Introduction

Land-grant institutions in the United States were established in 1862 through the passing of the first Morrill Act to support colleges of agriculture throughout the country. More than 50 years later, in 1914, the Smith-Lever Act established the Cooperative Extension Service that allowed land-grant institutions to connect research to the public, even beyond traditional instruction in university classrooms (Association of Public and Land-Grant Universities [APLU], 2012). Faculty at land-grant universities express feeling motivated to participate in science communication because of their connection to the land-grant mission (McLeod-Morin et al., 2020). Complex issues in many different disciplines are best examined through an interdisciplinary approach (Corbett et al., 2013), where researchers from various and diverse disciplines join to study issues from different perspectives, using different methods and research designs (Corbett et al., 2013).

Universities and research institutions have created initiatives to promote collaboration among interdisciplinary faculty, including the formation of centers, in an attempt to promote science and improve society. An interdisciplinary approach to research brings together scientists from diverse disciplines and integrates theories and approaches from those distinct disciplines (Aboelela et al., 2006). Centers at universities throughout the United States have been categorized by three determinants: centers that allow researchers to analyze problems in one discipline with methods used in another discipline, centers with diverse scholars working together on problems from their own discipline, and scholars chosen to work with the center based on the problem at hand and the experiences of the scholars (Alpert, 1969). Advocates for interdisciplinary research have maintained that scientific breakthroughs and achievements have likely been the outcome of collaborative efforts across disciplinary boundaries (Frodeman et al., 2017; Wilson, 1998). However, interdisciplinary research has often been threatened or not executed successfully due to a wide range of reasons, including lack of university incentive, insufficient funding, difference of opinions among researchers, and ineffectively translating research from distinct disciplinary approaches (Bohen & Stiles, 1998; Klien, 1999; Krohn, 2017). Interdisciplinary agricultural research centers have been established at land-grant universities to address complex science issues impacting the agricultural sector, including water quantity and quality, food safety and security, and zoonotic diseases, but it is unclear if these centers have been successful in communicating science to the public or if these centers have valued the effort in communicating science to the public.

Communicating about science is an urgent need as society experiences an increased advancement of science and technologies (National Academies of Sciences, Engineering, and Medicine, 2017), but to do so effectively has been more difficult than ever before (Burns et al., 2003). Advancements in digital communication since the turn of the 21st century, including websites, blogs, and social media provide both challenges and opportunities in science communication. The goal of science communication is determined by the communicator, the intended audiences, and the nature of the science being communicated, but includes sharing research results, cultivating appreciation for science, improving the understanding of issues related to science, or informing behaviors or policy decisions of the public (National Academies of Sciences, Engineering, and Medicine, 2017).

Scientists are experts in their particular field and are trusted authorities to provide information to the public (Navarro et al., 2014). The American public is generally confident in the work of scientists and the recommendations that scientists make, but that confidence has

steadily decreased over the last 50 years (National Science Board, 2018). This decline in confidence highlights the need to effectively build a relationship between scientists and public audiences. Despite the importance of communicating science, scientists face many barriers when communicating about science, such as the use of language that is difficult for the lay public to understand, professional or organizational deterrents, and lack of interest from the public (Treise & Weigold, 2002). Additionally, scientists may lack the skill to communicate effectively with the public and struggle to use words and language that lay audiences understand (Lundy et al., 2006). Some scientists work with journalists or communication experts to develop their message and have positive experiences (Peters et al., 2008), while other scientists may have negative views about working with journalists because of past negative experiences (Maille et al., 2010; Treise & Weigold, 2002). Additionally, today's 24-hour news cycle does not align with a lengthy timeframe that scientists must work with given the nature of the scientific process. The misalignment between a journalist's and scientist's time frame makes effective science communication more difficult (Maille et al., 2010). Scientists at academic institutions may not be motivated to communicate about research and science because of a lack of reward, including awards or job promotion, for exceptional science communication (Hulcr, 2016). However, other academic pursuits, such as research and teaching, are often rewarded through award recognition or tenure and promotion (Hulcr, 2016). Barriers and motivations to communicate about science may differ for faculty and administration at a land-grant university because of the institution's mission to connect research to the public. As such, the purpose of this study was to explore what factors may limit or motivate interdisciplinary agricultural center directors to communicate about science.

Conceptual Framework and Literature Review

This study was guided by a conceptual framework that combined concepts of science communication and the theory of excellence in public relations. Concepts of science communication focus on the importance of science as a topic of dialogue, while theory of excellence allows the researcher to view the research problem from a strategic management perspective. Previous research supports integrating principles of public relations and science communication to explore research questions related to the science communication of organizations (Borchelt & Nielson, 2014; Lee & VanDyke, 2015).

Effective communication and public relations are vital components of excellent organizations, which is an idea that has been further developed through the theory of excellence. Theory of excellence derived from the 1984 Excellence Study, a research project commissioned by the International Association of Business Communicators (IABC) Research Foundation that investigated the impact of successful communication and public relations on an organization (Grunig, 1992). This project was purposed to determine (a) what public relations practices were being used, (b) if successful practices impacted the overall organization, and (c) the characteristics of excellent public relations and communication and the effects of successful public relations (Diggs-Brown, 2012; Grunig & Grunig, 2008).

The main principles of the theory of excellence in public relations were an integral component of this study. Major characteristics of effective public relations include strategic management, a direct relationship between the public relation department and administration, and a two-way model symmetrical model (Grunig, 1992). Strategic management of the public relationship and evaluation of effects are necessary components for excellent public relations at the program level. Excellent public relations at the departmental level is more complex and

utilizes a two-way symmetrical model. An excellent public relations department also operates separately from a marketing department and is integrated in the organization. Finally, excellent public relations at the organizational level includes an organizational worldview focused on two-way communication, a participative culture, and an organic structure (Grunig, 1992).

Science communication was conceptualized in this study based on a review of prior literature and analysis of existing communication activities in science and communication organizations. Borchelt (2001) concluded that institutions are motivated to communicate about science to (a) inform the public on issues or problems related to science that may be useful, (b) provide information that allows the public to make more informed decisions about policy and potentially participate in policy decisions, and (c) offer scientific descriptions or explanations to enhance scientific literacy. According to Telg et al. (2012), a communicator is likely to have more influence over other people when the communicator is believed to be a well-known expert. When a communicator is identified as a credible source, the message the communicator is trying to share will have more of an impact compared to a communicator who is perceived as less credible (Telg et al., 2012).

Lamm et al. (2016) found that source credibility could also influence perceptions when communicating about agricultural issues. Lamm et al. (2016) determined how different communication sources impacted the perception of water use. Lamm et al. (2016) found people were more trusting of the Nature Conservancy, an environmental science organization, when the message was negatively framed, but more trusting of farmers when the message was positively framed. The source of information is extremely important when communicating about agricultural issues to the public and should be chosen carefully when developing messages for the public (Lamm et al., 2016). Serving as a credible source may be a motivational factor to communicate about science.

Given the complexity of effective communication, many barriers can arise that further hinder effective communication. Shrivastava (2012) noted "factors affecting communication can lead to either lack of communication, ineffective communication or misrepresentation of the message sent and creation barriers in the communications process" (p. 8). Physical and psychological issues can interrupt messages and impact the interpretation for the receiver (Fielding, 2006). Physical barriers to communication may include noise that drowns out the message, while psychological barriers may include cultural differences between the sender and receiver (Fielding, 2006). Barriers are unique to every situation, so messages must be monitored intently to avoid barriers through the communication process. Shrivastava (2012) further categorized communication barriers into nine groups: physical, perceptual, emotional, cultural, technological, language, gender, interpersonal, and noise barriers.

Purpose and Objectives

The purpose of this study was to identify the barriers and motivations of interdisciplinary agricultural center directors when communicating about science. The objectives that guided this study were: 1) to explore internal challenges, 2) to explore external challenges, and 3) to identify what factors motivate interdisciplinary agricultural center directors to communicate about science.

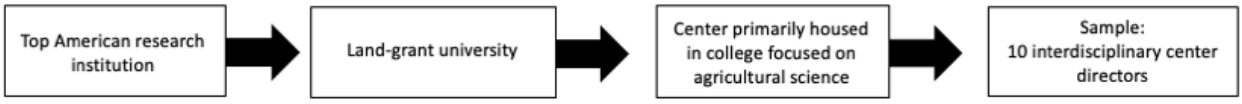
Methods

Qualitative interviews were utilized to address the purpose of this study. This study was part of a larger research endeavor that explored interdisciplinary agricultural center directors' perceptions of science communication at interdisciplinary agricultural centers (McLeod-Morin et al., 2020). A qualitative interview guide was developed based on the main components of the theory of excellence (Grunig, 1992), including questions related to communication activities, strategic management, and organizational culture as it relates to public communication. The interview guide was reviewed prior to data collection by an expert panel comprised of individuals familiar with science communication and interdisciplinary science (McLeod-Morin et al., 2020). The individuals on the expert panel were university faculty whose research focused on agricultural communication. Other members of the expert panel were directors of interdisciplinary agricultural research centers or were affiliated with an interdisciplinary agricultural research center. Additionally, the interview guide was pilot tested with an individual who was similar to the participants of the study and revised to improve the flow and clarity of the interview questions. The interview guide and data collection procedures were approved by the University of Florida Institutional Review Board prior to data collection.

A purposive sample of 10 interdisciplinary agricultural center directors at prominent research land-grant institutions in the United States was interviewed for in this study. The participants were the leader and/or supervisor at an interdisciplinary agricultural research center that addressed an issue or range of issues related to the agricultural industry, including animal science, ecology, plant science, food science, and economics. Directors were chosen as the sample for this study since it was determined that most centers did not have a communication staff and that the director was listed on most websites as the main point of contact. Directors were chosen rather than scientists since directors were likely to set the expectations for others that worked in the center. The selected centers met the following three specifications: located at a top American research university according to the Center for Measuring University Performance (Lombardi et al., 2016), located at a land-grant university (National Institute of Food and Agriculture, 2014), and were primarily housed in a college that focused on agricultural sciences (McLeod-Morin et al., 2020). The sampling process for this study is summarized in Figure 1.

Figure 1

Summary of Study Sampling Process



Note. This sampling procedure was also part of a larger research endeavor that explored interdisciplinary agricultural center directors' perceptions of science communication at interdisciplinary agricultural centers (McLeod-Morin et al., 2020).

Of the top 25 American research institutions, six of those were land-grant universities. Interdisciplinary agricultural research centers were identified at each of the six top American research land-grant universities, resulting in 108 centers (McLeod-Morin et al., 2020). Two

centers were then randomly selected at each institution, and the directors were initially contacted via email by the lead researcher's supervisor because the advisor was seen as a peer. The lead researcher then followed up with a telephone call to explain the research study and followed up again with an email asking for the director's participation in the study. If no response was received from the participant after three days, another email was sent to the director. After another three days, if no response was received, the director was eliminated from the sample and another center was randomly selected from the same university. At two universities, only one center each was included in the sample because all other interdisciplinary agricultural research centers at the universities were contacted but declined to participate or did not respond. The final sample included two interdisciplinary agricultural research centers each from four land-grant universities (eight) and one center from two universities (two), for a total of 10 centers, representing a wide range of disciplines within agricultural science and were spread across the United States. With the exception of the Pacific Northwest, these institutions represented each geographic region: the Southeast, Midwest, Southwest, and Northeast.

Participants of this study were assigned an alias name. Some participants requested their center also remain anonymous, so for this reason, recognizable characteristics of the centers included in this study are not revealed. One woman and nine men were interviewed. Most participants had a doctoral degree, while one participant had a master's degree. The years of experience as director ranged from one year to 12 years.

By visiting each center's webpage, which was directly linked on all university webpages, email addresses of the directors of the centers were identified. The participants were sent an email describing the purpose of the study, the importance of their participation as academic faculty, and the data collection procedures. Upon receiving the email, participants were then contacted via telephone to confirm a time and date for an interview. During this call, interview methods and informed consent were also discussed. Telephone interviews took place within a two-week time frame in Fall 2017 to aid in the consistency of the interview. Field notes were taken during the interview, but interviews were also recorded for a complete transcription at a later date. The interviews lasted between 30 minutes and 70 minutes in length, averaging around 40 minutes (McLeod-Morin et al., 2020).

The first step in organizing the data was to transcribe all the data collected during the interviews (McLeod-Morin et al., 2020). Words were transcribed verbatim, and field notes were added to help give context and meaning. The researcher then became familiar with the data to help ease the analysis process. During this step, the researcher kept a reflective log noting initial thoughts or questions and how the discussion related to the study's objectives (Emerson et al., 2011). Transcribed interviews were each read several times by the researcher and notes were made and revised throughout the process. Notes and data were analyzed using the constant comparative method (Bogdan & Biklen, 1992). Per constant comparative methodology, findings and data were compared to previous findings from literature in order to build themes for the current study (Bogdan & Biklin, 1992). The notes were compared to each other throughout the analysis process, as well as compared to the notes made during the interviews.

After the data were organized, the researcher coded the data by identifying common themes that emerged. Emerging themes can be noted through language, emotion, or even lack of response (Corbin & Strauss, 2008). Inductive coding techniques, commonly used in qualitative data analysis, were specifically employed to analyze the themes (Ary et al., 2013). This process included categorizing codes, identifying relationships between codes, and developing major themes from the codes (McLeod-Morin et al., 2020). Lincoln and Guba (1985) suggested several

analysis techniques to ensure credible studies, including participant observations, triangulation, peer debriefing, and member checking. For this study, peer debriefing was included to enhance the credibility of the study.

Qualitative research requires that the researcher is the instrument used to collect and analyze qualitative data, an idea first brought to fruition by Lincoln and Guba (1985). Bias is unavoidable and accepted in qualitative research, with the belief that qualitative researchers are conscious of their own bias. Daymon and Holloway (2010) outlined reflexivity as a valuable tool throughout the qualitative research process, noting that qualitative research becomes more authentic and credible as the researcher becomes aware of any personal assumptions related to the research. I, the researcher, kept a reflexive journal and identified any predetermined opinions or experiences that were related to the communication of agricultural science to identify any bias that may occur throughout research.

I grew up on my family's agricultural operation that included many aspects of the industry, including cattle, poultry, and forestry. My interest in agricultural issues and communicating to others about science in an effective way inspired me to accept a job as a communicator for an interdisciplinary agricultural research center. My interest in the topic of interdisciplinary agricultural science communication originated from my work as a public relations specialist at an interdisciplinary agricultural research center at a land-grant university. Through this position, I recognized the challenges associated with science communication, as well as the importance of communicating about science to the public audience. My beliefs related to science communication and this study can be summarized in three key points: 1) researchers at land-grant institutions have an obligation to communicate relevant research to public audiences, 2) researchers and scientists best understand their own research but are not the best at articulating the broader impacts of their research, and 3) interdisciplinary centers do not see an incentive to communicating their research, thus they do not prioritize science communication. Through my experiences as a professional communicator of agricultural science, I have developed a unique understanding of the benefits and challenges of communication and the intricate workings of communicating interdisciplinary research. In addition to the knowledge I have gained, these experiences have formed a foundation for my interest in this study.

There were limitations to this study given the qualitative nature of data collection and analysis. Data were only collected from a small population since qualitative interview methods were used. The population of this study was limited to interdisciplinary research centers that focus on agricultural disciplines and did not include other science-related centers. The population was also limited to interdisciplinary agricultural research centers at top research land-grant institutions in the United States. Thus, the findings were not generalizable to other centers.

Assumptions of this research were that subjects of this study provided truthful answers to the best of their ability and that the subjects had a general understanding of overall science communication. It was also assumed that directors had the best overall understanding in the center of barriers and motivations related to science communication. Another assumption was that interdisciplinary research centers faced different obstacles than other entities when communicating about science. The researcher also assumed science communication was at least a part of each center's mission or purpose.

Findings

Objective One: Internal Challenges

Objective one aimed to explore what internal challenges existed for interdisciplinary agricultural research center directors when communicating about science. Directors specifically discussed lacking resources, such as staff, time, and funding, as an internal challenge. Many participants indicated one challenge their centers faced was a lack of full-time staff dedicated to communication efforts. Many centers would acquire graduate students, unpaid interns, or part-time communicators to develop communication outputs in order to overcome this challenge. Other centers would require program assistants, secretaries, center administrators, and affiliate faculty to develop communication outputs as needed. Tim said, "I would say that the lack of a specific individual to do that communication is the biggest barrier."

In centers that asked faculty or center administrators to develop communication outputs, such as a news article or material for the website, a lack of time was often seen as a challenge. Participants, who were often partaking in developing communication outputs, indicated having many responsibilities and duties to complete, and not having enough time to regularly prioritize communication. Mark said, "Let me just say resources, in the sense of maybe the center's director's time – in other words, mine. Focusing on that as an objective and doing more in the way of public information."

Many participants indicated a lack of finances as a challenge when communicating science to the public. Participants explained being unable to develop communication outputs because of a lack of money to do so. A lack of finances also limited centers' ability to hire full-time communication staff responsible for the center's communication efforts. Jeff explained the funding allows for more consistency and greater diversity in communication.

Objective Two: External Challenges

Objective two aimed to explore what external challenges existed for interdisciplinary agricultural research center directors when communicating about science. Participants said unattainable expectations set by the public was a challenge when communicating with the public. They indicated the public has a lack of knowledge about science, which limited the center's ability to develop effective communication messages. Participants explained the public lacks knowledge related to science and cannot understand the complexity of their messages. Mark said, "We might talk about polymers and people not knowing what that is, just science literacy." Jeff noted:

> Whenever someone is being introduced to a new field, there can be a fairly steep learning curve. And when scientists are talking about what it is that they do and how they do it, that's not always clear to the lay audience.

Some participants indicated expectations from the public related to science that limited the center's communication effectiveness. Participants explained that the public would want scientific results quicker than what scientists could produce, or the public would want different scientific results than what was being produced by the interdisciplinary centers. Participants indicated that these expectations lead to difficult conversations with the public. Joey explained:

> I think the greatest barrier is setting public expectations of research. The fact is that research takes time and costs a lot of money and it's not always going to get an answer. When we do work that will spend several years and a lot of money working on something that ultimately won't get implemented.

Some directors indicated being unfamiliar with general communication practices, both in general and in their own center. Nancy said it would be useful to know what form of media would be best for communication. Some participants who did not have communications staff were not sure what communication staff could do for the center. Tim said he just did not know how much work a communication specialist would be doing. Many participants indicated not knowing what communication efforts were utilized by their center. Participants could discuss the broad communication efforts utilized by the center but were unsure about more specific details related to the center's communication efforts. When asked what specific communication efforts were used in their center, many directors responded, "Honestly, I don't know."

Many participants indicated wanting to share information about the science or research related to the work of researchers in the center, but they said they had difficulty receiving information from the faculty member. Participants often explained researchers did not always understand or fully appreciate communicating about the research that was being conducted in the center. Jason said, "It's [an effort] getting the content from the specialists. That's always a continuing effort, shall we say. I was going to say it's a challenge but sometimes it's a challenge. Sometimes it's not."

Participants indicated working with college of agriculture communication staff could sometimes be a challenge when developing effective communication outputs. Some participants described relationships with college communication staff that were not always the most productive and efficient. Various participants said college communication staff did not always give attention to potential stories from their center. Mark said, "Our [college communication staff] do news releases and such, and for whatever reason, we haven't been a high priority for that outreach service."

Nancy shared a story comparing college communication staff and a freelance communicator:

> We had a story that seemed really awesome. And I went to our guy who manages that [with the college communication staff], and I pitched it to him. And he said he would think about it. And then I asked him the next week. He said he was still thinking about it. And so then we hired a freelance science writer who wrote a story, and it ended up getting picked up by the *LA Times*.

Few participants noted college communication staff was not always well-trained to communicate about science. According to participants, university communication staff sometimes lacked knowledge on science and did not accurately communicate about research. David explained:

> We have, over the years, worked with various people who we can tap into for low cost. These have included university communication groups, who I think they tend to be trained more in a marketing kind of thing than in terms of science communication.

When participants were asked to indicate what challenges or barriers impacted science communication with the public, some participants indicated the public lacked trust of public institutions. Participants discussed various indicators of source credibility. The following subtheme emerged relating to this theme: lack of trust of public institutions. Some participants explained situations where the public indicated not trusting information from the center, which challenged communication with the public. Participants indicated needing to work with the public to build trust.

Participants also indicated facing barriers communicating to the public when citizens do not trust information from public institutions, such as universities. Participants explained occurrences when the public lacked trust of the information shared by the centers because of their affiliation with a university. Brian said, "There's so much suspicion of institutions these days that [some communication practices] are often not sufficient. It's a slower process." Brian went on to explain, "I think a huge issue in communication is trust in social relationships. Just putting out a research brief, then you stick a logo on it, gives only a very institutional form of trust."

Objective Three: Motivations

Objective three aimed to identify what factors motivate interdisciplinary agricultural research center directors to communicate about science. Communication being prioritized through internal factors was typically categorized relating to the center's mission and staff available to the center. All centers included in the study reported having a mission statement, which typically determined the center's priorities. Participants who identified communication as a priority typically reasoned the center's mission was to communicate or create awareness of an issue through communication or outreach. David explained how the purpose of the center often guided whether the center communicates with stakeholders: "I'm going to say that, in general, some centers should [communicate], and some centers probably should not. I think a lot depends on their orientation."

The center's mission usually determined the orientation of centers. David further explained how communication could be prioritized when communication is the mission of the center: "And if you do have a communications-oriented mission, then it's important that you invest in people and methods that enable you to do it well." Jason said, "Educating the public about science was kind of one of the things we were founded on. Educating and informing the public through outreach are tenets to our mission. So, for us, it is vitally important."

Some centers had various missions that required attention. "We have a research mission, we have an education mission, and we also have the outreach mission. And all three are equally important to what we do, and the reason why people want to see our [center] continue," said Brian.

Many participants explained they place a priority on communication in their center, as evidenced by the allocation of communication staff or personnel on their team. Mark said his center makes communicating a priority, noting that the center had recently hired a communication specialist for our center prior to his interview for this study. Joey also said his center emphasized communication through budget expenditures:

> [Communication as a priority] is most clearly seen in our budget where we have dedicated funding to support a communication specialist. [The communication specialist] has a whole variety of responsibilities, but translating the science into public message cuts across all of them.

Communication staff varied by centers and had various skills and responsibilities. Some directors indicated hiring part-time science writers or part-time communication specialists, while other directors had a team of communicators. Larry indicated having an outreach program manager, an outreach specialist, and a science writer. Many directors mentioned having communication staff with writing skills, while only Mark mentioned his communication staff having "strong design skills." Even still some directors "did not have an individual person for communication" (Tim).

Participants also identified external factors for prioritizing communication, such as prioritizing communication because of requirements from funding agencies or requirements from university administration. Many participants explained they prioritized communication at their center because funders of grant projects required it, with some centers hiring communication staff due to the acceptance of grants that required communication components, such as Mark. "We just received a $2.8 million USDA grant, in which communication was a priority, and the [communication] position was created in support of that grant."

Some participants identified prioritizing communication because it was required or expected from administration at the college or university level. Some participants also explained the issue or issues studied by the center were prioritized by academic administration, causing the administration to expect communication with the public related to the research of the issue or issues. David explained:

> So what we're really doing is we're taking our priority from the broader policy context, and just strategic thinking on our part says, if we allocate our scarce resources to an issue on which we could have the largest impact, what is it going to be? It's going to be this particular issue. So, you know from the standpoint of being in a college of [agriculture], [agriculture] issues being our number one priority, this being the number one [agriculture] environment priority, it's pretty easy to pick that one as our top priority for communication.

Some centers asked faculty to participate in communicating with the public about science and research from the center, but struggled to ensure faculty were accountable during the process. Tim said faculty are evaluated on teaching and research, but never evaluated on communication. Joey explained that scientists may not see the value or importance of a research finding, so it was the communication specialist's job to ensure the information was shared with people outside of the center.

Conclusions and Recommendations

Interdisciplinary agricultural research center directors in this study outlined various challenges that limited their center's communication with the public. A common challenge was the limitation of time. Directors discussed being pulled in many directions and having numerous responsibilities and, thus, not having time to devote to communication.

Time was especially an issue when centers did not have the financial ability to hire a communication professional. Other directors chose not to have a communication professional, regardless of financial ability, because they did not see a communication professional as necessary. When directors acknowledged needing a communication professional but were not able to financially support the staff, directors would creatively solve the problem by hiring freelance science writers, utilizing graduate students, or working with college and university communication staff.

Even though the directors saw their centers as a solution to the issues at hand, directors acknowledged that communicating about these issues was more difficult because many audiences did not always understand the broad view of the issue or the specific science that related to the issues. Directors also explained their centers were not seen as credible sources of information and it was difficult to engage with public audiences because the public was skeptical of information from academic institutions. Communicators, including journalists and college communication staff, also lacked understanding about science and scientific issues, according to the directors. This lack of understanding, then, led to more communication challenges, as inaccurate information would be shared as a result.

Often, centers are funded through research grants that require researchers to communicate about the research findings. These grants also provide funding for producing communication outputs or funding for hiring a communication professional. Interdisciplinary agricultural research centers in this study that were not funded by grants were typically funded through state legislative budgets. Some centers received funding through both sources. Centers funded through legislative budgets were motivated to communicate in two ways: to promote the center to continue having a presence with the state's stakeholders and taxpayers, and to continue receiving financial assistance through legislative budgets. However, centers funded through legislative budgets may not have been required to prioritize communication, so it was left up to the center and the director to determine the importance of communication. Based on discussions from directors, communication became less of a priority and more of a strain when funding was not explicit to communication.

Funding seemed very important in the discussions with directors, but was not the only motivation for communicating that was mentioned. Currently, the tenure and promotion process for faculty requires achievements in such areas as teaching, academic publications, academic and professional presentations, and grants received, but achievements in science communication are not typically acknowledged or evaluated. Center directors and communication professionals, if available, were typically the individuals responsible for communicating about science because scientists were not communicating about science. Directors discussed researchers not benefiting from science communication since science communication was not included in the tenure and promotion evaluation process.

The theory of excellence served as the main conceptual underpinning of this study and offered insight to many conclusions as this study relates to the strategic effort of science communication at interdisciplinary agricultural centers, including a lack of staff and non-strategic relationships with publics (Grunig, 1992). Literature related to the theory of excellence explains the importance of strategic management, staff dedicated to public relations and communication, and a two-way symmetrical model with publics (Grunig, 1992). Directors in this study discussed challenges related to all of these areas. These findings conclude that the interdisciplinary agricultural centers in this study did not have excellent public relation attributes. Previous literature outlined challenges that impact interdisciplinary agricultural research centers,

including a lack of university incentive and insufficient funding (Bohen & Stiles, 1998; Klien, 1999). Directors in this study also discussed these challenges, but related them directly to the communication of the centers. This finding leads to the conclusion that these challenges transcend the operational challenges of a center but also impact the influence the center can have on society.

Lamm et al. (2016) found the public is trusting of scientists and universities as sources of information. However, in this study, directors described a sense of skepticism they receive when communicating with the public. Directors discussed universities and scientists not being sources of information that were sought by the public. This finding would counter findings from Lamm et al. (2016), but does confirm findings from Telg et al. (2012), which states that the communicator of a message has an incredible impact on the influence of an audience.

Borchelt (2001) identified scientists' motivations to communicate, including the desire to inform decisions, improve science literacy, and inform the public about general science information. Those same motivations were present with the directors who were included in this study. However, more tangible motivations and priorities to communicate about science were inspired through funding. The National Academies of Science, Engineering, and Medicine (2016) found that a more science literate public is more likely to support science funding, which reinforces a trinity of funding, communication, and literacy being dependent on one another. Just as Klein (1999) found that a lack of continuous funding led to barriers to success for interdisciplinary centers, directors included in this study also discussed seeking money became more of a priority than other pursuits because the next dollar to support research was never guaranteed.

Universities have the opportunity to motivate faculty to communicate about science through the tenure and promotion process. Other academic pursuits and faculty responsibilities are recognized through tenure and promotion, but not science communication (Hulcr, 2016). Faculty most likely will not be able to prioritize science communication until universities acknowledge its value in the tenure process. This shift will take time and will require communicators to provide proof of impact from science communication to upper-level administration. In the meantime, departments, colleges, and universities can recognize excellence in science communication through award programs as a form of motivation.

Interdisciplinary agricultural research centers should regularly evaluate their public relation efforts through models, such as the theory of excellence, to better understand what areas should be improved and how stronger two-way relationships can be formed with the organization's publics. Agricultural communication academic departments or college communication staff could offer training related to public relations and public relations evaluation for center administration or communication staff. This training would allow administrators and communicators to better understand the relationship between public relations and science communication, while also helping them to provide proof of impact for their public relations efforts.

Future research should examine the effectiveness of messages communicated by interdisciplinary agricultural research centers. Many centers lack the ability to hire full-time communication professionals, so it would be important to compare the messages developed by outside parties, such as freelance science writers, student interns, and college communication staff. Future research should also explore the influence of messages related to science communication from interdisciplinary agricultural centers on the intended audience's behaviors and decision-making. Since this study included a small number of agricultural scientists as

directors, it is also recommended that future research explore factors that may motivate other agricultural scientists to communicate about science. A lack of consistent financial resources was often mentioned in this study as a challenge to communicating about science. It is recommended that future research examine the variety of financial structures that exist for interdisciplinary agricultural research centers at academic institutions to determine best practices.

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