the context of small-scale family farms (O'Hara, 1998; Pilgeram & Amos, 2015; Preibisch & Grez, 2010). Such farming activities have been mostly depicted as opportunities for women to engage in food and fiber production in isolation of the gender biases that exist in mainstream agriculture. Women have also been recognized as leaders in alternative agricultural movements (e.g., local agriculture). In some cases, women have engaged in the production side of alternative agriculture in an effort to counter various economic, environmental, political, and social injustices that have been linked to mainstream agriculture (Allen & Sachs, 2007; Jarosz, 2011; Little et al., 2009; Sbicca, 2012; Trauger et al., 2008; Trauger et al., 2010; White, 2011). In other cases, women

have turned to alternative agriculture as a way of contributing to movements such as those that promote community development and public health (Chiappe & Flora, 1998; Sumner & Llewelyn, 2011; Trauger, 2004; Trauger et al., 2010). Yet, engagement in alternative agriculture has also been revealed as an economic reality as “women entering farming are doing so with limited capital and, unless they marry into farming, are left to farm small-acreage farms that are best suited to sustainable production” (Pilgeram & Amos, 2015, p. 35). In this regard, small-scale family farming and alternative agriculture, at least in part, has served a “cooling out” function through which women farmers and food entrepreneurs are channeled into and confined to modest market spaces that operate outside of mainstream agriculture (Wright & Annes, 2016).

The current study expanded the existing narrative on women in agriculture through an exploration of the organizational and institutional factors that shape the academic experiences and professional paths of women enrolled in STEM-based graduate degree programs within research-intensive agriculture colleges. By doing so, we have developed a deeper understanding of the role of GSAE in preparing women to be highly qualified, highly competitive *scientists* and *technologists* within mainstream agriculture and other masculinized agricultural domains.

Conceptual Framework

Principles and concepts from two theoretical domains guided our study. The first domain was human agency (Bandura, 2001; Emirbayer & Mische, 1998; Locke, 1978; Lukes, 1973; Sewell, 1992; Terosky, Campbell, & O’Meara, 2014), while the second was gendered organizations (Acker, 1990, 2012). In the current section, each of these domains have been outlined in relation to our study.

Human Agency

The theoretical scope of human agency spans the disciplines of philosophy, social psychology, and sociology. Philosophically, the concept of agency is considered to be the capacity of individuals to make rational choices both freely and independently (Locke, 1978; Lukes, 1973). In the field of social psychology, the concept of agency describes individual actions that are planned, self-regulated, and self-affirmed (Bandura, 2001). In sociological terms, agency refers to the ability of individuals to autonomously and intentionally engage in actions that are relevant to specific social conditions and environments (Emirbayer & Mische, 1998; Sewell, 1992). In this paper, we explored the implications of GSAE on the academic and professional agency of women agriculturalists.

Humans express agency in two main ways: *meaning making* and *action* (Terosky, et al., 2014). *Meaning making* refers to individuals anticipating what they need to do to establish control over their position and status within particular social settings (Bandura, 1989). In doing so, individuals intentionally draw on their self-efficacy to create and shape opportunities for personal advancement. *Action* refers to individuals intentionally and willfully pursuing opportunities within the settings in which they are situated (Marshall, 2005).

Human agency is likely to be expressed differently from one organizational, institutional, and/or systemic setting to the next (Terosky, et al., 2014). Such variation in expression is understood to be the result of fluctuations in levels of perceived self-efficacy that one has within specific settings (Marshall, 2000). For example, a woman may express a high degree of agency within a family-operated farm, but much less as a researcher within a university or industry lab. Throughout the current study, we remained attentive to how variations across the organizational settings and social contexts associated with GSAE likely influence the expression of academic and

professional agency by emergent women agriculturalists.

Gendered Organizations

The normative landscapes of organizations and the institutional fields they comprise are inherently gendered with some favoring men and masculinity and others women and femininity (Gherardi, 1995). Our focus was on the academic and professional agency of women within two organizational domains that have been shown to be masculine in form and function: graduate STEM education (De Welde & Laursen, 2011; Ferreira, 2002, 2003; Fox, 2001; Herzig, 2004) and mainstream agriculture (Allen, 2008; Barbercheck, et al., 2014; Meinzen-Dick, et al., 2011; Trauger, et al., 2008; Trauger, et al., 2010). We turned to Acker's (1990, 2012) conceptualization of gendered organizations to consider how the socio-cultural fabric of graduate STEM education within research-intensive agriculture colleges influences the academic and professional agency of women agriculturalists. Gendered organizations refer to settings and environments that favor (explicitly and/or implicitly) men and masculinity over women and femininity. According to Acker, organizations and institutions become and remain gendered through three substructures. First, subtexts frame organizational narratives and shape practices and policies in ways that give preference to men (Bendl, 2008). Second, the cultures of gendered organizations influence the day-to-day life of members in ways that advantage men and marginalize women. Third, gendered organizations promote the notion of an ideal worker that reflects and rewards the common life pattern of men (e.g., limited family responsibilities and caretaking obligations) and overlooks and suppresses that of women (Williams, 2000).

Purpose Statement

Here, we used the preceding principles and constructs of human agency (Bandura, 2001; Emirbayer & Mische, 1998; Locke, 1978; Lukes, 1973; Sewell, 1992; Terosky, et al., 2014) and Acker's (1990, 2012) three substructures of gendered organizations to explore how, if at all, GSAE within research-intensive agriculture colleges influences the academic and professional agency of emergent women agriculturalists. We asked the following two research questions:

1. What are the academic and/or professional experiences and aspirations of women agriculturalists in STEM-based graduate degree programs in research-intensive agriculture colleges?
2. How, if at all, does participation in STEM-based graduate education in research-intensive agriculture colleges influence the academic and professional agency of women agriculturalists?

Our purpose in addressing these two questions was to develop a stronger understanding of how STEM-based graduate education in research-intensive agriculture colleges influences the intended participation of women in mainstream agriculture, as well as in other agricultural domains that are also likely to favor men and masculinity (e.g., agricultural research, Extension). The insights we developed here support Priority Number Three (Sufficient Scientific and Professional Workforce That Addresses the Challenges of the 21st Century) of the AAEE National Research Agenda (Roberts, Harder, & Brashears, 2016).

Methods

General Design

We relied on a qualitative, case study design to explore the preceding two questions. The phenomenon of being a woman student in GSAE within the agriculture colleges located in one of three land grant, research universities in the U.S. bound our exploration. Consistent with the purpose of case study design (Creswell, 2007; Yin, 2014), we aimed to achieve a deeper and fuller understanding of how GSAE influences the academic and professional agency, as well as the aspirations, experiences, and perspectives of emergent women agriculturalists.

Site Selection

Three agriculture colleges located in a public land grant university (LGU) with the Carnegie Classification of “highest research activity” were purposefully selected as the sites for this study (Schofield, 1990). This selection was in part informed by the historical foundation of land grant agriculture colleges, which is largely rooted in the mission to develop and distribute agricultural innovation through research, instruction, and outreach (Sorber, 2013). These colleges continue to serve mainstream agriculture through the development of both the scientific/technological knowledge and human resources needed to be competitive in a global economy that turns on the rapid development and distribution of innovation (Glenna, Lacy, Welsh, & Biscotti, 2007; Powell & Snellman, 2004). Thus, we considered research-intensive agriculture colleges in LGUs as the most likely training sites of women preparing for scientific and technological careers in mainstream agriculture, as well as other agricultural domains that are also likely to favor men and masculinity (e.g., agricultural research, Extension).

We ultimately selected research-intensive agriculture colleges in LGUs in three geographically distinct locations in order to increase variation across the participant sample. To help protect participant confidentiality, we used the following three pseudonyms: Eastern College (EC), Central College (CC), and Western College (WC). Prior to making our final site selections, we confirmed through a scan of college and department websites that each of the three agriculture colleges maintained graduate programs in STEM-based fields. We also confirmed with unit administrators that, with their assistance as gatekeepers (Miles & Huberman, 1994), we would be able to access potential participants through college and departmental email listservs and other relevant forms of mass communication.

Participant Selection

We used both theoretical-based and maximum variation sampling strategies to develop our sample (Onweuegbuzie & Leech, 2007; Patton, 2015). First, we limited our sample to women enrolled in STEM-based graduate programs in one of the three selected research-intensive agriculture colleges. Reflective of the constructs composing our conceptual framework, these students provided us with direct insights into the academic and professional agency of women preparing for careers in mainstream and other masculine domains of agriculture. Second, we applied a maximum variation sampling strategy (Patton, 2015) to develop a sample composed of women pursuing a range of disciplines within GSAE.

We recruited our participants by first asking unit heads and/or graduate directors of the STEM-focused departments within each of the three selected agriculture colleges to distribute an open invitation to participate in the study to all women graduate students in their department via relevant email listservs. Students interested in participating in the study contacted us directly by

email. We then provided each participant with a more detailed description of the study and its protocol. We also confirmed each participant's gender through their self-identification and verified their enrollment in a GSAE program with our administrative gatekeepers. Our final sample is composed of 11 women representative of five STEM-based disciplines. To protect confidentiality, each participant has been randomly assigned a pseudonym (see Table One).

Table 1

Sample Composition

Participant Pseudonym	University	Field of Study / Degree	Career Target
Amy	CAC	BioChemistry / Ph.D.	Academia
Beth	EAC	Animal Sciences / Ph.D.	Industry
Christine	WAC	Environmental Science / M.S.	Industry
Eugenia	CAC	Animal Sciences / Ph.D.	Industry
Kate	EAC	Environmental Science / Ph.D.	Extension
Lilly	CAC	Animal Sciences / Ph.D.	Academia
Martha	EAC	Animal Sciences / Ph.D.	Extension
Natalie	WAC	Plant Sciences / M.S.	Extension
Payton	EAC	Environmental Science / Ph.D.	Industry
Raquel	CAC	Animal Sciences / Ph.D.	Industry
Sarah	EAC	Plant Sciences / Ph.D.	Extension

Data Collection

Data were generated primarily through in-depth, semi-structured interviews with each participant (Miles & Huberman, 1994). The interviews were intended to identify and describe the aspirations, experiences, and perspectives that motivate and shape the women's enrollment in STEM-based graduate programs within research-intensive agriculture colleges. The developed interview protocol was framed using the theoretical constructs of human agency and gendered organizations. In particular, we aimed to capture the meaning the women associated with their graduate education and future agricultural careers, as well as the actions they are taking to create and/or prepare for future professional opportunities. Equally important, we sought to understand how the women perceive and experience, if at all, the masculine nature of GSAE, mainstream agriculture and/or other similarly gendered agricultural domains. Specific to human agency, we designed questions to identify the ways in which the participants made sense of their academic experiences and professional paths within the context of being women learning and working within

masculine environments and systems. We also asked questions regarding the actions and strategies the women had applied in order to enhance their capacities to perform as agricultural scientists and technologists (i.e., agriculturalists). Additionally, we inquired about the types of academic and industry networks the women were accessing through their GSAE programs. Lastly, our protocol included prompts designed to capture how, if at all, the women recognize, confront, perceive, and/or respond to the masculine underpinnings of both their GSAE programs and future agricultural career pathways within gendered organizations and systems. Although we developed the protocol according to the theoretical constructs of human agency and gendered organizations, we also designed it to allow for flexibility during the interview process.

The duration of the interviews ranged from 48 to 142 minutes and were conducted in-person on the campuses where the students are enrolled. Each interview was audio recorded and later transcribed. Per human subjects protocol, the audio recordings were destroyed following transcription.

We also collected the research profiles of each participant from the respective departmental websites as secondary data sources (Yin, 2014). We did so to capture any information in their profiles that reflected their academic and professional goals (e.g., research interests, internships, other work-related experiences), as well as any activities and experiences outside of the formal classroom and laboratory settings (e.g., assistantship appointments, grant awards, journal publications) that indicated progress toward achieving these goals.

Data Analysis

Yin (2014) notes that data analysis is one of the most challenging aspects in case study research, largely because analytic techniques specific to this design are underdeveloped. Thus, we borrowed strategies from other qualitative traditions to guide our analysis. Specifically, we relied on techniques that are traditional in grounded theory studies (Corbin & Strauss, 2015). However, we note our purpose was not to generate theory, as theoretical propositions framed our research. Instead, the inclusion of open, axial, and selective coding techniques served as a way to reduce data and develop explanatory context.

We first reviewed each transcript and research profile multiple times looking for patterns in the data relevant to our research questions. We did not rely on our theoretical framework during this open coding process. Next, we conducted axial coding by taking the emergent themes and searching for connections between and among them. Finally, we narrowed our analysis further by conducting selective coding. Specifically, we identified the categories and data that explain the case and then further refined our findings by contextualizing the selective codes with the guiding theoretical underpinnings of human agency and gendered organizations. For example, the following quote reflects our analysis of *human agency* in the data: “I know that I will have to show them [companies] how what I want and can do with my research will benefit their [company] products. This will be fine if I am doing research that is interesting and meaningful.” Additionally, the following participant statement is an example of how we observed the principles of *gendered organizations*, such as a “traditional” division of labor within a family (Acker, 1990; 2012), within the data: “When I came, the main reason was because of my husband because he was approved before me to do his PhD, and then I had to come.”

Trustworthiness

We used five techniques recommended by Lincoln and Guba (1985) to establish and enhance the trustworthiness of our findings. First, we relied on prolonged engagement. Although

we did not spend extensive time in the field, as researchers do in ethnography, we did speak with a range of people and developed rapport in the interview process. This rapport enhanced the shared meaning making during the interview process. Second, we collected and analyzed data from two sources (i.e., interviews, research profiles) to allow for data triangulation. Third, we amplified trustworthiness through researcher triangulation, which involved us reviewing the analysis both individually and together multiple times, as well as when possible, conducting the interviews together. This process allowed us to consider the data from more than one person's perspective. Fourth, we called on two theories to interpret the data, which allowed for theory triangulation. Fifth, we developed the presentation of the case using thick description to increase the possibility of transferability.

Positionality

We each practiced reflexivity throughout the research process (Lincoln & Guba, 1985). The identification and consistent consideration of our positionalities toward the phenomenon of focus allowed us to be reflexive, which in turn improved the confirmability and transferability of the findings (Malterud, 2001). Specific to our positionalities, we are both faculty members at different land grant universities. One of us is located in an education college with an expertise in higher education, the other in an agriculture college with an expertise in agricultural leadership. We have each conducted previous research about the STEM disciplines. One of us identifies as a woman, is a feminist scholar, and has conducted numerous studies on women in academe. The other of us identifies as a man, grew up on a family farm, and has conducted multiple studies on the cultural, economic, and organizational dynamics that influence agricultural practices and enterprises. Additionally, we are both Caucasian and grew up in the U.S. Identifying, processing, and sharing our positionalities and thereby revealing our individual and shared values, perceptions, and assumptions helped reduce bias throughout the analytical process (Creswell, 2007; Lincoln & Guba, 1985; Malterud, 2001).

Limitations

Our research did have several limitations. First, the participants themselves limited the findings of our study. That is, the aspirations, experiences, and perspectives they shared with us are theirs alone, and do not take into account those of other women students in GSAE programs within the agriculture colleges included in our study or those located in other universities. Second, our analysis was limited by our focus on gender, and for the purpose of the theory of gendered organizations, gender is considered a binary construct. We recognize and value the importance of intersectionality and how it shapes individual experiences, as well as gender being a fluid social construct. However, we made a conscious decision to narrow our analysis to gender and our sample to only participants who self-identify as women, given our specific interest in exploring the academic and professional agency of women agriculturalists enrolled in GSAE programs within research-intensive agriculture colleges (N.B., we did not inquire whether they identified as cis-gender or trans*). Finally, although we took care to establish rapport and trust with the participants, it is possible that they were reluctant to be candid because of reasons such as perceived power differences between us and them.

Findings

Intentionality

All the women in our study were pursuing STEM graduate education with academic purpose and professional intent, which represented an expression of their agency. Five of the

participants were preparing for industry-based agricultural careers, while four intended to work in Extension or two aspired to be university professors. While several of the participants expressed some interest in engaging in agricultural development, none of the women had an interest in applying their advanced scientific and technological training within the feminized settings of small-scale family farming and local agriculture.

The women who were pursuing industry-based careers were all interested in research and development (R&D) positions. These women commonly described a two-pronged rationale for their interest. First, they were driven by their own curiosity for science and technology and viewed industry as an environment in which the resources necessary to pursue such curiosities were likely to be more available than in resource-strapped universities. Christine stated, "I enjoy being at the university as a student, but I think industry will likely have more resources to support my research." The women were not, however, naïve to the stipulations tied to agricultural industry R&D, which generally supports only research with clear market potential. Christine went on to say, "I know that I will have to show them [companies] how what I want and can do with my research will benefit their [company] products."

The women were aware and accepting of the general mainstream agriculture narrative that frames the commercialization of scientific and technological innovations as the most effective and efficient means of solving the pressing challenges and so-called "wicked problems" that threaten global food security (e.g., climate change, crop and livestock disease, water scarcity). Beth, for example, identified an intersection between agricultural industry R&D and global food security when saying, "We need innovation to happen in order to feed and nourish people around the world. In my opinion, industry is much more likely to effectively and efficiently apply research and discoveries in ways that benefit people compared to universities." Overall, these women were well aware of and had internally reconciled the conditions and priorities inherent to R&D within industrial agriculture. This awareness of both self and system was indicative of the agency these women were developing relevant to mainstream agriculture.

The women interested in Extension were largely driven by the goal of distributing scientific and technological information to agricultural practitioners. While this goal involved an element of altruism (i.e., community education and outreach), the women primarily believed working in Extension would create opportunities to experiment with and apply science and technology in the "field." Natalie described the mutual influence of outreach and scientific and technological experimentation on her choice to pursue a career in Extension by saying, "Farmers in the community need science and technology just as much as industry does. That is why I want to conduct and apply my research through Extension." Here, the women illustrated their personal and professional self-awareness by identifying Extension as a career field in which to pursue their academic preparation and professional paths. They also demonstrated their self-efficacy by pursuing the GSAE training necessary to make Extension a viable career path.

Of the women included in our study, only Amy and Lilly were interested in pursuing a university professorship. Both of these women were motivated by the notion of having the freedom to pursue their intellectual interests without commercial pressures or the burdens of immediate and direct application that is inherent in Extension. Amy said,

I think by being in an academic setting I will enjoy more of the freedom of getting to decide what I am working on. I will not have to direct my research toward what the company is interested in producing.

Lilly expressed a similar, but more holistic view when describing her research interests and activities. She stated,

We are trying to identify the mechanisms by which we can improve animal reproduction. We also want to give some answers to the industry and to the people that are in the field so we try to combine applied research with basic research. I enjoy the ability to do both and a university is the only place that will allow this, which is why I want to be a professor.

Amy and Lilly were both expressing academic and professional agency by intentionally creating opportunities to pursue professorial tracks within STEM-based disciplines that are known to be masculine (De Welde and Laursen 2011; Ferreira 2002, 2003; Fox 2001; Herzig 2004).

Experiences, Perspectives, and Strategy

None of the women in our study, regardless of their professional goals and motives, provided any indication of notable concern over the masculinity of the organizations and systems in which they intended to pursue their agricultural careers. For instance, the women reported no observed differences in how they and their men colleagues “fit” within their GSAE programs. Sarah says, “I have never felt discriminated against and have never felt that I've been taken less serious because I'm a woman. I honestly feel equal... I have never felt less or discriminated or left behind by it.”

The women did, however, express that their confidence and identity as agricultural scientists and/or technologists increased as they gained experience and developed greater understanding of how research is conducted in both technical and cultural terms. Christine explained,

I am definitely getting stronger as a bench scientist. But, yes, with every new experience I have in the lab I learn more and more how labs are run and the do's and don'ts in setting up partnerships. I am also learning that research does not pop up and take place in a bubble. We as scientists have to understand and respond to the needs of industry. We have to speak the same language [as industry] to make it clear we are on the same page and are reliable allies.

Similarly, Eugenia described how her experiences in the laboratory increased her understanding of the cultural dynamics that tie scientific and technological research to mainstream agriculture. She said, “I don't think that being a woman will make a difference... I think that what will matter the most is the degree and level of expertise I will have when I begin my career.” The perspectives shared by Christine and Eugenia illustrated how they, and others in the study, have enhanced their sense of academic and professional agency through the actions they have taken as STEM-based agriculture graduate students. In general, the clarity, intentionality, and self-efficacy expressed by the women in our study revealed their sense of agency over their graduate studies and professional trajectories within mainstream agriculture and/or other similarly gendered agricultural domains.

The participants also conveyed little recognition of the role gender plays in the cultural dynamics of mainstream agriculture and other gendered agricultural domains. Instead, they were confident that the scientific and technological expertise being developed through their graduate programs would make them competitive in whatever agricultural career path they choose for

themselves. For example, through her graduate program, Eugenia had become actively involved in creating an R&D department within an animal nutrition company. She stated,

We [students in her research group] have opportunities to work with [company] on some projects. We did some research for them and they now have R&D positions due to that work. We actually develop projects like that, which are opportunities I will be pursuing when I am done. I think I will be competitive based on my experience and training.

In a like manner, Sarah said,

I have this notion about race and gender. I don't like to be classified based on these areas. If you have the qualities and you are qualified for it, I don't care if you're black, white, or whatever, or if you're a woman or a guy. As long as you are a qualified expert, it does not matter.

In describing the pride and sense of privilege and professional status she has gained through her graduate education, Christine stated, "I think it is a great honor to be able to complete my degree and soon be qualified to compete and innovate in a forward-thinking company." Thus, the culmination of experiences and learning tied to their GSAE was bolstering the women's sense and expression of academic agency specific to mainstream agriculture.

Agency and Meaning Making in the Gendered Context

The women were either unaware or dismissive of the potential ways in which their gender may have been influencing their graduate training and shaping their career trajectories. For example, Amy stated,

I find the male faculty and students I work with treat me and the other women in my department no different than they do their male colleagues. What matters to them is that I am contributing to the research. As long as the science is sound, gender does not seem to me to be an issue.

Natalie shared a similar perspective when stating, "There are plenty opportunities to network with agribusiness leaders through workshops, guest lectures, career events, and so on. I find these [opportunities] to be interesting and insightful even though most of the speakers are men!"

While seemingly positive, the aforesaid observations and perspectives shared by Natalie and Amy become concerning when considered in the gendered organization context. When applying meaning to their professional goals (i.e., expressing agency), the women tended to minimize the implications of their gender on their future experiences and opportunities within mainstream agriculture and other masculinized agricultural domains. For instance, when asked if she was concerned about the possibility of confronting sexism or other more subtle forms of mistreatment once working in agricultural industry, Natalie replied, "No, times have changed. It is about performance regardless of whether you are a man or a woman." This optimism may have been reflective of transformation within mainstream agriculture. However, when viewed through Acker's (1990, 2012) lens of gendered organizations, this sense of optimism is likely to have been at least partially grounded in a false sense of security and the failure to recognize the powerful, albeit at times latent, gendered effects of mainstream agriculture. In other words, the meanings the women made of their GSAE experiences were perhaps productive in the short-term, but likely not realistic or sustainable in the long-term. Similarly, the same self-efficacy that helped sustain the

women's agency may have also bound them to the perhaps subtle, yet powerful forces working against them within mainstream agriculture and other gendered agricultural domains.

The women also frequently discussed the importance they placed on the integration of work and life, including family. Many believed that somewhere in their intended profession, it would be possible to achieve this goal. For example, most indicated an unwillingness to forego having children in order to pursue their careers as agricultural scientists and technologists, which pushes against ideal worker norms, but aligns with gendered expectations of women. Instead, they held, to varying degrees, a blended commitment to pursuing their intended careers and raising families. Lilly, who was interested in a professorial career stated,

I used to work from Sunday to Sunday, no weekends, holidays nothing. I started to think about my future, I wanted to have a family and decided life is not going to work like this. I had no personal life. So I said, "You know what? I need a say in my life. I'm going to go back to the university for my PhD.

Her choice to pursue a doctorate was intentional and thereby agentic, as well as a reflection of her belief that academe is much more family-friendly than was her previous career in agricultural sales. Similarly, Eugenia summarized the intersection of her professional and life goals when saying, "I think industry will allow me to have a flexible job. You could have weekends and spend time with your family and stuff like that. I think that's what I'd focus more for my future." These and similar comments by other study participants indicated the women understood STEM-based agricultural research and mainstream agriculture in ways that do not reflect in theory, or likely in practice, the masculine nature of these academic and professional agricultural domains (Benard & Correll, 2010; Williams, Blair-Loy, & Berdahl, 2013; Wolf-Wendel & Ward, 2015).

For three of the women in our study, the choices of their partner (all of whom were men) helped lead them to their current circumstances. For example, Beth, who was an international student from South America, enrolled in the EU graduate program not as a result of her own autonomous planning and decision making, but rather based on that of her husband. She explained,

When I came, the main reason was because of my husband because he was approved before me to do his PhD, and then I had to come. Then I said, "No, I have to develop my PhD. It's a great opportunity. Don't want to be there doing nothing," so I went online and I had to choose, because he came first.

Beth accepted this situation as a personal compromise made between her and her husband and not as a more systemic gendered condition that is inherent to mainstream agriculture and other gendered agricultural domains. She said, "I want to support my husband and know I will be able to do just as well as him no matter where our lives together take us." None of the women in our study reported their husbands or partners (for those who had them) followed them to the universities. Although Beth was expressing her agency by acting on her self-efficacy to pursue a STEM-based graduate degree and eventually a career within mainstream agriculture, her husband's decisions about his own pursuits influenced her current path. However, her choice is not unlike so many women in STEM who are categorized as "trailing spouses," who find themselves at a university or in a particular job because their husbands secured positions first (Harper, Baldwin, Gansneder, & Chronister, 2001; Holmes, 2015). This example reflected our concern about whether the women in our study will continue to express and sustain academic and professional agency in the long term within the masculine environments that compose mainstream agriculture and other gendered agricultural domains. Yet, we also noted, consistent with the previously articulated pattern of intentionality, that all three of the women who followed their life partners to their respective

universities were highly motivated to pursue GSAE by their own academic and professional interests and passions.

Discussion and Conclusion

Our findings have illustrated the complexities associated with women pursuing GSAE to enhance their qualifications and competitiveness as agricultural scientists and technologists. The women in our study entered their graduate programs with and retained throughout confidence and clarity both in terms of their intellectual abilities and professional goals. In general, the meaning the women made of their graduate education and the actions they purposefully took to develop their scientific and/or technological expertise in preparation for mainstream agriculture and other gendered agricultural domains was an expression of their academic and professional agency. In doing so, they inherently privileged masculine production and application of scientific and technological research, which on the surface should help them succeed in their future agricultural careers.

However, we argue that the women in this study were largely unaware of the gendered subtexts, organizational logics, and ideal worker norms that are prevalent in masculine domains (Acker, 1990, 2012). Accordingly, the academic and professional agency expressed by the women were compromised, if not threatened, by the masculinization of the agricultural domains in which they intended to enter as emergent professionals. The conciliations and threats were subtle and not outwardly apparent to the women. Eugenia and Lilly, for instance, assumed their advanced scientific and technological expertise would provide them the flexibility to integrate family and work throughout their agricultural careers. Beth did not recognize her decision to adapt her own education to support her husband's as an indication of future professional compromises that she will likely need to make, especially because he expected to enter the job market before she completed her degree. These examples illuminated the women's overall lack of awareness of and concern over the challenges they will likely face as women agriculturalists working in masculine environments (Acker, 1990, 2012; De Welde and Laursen, 2011; Ferreira, 2002, 2003; Fox, 2001; Herzig, 2004; Meinzen-Dick, et al., 2011; Pande, 2000; Phillips, 2006). We interpret this finding as an indication that, despite the scientific and technological expertise developed through GSAE and the positive influence it has on the development and expression of agency, women are not being prepared for the professional realities they will most likely confront within mainstream agriculture and other gendered career pathways. Indeed, masculine privilege is able to be reproduced in large part through its obscure, yet pervasive presence.

The preceding concern leads us to consider more deeply the longer-term implications of the experiences and perspectives the women are gaining through GSAE. Undoubtedly, the scientific and technological expertise the women are developing will make them highly qualified agriculturalists. Yet, gender bias will sometimes subtly, and other times overtly, diminish their credibility and status. Consequently, the academic and professional agency the women were developing through GSAE is more likely to promote than counter their assimilation into masculinized agricultural domains as marginalized scientists and technologists. Of course, we do not discount the importance of women pursuing and achieving success as scientists and technologists within mainstream agriculture and other gendered agricultural domains. Women have, and continue to, make significant strides (National Science Foundation, 2015). However, we do emphasize the importance of empowering women to be change agents rather than highly qualified cogs in an oppressive system. This emphasis leads us to close with several recommendations for both practice and future research.

We recommend that faculty in STEM-related departments within research intensive agriculture colleges more purposefully integrate the realities of gender bias in the curricular and co-curricular experiences that are made available to students of all genders. For example, discussions focused on how gender is experienced and treated (both explicitly and implicitly) in classrooms, seminars, and laboratories should be conducted as part of routine departmental and research group meetings. Also, increasing the participation of agricultural leaders who are women in career events, workshops, and lectures would not only model women's success and perseverance, but also invite constructive dialogue specific to the realities and underlying factors of gender bias within mainstream agriculture and similarly gendered agricultural domains. Likewise, efforts to increase the number of women in STEM-related faculty positions within agriculture colleges, whether or not they have followed a "typical" career trajectory, should also remain an ongoing objective of university leadership.

We expect our study will bring greater attention to the need to better understand the conditions that shape the experiences and influence the opportunities available to women in mainstream agriculture and other masculinized agricultural domains. In particular, we encourage follow up research that examines the agency of women similar to those we have included in our study once they have completed their graduate training and are working as scientific or technological agriculturalists. This research would be particularly useful in understanding how women can be more empowered through GSAE with knowledge and strategies essential to not only overcoming professional gender bias, but also changing the organizational and systemic underpinnings that sustain such inequities.

In this study, we have worked to understand how participation in GSAE influences the academic and professional agency, as well as aspirations and perspectives of women agriculturalists. In doing so, we have focused on the ways women perceive and respond to the gendered organizations that generally compose STEM-based graduate education and mainstream agriculture. We have also contributed an agricultural context to the overall understanding of the institutionalized conditions that influence the participation and leadership of women in overcoming current and future agricultural challenges through the discovery and advancement of scientific and technological innovations. Although the development of individual agency within gendered organizations and institutions is important, it is not an end goal. Instead, we argue that the agency of women graduate students is necessary but not sufficient. This is to say that all students should have the freedom to be agents of their own lives. However, many agentic behaviors only compensate for and reproduce the institutional inequities that exist within flawed organizations. Indeed, it is the "system" and the organizations within that need repair, not the women who aspire to participate in equitable and meaningful ways. Future research must respond to this call.

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