ATTRIBUTES AND BARRIERS IMPACTING THE DIFFUSION OF INFORMATION COMMUNICATION TECHNOLOGIES (ICTs) IN AGRICULTURAL COLLEGES AND UNIVERSITIES IN THE DEVELOPING WORLD: VIEWS OF ASPIRING FACULTY

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CHAPTER I

INTRODUCTION

"Agriculture has been a part of human life since the beginning of the human race and the need for agricultural information is probably almost as old as agriculture itself" (Malhan & Rao, 2007. p. 1). Therefore, it is important for stakeholders in agriculture such as farmers, agricultural educators and students to have access to agricultural information and content knowledge for the purpose of making informed decisions (Economic and Social Commission for Asia and Pacific [ESCAP], 2009; Inwent, 2010). The invention of the World Wide Web has made it possible for many people in the developed world and some in developing countries to access, use and disseminate information about agricultural inputs and training materials, for example (Dione, Weber, Staatz, & Kelly, 2004).

Agriculture is a livelihood for many people all over the world. In India, 65% of the labor force is in the agricultural sector, and in Africa approximately 70% of the population is engaged in agricultural production (Cleveland, 2008; Malhan & Rao, 2007). In the wake of shrinking natural resources coupled with environmental degradation and yet growing demand for food by an ever increasing world population, the need to design and develop an agricultural resource information system to assist in planning and implementing agricultural projects exists (Christiansen, 2000; Malhan & Rao, 2007).

However, Africa, for example, has the capacity to feed its population if resources are managed well (Cleveland, 2008).

The source of sustainable agricultural prosperity is human capital that is empowered with information, yet the systems of transferring technologies to prospective farmers (i.e., students and/or training participants) and current farmers in developing countries are inadequate (Erbaugh, Donnermeyer & Amujal, 2010). Agricultural success in developing countries lies with enhancing the skills and knowledge of their people, especially the youth as future agricultural producers and entrepreneurs (Inwent, 2010; Miller, 2004; United Nations Population Fund Agency [UNFPA], 2009). The dynamics within socio-economic structures of the developing world has changed so drastically that "the years old administrative, strategic, policy and operational practices of almost all relevant organizations, including public, private and NGOs seem to be outdated" (Qamar, 2003, p. 9).

According to a National Research Council report (2009), agriculture colleges and universities must recognize the core changes needed for the future well-being of the next generation. The report mentioned specifically the need to reform curricula to empower students with skills that will help them survive in an ever changing world. Furthermore, some students are future farmers who need proper dissemination of information through the Internet, cell phones and other forms of communication technologies to make informed choices thereby increasing agricultural production in their respective countries (Inwent, 2010).

The preparation of developing countries' human resources should include the use of existing and emerging information communication technologies (ICTs) (McHale,

2010). Therefore, the need for human resource development is imperative, especially in the agricultural and food sector where fully developed ICTs could assist in this effort (Farrell & Isaacs, 2007; Kabaji, 2010; Quinones, 2000).

Global integration and changes in demographics pertaining to the workforce in agriculture, coupled with pressure from many qualified high school graduates for university education, demands that institutions of higher learning embrace ICTs as a way of keeping pace with the realities of the 21st century (McHale, 2010; Sawyerr, 2004). For example, Uganda had 37,000 secondary school pupils in 1980 and by 1996 the number increased to 256,000 (Musisi, 2003). In 1994, Uganda had 7,472 qualified students for university admission and by year 2000 an increase of 24,000 students of the same caliber of whom only one-third were admitted for university education (Sawyerr, 2004).

According to Sawyerr, the situation is not different for countries such as Ghana and Nigeria as their universities can accommodate only 33% and 12% of qualified students, respectively. In Kenya and India, the rates of students admitted for university education are roughly 33% and 10%, respectively (Anami, 2011; Azam & Blom, 2008). Traditional in-class learning or "face-to-face" methods are no longer meeting the demand of all qualified students for tertiary education based on the meager number of students being accepted at various universities in developing countries (United Nations Population Fund Agency [UNFPA], 2009). The swelling population of youth in African countries is more than 50% of the total in many cases, and it is estimated that 75% are below thirty years of age in East Africa (Haji, 2007; Okojie, 2003).

Adult workers are always in need of improving their skills but time and location may limit their opportunities (Askov, Johnston, Petty & Young, 2003). Moreover,

students from low income families who are marginalized from mainstream university educational opportunities due to its prohibitive cost have a similar need (Loxley & Julien, 2004). It is ironic and untenable to see important systems for transferring technologies to students and farmers in developing countries being employed so inadequately that the dissemination and adoption of new innovations in the agricultural sector is hampered significantly (Erbaugh et al., 2007; Inwent, 2010; Kabaji, 2010).

Some of the reasons mentioned for such slow diffusion of ICTs into universities and schools include inadequate funding from the national governments, lack of infrastructure and too few qualified human resources (Chacha, 2004; Loxley et al., 2004; Obijiofor, Inayatullah, & Stevenson, 1999; UNESCO, 1998). Frequently, college and university lecturers have limited teaching skills and yet they are expected to deliver learning because they are experts in their fields (Kabaji, 2010; Li & Lindner, 2007; Sigei, 2011).

Despite overwhelming support for ICTs by many people as appropriate to their farming information needs, many elected politicians may not see the improvement of education as their priority, especially where political instability, corruption, poverty and mismanagement of resources are the norm (Obijiofor et al., 1999). In addition, some teachers and administrators alike have been resistant to new technologies, as too many have been quoted as saying, "if they [i.e., teachers and administrators] were able to do without computers, multimedia materials, or management information systems in their schooldays, so can the current generation" (Loxley et al., 2004, p. viii).

According to Loxley et al. (2004), this kind of attitude has resulted in developing countries losing many of their very promising youth to developed countries where their

educational needs, including learning at a distance via ICTs, are met more readily. In some instances, universities and other agricultural education institutions of developing countries at the tertiary level may be doing their best to contribute toward development of agriculture using ICTs. But, the consensus is, they have been slow in responding effectively to changes in socio-economic development needs, which could be mitigated by the use of ICTs (Chakeredza et al., 2008).

One of the reasons mentioned to support this argument is how poorly these institutions of higher learning have handled the use of technologies to access and disseminate information (Zachmann, Musewe, Baguma, & Mukhebi, 2005). Nonetheless, according to Okapaku (2003), ICTs have been identified as important catalysts in the development of agriculture on the continent of Africa. ICTs are also considered crucial for good governance and production of other resources related to agriculture that could assist in alleviating poverty in the developing world (Sciadas, 2003; United Nations Development Program [UNDP], 2001).

Information communication technologies have transformed education systems in developed countries more than what anyone could have imagined a generation ago, such as bringing into existence distance education (DE) to accommodate the needs of individual students and faculty (Loxley et al., 2004). Flexibility in scheduling and multimedia-facilitated interaction made possible by distance education technologies is very convenient for today's students and faculty as it gives them an opportunity to learn and teach in remote and non-traditional venues (Dione et al., 2004; Harder & Lindner, 2008; Moore, 2000). This is possible because courses are online any time of the day or night and can be accessed from any location with the Internet hence creating

opportunities for more students in developing countries to participate in tertiary education (Chacha, 2004; Loxley et al., 2004).

Distance education also goes beyond traditional, physical classroom constraints (i.e., a "virtual classroom") whereby more students of diverse backgrounds including age, ethnicity and socio-economic levels are reached through an electronic delivery format that is also more cost-effective (Bunnell, 2008; Moore, 2000; Loxley et al., 2004). According to Keegan (1988), distance education is also meant for people in the labor force, homemakers and those who do not prefer the formal educational setting. Therefore, it is imperative for agricultural universities and colleges in developing countries to begin using ICTs to deliver their curricula at a distance to reach their formal students as well as provide learning opportunities to farmers and other agricultural entrepreneurs.

Tying university curricula, that includes the use of ICTs, to national, regional and global agricultural development agendas is essential as well, as it necessitates a paradigm shift in an approach to training graduates where expertise is needed to guide policy, relevant research, and the general development vision for a country or region. According to a United Nations Development Program [UNDP] report (2001), "classrooms and lecture theaters can be traced back to the needs of the 19th century industrial age. At the start of the 21st century, we need to re-engineer the learning process" (p. 80).

Learning in institutions of higher education in developing countries needs to be reformed to take advantage of emerging new technologies such as ICTs to increase opportunities for advancing human capital in the agricultural sector. However, African universities and other institutions of higher learning in developing countries have fewer resources, such as financial support from their respective governments to support and

propel the use of ICTs in their institutions (Chacha, 2004; International Agricultural Science and Technology Development [IAASTD], 2008b; Kabaji, 2010). The need for institutions to forge alliances or collaboration among themselves and with their peers abroad for the purpose of information exchange, resource mobilization, and the sharing of knowledge and global experience exists (IAASTD, 2008a; UNDP, 2001).

Some may ask, what kind of reforms are needed in institutions of higher learning in the developing world that would yield relevant training in agriculture, which is responsive and attuned to the changing socio-political, economic and technological era of today? Institutions of higher learning in developing countries need to have adequate and affordable infrastructure to support the use of ICTs such that more skilled faculty, support personnel, and students have access to it (Farrell & Isaacs, 2007; Kizza, 2009). Cost-effective teaching and training of agricultural professionals at the tertiary level remains a desirable aim for many institutions of higher learning in developing countries so that more people can access university education in the agricultural sector (Eicher, 2006).

Therefore, institutions of higher learning in developing countries must be the incubators of ICTs for the purpose of building needed infrastructure and human capital capable of solving local problems in one of their most vital economic sectors, agriculture (Christiansen, 2000; Kizza, 2009; Sawyerr, 2004). Developing countries find themselves at a crossroads regarding ICTs and their implementation, i.e., they can ill afford to not use this new technology effectively, leading future generations to lag behind in development and to struggle for a long time to come. However, if they embrace this technology without using it to assist in solving immediate needs of their citizens, such as

food and shelter (Kozma, 2005), they may find themselves "placing their carts before their horses" (Obijiofor et al., 1999).

A strategy for these countries to avoid making catastrophic mistakes regarding the use of ICTs would be to consult widely within and outside their borders. Participatory planning in this endeavor is vital for the purpose of capturing ideas from all interested parties, including current and aspiring faculty who are in these countries as well as those in the Diaspora (Christiansen, 2000; Nair & Prasad, 2002; Sawyerr, 2004). As the former Prime Minister of Malaysia stated while attending an Asian-Pacific youth seminar,

> If we are to be true statesmen, we must take into account the needs, desires and the ambitions of the generations for whom we plan our development. No architect would build a house without consulting the wishes of those who live in it, and designing the house to their way of life. (ESCAP, 1999, p. 4)

It is because of these conditions that this study examined the role of ICTs in advancing agricultural education at colleges and universities in developing countries through the prism of international graduate students in the College of Agricultural Sciences and Natural Resources at Oklahoma State University. The researcher posited that the study participants aspire to be faculty members at colleges and universities in developing countries after they graduated. Accordingly, the study examined the attributes and barriers impacting the diffusion of Information Communication Technologies in colleges and universities in developing countries based on the perceptions of international graduate students who were studying agricultural sciences and natural resources.

Statement of the Problem

Agricultural success in developing countries lies with enhancing the skills and knowledge of the people who populate these nations, especially the youth as future agricultural producers and entrepreneurs (Inwent, 2010; Miller, 2004; UNFPA, 2009). The youth population under 25 years of age stands at approximately 3 billion of the estimated 6.7 billion people who inhabit the world (Redding, 2007). An increase of the youth population in developing countries, especially in African nations, has posed many challenges to the provision of tertiary education. For example, in East Africa, 75% of the nations' populations are youth under the age of thirty years (Haji, 2007; Okoje, 2003). Tertiary institutions are being pressured by these youth who wish to further their education. For example, only 33% and 10% of qualified university students are admitted to Kenyan and Nigerian universities, respectively, each year (Anami, 2011; Government of Kenya [GoK], 2008; Sawyerr, 2004).

An increased enrollment has necessitated classes to be overcrowded; an exodus of experienced but aging faculty due to retirement (not replaced speedily); qualified, youthful faculty leaving to developed countries because of low pay and poor working conditions has compromised the quality of education in many tertiary institutions in the developing world (Chacha, 2004; UNESCO, 1998). As a result, many universities in developing countries are delivering inferior instruction and learning environments that necessitate a call for change in teaching and delivery strategies and practices (Musisi & Muwanga, 2003; Sawyerr, 2004).

ICTs have transformed educational systems in developed countries from their universities and colleges to even high schools (Loxley, 2004). Although the adoption of

ICTs in developed countries may be uneven in some cases, it has been useful in assisting in improving education, including aspects of agricultural education and development (Zachmann et al., 2005).

However, many colleges and universities in developing countries have not changed significantly to address the many problems of their agricultural sector, e.g., they are struggling with inadequate resources to fund needed "hardware" (computers) as well as "software" (Internet access and human capital) required to use ICTs effectively (Bloom, Canning & Chan, 2006; Obijiofor et al., 1999). The governments of many developing countries are contributing very little financial resources toward their universities. This condition is hampering not only their abilities to recruit and retain qualified faculty but also incentivize them regarding the use of ICTs to strengthen the delivery of education in these countries (Clark, 2006; Loxley, 2004; Sawyerr, 2004; World Bank, 2008).

The reform of higher education curricula in many developing countries has been driven frequently by either the desire of governments to have a larger number of trained professionals regardless of the needs of the citizens or are "donor driven" by short-term, volatile funding, which is neither sustainable nor adapted to the specific context of that nation (Bloom, 2006; Kabaji, 2010; Sawyerr, 2004). Kenya, for example, seems to change education policies for the purpose of accessing financial aid regardless of its national priorities (Otieno & Colclough, 2009).

Information technologies need to be used as a means of stimulating development in developing countries by improving the connectivity of knowledge and skills among the youth within and outside their borders (Loxley, 2004). Universities in developing

countries should move away from rhetoric and embrace participatory curriculum with their stakeholders' input (e.g., youth, aspiring faculty and farmers) on what is core and relevant to their context without compromising high educational standards (Miller, 2004). The accessibility of ICT infrastructure as being "too little, too expensive, and poorly managed" (Farrell & Isaacs, 2007, pp. 3-4) is very troubling and must be resolved to achieve global connectivity among universities and other institutions of higher learning to foster increased collaboration, learning and discovery.

Participatory planning involving the collection and analysis of views from stakeholders, including aspiring university faculty members is essential (Acker & Gasperini, 2008; Sawyerr, 2004). Accordingly, this study examined the views of aspiring faculty members on the use of ICTs to advance the teaching of agricultural education in developing countries.

Significance of the Study

The time is now for bridging the ICTs' gap between developed and developing countries. The success and sustainability of ICTs in developing countries will depend on how appropriate the technology is, including its compatibility with local conditions and needs (Acker & Gasperini, 2008; Reijswoud, 2009; Rogers, 2003). The views of natives of developing countries on advancing agricultural education in colleges and universities and on implementing ICTs in their institutions should be understood better. The findings of this study could make a vital contribution to an increased awareness of what needs to be done to cope with current challenges and address new ones as they emerge. Results could also help to guide corrective policies at both national and international levels and set priorities for the future.

The results of this study will help higher education institutions in developing countries reform their curricula and design infrastructure to support the integration of ICTs to advance agricultural education. Leaders of these institutions could be informed better on the views of future faculty who aspire to use ICTs when designing and planning their teaching, research and extension or outreach activities. In turn, more youth who qualify to pursue tertiary education but suffer from lack of classrooms and teachers may be served more effectively.

Purpose of the Study

The purpose of this study was to determine the perceptions of international graduate students from developing countries in the College of Agricultural Sciences and Natural Resources (CASNR) at Oklahoma State University on the diffusion of information communications technologies (ICTs) to advance agricultural education at colleges and universities in developing countries. A secondary purpose was to describe the personal and professional characteristics of international graduate students from developing countries who were studying agricultural sciences and natural resources at Oklahoma State University. The period of data collection was the fall semester of 2010.

Research Questions

1. What were selected personal and professional characteristics of graduate students from developing countries who were studying in CASNR at Oklahoma State University?
2. What were the study participants' perceived levels of "innovativeness" regarding their use of ICTs for academic learning?

3. What were the study participants' views on selected **attributes** impacting the diffusion of ICTs to advance agricultural education at colleges and universities in developing countries?
4. What were the study participants' views on selected **barriers** impacting the diffusion of ICTs to advance agricultural education at colleges and universities in developing countries?
5. What **relationships** existed between selected personal and professional characteristics of the study participants and their perceptions on variables impacting the diffusion of ICTs to advance agricultural education at colleges and universities in developing countries?

Assumptions

1. The survey instrument developed obtained accurate responses from the study's participants.
2. The study's participants willfully provided the information sought to the best of their ability.
3. Participants were computer literate and had access to the Internet.
4. The study's participants aspired to become faculty in the various disciplines of agriculture at institutions of higher education in the developing world.
5. Leaders in various departments in CASNR provided electronic mail addresses of graduate students from developing countries and/or facilitated hand delivery and retrieval of the study's instrument to and from their students.

Limitations

1. This research included only international graduate students in CASNR at Oklahoma State University from developing countries during the fall semester of 2010.
2. The data gathered were limited to perceptions as well as personal and professional characteristics of the participants on diffusion of ICTs at colleges and universities in developing countries.
3. Some students had no or very limited experiences with ICTs for the purpose of academic learning.
4. Coverage error was a potential limitation.

Definitions of Terms

For the purpose of this study, the following terms were used:

Accessibility: the process of making the availability of education facilities to everyone who qualifies for university education regardless of the cost, physical impairment or geographical location (United States Distance Learning Association [USDLA], 2011)

Agricultural Education: learning that encompasses the different academic disciplines found in most colleges or faculties of agriculture worldwide

Aspiring faculty: graduate students who have ambitions of becoming university level educators (Costanzo & Handelsman, 1998)

Attributes: characteristics of an innovation in the diffusion process (Rogers, 2003)

Barriers: factors that hinder diffusion of innovation (Li, 2004)

Curriculum: a plan written to show what is entailed in an educational program for an institution (Beauchamp, 1982)

Developing countries: countries that have low socio-economic growth where many of the citizens live on less than 1.25 USD a day (United Nations, 2009)

Diffusion: "the process in which an innovation is communicated through certain channels over time among the members of a social system" (Rogers, 2003, p. 5)

Distance education: "having the defining characteristic that, for all or most of the time, the teaching occurs in a different place from where the learning occurs, so that the normal or principal means of communication is through an artificial medium, either printed or electronic" (Moore & Shin, 2000, p. 215)

Graduate student: a student enrolled in an advanced academic study program beyond the baccalaureate (Oklahoma State University, Graduate College, 2011)

Human capital: human skills and talent that people acquire to enhance their economic productivity (Olaniyan & Okamakinde, 2008)

Information Communication Technologies:

> Information and communications technology is an umbrella term that includes all types of technologies for the communication of information. It encompasses any medium to record and broadcast information as well as technologies for communicating information through voice, sound, and/or images. Information technology (IT) has become a hub for communicating information, most often using computers. (Swanson & Rajalahti, 2010, p. 181)

International graduate student: a student who is in the United States on a non-immigrant student visa and is enrolled in an advanced academic program (Oklahoma State University, Graduate College Catalog, 2008-2009)

Internet: "a massive network of networks connecting computers around the globe" (Askov, Johnston, Petty & Young, 2003, p. 2)

Participatory planning: the process of bringing stakeholders together in order to collect information for the purpose of making informed decisions (UNDP, 2006)

Perception: an attitude of mind especially one that favors one alternative over others (Lionberger & Gwin, 1991)

Personal characteristics: individual attributes related to an individual's innovativeness (Rogers, 2003)

Professional characteristics: acquired skills, knowledge and attitudes of educators/facilitators related to improving student learning (Guskey, 2000)

Stakeholders: "persons, groups or institutions with interest in a project or program" (UNDP, 2006, p. 37)

Study leave: "a learning initiative which requires an individual to be absent from their usual place of work for a defined period of time" (Learning and Development Manager, Human Resource, 2005, p. 2)

Tertiary education institutions: institutions of higher learning that grant undergraduate, masters and PhD degrees (Azam & Blom, 2008)

Traditional education: face-to-face learning and teaching that occurs in a physical classroom usually (Askov et al., 2003)

World Wide Web: "an information-sharing model that is built on top of the Internet" (Askov et al., 2003, p. 3).

Youth: individuals who are thirty-four years of age and younger (United Nations, 2007a)

Summary

As indicated in this chapter, a majority of people in developing countries are involved in agriculture either directly or indirectly (USAID, 2011). Many of those engaged in this sector do not have necessary skills to be efficient in their production activities even though they are willing to be trained (Quinones, 2000). Population explosion among the youth in developing countries has created high demand for tertiary education. However, in many countries, a majority of those who qualify end up not being admitted to universities to pursue further studies (Haji, 2007; Okojie, 2003; Sawyerr, 2004; UNFPA, 2009).

Many qualified faculty in developing nations are either retiring or leaving for "greener pastures" in the developed world because of poor remuneration and inadequate working environments in their home countries (Chacha, 2004; Loxley et al., 2004; Sawyerr, 2004). As a result, many universities in developing countries have inferior delivery of instruction, which necessitates a call for change (Musisi & Muwanga, 2003; Sawyerr, 2004).

The source of sustainable agricultural prosperity is human capital, which could be improved through the use of ICTs the way developed countries have done through the provision of teaching and learning at a distance (Loxley et al., 2004). The systems of transferring technologies to prospective farmers (i.e., students) and current farmers in many developing countries are inadequate, because the institutions of higher education have been very slow in embracing ICTs due, in some cases, to inadequate support from their governments (Chacha, 2004; Chakeredza et al., 2008; Erbaugh et al., 2007). However, these technologies have been identified as important catalysts in agricultural

development as illustrated by several developed countries (Loxley et al., 2004; Okapaku, 2003).

The curricula of developing countries' institutions of higher learning need to be reformed because their planning strategies are too frequently not participatory; so, the stakeholder input that is vital for the success of a program may be lacking (Acker & Gasperini, 2008; Chacha, 2004). An increase in student age populations measured against the availability of colleges and universities, loss of lecturers through retirement and poor remuneration coupled with inadequate teaching facilities and related infrastructure is worrying in many developing countries (Loxley et al., 2004). So, the traditional way of teaching and delivering learning to nonformal and formal audiences must be complemented by other delivery mechanisms, e.g., the use of ICTs to deliver learning at a distance (UNESCO, 1998; Chacha, 2004).

The introduction of Distance Education (DE) would ease some of the abovementioned problems by making it possible for more qualified students to access a university education remotely hence circumventing the issue of inadequate physical space and too few teachers (Farrell & Isaacs, 2007; Inwent, 2010; Kabaji, 2010; Loxley et al., 2004: McHale, 2010). It is well known that education steers economic growth of a given country depending on the quality and quantity provided (Olaniyan & Okemakinde, 2008).

Capacity building, good policies on appropriate technologies such as access to the Internet by all interested citizens, with the reliable support of governments and the fostering of collaboration among institutions of higher learning globally are good ingredients to the recipe for development (UNDP, 2001). Moreover, participatory planning in which voices of those within and outside developing countries are heard on

ICTs, including aspiring faculty, is seen as a “best practice” to address the problems and opportunities associated with diffusing ICTs in agricultural colleges and universities in the developing world (IAASTD, 2008a; UNDP, 2001).

CHAPTER II

REVIEW OF LITERATURE

This chapter reviews literature pertaining to diffusion of information communication technologies (ICTs) to advance higher learning (tertiary education) in the agricultural sciences and natural resources in developing countries. The areas examined included accessibility of tertiary education in developing countries, the current situation of ICTs in colleges and universities in many developing countries vis-à-vis developed nations, challenges to using distance education to deliver tertiary education in developing countries, selected cultural aspects surrounding the use of ICTs, the current situation of ICTs in colleges and universities in developed countries, agricultural institutions in the developing world and their Internet connectivity, the conceptual/theoretical framework underpinning this study, capacity building related to the adoption and use of ICTs in the agricultural sciences and natural resources in the developing world, and chapter summary.

Accessibility of Tertiary Education in Developing Countries

According to Redding (2007), the exploding population of youth in developing countries has put a lot of stress on limited resources in various sectors such as education, health and security. Redding continued to state that more than 3 billion people (6.7 billion is the world's approximate population) in the world are below the age of 25 years and a majority of them are found in developing countries where tertiary education opportunities

are hard to come by. In East Africa, more than 50% of the populations are youth of whom 75% of them are below the age of 30 (Haji, 2007; Okojie, 2003).

In Uganda, for example, of the 24,000 students who qualified for tertiary education in the year 2000, only one-third of them gained university admission (Sawyerr, 2004). According to Sawyerr, the situation is not different for Ghana and Nigeria where their respective universities are able to admit qualified students at the rates of 33% and 12% respectively. In Kenya and India, university admission has been hovering around 33% and 10% respectively of the qualified candidates (Anami, 2011; Azam & Blom, 2008; Government of Kenya [GoK], 2008).

Apart from the population explosion of the youth, adult workers are always in need of improving their skills but time and location may limit their opportunities (Askov, et al., 2003). The rapid increase in secondary education graduates and the need for adults in developing countries to further their education is linked to the enrollment crisis these countries are facing in tertiary education (Mwapachu, 2010). Expanding tertiary education is also a part of global, regional and national strategies to spur economic growth through creating human capital needed to support national development plans of countries for the 21st century (Ndulu, Chakraborti, Lijane, Ramachandran, & Wolgin, 2007).

However, most developing countries have very weak tertiary education systems to withstand competition from developed countries (Ndulu et al., 2007). For example, Tanzania's index of quality tertiary education and training stands at 128 out of 134 globally and Cambodia was ranked 117 (World Economic Forum, 2009; World Economic Forum, 2010). Developing countries should therefore develop the skills and

expertise of their citizens that are relevant to the current environment by linking educational curriculum and its delivery to their priorities and needs (ESCAP, 1999; South Commission, 1990).

The issue of qualified human resources in tertiary education systems in developing countries is troubling as very few faculty and staff have the required qualifications (Chacha, 2004; Loxley et al., 2004; Sigei, 2011; UNESCO, 1998). Many of the lecturers, who may have very limited skills, are required to teach because they are considered to be "experts" in their fields whether that designation is truly accurate (Kabaji, 2010; Li & Lindner, 2007; Obijiofor et al., 1999; UNESCO, 1998). For example, of the lecturers at the University of Colombo in Sri Lanka, 37% were PhD holders in humanities and social sciences; moreover, on average, the Sri Lankan university system had 30% of its lecturers who held a doctorate in their field, compared to 90% PhD holders in Hong Kong's tertiary education system (Gamage, 2005).

"Full professors" in humanities and social sciences in the Sri Lankan university system added up to a paltry 9% of the total, associate professors were about 16% and lecturers holding masters degrees only were 44% (Gamage, 2005). In Cambodia, the top six institutions of higher learning in the country had only six percent of their lecturers holding with terminal degrees (as cited in Richardson, 2011). Of the faculty in Kenya, 352 "full professors" in the entire country accounted for serving approximately 200,000 students in 30 universities (Muindi, 2010; Sigei, 2011). This situation translates into heavy teaching workloads for the faculty as well as many under-qualified faculty members being a majority in teaching roles thereby compromising the quality of tertiary education in many developing countries (Chacha, 2004; UNESCO, 1998).

Some of the reasons attributed to fewer qualified faculties in developing countries' tertiary education systems are the retirements of aging faculty members, attrition of faculty, and low remuneration packages for faculty as well as poor teaching facilities and infrastructure in their institutions. Yet, the opposite conditions, i.e., good pay and state of the art teaching facilities, are readily available in many developed countries thereby attracting faculty from the developing world and exacerbating a "brain drain" problem (Chacha, 2004; Loxley, 2004; Musisi & Muwanga, 2003; Sawyerr, 2004; UNESCO, 1998; World Bank, 2008).

A new system of learning in institutions of higher education is needed in many developing countries, i.e., where access to tertiary education is bolstered by using scarce human resources more effectively to produce graduates who are equipped to succeed in the ever changing global, regional and national landscapes (Mwapachu, 2010; South Commission, 1990). The traditional way of teaching (or the face-to-face classroom) must be complemented by other delivery mechanisms to ease problems of inadequate physical space and lack of qualified teachers endemic to many institutions that are faced with surging number of students in need of tertiary education (Farrell & Isaacs, 2007; Loxley et al., 2004; McHale, 2010).

Use of emerging new technologies such as ICTs must be embraced by institutions of higher learning in the developing world just as the developed world's nations did and are doing in transforming their tertiary education systems to accommodate the needs of 21st century students, faculty and societies (GoK, 2008; Loxley et al., 2004). Distance education, where learning through information communications technologies (ICTs) is

the primary mode of delivery, promotes more access to tertiary education (Mwapachu, 2010).

According to Keegan (1988) and Askov et al. (2003), distance education is not only meant for traditional students but also for people in the labor force, homemakers and those who do not prefer the formal educational setting. Flexibility in scheduling and multimedia-facilitated interaction made possible by distance education technologies is very convenient for today's students and faculty as it gives them an opportunity to learn and teach in remote and non-traditional venues (Dione et al., 2004; Harder & Lindner, 2008; Moore, 2000).

Universities and colleges in the developed world are well known for their academic contribution to the well being of the global society (Etzkowitz, 2002; Kaino, 2008; Kozma, 2005). It is imperative that, based on the needs for expanded access to tertiary education in developing countries, their institutions of higher learning embrace ICTs to keep pace with the realities of the 21st century (McHale, 2010; Sawyerr, 2004). These emerging technologies would help countries, such as Ghana, India, Kenya, Sri Lanka and Uganda to mention only a few, by increasing their student intake into tertiary education, including students who may have been denied access otherwise (Anami, 2011; Azam & Blom, 2008; EdInvest, 2005; Gamage, 2005; GoK, 2008; Sawyerr, 2004; UNFPA, 2009).

The Current Situation of ICTs in Colleges and Universities in Developing Countries vis-à-vis Developed Nations

More than 70% of the population in Africa depends on agricultural production for their livelihood and 65% of the labor force in India is in the agricultural sector. However, many developing countries in these regions are likely to miss the Millennium Development Goal on poverty and hunger, making it difficult to halve poverty by 2015 (Cleveland, 2007; Malhan et al., 2007). However, ICTs are being used by universities in developed countries to stimulate and enhance development in many realms, including their agricultural sectors (Loxley et al., 2004).

The success and sustainability of ICTs in the developing countries will depend on how appropriate the technology is, including its relative advantage and compatibility with local conditions and needs (Acker & Gasperini, 2008; Reijswoud, 2009; Rogers, 2003). For example, institutions can train people using Internet technologies not only to empower them with skills to improve their technological know-how, but also to open up their accessibility to the world generally (Brown, 2000; Nair & Prasad, 2002).

The use of ICTs to alleviate poverty has been recognized internationally and that is why many international agencies have numerous projects driven by aspects of ICTs (UNDP, 2001). In education, ICTs enhance changes by improving the learners skills (i.e., building human capital), reaching out to more students who may not have been served otherwise, and lowering the cost of education per pupil; thus, preparing students to be viable in the global economy and societies driven by information and its uses (Haddad & Draxler, 2002; Loxley et al., 2004; McNamara, 2003; UNESCO, 2002; Wagner & Kozma, 2005). The benefits that came with the adoption of ICTs by tertiary institutions in

the developed world have made it possible for many universities to redefine their mission by accommodating the virtual campus courses they offer (Askov et al., 2003).

Furthermore, developed countries have higher enrollment rates in colleges and universities than many developing countries, in Sub-Saharan Africa particularly, partly because of distance education (enabled by ICTs), which makes up a portion of their education systems (Daniel, 2007; Lewin & Sayed, 2005; UNESCO, 2004). In the United States, colleges and universities offer distance education classes, and about 12.2 million students are enrolled in these courses annually (Parsad, & Lewis, 2008).

Cost-effective teaching and training of agricultural professionals at the tertiary level remains desirable for many institutions of higher learning in developing countries (Eicher, 2006). By creating an enabling environment for their citizens to access tertiary education through distance education, developed countries have created relevant pools of skilled labor that have propelled them to the top in development, including aspects of agricultural and food production (World Bank, 2000).

Policies to improve ICTs in developing countries are not effective as they are fragmented, making the implementation capacity within the institutions of higher learning weak and under-performing (Cheng & Townsend, 2000; Malhan et al., 2007). This is because, although developing countries have created policies promoting ICTs in education, a missing link exists between what the national plans of these countries advocate and the expected socio-economic impacts anticipated by the countries' plans (Jones, 2003; Kaino, 2008; Kozma, 2003). This condition is to the detriment of developing countries where resources are inadequate if not scarce; hence, the budgetary implications of such mismatches are very high (Kozma, 2005).

This situation has been made worse by the governments of many developing countries who have contributed very little financial resources towards their universities hence hampering the institutions' abilities to be more technologically innovative and incentivize their faculty regarding the use of ICTs (Clark, 2006; Loxley, 2004; Richardson, 2011; World Bank, 2008). However, some developing countries, such as Egypt, have brought forward policies to support the use of ICTs in their tertiary education institutions. The Egyptian ruling National Development Party (NDP) came up with a policy that stated, "integrating modern technology into education has astounding positive influence on nations' educational development, economical progress and global position" (NDP, 2003, p. 3).

The NDP's policy envisioned collaboration between the government of Egypt and the private sector in enhancing ICTs through subsidizing Internet service providers thereby bringing on board new service users from nine per 10,000 people to 55 users per 10,000 people (Postnote, 2006). At the university level, Egypt is using ICTs to improve its quality of education and research by training teachers on how to use computers, i.e., the acquisition of basic computer skills (Kozma, 2005).

Investing in ICTs will not do much if the work force and businesses have no capacity to use them productively, however (Nair & Prasad, 2002). Public and private investments in people (i.e., human resources) with good economic policies and flexible information infrastructure that is driven by universities as well as research and development centers must support this endeavor (Malhan et al., 2007; World Bank, 2003). Building on ICTs infrastructure as well as the capacity building of faculty and redefining the missions of universities (Askov et al., 2003) to provide distance learning

are crucial aspects to addressing the fundamental and complex challenges inherent to this enterprise. Yet, institutions of higher learning in developing countries provide these kinds of capacity building efforts too rarely (Eastmond, 2000).

According to Loxley et al. (2004), the acquisition of computer skills enhanced the self-efficacy of teachers/lecturers as well as students and improved their levels of job/class performance and satisfaction. It also strengthens content delivery and the support accorded to distance students in using the knowledge acquired through distance learning as it becomes more about learning the content than learning how to use the technology delivering the lessons (Frost, 1998). According to Askov et al. (2003), computer literacy motivates distance learning lecturers and students as they are more comfortable working independently thereby strengthening their organizational skills, which translates into a strong study and teaching ethos propelling them to success.

"The most significant predictors of satisfaction with online courses were individuals' computer competency and perceptions that they were perceived as 'real' by others in the course" (Askov et al., 2003, p. 6). Therefore, students and lecturers in distance education classes must have access to an Internet-connected computer with some minimal skills of operating it to meet the challenges that may accompany online courses (Askov et al., 2003). However, the information and instructional technologies in colleges and universities in developing countries are often obsolete and even inaccurate. This is due to a deficit of current research and the lack of incentivizing faculty to be up-to-date on what is occurring regarding the use of ICTs in distance education by attending conferences and seminars, for example (Giltrow & Pannen, 1992; Askov et al., 2003).

The accessibility of ICTs and related infrastructure as being "too little, too expensive, and poorly managed" (Farrell et al., 2007, pp. 3-4) in many developing countries is very troubling and must be remedied if global connectivity among universities and other institutions of higher education is to occur. Developing countries must embrace these technologies if they want to advance in agricultural production as well (McHale, 2010). The international agencies and non-governmental organizations that have expertise in installing, maintaining and using ICTs have started to penetrate developing countries (Bruggink, 2003; Heeks, 1998). Because of the actions of these organizations, the use of ICTs is increasing in some developing countries, which is raising the hopes of stakeholders for improved socio-economic development in their nations (McNamara, 2003; Walsham, Robey & Sahey, 2007).

Even though some progress is being made in the use of ICTs by developing countries, the use of computers by the people and most small scale business owners as compared to the West is very low (Jensen, 2002). For example, the rate of personal computers in the United States and Norway per 100 people is 78.67 and 62.68 respectively compared to India and China who reported 3.18 and 5.61 per 100 people respectively (United Nations, 2010). The challenge is how best to bridge the digital gap or divide between those who have the ability to access the technologies (whether in urban or rural areas) and those who do not (Walsham et al., 2007).

Universities in developing countries are suited to bridge this gap; however, they must overcome ineffective communication links with students and farmers in rural areas to share research findings, instruction and training, which may be difficult due to inadequate ICT infrastructure, as their libraries and classrooms may not be networked

(Malhan et al., 2007). In addition, the low collaboration between the institutions of higher learning, the government and other development agencies affects the implementation of ICTs in developing countries because it creates a disconnect in the policies that are supposed to guide the goals of respective countries (Avgerou, 2003; Richardson, 2011).

A big gap exists between citizens living in rural areas who are farmers mostly and the knowledge of agriculture they need to know and understand to perform optimally (Swanson & Rajalahti, 2010). Research findings are very important to stakeholders of any sector of the economy, at least potentially, especially when diffused to the public by colleges and universities (Rosenberg, 2001). The universities and colleges in developing countries should be empowered to develop appropriate ICTs for the diffusion of effective and sustainable solutions that would diminish economic and livelihood failures and enhance development efforts, especially in rural areas (Avgerou & Walsham, 2000).

All over the world, libraries are "entrusted with the permanent storage of the results of scholarship" (Kanyengo, 2006, p. 2). However, creating and storing knowledge in developing countries is challenging as many university libraries entrusted with these responsibilities still do not keep the information in digital formats, which not only increases the likelihood of permanent storage but also easier access for users (Kanyengo, 2006). According to Kanyengo (2006), electronic journals and books have a lot of challenges to students and scholars in colleges and universities in developing countries as many of these countries have no policies to check or handle information whether in electronic or print format.

Most institutions of higher learning in developing countries are struggling to access the utility of ICTs because they are working still in paper-driven environments

(Kanyengo, 2006). In India, institutions of higher learning are using satellite broadcasts, which have proven to be very expensive to provide distance education as has the provision of distance education through computer systems (e.g., via the Internet), which has the limitation of accessibility by many students as well (Eastmond, 2000). This slowness in diffusing ICTs in many educational institutions in the developing world exacerbates the number of potential users who may be unaware of the digital divide and hence not demanding these services from their leaders (Kaaya, 2004). Put simply, these individuals do not know what they do not know! Per Rogers (2003), the "issue of equality" between adopters and non-adopters is intensified.

The lack of technical knowledge regarding ICTs is another challenge facing many colleges and universities, especially in Sub-Saharan Africa, as these deficiencies slow their adoption and use (Gisesa, 2010; Kanyengo, 2006). Instructors who use distance education methods may spend a lot of time learning how to use and manage the technology to interact effectively with their students online at the expense of pedagogical and course content issues, in some cases (Flowers & Cotton, 2007). So, training and professional development on the use of ICTs for education delivery is vital coupled with support personnel who are trained properly and readily available. Training and professional development of support staff on the use of ICTs would not only enhance teaching but also provide improved library services enabling students and faculty access to journals and books electronically (Canada, 2010; Kanyengo, 2006).

Challenges to Using Distance Education to Deliver Tertiary Education in Developing Countries

According to Marquand (1999), the world's population is more than six billion with those living in developing countries accounting for 80% of the total. The demand for post-secondary education in Sub Saharan Africa has increased due to economic growth, as student enrollment increased from 660,000 in 1985 to more than 3.4 million in 2005 in the region (National Association of State Universities and Land Grant Colleges [NASULGC], 2008). Asia has more students enrolled in open and distance learning institutions than anywhere else due to economies of scale even though the completion rate is rather low, averaging 28% compared to the United Kingdom's 49% (Eastmond, 2000).

In developing countries, distance education is the probable "thing to do" for many students because they do not have the many choices to choose from unlike their counterparts in most developed countries (Latchem, Abdullah, & Xingfu, 1999). Due to this increase in demand, students seeking higher learning in developing countries are facing tough times gaining access to tertiary education. The challenges that make admission more difficult for students in developing countries include shortages of core faculty, inadequate classrooms space, poor quality of teaching, in some cases, and inadequate funding generally (NASULGC, 2008).

The aforementioned challenges are also barriers to research and innovation in sectors such as agriculture, engineering and technology (UNESCO, 1998). Some of these problems are manifested through the qualifications of those who teach in the tertiary institutions of developing countries (Chacha, 2004; Li & Lindner, 2007; Loxley et al.,

2004; Richardson, 2011). For example in Kenya, two-thirds of the teaching staff in tertiary institutions have neither pedagogical training or terminal degrees or both (Chacha, 2004).

Inadequate classroom space in tertiary institutions has contributed immensely towards only a minority of the qualified students being admitted (Chacha, 2004; Musisi, 2003; Sawyerr, 2004). As indicated earlier, Uganda at one point had 24,000 qualified students for tertiary education but only one-third were admitted because of the physical space limitations (Sawyerr, 2004). In Kenya, overcrowded classrooms have contributed to falling academic standards (Chacha, 2004). Ways to build human capital in critical areas such as agriculture through the use of ICTs to meet the demand of surging enrollments in higher education must be explored.

Curricula of various universities are being revised to embrace the use of ICTs in distance education to create virtual campuses to make learning more accessible and effective (Anthony & Muliaro, 2008; Askov et al., 2003; Eastmond, 2000). However, many colleges and universities in developing countries have neither enough computers for students or faculty to be connected to the Internet sufficiently; so, ICTs have not been used for teaching purposes (Hare, 2007). Moreover, many faculty and students lag behind in their respective disciplines because they cannot keep up with current issues in their professional areas due to limited access to ICTs supporting the Internet's use (Chacha, 2004; Rodrigo, 2005).

The number of Internet users in the year 2011 has reached two billion people in the world compared to 250 million in the year 2000 (Toure, 2011). However, only 21% of the population is estimated to have access to the Internet in developing countries,

compared to the developed countries' 71%. Consequently, many people are still removed from using the Internet in the developing world (International Telecommunications Union [ITU], 2010). According to ITU, the African continent has 9.6% of its population connected to the Internet; Asia and the Pacific is at 21% compared to Europe and the Americas that have 65% and 55% of their populations connected to the Internet respectively.

The cost of connectivity to the Internet by African universities is 50 times more than universities in the United States (Juma & Moyer, 2008). Juma and Moyer described a university in Senegal that has a total fiber bandwidth of 1.2 gigabits per second which it has to share with neighboring countries, even though the bandwidth is just one-tenth of Harvard University's. A few universities, such as Africa University in Zimbabwe, have a classic ICTs infrastructure where students, faculty and staff have adequate computers connected to the Internet (Hoosen, 2010), but they are the exception. Africa University is a private, international higher education institution that draws its resources from the United Methodist Church worldwide.

Nevertheless, distance education study centers have been successful in some parts of Latin America and Africa by engaging many students in afternoon and evenings sessions (Eastmond, 2000). For example, some universities in developing countries use the same facilities employed to teach in resident, full-time students via online technologies to reach more non-traditional students who are studying off-campus at a distance (University of Swaziland [UNISWA], 1996).

Selected Cultural Aspects Surrounding the Use of ICTs

According to Eastmond (2000), "[w]hether utilizing high or low technology, distance education can be effective when it fits within the technological infrastructure and cultural context" (p. 110). In developing countries, especially in Asia, traditionally, a teacher plays a crucial role in a student's learning environment by imparting knowledge and wisdom. However, distance education advocates for a self-directed, individualized learning which is very foreign to their culture (Eastmond, 2000; Westrup, Al Jaghoub, El Sayaed & Liu, 2003). In China, a saying exists that, "learning without the company of friends makes one narrow-sighted" (Latchem et al., 1999, p. 108).

Many lecturers in developing countries have not embraced distance education because they do not trust Internet only learning technologies, nor do they comprehend how a student, who they see rarely face-to-face during the academic year, can pass their examinations (Harder & Lindner, 2008; Li & Lindner, 2007). Furthermore, "instructors' enormous difficulty in adequately evaluating students they never meet face-to-face" adds further to their skepticism (Hellman, 2003, p. 1). Moreover, it is perceived that these students are not exposed fully to learning resources thereby learning less than the full-time, face-to-face students (Sukati et al., 2010). Another issue that has slowed the implementation of ICTs in some institutions of higher learning is the perception that students who enroll in this kind of programs are failures who did not attain the necessary grades to make it into the institutions of higher learning through the traditional admission procedures (Sukati, et al., 2010).

Many people, including lecturers and leaders in developing countries, still perceive the classroom, face-to-face mode of learning to be superior to other modes of

education delivery, and they view the quality of students produced through distance education to be suspect (McDonald, 2002; Shachar & Neumann, 2003; Shomaker, 1998). In addition, many politicians, may not see the improvement of education as a priority, especially where political instability, corruption, poverty and mismanagement of resources are the norm (Obijiofor et al., 1999).

In some cases, teachers and administrators alike have been resistant to new technologies, including ICTs. Furthermore, misconceptions about ICTs replacing manpower are a problem in some countries (Nair & Prasad, 2002). Moreover, some parents in developing countries, such as Kenya, have apathy towards the introduction of ICTs in schools because they believe Internet activities are unnecessary and impart immoral behaviors to their children (Komen, 2011).

Some universities have not embraced change because they prefer the status quo and do not perceive the importance of addressing current changes to meet students' needs and interests (Tanzer, 2007). According to Nair and Prasad (2002), "in a democratic country like India, co-operation and participation of the people is a necessary condition for adaptation of any new technology" (p. 7). The Malaysian government had an ICTs awareness campaign that included tax deductions for first-time buyers of personal computers and also soft loans towards the same effort (Nain & Mustafa, 1998; Nair & Prasad, 2002). The results are reflected in the Malaysian people having 23.15 personal computers per 100 persons versus India and China that have 3.18 and 5.61 personal computers per 100 people respectively (United Nations, 2010).

The reluctance of many governments in the developing world to promote ICTs has not only slowed its adoption but also has been the stimulus of many junior faculty

leaving developing countries for more developed nations where ICTs are embraced (Loxley et al., 2004; Nair & Prasad, 2002). Nevertheless, some stakeholders in developing countries have accepted distance education as an alternative to the traditional, face-to-face, study mode of education delivery (Tait & Mills, 1999; Zhao, Lei, Yan, Lai & Tan, 2005). However, using ICTs to strengthen distance education efforts in developing countries may be hampered by insufficient financial resources and the political will to support and embrace it (Chacha, 2004; UNESCO, 1998). In addition, culturally-based perceptions, language barriers and, in some cases even complex emergencies, such as civil unrest and conflicts, among other calamities have caused leaders to lose their focus on the process of implementing new technologies for example (Ebrahimian, 2003; Ramanujam, 1997).

Even though many tertiary institutions in developing countries are perceived as trying their best to contribute towards the development of agriculture using ICTs, the consensus is they have been slow in responding effectively to socio-economic development needs that could be mitigated by the use of ICTs (Chakeredza et al., 2008). One of the reasons mentioned to support this argument is how poorly these institutions of higher learning have handled the use of technologies to document and disseminate information (Zachmann, Musewe, Baguma, & Mukhebi, 2005). For example, according to Okapaku (2003), ICTs have been identified as important catalysts in development of not only agriculture in the developing world, but also crucial to good governance and the production of other resources related to agriculture that assist in alleviating poverty.

However, signs of this technology being embraced sufficiently are minimal (Nair & Prasad, 2002; Sciadas, 2003; UNDP, 2001). The learning process in tertiary

institutions must be re-engineered to meet the challenges of the 21st century by according more students access to tertiary education, whether formal or non-formal, for the purpose of spurring agricultural production and entrepreneurship (UNDP, 2001).

Current Situation of ICTs in Colleges and Universities in Developed Countries

ICTs have been embraced and adopted very fast in developed countries where they have reformed the public and private sectors resulting in incredible potentials (Loxley, 2004). State and private funding sources in developed countries for ICT development are evidence of the recognition of this new technology's importance; however, in developing countries, financial resources have been difficult to come by (Ebrahimian, 2003). At the turn of last century, 95% of computers were found in developed countries, and 75% of all telephone landlines in the world were in only 10 developed countries (Eastmond, 2000). Moreover, Internet access by adults in the United States was more than 45% but in Latin America only 1% of the entire population had access to the Internet (Ebrahimian, 2003; Haymond, 1998).

Developed countries have used ICTs to transform their education systems more than what one could have imagined a generation ago, such as bringing into existence distance education to accommodate the needs of individual students and faculty (Ebrahimian, 2003; Loxley et al., 2004). Flexibility in the scheduling of courses and multimedia interaction of distance education classes are very convenient for the students of today's generation and their instructors, as it gives them an opportunity to learn/teach while pursuing other goals in their lives (Askov, 2003; Moore, 2000).

This is possible because components of distance courses are online any time of the day or night and can be accessed from any location with limited exceptions (Hogan & Kedrayate, 2010; Loxley et al., 2004). Distance education also goes beyond traditional physical classroom constraints (i.e., from a traditional classroom to a virtual classroom) whereby more students of diverse backgrounds, including age, ethnicity and socio-economic levels, are reached by an electronic format that is more cost-effective (Loxley et al., 2004; Moore, 2000). The cost of ICTs in developed countries has decreased tremendously due to creativity and innovativeness of their societies. According to the UNDP (2001a),

> In 2001 more information can be sent over a single cable in a second than in 1997 was sent over the entire Internet in a month. The cost of transmitting a trillion bits of information from Boston to Los Angeles has fallen from $150,000 in 1970 to 12 cents today. A three minute phone call from New York to London that in 1930 cost more than $300 (in today's prices) costs less than 20 cents today. E-mailing a 40-page document from Chile to Kenya costs less than 10 cents, faxing it about $10, sending it by courier $50.10. (p. 30)

Developed countries have taken advantage of this environment by using distance education to empower education administrators with leadership skills, teachers with skills that will help students in their studies and research thereby improving their quality of education holistically (Ebrahimian, 2003). Enrollment of online courses in developed countries has been increasing steadily. In the United States, online enrollment has been increasing by 33% each year. It was estimated that 2.3 million students were enrolled by 2002, and, approximately 12.2 million students by 2008, and more than 200 schools were

offering online graduate degrees (Katz-Stone, 2000; Parsad, & Lewis, 2008; Pethokoukis, 2002). The University of Phoenix surpassed an enrollment of 300,000 online students a year providing greater access to educational opportunities to those who may have missed it through traditional face-to-face schooling approaches (Hogan & Kedrayate, 2010).

Both synchronous (students log on and communicate with one another and the course instructor at the same time) and asynchronous (students log on at different times and work individually) classes are offered online in developed countries (Waits & Lewis, 2003). Even though developed countries have made a lot of progress in distance learning, some students are still uncomfortable taking online courses because they would rather listen to and interact face-to-face with a teacher and fellow students rather than learning online (Faux & Black-Hughes, 2000). This may be the case for some students in the developing world as well.

Agricultural Institutions in the Developing World and Their Internet Connectivity

An enabling environment must be provided in agricultural colleges and universities for technology and other innovations to thrive (Nain & Mustafa, 1998; Nair & Prasad, 2002). Building robust capacities in agricultural schools will depend on the linkages among institutions of higher learning, other sectors and countries to promote technical and human capital supporting the sustainable economic development of developing countries (Eastmond, 2000). In India, for example, the Internet has connected remote and isolated villages enabling critical information on health, weather and crop information to be accessed and shared by the communities hence spurring economic growth in the marginalized regions (UNDP, 2001a).

The salient challenge that confronts many developing countries is the promotion of agriculture in a dynamic context of economic transformation (Qamar, 2003). Transforming agriculture in developing countries calls for collaboration among stakeholders by strengthening their networks to improve agricultural productivity, including the integration of ICTs for training and education (Dione, Weber, Staatz & Kelly, 2004).

Furthermore, it has been demonstrated in the developed countries, such as the United States, that the success of many students in colleges and universities depends on their access to online technologies. So, an aggressive campaign by both public and private sectors to make sure all citizens of a given nation have access to ICTs is a critical *key* component of development (Ebrahimian, 2003; McHale, 2010). Institutions of higher learning in developed and developing countries are very important as sources of discovery and innovation as long as the capacity to disseminate and diffuse is sufficient (Oyelaran-Oyeyinka & Adeya, 2004).

Conceptual/Theoretical Framework

The totality of enhancing agricultural development must be understood better within the larger context of developing countries' institutions of higher learning and their processes for producing human capital that has the knowledge and skills required to promote sustainable rural development and respond to the diverse needs of agricultural producers (Meera, Jhamtani, & Rao, 2004). The adoption of ICTs by universities, students and agricultural practitioners to suit their needs, including advocacy and community planning, must address the actual contextual characteristics of the institution

and country (i.e., social system) in which the innovation is going to be implemented (Avgerou et al., 2000; Nair & Prasad, 2002; Rogers, 2003).

The creation of new networks of agricultural stakeholders, such as educators, farmers and businessmen, for information sharing in the areas of best practices and building on local information channels should be encouraged (Maurer, 2009: Meera et al., 2004; Rogers, 2003). Furthermore, institutions of higher learning should be able to use ICTs to disseminate information about relevant innovations that are capable of confronting their nations' challenges. This education and training may address topics as diverse as pest control, product marketing, monitoring weather variability to avoid disasters and other risks to crops and livestock, as well as ensuring food security and the overall well being of people (Maurer, 2009; Phougat, 2006). Moreover, it is not only improvement of the population's accessibility to information communication technologies to improve the flow of information that matters, but also the relevance of information to development of the local areas (Phougat, 2006).

The conceptual framework for this study was drawn from a theory that is related to the transfer of innovations based on the contextual characteristics of an institution or country, i.e., the relevant social system. Therefore, this study was framed through the lens of diffusion of innovations theory (Rogers, 2003). This theory embraces the thinking that new ideas are accepted more readily or diffused into a social system more widely if communication of these ideas follows familiar or well established communication channels within the system (Rogers, 2003). The theory articulates the elements and attributes that are perceived to drive diffusion of innovations in a given social system.

Diffusion of Innovations Theory

According to Rogers (2003), "diffusion is the process in which an innovation is communicated through certain channels over time among the members of a social system" (p. 5, Figure 1). Technological needs in the agricultural sector are becoming intense and complicated, especially in developing countries where challenges and risks need to be overcome for the agricultural sector to be developed. As governments, institutions of higher learning and students consider or contemplate the adoption of new ideas and tools such as the use of ICTs in education and training to support agricultural development, their perceptions about the new technology influences their willingness to accept or reject it (Rogers, 2003).

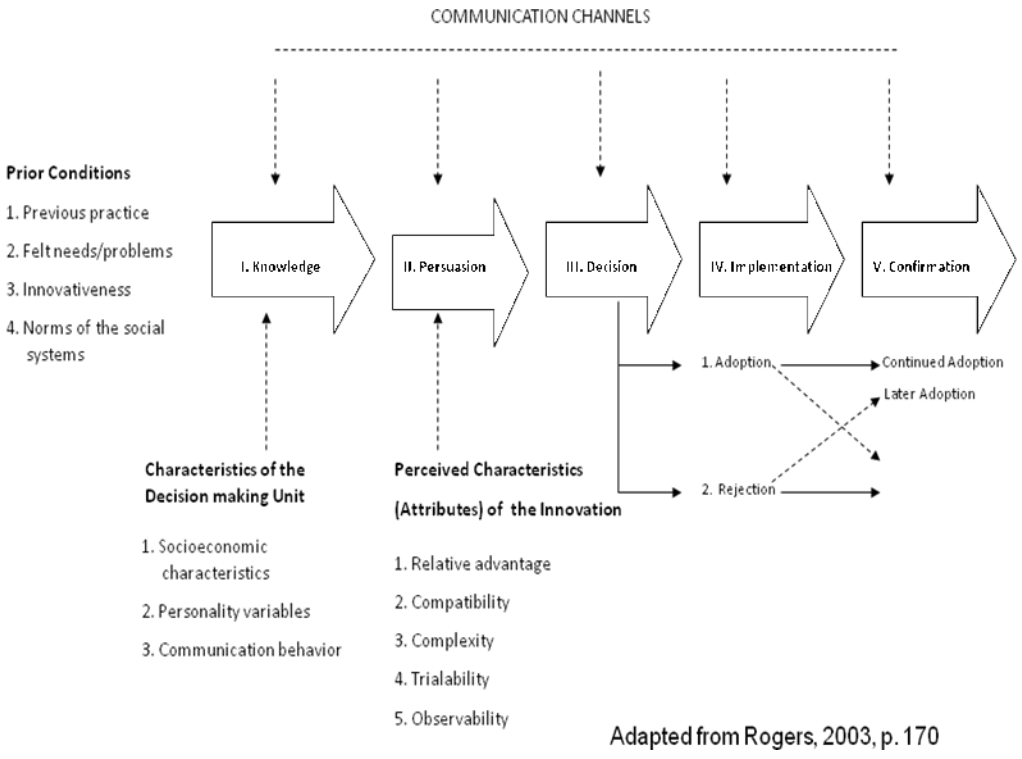

Figure 1. Innovation-decision process for an individual

Because new ideas brew uncertainty among potential adopters (Rogers, 2003), including individuals who populate institutions of higher learning, the channels of information exchange in a social system matter. As per Rogers, the members of a given social system have to be taken through a process where they are able to perceive the relative advantage, compatibility, complexity, trialability and observability of the innovation (i.e., its attributes) being introduced as compared to their current attitudes, behaviors and practices.

These aforementioned attributes assist members of a particular social system in acquiring knowledge about the innovation that may persuade them to make a decision to implement the new idea, practice, or tool in question (Rogers, 2003). Creating awareness about the importance of ICTs among the educational and political leaders of developing countries may augment the innovation-decision process, as espoused by Rogers (2003), and accumulate sufficient political support or "will" for the new technologies to take-off or be diffused widely.

Understanding and examining the four elements of the diffusion of innovations process, i.e., the innovation itself, the role of communication channels, time and the social system, during the act of creating awareness regarding the use of ICTs in higher education is critical (Rogers, 2003). The university administrators, faculty, students and government officials are key actors in the adoption process if sustainability of the innovation is to be achieved.

These actors must perceive that ICTs will produce educated and skilled persons to advance agricultural knowledge and strengthen university faculty capacities to create dynamic human capital relevant to the needs of the given social system by expanding

opportunities for more people to access tertiary education through distance learning (Farrell & Isaacs, 2007; Loxley et al., 2004; McHale, 2010; Ndulu et al., 2007). In other words, the relative advantage associated with adopting and implementing ICTs must be perceived as too significant to ignore (Rogers, 2003). And, as Eastmond (2000) stated, "[w]hether utilizing high or low technology, distance education can be effective when it fits within the technological infrastructure and cultural context" (p. 110) of a social system.

However, this is not the case for many developing countries as innovations are rarely focused on the needs of the end users (Richardson, 2011). "Without the voice of the end user, we fail to understand the unique needs of the person as well as the community" (Richardson, 2011, p. 13). This study sought to capture the views of future potential users (aspiring faculty) of ICTs in tertiary education by describing their views on the diffusion of ICTs in the agricultural colleges and universities of their respective developing countries

Capacity Building Related to the Adoption and Use of ICTs in the Agricultural Sciences and Natural Resources in the Developing World

In the UNDP report (2001a), Malloch Brown, the program's administrator, acknowledged that many developing countries were trying hard to adopt ICTs to meet their local needs by formulating technologically-friendly policies. Policies that are formulated in a participatory manner, taking the views of the natives into consideration will prepare the developing countries better to match the technological pace of the world and sustain it (Conroy, 2005). Therefore, the process of participatory planning focusing on local needs that address the real situation on the ground, coupled with the views

natives in the Diaspora must be considered for the vital growth and sustainability of ICTs in developing countries to occur (Reijswoud, 2009; Richardson, 2011; UNDP, 2001a).

However, much remains to be done by developing countries to bridge the technology divide, as many of them are lagging far behind the rest of the world (UNDP, 2001a). Developed countries have not only advanced in their use of ICTs, but also have mainstreamed ICTs in education to overcome socio-economic and geographical factors (Loxley et al., 2004). According to Loxley et al., this has been expedited by the fact that,

> Once a country has developed an echelon of properly trained ICT-competent teachers, technologists, course designers, trainers, and administrators sufficient to create a social and political awareness and acceptance of the value of ICTs, and an adequate communications infrastructure, incremental cost per student of expanding the system is, in relative terms, very low. (p. 54)

Little doubt exists that many millions of people in the developed world have more opportunities to access education regardless of their social economic status or geographical location based on their nations' well developed ICTs networks. Developed countries have their national policies in education coordinated well with specific goals and visions that are supported financially by both the public and private sectors. Finland is a prime example where the importance of ICTs in sustaining economic growth and social development has been realized (Ebrahimian, 2003; Kaino, 2008; Kozma, 2005).

In developing countries, such as China, Ghana, Iran and Trinidad and Tobago, ICTs have been recognized as important tools for agricultural and rural development (Annor-Frempong, Kwarteng, Agunga, & Zinnah, 2006; Dolly & Kissoonsingh, 2006; Hedjazi, Rezaee, & Zamani, 2006; Li & Lindner, 2007). However, not all faculties in

institutions of higher learning in those countries have embraced distance education. They may lack time and technical expertise or the lack of funding to compensate them for the extra workload associated with the use of ICTs for teaching via distance, for example (Haber, 2006; Li & Lindner, 2007; Maguire, 2005; Murphy & Terry, 1998; Roberts & Dyer, 2005).

Learning how to use ICTs to teach as well as developing teaching material for distance education has been a challenge for not only junior faculty but also those with a lot of online teaching experience (Tiene, 2004). The time involved in preparing teaching materials (e.g., translating classroom lessons to an online delivery format), especially during the initial online offering of courses and the related training deficits has been a challenge (Bender, Wood, & Vredevoogd, 2004; Cavanaugh, 2005; Curbelo-Ruiz, 2002; Daugherty & Funke, 1998; Nelson & Thompson, 2005; Spector, 2005)

To address the issue of fear and misinformation about ICTs and distance education compared to traditional education methods among faculty members in universities in developing countries, diffusion of this technology must be tailored towards the social systems of their universities. Appropriate communication channels (i.e., those familiar to faculty members) should be used coupled with enough time so that the potential adopters can observe and try it (Rogers, 2003). The diffusion of innovation process identifies five characteristics or attributes that influence the rate of adoption: relative advantage, compatibility, complexity, observability and trialability (Harder & Lindner, 2008; Rogers, 2003; Schifter, 2000). Any attempt to diffuse ICTs in institutions of higher education must account for these attributes and the perceptions of adopters related to them.

In developing countries, national policies on ICTs that are driven by financial support from governments and the private sector must be coordinated well at the local level as is done in developed countries, if ICTs are to be adopted and their use sustained by faculty members at colleges and universities (Avgerou, 2003). Such policies should address the concerns about traditional education being in conflict with distance education and also misinformation regarding the loss of jobs due to the new technology replacing some members of the social system (Harder & Lindner, 2008; Li & Lindner, 2007). Furthermore, many people in developing countries are yet to trust Internet technologies; so, it is very critical that misinformation be negated and trust be built among the potential adopters (Harder & Lindner, 2008; Murphrey & Dooley, 2000).

The growth and sustainability of ICTs in developing countries will therefore depend on *how* the technology is diffused. The capacity building of faculty for distance learning is critical to its success, i.e., for sustained and wide spread adoption to occur (Harder & Lindner, 2008; Li & Lindner, 2007). It is very crucial for faculty to understand the fundamental and complex challenges and the roles they must play to avoid frustrations that could lead to them abandoning or discontinuing their use of the technology or "rejecting" it outright (Eastmond, 2000; Rogers, 2003). So, understanding the related views of individuals who may aspire to be faculty members in the future was the purpose of this study.

Summary

The world's youth population individuals at the age of 25 years and below, stands at approximately 3 billion of the total, which is estimated to be about 6.7 billion persons (Redding, 2007). Redding stated that a majority of these youth are found in developing

countries where limited resources in various sectors such as education, health and security are endemic. Furthermore, young adults are looking for opportunities to further their education, especially at the tertiary level if their career prospects are to be enhanced (Askov, Johnston, Petty & Young, 2003). However, poor educational planning in developing countries has resulted in weak tertiary education systems unable to withstand competition from developed countries (Mwapachu, 2010; Ndulu et al., 2007).

Therefore, the competition for tertiary education in developing nations is so high that countries such as Ghana and Nigeria can manage to admit only small portions of their qualified students to their universities (Sawyyer, 2004). The same is true of countries in Asia such as India and Sri Lanka (Azam & Blom, 2008; Gamage, 2005). The issue of many unqualified faculty and staff populating tertiary educational institutions in developing countries is worrying as well (Chacha, 2004; Loxley et al., 2004; UNESCO, 1998). For example, in the Sri Lankan university system, only 30% of the lecturers in humanities and social sciences have terminal degrees (PhDs) as compared to Hong Kong's university system that has 90% of its lecturers holding terminal degrees in the discipline they teach (Gamage, 2005).

Fewer qualified faculties are found in many developing countries because a majority of who retire or die may not be replaced; moreover, low remuneration packages coupled with poor teaching conditions are not attractive to the young and well qualified lecturers who have ambitions of enhancing their careers. Accordingly, many move to developed countries where more enabling environments are provided (Chacha, 2004; Loxley, 2004; Musisi & Muwanga, 2003; Sawyerr, 2004; UNESCO, 1998; World Bank, 2008). So, the need exists for developing countries to have strategies to reverse the trend

of losing qualified faculty to developed countries. Expanding tertiary education so that opportunities are given to more qualified students to acquire relevant skills through their degree programs would further the economic growth of their respective countries as well (Ndulu et al., 2007).

The development of education policies for mainstreaming curricula with the needed skills and expertise relevant to the respective countries is also required (ESCAP, 1999; South Commission, 1990). Information communication technologies have been used in developed countries to stimulate and enhance development in many realms, including universities that contribute to the well being of their societies (Etzkowitz, 2002; Kaino, 2008; Kozma, 2005; Loxley et al., 2004). A majority of the people in developing countries earn their livelihoods from the agricultural sector (Cleveland, 2007). Therefore, it is paramount that the developing countries embrace ICTs to assist in transforming their agricultural sectors through the efforts and contributions of their tertiary educational institutions (Dione, Weber, Staatz & Kelly, 2004; Malhan et al., 2007; Qamar, 2003).

For more students to access agricultural institutions of higher learning in developing countries, distance education which relies on the use of ICTs, should be implemented. It also can be used to train people in the labor force, homemakers and others who may prefer learning in a nonformal setting (Askov et al., 2003; Keegan, 1988; Loxley et al., 2004; Mwapachu, 2010). Furthermore, distance courses may be lower in cost and attract more students thereby preparing them to be viable within a global economy and society driven increasingly by the speed of information access (Askov et al., 2003; Haddad & Draxler, 2002; Loxley et al, 2004; McNamara, 2003; UNESCO, 2002; Wagner & Kozma, 2005). This mode of education delivery has assisted more than

12.2 million people annually who may have otherwise missed the chance of accessing tertiary education in the United States (Parsad, & Lewis, 2008).

To introduce and/or further develop distance education in developing countries, policies to improve ICTs must be linked to their national plans vis-a-vis the socio-economic goals of those nations (Jones, 2003; Kaino, 2008; Kozma, 2003a; Malhan et al., 2007). Building ICT infrastructure, capacity building the faculty and redefining the missions of universities to provide for distance learning are very important aspects for the implementation and sustainability of this innovation (Askov et al., 2003; Eastmond, 2000). According to Askov et al. (2003) and Loxley et al. (2004), computer literacy motivates (i.e., enhances an individual's self-efficacy) lecturers and students of distance education as they are comfortable working independently thereby strengthening their organizational skills, study habits, and teaching/learning ethos.

However, many lecturers, university administrators and government officials in developing countries have not embraced distance education because they are content with the traditional way of learning, i.e., face-to-face, classroom teaching and learning conditions (Sukati et al., 2010). They perceive the classroom, face-to-face approach of learning to be superior to any other mode of education delivery, and they consider the quality of students produced through distance education to be suspect (McDonald, 2002; Shachar & Neumann, 2003; Shomaker, 1998). Moreover, some parents in developing countries, such as Kenya, have apathy towards the introduction of ICTs in schools because they believe Internet activities are unnecessary and may impart undesirable behaviors in their children (Komen, 2011).

According to Nair and Prasad (2002), "in a democratic country like India, co-operation and participation of the people is a necessary condition for adaptation of any new technology" (p. 7). Therefore, the process of participatory planning focused on local needs that addresses the situation "on the ground" coupled with the views of the natives in the various diasporas must be considered for the vitality and sustainability of ICTs in developing countries (Reijswoud, 2009). Developing countries must create awareness regarding the importance of the opportunities presented by distance learning for their people (Loxley et al., 2004; Nair & Prasad, 2002; Rogers, 2003).

It was because of the contextual needs of each country in the developing world that this study was framed through the lens of diffusion of innovations theory. According to Rogers (2003), "[d]iffusion is the process in which an innovation is communicated through certain channels over time among members of a social system" (p. 5). For the government and institutions of higher learning in agriculture to look favorably on ICTs, their perceptions about the innovation, i.e., whether it has relative advantage over what they have had previously and compatible with their needs, are critical considerations (Rogers, 2003). How rapidly or slowly the innovation is diffused will depend on how well the elements and characteristics of diffusion of innovation theory are put to use (Rogers. 2003). This includes understanding the perceptions of aspiring faculty regarding the attributes and barriers associated with ICTs for the delivery of teaching and learning in the agricultural sciences and natural resources at tertiary education institutions.

Building faculty capacity for the use of distance education by addressing their fears and concerns is very important to avoid frustrations and misunderstanding that may lead them to rejection or discontinuance of the technology (Eastmond, 2000; Harder &

Lindner, 2008; Li & Lindner, 2007; Rogers, 2003). National policies on ICTs that are well coordinated and supported financially as in the developed world would make distance education in developing countries more likely to be realized (Ebrahimian, 2003; Kaino, 2008; Kozma, 2005; Nair & Prasad, 2002).

Finally, the use of ICTs could produce more educated and skilled persons to advance agricultural knowledge and practices in developing countries by strengthening university faculty capacities to produce dynamic human capital for the agricultural sector. Enhanced networking with other sectors and institutions of higher learning domestically and internationally could be achieved as well (Dione, Weber, Staatz & Kelly, 2004; Farrell & Isaacs, 2007; Loxley et al., 2004; McHale, 2010; Ndulu et al., 2007).

CHAPTER III

METHODOLOGY

The purpose of this chapter is to describe the methods and procedures used to conduct this study. It contains a description of research methodology, the targeted population and the instrument used, which included electronic and hard copy versions. The procedures followed for answering the research questions of the study through data collection and statistical analyses are presented as well.

Institutional Review Board

Federal regulations and Oklahoma State University policy require review and approval of all research studies that involve human subjects before investigators can begin their research. The Oklahoma State University Office of University Research Services and the Institutional Review Board (IRB) conduct this review for the purpose of protecting the rights and welfare of human subjects involved in biomedical and behavioral research. In compliance with the aforementioned policy, this study received proper review and was granted permission to proceed. The IRB assigned the number of AG1033 to this study. A copy of the IRB approval letter appears as Appendix A. After consultation with members of the researcher's dissertation committee and department heads in the College of Agricultural Sciences and Natural Resources at Oklahoma State University, modifications were made regarding the data collection methods used in the

research study. The IRB approved the modification and the Modification Approval Letter appears as Appendix B. Furthermore, the researcher requested for modification of the data collection period, i.e., to extend it, which was approved by the IRB office. The approval letter appears as Appendix C.

Purpose of the Study

The purpose of this study was to determine the perceptions of international graduate students from developing countries in the College of Agricultural Sciences and Natural Resources (CASNR) at Oklahoma State University on the diffusion of information communications technologies (ICTs) to advance agricultural education at colleges and universities in developing countries. A secondary purpose was to describe the personal and professional characteristics of international graduate students from developing countries who were studying agricultural sciences and natural resources at Oklahoma State University. The period of data collection was the fall semester of 2010.

Research Questions

1. What were selected personal and professional characteristics of graduate students from developing countries who were studying in CASNR at Oklahoma State University?
2. What were the study participants' perceived levels of "innovativeness" regarding their use of ICTs for academic learning?
3. What were the study participants' views on selected **attributes** impacting the diffusion of ICTs to advance agricultural education at colleges and universities in developing countries?

4. What were the study participants' views on selected **barriers** impacting the diffusion of ICTs to advance agricultural education at colleges and universities in developing countries?
5. What **relationships** existed between selected personal and professional characteristics of the study participants and their perceptions on variables impacting the diffusion of ICTs to advance agricultural education at colleges and universities in developing countries?

Research Design

The design of this study was descriptive-correlational (Best, 1970; Ary, Jacobs, & Razavieh 2002). One aspect of this study was to determine the perceptions of international graduate students from developing countries on the diffusion of ICTs to advance agricultural education at colleges and universities in the developing world. The second aspect was to describe the personal and professional characteristics of international graduate students from developing countries who were studying agricultural sciences and natural resources at Oklahoma State University during the fall semester of 2010.

A descriptive-correlational research design was chosen because this study dealt with describing the perceptions of international students on diffusion of ICTs in developing countries, especially regarding their views on attributes and barriers associated with ICTs for use with delivering education at a distance. According to Best (1970), "[t]he process of descriptive research goes beyond the mere gathering and tabulation of data. It involves an element of analysis and interpretation of the meaning of significance of what is described" (p. 116).

The researcher was also interested in describing associations (relationships) between selected personal and professional characteristics of the respondents (i.e., aspiring faculty) and their perceived innovativeness as well as their views on attributes and barriers involved with the adoption of ICTs. According to Ary et al. (2002), "correlational research is nonexperimental research that studies the direction and strength of relationships among variables" (p. 367). Moreover, Miller (1994) stated that, "independent variables (causes) are not under the control of the researcher, but are naturally occurring or self-selected by the subjects" (p. 5), and because "the researcher cannot exercise control" (p. 5), this type of study is considered descriptive. So, to understand better the relationships between variables examined in this research study, a descriptive-correlational approach was followed.

The Study's Population and Sample

The international students from developing countries who were in the College of Agricultural Sciences and Natural Resources (CASNR) at Oklahoma State University during the fall semester of 2010 were the target or survey population of this study. CASNR has nine academic departments and two interdisciplinary programs (Division of Agricultural Sciences and Natural Resources [DASNR], 2011). The academic departments in CASNR are Agricultural Economics; Agricultural Education, Communications and Leadership; Animal Science; Biochemistry and Molecular Biology; Biosystems and Agricultural Engineering; Entomology and Plant Pathology; Horticulture and Landscape Architecture; Natural Resource Ecology and Management; and Plant and Soil Sciences. The two interdisciplinary programs in CASNR are Environmental Sciences and International Programs in Agriculture (DASNR, 2011).

Accordingly, 120 international students from developing countries were identified as being enrolled in either departments or interdisciplinary programs in CASNR during the fall semester of 2010. This sample derived from the target population described was a purposeful sampling approach (Creswell, 2005). "Purposeful sampling is a type of nonprobability sampling in which the units to be observed are selected on the basis of the researcher's judgment about which ones will be the most useful or representative" (Babbie, 2007, p. 184). These students were identified by departmental graduate coordinators, department heads, faculty and graduate students who interacted closely with international graduate students in their respective department or interdisciplinary program.

This method yielded 120 international graduate students. The aforementioned sources either provided electronic contact information for the international graduate students (i.e., e-mail addresses) or distributed paper (or hard) copies of the study's instrument to them. It were these individuals who formed the study's "accessible population" (Ary et al., 2002). To that end, coverage error was a potential limitation to this approach (Dillman, 2000).

The international graduate students, who completed the hard copy version of the instrument, returned the instruments to either their respective department head's office, where the researcher received them or the researcher's departmental mailbox on campus using the return envelopes provided. From the total target population of 120 participants, 72 responded (i.e., the responding sample) of whom 47 filled the instrument electronically and 25 completed it as a paper copy (Figure 1). This level of return yielded a combined response rate of 60% (Figure 2).

Selection and Development of the Study's Survey Instrument

After reviewing the scholarly literature and consulting with the researcher's dissertation chair, a survey instrument was identified, modified and used to collect the data for this study. The survey instrument, modified from Li and Lindner's (2007) study, had four parts with a total of 84 items, including 64 statements and 20 questions (Appendices D & E). One question asked the international graduate students to indicate their level of innovativeness (i.e., Rogers' [2003], stages of the innovation-decision process) regarding the use of ICTs to advance agricultural education at colleges and universities in developing countries (Part 1).

The 20 statements from the original instrument (Li & Lindner, 2007), which were intended to describe a respondent's views on attributes associated with the use of ICTs for the delivery of distance education (Part II), were retained and modified slightly (i.e., word choice and/or tense) to conform better to the purpose of this study. This part of the instrument included five attribute constructs: relative advantage, compatibility, complexity, observability, and trialability (Rogers, 2003).

For the 38 statements describing potential barriers associated with the use of ICTs for the delivery of agricultural education (Part III), the same modification procedure was followed to ensure the study's research questions would be answered sufficiently. The original instrument developed by Li and Lindner (2007) was used to examine barriers to diffusion of web-based, distance education at an agricultural university in China. Li's and Lindner's (2007) research instrument was based on an instrument developed by Muilenburg and Berge (2001) that they used to determine barriers to distance education generally. This study's instrument, with its nine barrier constructs, as described, included

items from the research instrument used by Li and Lindner (2007). Information describing selected personal and professional characteristics of the participants was also collected. Part IV of the instrument contained 20 questions.

Validity

After modifying the instrument developed by Li and Lindner (2007), a panel of experts from the Department of Agricultural Education, Communications and Leadership at Oklahoma State University reviewed it for face and content validity**.** The experts examined closely the constructs and items in the instrument to ensure their appropriateness and coherence. The panel of experts also provided guidance on improving the instrument's directions. After receiving their input, the instrument was modified further based on the panel's recommendations.

The researcher relied on Rogers' (2003) posits regarding the perceived attributes of an innovation (i.e., ICTs) to ensure the construct validity of Part II of the study's instrument. This portion of the instrument included items describing the respondents' views on "relative advantage," "compatibility," "complexity," "observability," and "trialability" (Rogers, 2003) vis-à-vis the use of ICTs to advance the teaching of agricultural education at colleges and universities in developing countries. Rogers stated that, "most of the variance in the rate of adoption of innovations, from 49 to 87 percent, is explained by [these] five attributes" (p. 221). The choice of items describing the respondents' perceptions of potential barriers associated with the use of ICTs was supported by the earlier work of Li and Lindner (2007) who examined the perceptions of faculty at an agricultural university in China regarding aspects of adopting web-based,

distance education delivery. The "conceptual prism" or content validity of those items was based on a factor analysis study conducted by Muilenburg and Berge (2001).

Reliability

Post-hoc reliability analysis of the instrument by constructs revealed estimates, i.e., Cronbach's alphas, ranging from .717 to .915 for the five attribute constructs, and estimates ranging from .808 to .949 for the nine barrier constructs. Li and Lindner (2007) reported a range of .70 to .94 for the barrier constructs used in their study. The overall reliability estimate for the attributes portion of the instrument was .870, and the estimate was .941 for the barriers portion overall (Table 1).

Field Test of the Instrument

A pilot or field test was done of the instrument using international graduate students from developing countries in the College of Human and Environmental Sciences at Oklahoma State University. The hard copy version of the survey instrument was used during the field test. According to Ary et al. (2002), "the researcher must field-test the instrument to identify ambiguities, misunderstandings, or other inadequacies" (p. 402). On completion of the field test, which was conducted over a four-week period, a few revisions were made to the instrument (i.e., minor re-wording) to improve its clarity and readability based on feedback received from the participants.

Table 1

Post-hoc Reliability Estimates for the Instrument's Constructs and Overall per Attributes and Barriers

	Cronbach's alpha
Attributes	
Relative advantage	.717
Compatibility	.882
Complexity	.793
Trialability	.846
Observability	.915
Overall	.870
Barriers	
Faculty compensation and time	.881
Credibility of ICTs	.817
Financial concerns	.837
Lack of needs	.895
Conflict with traditional education	.821
Fear of technology	.808
Lack of technical expertise	.896
Lack of administrative support	.831
Lack of infrastructure	.949
Overall	.941

The Final Survey Instrument

The final survey instrument contained four parts (Appendices D & E), with specific statements and questions designed to obtain respondents' views on the diffusion of ICTs in tertiary education institutions in developing countries to advance teaching and learning in the agricultural sciences and natural resources. The participants were asked to respond to items regarding the following areas: the stage of the innovation-decision process (as an indicator of their "innovativeness"; Rogers, 2003) for which they identified, attributes impacting the diffusion of ICTs to deliver higher education, barriers to the diffusion of ICTs to deliver higher education, and selected personal and professional characteristics. The first part of the instrument (Appendices D & E) asked the participants to select one of six statements to establish their level of innovativeness regarding the use of ICTs.

Part two of the instrument had 20 scaled statements that focused on five attributes impacting diffusion of ICTs in higher education, as perceived by the respondents (Rogers, 2003). The attributes were "relative advantage," "compatibility," "complexity," "trialability," and "observability" (Rogers, 2003). Each of the five attributes had four related statements. The participants were asked to indicate their level of agreement with each item using a five-point, summated rating scale: "1" = "strongly disagree," "2" = "disagree," "3" = "neutral," "4" = "agree," and "5" = "strongly agree" (Appendices D & E).

Part three of the instrument (Appendices D & E) included 38 scaled items associated with nine perceived barriers (Li & Lindner, 2007; Muilenburg & Berge, 2001) to the diffusion of ICTs to advance higher education in agricultural colleges and

universities in developing countries. The barriers, or sub-sections of Part III, included "faculty compensation and time," "credibility of ICTs," "financial concerns," "lack of needs," "conflict with traditional education," "fear of technology," "lack of technical expertise," "lack of administrative support," and "lack of infrastructure" (Appendices D & E). Each of the nine perceived barriers had either four or five statements to which the participants were asked to respond using a five-point, summated rating scale: "1" = "no barrier," "2" = "weak barrier," "3" = "moderate barrier," "4" = "strong barrier," and "5" = "very strong barrier."

The real limits of the mean scores for all scaled statements were interpreted as 1.00 to 1.49, "strongly disagree" / "no barrier"; 1.50 to 2.49, "disagree" / "weak barrier"; 2.50 to 3.49, "neutral" / "moderate barrier"; 3.50 to 4.49, "agree" / "strong barrier"; and 4.50 to 5.00, "strongly agree" / "very strong barrier." Part four of the instrument included questions regarding selected personal and professional characteristics of the respondents, e.g., gender, age, academic qualifications, country of citizenship and work experience (Appendices D & E).

Data Collection Procedure

The researcher identified 120 graduate students enrolled in departments and interdisciplinary programs in CASNR during the fall semester of 2010 who were potential respondents, i.e., the study's accessible sample. So that a higher percentage of responses could be obtained, two methods were employed to distribute and collect the study's data collection instrument: electronic and hard copy versions were used (Appendices D & E). The research instrument was delivered electronically to 70

participants whose departments (six) and interdisciplinary programs (two) provided their electronic mail addresses.

Per this procedure, a departmental information technology (IT) specialist assisted the researcher to develop an electronic version of the study's instrument (Appendix D). An electronic mail message was sent to the participants asking for their informed consent (Appendix F) with a hyperlink to the survey instrument. As a sign of agreeing to give their informed consent, these individuals were asked to enter a randomly computer-generated number as an access code to the online instrument before completing it. After clicking on the hyperlink, and entering the access code, the participants were asked to read the instrument's instructions carefully before completing the survey instrument (Appendix D). The participants' responses were stored in an Excel file managed by the researcher's departmental IT specialist who provided the researcher an electronic file containing the participants' responses.

Participants who completed the paper version of the study's instrument (Appendix E) were also required to provide their informed consent (Appendix G). A hard copy or paper version of the survey instrument (Appendix E) was delivered to the three departments in CASNR whose leadership requested this method for provision of the instrument to their 50 international graduate students. The participants were given approximately one month to complete the instrument. Those participants who received an electronic version of the instrument were sent three follow-up reminders (Appendix H) via electronic mail from the researcher (Dillman, Smyth, & Christian, 2009) asking them to complete the instrument. In the case of paper version respondents, the researcher relied on the respective departmental officials to remind their graduate student participants to

return the survey instrument. The study's data collection was conducted between November 18 and December 20, 2010. The first electronic mail message containing the hyperlink to the survey instrument (Appendix D) was sent to the participants on November 18, 2010. Beginning on November 26, 2010, the first of three reminder electronic messages was sent on a weekly basis to participants who had not completed the instrument (Appendix H). The second reminder was sent on December 3, 2010, and the final reminder was sent on December 10, 2010. The online data collection period was concluded on December 20, 2010.

The hard copy version of the instrument (Appendix E) was distributed on November 19, 2010. The final completed hard copy instrument was received on December 20, 2010. Of the 120 graduate students who were potential respondents, 47 responded electronically and 25 completed and returned the hard copy instrument (Figure 1). The total number of respondents was 72, which resulted in a 60% response rate overall (Figure 2). To address the threat of non-response bias, a procedure described by Miller and Smith (1983) was used. Miller and Smith stated that, "[r]esearch has shown that late respondents are often similar to nonrespondents" (p. 48). So, if the responses of early and late respondents are compared and no statistically significant differences are found, "then respondents are generalized to the sample" (p. 48).

Accordingly, the researcher identified December 7, 2010 as an appropriate "midway point" in the data collection period to establish early (responded by December 7, 2010) versus late (responded after December 7, 2010) responders. This procedure included both methods of return, i.e., online and hard copy responses. An electronic date and time stamp identified the online responses by December 7, 2010, and hard copy

instruments in possession of the researcher on December 7, 2010 comprised the early portion of that return group. Independent samples *t*-tests were conducted to compare differences in the construct and overall means of the study's dependent variables by method of instrument return. The results of these tests are reported as findings in chapter 4.

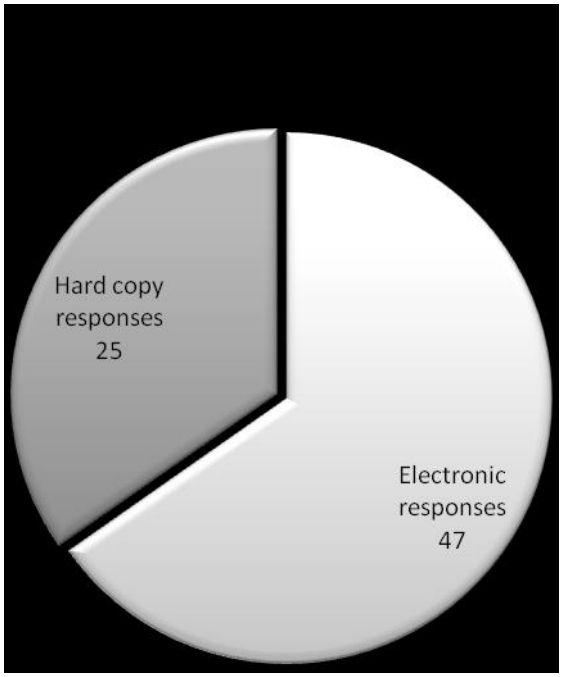

Figure 2. Number of survey responses by method of return: electronic vs. hard copy (n = 72)

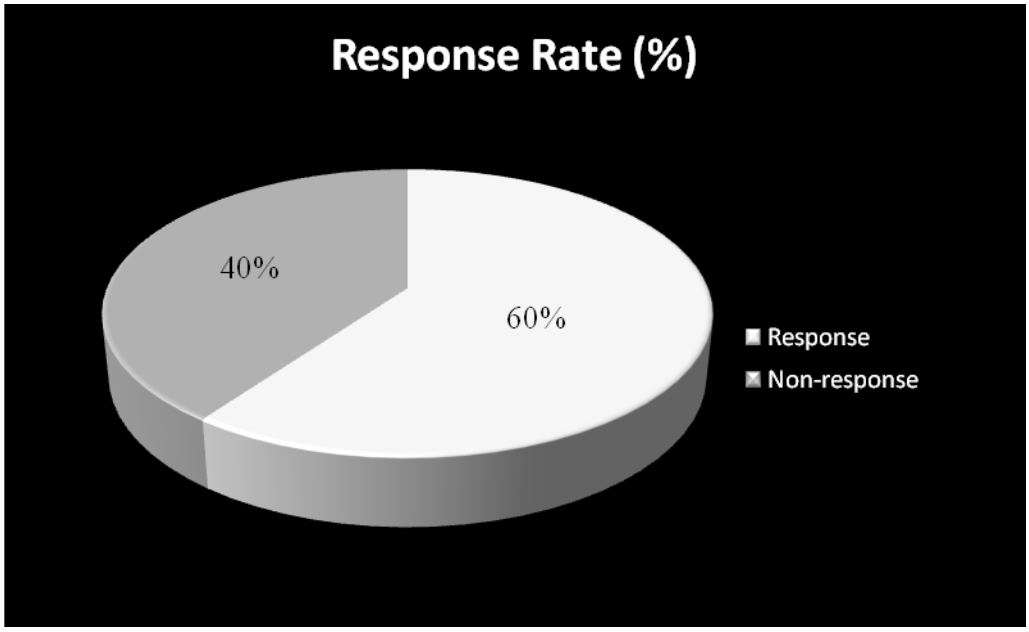

Figure 3. Response rate for this study by percentage (N = 120)

Data Analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS), version PASW statistics 18. The responses received from the participants, via both methods of collection, were coded and entered into an SPSS data file using the SPSS software. The data were analyzed descriptively, i.e., frequencies, percentages, means, standard deviations, and *mean differences* were calculated. Frequencies and percentages were used to describe the selected personal and professional characteristics of the international graduate students and their perceived levels of innovativeness. Means, standard deviations, and *mean differences* were calculated to describe the participants' views on selected attributes and barriers impacting the diffusion of ICTs to advance agricultural education at colleges and universities in developing countries.

Selected relationships were measured using Cramer's *V*, Spearman's rho and point biserial correlation coefficients. Davis' (1971) conventions were used to describe the magnitude of the relationships between selected personal and professional characteristics of the participants and their perceptions on variables impacting the diffusion of ICTs to advance agricultural education at the tertiary level in developing countries. Some of the selected personal and professional characteristics included gender, education level, professional experience, country of citizenship, regions in which participants were educated previously, regions where they anticipated working after completing school, and the professional positions the participants intended to pursue after graduation (Appendices D & E).

Summary of the Research Study's Methods and Procedures

A descriptive-correlational research design (Ary et al., 2002; Best, 1970) was chosen for this study because it dealt with not only describing the perceptions of international graduate students on the diffusion of ICTs to advance agricultural education with regard to innovativeness, attributes, barriers, and their personal and professional characteristics, but also with selected relationships. For the purpose of this research study, 120 international students from developing countries, who were enrolled in CASNR at Oklahoma State University during the fall semester of 2010, served as the study's target population and were surveyed.

Nine departments and two interdisciplinary programs in CASNR (DASNR, 2011) facilitated this research study through their graduate coordinators, department heads, faculty and students who interacted closely with international graduate students in their respective departments or programs. The researcher used both electronic and hard copy versions of the study's instrument (Appendices D & E) to gather data from the participants. Of the 120 graduate students, 72 responded for a response rate of 60% (Figures 1 & 2). The survey instrument had four parts with statements and questions seeking information on the perceptions of international graduate students on the diffusion of ICTs in agricultural colleges and universities in the developing world as well as their selected personal and professional characteristics (Appendices D & E).

The survey instrument was modified from Li and Lindner's instrument (2007) that described the perceptions of faculty members at an agricultural university in China regarding the use of web-based, distance education methodologies. A panel of experts was used to ensure the modified instrument's content validity, and appropriate literature

(i.e., Rogers, 2003) was relied on to address aspects of construct validity. The research study's data collection was conducted between November 18 and December 20, 2010. The data were analyzed using SPSS version PASW 18 to employ descriptive statistics, including the calculation of frequencies, percentages, means, standard deviations, *mean differences,* Cramer's *V* associations, and correlation coefficients. The magnitude of relationships were interpreted using Davis' (1971) conventions.

CHAPTER IV

FINDINGS

The purpose of this chapter is to present the findings derived from data collected to answer the research questions for this study. This chapter is divided into the following sections: (1) purpose, (2) research questions for the study, (3) population of the study, (4) findings related to research question one, (5) findings related to research question two, (6) findings related to research question number three, (7) findings related to question number four, (8) findings related to research question number five, and (9) summary of the study's findings.

Purpose

The primary purpose of this study was to determine the perceptions of international graduate students from developing countries in the College of Agricultural Sciences and Natural Resources (CASNR) at Oklahoma State University on the diffusion of information communications technologies (ICTs) to advance agricultural education at colleges and universities in developing countries. A secondary purpose was to describe the personal and professional characteristics of international graduate students from developing countries who were studying agricultural sciences and natural resources at Oklahoma State University. The period of data collection was the fall semester of 2010.

Research Questions

From the purpose of the study, the following research questions were developed:

1. What were selected personal and professional characteristics of graduate students from developing countries who were studying in CASNR at Oklahoma State University?

2. What were the study participants' perceived levels of "innovativeness" regarding their use of ICTs for academic learning?
3. What were the study participants' views on selected **attributes** impacting the diffusion of ICTs to advance agricultural education at colleges and universities in developing countries?
4. What were the study participants' views on selected **barriers** impacting the diffusion of ICTs to advance agricultural education at colleges and universities in developing countries?
5. What **relationships** existed between selected personal and professional characteristics of the study participants and their perceptions on variables impacting the diffusion of ICTs to advance agricultural education at colleges and universities in developing countries?

Population

The population (N = 120) of this study included international graduate students from developing countries who were enrolled in either departments (9) or interdisciplinary programs (2) in the College of Agricultural Sciences and Natural Resources (CASNR) at Oklahoma State University during the fall semester of 2010. Of the total population (N = 120), 72 students responded to the researcher's invitation to complete the study's instrument. Forty-seven participants completed the instrument electronically (i.e., online) and 25 participants completed a hard copy version of the instrument. The 72 respondents constituted 60% of the study's accessible population.

Findings

Findings of this study are presented according to each research question. The data is reported in frequencies and percentages for research questions 1 and 2. For research questions 3 and 4, the data is reported using means, standard deviations, and *mean differences.* Bivariate correlational analyses were used to address research question five, including Cramer's *V,* Spearman rank order correlation coefficients, and point biserial correlation coefficients.

Findings for Research Question One

Selected Personal Characteristics of International Graduate Students

The first research question was to determine the selected personal and professional characteristics of the study's participants. Based on the responses of 72 participants, it was found that 62.5% of the international graduate students were male and 37.5% female (Table 2). A large majority of the participants were not on study leave (79.2%). The range in age of the participants was 21 to 47 years and the mean participant age was 30.28 (Table 2).

For those participants who were enrolled at the master's level, slightly less than three-in-ten (26.4%) indicated "probably yes" regarding their intent to pursue a terminal degree. In addition, nearly two-in-ten (18.1%) expressed the view of "definitely yes" as an indication of their intent (Table 2).

Table 2

Selected Personal Characteristics of International Graduate Students Who were Enrolled in CASNR during the Fall Semester of 2010 (n = 72)

	f	*%*
Gender		
Male	45	62.5
Female	27	37.5
On study leave		
Yes	15	20.8
No	57	79.2
If a master's student, intent to pursue a terminal degree		
Probably yes	19	26.4
Definitely yes	13	18.1
Not sure/uncertain	10	13.9
Probably not	2	2.8
	Range	*Mean*
Age in years	21 to 47	30.28

For the question regarding country of origin, the participants came from 28 different countries. More respondents came from China and Nepal, tying at 12.5% each, than other countries. India and Mexico had the second highest number of international graduate students enrolled in CASNR during the fall semester of 2010. The continent of Africa was represented by 10 different countries, all from the Sub-Saharan region (Table 3).

Table 3

Selected Personal Characteristics of International Graduate Students Who were Enrolled in CASNR during the Fall Semester of 2010: Country of Origin (n = 72)

	f	*%*
Country		
China	9	12.5
Nepal	9	12.5
India	6	8.3
Mexico	6	8.3
Nigeria	4	5.6
Ghana	3	4.2
Kenya	3	4.2
Niger	3	4.2
Thailand	3	4.2
Ecuador	2	2.8
Ethiopia	2	2.8
Guatemala	2	2.8
Mali	2	2.8
Senegal	2	2.8
Sri Lanka	2	2.8
Uganda	2	2.8
Colombia	1	1.4
Haiti	1	1.4
Indonesia	1	1.4
Iraq	1	1.4
Jamaica	1	1.4
Laos	1	1.4
Malaysia	1	1.4
Mozambique	1	1.4
Philippines	1	1.4
Sierra Leone	1	1.4
South Korea	1	1.4
Suriname	1	1.4
Total number of countries	28	100.0

The sources of primary funding support for the participants' graduate education varied. However, a majority of the respondents (52.8%) identified their academic departments as the primary source of funding support. The second most highly identified sources of financial support included Fulbright (9.7%) and "family" (9.7%) (Table 4).

Table 4

Selected Personal Characteristics of International Graduate Students Who were Enrolled in CASNR during the Fall Semester of 2010: Primary Source of Funding to Support Their Graduate Education (n = 72)

	f	*%*
Funding sources		
Support from an academic department at OSU	38	52.8
Fulbright	7	9.7
Family	7	9.7
Home country's Ministry of Education	5	6.9
Scholarships	4	5.6
My "home" university	4	5.6
Ford Foundation	2	2.8
Employer or a business	2	2.8
Other	2	2.8
No response	1	1.4
Total	72	100.0

Regarding the graduate students' educational and professional experience before enrolling at Oklahoma State University, 56.9% of the respondents had earned a bachelor's degree only, 38.9% held master's degrees and 4.2% earned doctoral degrees (Table 5). Asia was the region where 38.9% of the respondents had earned their degrees before coming to Oklahoma State University, followed by Sub-Saharan Africa (19.4%), the United States (18.1%), and Latin America (13.9%) (Table 5). The remainder of the participants earned their degrees from other regions of the world (Table 5). Nearly

two-thirds (63.9%) of the participants had held a professional position prior to graduate studies at OSU (Table 5). The respondents' years of professional experience ranged from 1 to 20, and their mean years of professional experience was 3.43 (Table 5).

Table 5

Selected Personal Characteristics of International Graduate Students Who were Enrolled in CASNR during the Fall Semester of 2010: Educational and Professional Experience before Enrolling at OSU (n = 72)

	f	*%*
Highest degree earned		
Bachelor's	41	56.9
Master's	28	38.9
Doctoral	3	4.2
Region of the world where the degree was earned		
Asia	28	38.9
Sub-Saharan Africa	14	19.4
USA	13	18.1
Latin America	10	13.9
Europe	2	2.8
Other	2	2.8
Australia/New Zealand	1	1.4
North Africa	1	1.4
No response	1	1.4
Held a professional position prior to graduate studies at OSU		
Yes	46	63.9
No	26	36.1
	Range	*Mean*
Years of professional experience	1 to 20	3.43

Regarding the participants' selected educational experiences in CASNR at OSU, slightly more than one-third (36.1%) indicated they were studying in the Agricultural Economics department (Table 6). The second, third, and fourth largest enrollments were in the departments of Biosystems & Agricultural Engineering (18.1%), Plant & Soil Sciences (13.9%), and Entomology & Plant Pathology (12.5%), respectively. The other CASNR departments and two interdisciplinary programs comprised the remainder of the study's participants (Table 6). Slightly more than one-half (51.4%) of the participants indicated they were pursuing a master of science degree, 43.1% were pursuing a doctoral degree and 4.2% were master of agriculture students (Table 6).

Additionally, 27.8% of the participants had completed two semesters of course work in CASNR at OSU, 19.4% had completed three semesters, 13.9% had four semesters completed, 9.7% indicated six semesters completed, and 8.3% had five semesters completed (Table 6). Furthermore, 61.1% of the participants anticipated they had one year or less remaining until their graduation, and 12.5% anticipated graduating in two years. The other participants anticipated more than two years until their graduation, or they had graduated already (Table 6).

Table 6

Selected Personal Characteristics of International Graduate Students Who were Enrolled in CASNR during the Fall Semester of 2010: Students' Selected Educational Experiences (n = 72)

	f	%
Major department or interdisciplinary program		
Agricultural Economics	26	36.1
Biosystems & Agricultural Engineering	13	18.1
Plant & Soil Sciences	10	13.9
Entomology & Plant Pathology	9	12.5
Agricultural Education, Communications & Leadership	5	6.9
International Programs in Agriculture	4	5.6
Environmental Sciences	3	3.0
Biochemistry & Molecular Biology	1	1.4
Horticulture & Landscape Architecture	1	1.4
Degree pursuing		
Master of Science	37	51.4
Doctoral	31	43.1
Master of Agriculture	3	4.2
Semesters completed		
Two	20	27.8
Three	14	19.4
Four	10	13.9
Six	7	9.7
Five	6	8.3
Eight	4	5.6
Seven	1	1.4
No response	10	13.9
Anticipated time remaining to graduation		
One year	26	36.1
One semester	18	25.0
Two years	9	12.5
One and one-half years	7	9.7
Two and one-half years	6	8.5
I have graduated*	3	4.2
More than three years	2	2.8

**Note.* The researcher concluded that these respondents were studying as post-doctoral students or "post-docs."

Regarding educational experience with, and related views on ICTs as a primary means of course delivery, 50.7% of the participants indicated they had not taken any courses using ICTs as the primary mode of delivery (Table 7). Of the international graduate students who indicated they had taken courses using ICTs as a primary mode of delivery, nearly one-in-five (19.4%) had such an experience in only one course, and about one-in-ten (11.1%) in six courses. Five graduate students indicated they had experience using ICTs in either three or four courses previously (Table 7).

The study participants were also asked to indicate whether they would recommend to others courses that use ICTs as the primary mode of delivery. It was found that nearly three-fourths of the participants were either "not sure/uncertain" (37.5%) or they indicated "probably yes" (36.1%); 18.1% indicated "definitely yes" and 6.9% "probably not" (Table 7).

Table 7

Selected Personal Characteristics of International Graduate Students Who were Enrolled in CASNR during the Fall Semester of 2010: Educational Experience with, and Related Views on, ICTs as a Primary Means of Course Delivery (n = 72)

	f	%
Courses taken using ICTs as primary mode of delivery		
None	36	50.7
One	14	19.4
Two	8	11.1
Six	8	11.1
Four	3	4.2
Three	2	2.8
No response	1	1.4
Recommend others take courses using ICTs as primary mode of delivery		
Not sure/Uncertain	27	37.5
Probably yes	26	36.1
Definitely yes	13	18.1
Probably not	5	6.9
No response	1	1.4

Regarding the participants' "anticipated professional dispositions in the future," it is shown in Table 8 that nearly one-half anticipated being tertiary faculty members (40.3%) or administrators (8.3%). About one-fourth of the participants (26.4%) anticipated employment in the private sector, and 15.3% anticipated being self-employed or working as a consultant (Table 8).

The participants were asked if they would work in their country of citizenship after completing their formal schooling (whether at OSU or another institution): nearly two-thirds (65.3%) of the respondents answered "Yes," and one-third (33.3%) were "Not sure" (Table 8). When asked in which region of the world they anticipated working,

almost three-in-ten (29.2%) of the participants specified Asia, slightly less indicated the United States (26.4%), and one-fourth (25%) expressed Sub-Saharan Africa (Table 8). The remaining participants stipulated Latin America, Canada, Europe, or "Other" (Table 8).

Table 8

Selected Personal Characteristics of International Graduate Students Who were Enrolled in CASNR during the Fall Semester of 2010: "Anticipated" Professional Dispositions in the Future (n = 72)

	f	*%*
Anticipated professional position after graduation		
Faculty/Lecturer	29	40.3
Private sector employee	19	26.4
Self-employed/Consultant	11	15.3
College or University Administrator	6	8.3
Other	6	8.3
No response	1	1.4
Work in country of citizenship		
Yes	47	65.3
Not sure	24	33.3
No response	1	1.4
Region in the world in which anticipated working		
Asia	21	29.2
USA	19	26.4
Sub Saharan Africa	18	25.0
Latin America	6	8.3
Canada	2	2.8
Europe	1	1.4
Other	1	1.4
No response	4	5.6

International Graduate Students' Perceived Levels of Innovativeness Regarding the Use of ICTs

The second research question of this study was to determine the participants' perceived levels of "innovativeness" regarding their use of ICTs for academic learning in the agricultural sciences and natural resources. Table 9 presents the respondents' perceived levels of innovativeness. Twenty-nine of the respondents indicated that "ICTs may be a good way to overcome" limited access to higher education by students in developing countries (Table 9). The second largest group of respondents (17) indicated that "ICTs are a good way to overcome this problem." Notably, these findings are the "Total" or combined counts regardless of respondents' method of returning the study's instrument.

Thirteen of the respondents indicated they knew "very little about whether ICTs could be used to overcome" the problem of limited access to higher education in agricultural sciences and natural resources by students in developing countries (Table 9). Six of the respondents had never used ICTs to teach but intended to use them to overcome the problem in the future. Eight of the respondents had used ICTs to teach and would continue that practice to overcome the problem of limited accessibility to higher education by students in developing countries. All of the participants (8) who indicated this level of perceived innovativeness responded to the online version of the study's instrument (Table 9).

A significant association existed between international graduate students' perceived levels of innovativeness regarding the use of ICTs to advance tertiary education in the agricultural sciences and natural resources in developing countries and

their method of returning the study's survey instrument (Cramer's V = .381, sig. = .034). Eight of the respondents who completed the online version of the survey instrument chose scale anchor five: "I have used ICTs to teach and will continue that practice to overcome this problem in the future." However, no participant who completed the hard copy version of the instrument chose scale anchor five (Table 9).

Table 9

Cramer's V Association of International Graduate Students' Perceived Levels of Innovativeness[a] Regarding the Use of ICTs to Advance Tertiary Education in the Agricultural Sciences and Natural Resources in Developing Countries by Method of Returning the Study's Survey Instrument

Method of Return	Perceived Innovativeness					Total	Cramer's *V** sig.
	1[a]	2[a]	3[a]	4[a]	5[a]		
Online	11	18	8	2	8	47	
Hard Copy	2	11	9	3	0	25	
Total	13	29	17	5	8	72	.381 .034

Note. *Cramer's *V* ranges in value from -1 to +1
Values near 0 indicate a very weak relationship, and values near 1 indicate a very strong relationship. Cramer's V = .10 (small effect size); Cramer's V = *.30* (medium effect size*);* Cramer's V = .50 (large effect size) (Green, Salkind, & Akey, 1997)
[a]Scale items: "1" = I know very little about whether Information Communication Technologies (ICTs) could be used to overcome this problem; "2" = ICTs may be a good way to overcome this problem; "3" = ICTs are a good way to overcome this problem; "4" = I have not used ICTs to teach but intend to use them to overcome this problem in the future; "5" = I have used ICTs to teach and will continue that practice to overcome this problem in the future

The crosstabulations between participants' perceived levels of innovativeness and their method of returning the study's survey instrument, as presented in Table 10, provide additional detail regarding the "Expected" counts and percentages for each scale item

choice versus what was observed (found) by group and overall. Although the expected count for the most "innovative" choice (i.e., "5") within the online return group was only 5.2, the "observed" count was eight respondents or 17% of the total (Table 10). In contrast, none of the hard copy returnees indicated "5" as the choice for describing their perceived level of innovativeness regarding the use of ICTs to advance tertiary education in the agricultural sciences and natural resources in developing countries. However, it was expected that 2.8 (or 3 individuals) would have indicated that choice to describe their perceived level of innovativeness (Table 10) regarding the phenomenon in question.

Table 10

Crosstabulations of International Graduate Students' Perceived Levels of Innovativeness[a] Regarding the Use of ICTs to Advance Tertiary Education in the Agricultural Sciences and Natural Resources in Developing Countries by Their Method of Returning the Study's Survey Instrument

Method of Return	Perceived Innovativeness					Total
	1[a]	2[a]	3[a]	4[a]	5[a]	
Online	11	18	8	2	8	47
Expected	8.5	18.9	11.1	3.3	5.2	47
% within online return	23.4	38.3	17.0	4.3	17.0	100.0
% within perceived innovativeness	84.6	62.1	47.1	40.0	100.0	65.3
% of Total	15.3	25.0	11.1	2.8	11.1	65.3
Hard Copy	2	11	9	3	0	25
Expected	4.5	10.1	5.9	1.7	2.8	25
% within hard copy return	8.0	44.0	36.0	12.0	0.0	100.0
% within perceived innovativeness	15.4	37.9	52.9	60.0	0.0	34.7
% of Total	2.8	15.3	12.5	4.2	0.0	34.7
Total	13	29	17	5	8	72
Expected	13	29	17	5	8	72
% within combined return	18.1	40.3	23.6	6.9	11.1	100.0
% within combined perceived innovativeness	100.0	100.0	100.0	100.0	100.0	100.0
% of Total	18.1	40.3	23.6	6.9	11.1	100.0

Note. [a]Scale items: "1" = I know very little about whether Information Communication Technologies (ICTs) could be used to overcome this problem; "2" = ICTs may be a good way to overcome this problem; "3" = ICTs are a good way to overcome this problem; "4" = I have not used ICTs to teach but intend to use them to overcome this problem in the future; "5" = I have used ICTs to teach and will continue that practice to overcome this problem in the future

Figure 3 presents a visual comparison of international graduate students' perceived innovativeness as per their method of returning the study's survey instrument. Again, none of the hard copy respondents indicated "5" as the choice to describe their perceived level of innovativeness regarding the use of ICTs to deliver tertiary education in the agricultural sciences and natural resources in developing countries.

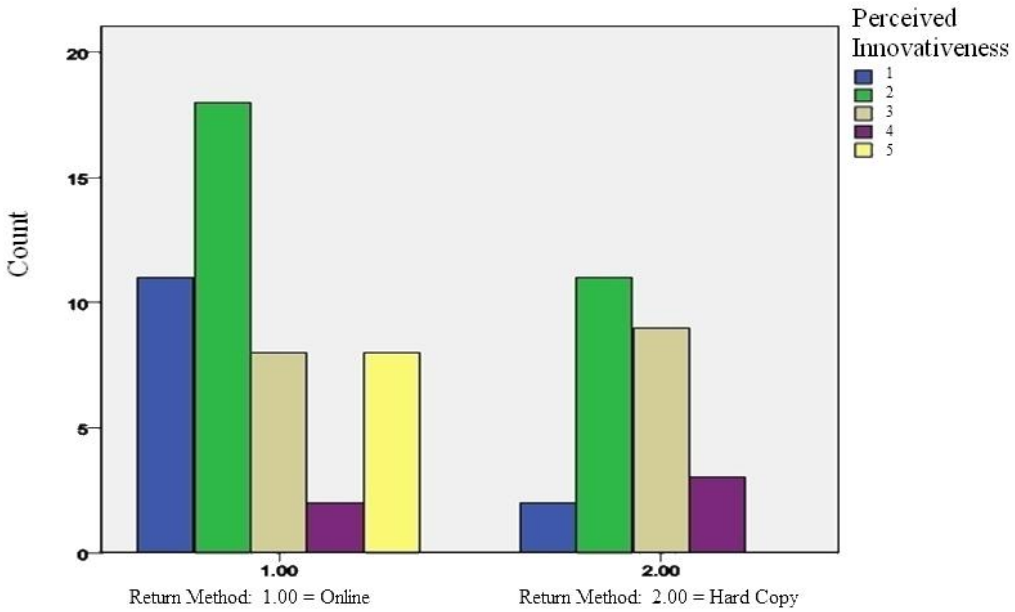

Figure 4. Comparison of groups by return method and respondents' ratings of their perceived innovativeness regarding the use of ICTs to advance tertiary education in the agricultural sciences and natural resources in developing countries

Table 11 presents a comparison of international graduate students' perceived levels of innovativeness regarding the use of ICTs in higher education and their method of returning the study's survey instrument as well as the overall (combined) return. The difference between the groups' means by method of return, online (M = 2.53, SD = 1.365) versus hard copy (M = 2.52, SD = .823), was not significant at an alpha level of .05 (*mean difference* = .012, t = .040, p = .968) (Table 11). The overall (combined) mean score of perceived innovativeness for all respondents was 2.53 (SD = 1.198) (Table 11).

Table 11

International Graduate Students' Perceived Level of Innovativeness[a] *Regarding the Use of ICTs to Advance Tertiary Education in the Agricultural Sciences and Natural Resources in Developing Countries by Method of Returning the Study's Survey Instrument and Overall (Combined) Return: Means, Standard Deviations, and Mean Difference*

Method of Return	*n*	Perceived Innovativeness				
		Mean	*SD*	*Mean Diff.*	*t*	Sig.
Online	47	2.53	1.365	.012	.040	.968
Hard copy	25	2.52	.823			
Overall (Combined)	72	2.53	1.198			

Note. [a]Scale items: "1" = I know very little about whether Information Communication Technologies (ICTs) could be used to overcome this problem; "2" = ICTs may be a good way to overcome this problem; "3" = ICTs are a good way to overcome this problem; "4" = I have not used ICTs to teach but intend to use them to overcome this problem in the future; "5" = I have used ICTs to teach and will continue that practice to overcome this problem in the future

International Graduate Students' Ratings of Selected Attributes Impacting the Diffusion of ICTs

The third research question was to describe the participants' views or perceptions on selected attributes impacting the diffusion of ICTs in advancing agricultural sciences and natural resources education at colleges and universities in developing countries. The five attributes examined included "relative advantage," "compatibility," "complexity," "trialability," and "observability" (Rogers, 2003).

The "real limits" of the scale used for interpretation of the findings were 1.00 to 1.49 = "Strongly disagree"; 1.50 to 2.49 = "Disagree"; 2.50 to 3.49 = "Neutral"; 3.50 to 4.49 = "Agree"; and 4.50 to 5.00 = "Strongly agree." The five attribute constructs (4 items each) and their individual items as rated by the study's respondents are shown in Table 12. Mean scores and standard deviations by attribute construct (i.e., composite) are displayed by method of survey instrument return ─ online and hard copy ─ and overall (combined) (Table 12). In addition, the results of independent samples *t*-tests are shown; mean differences were considered significant at an alpha level of $p < .05$. The practical significance of the *mean differences* were interpreted as "small," "medium" and "large" (Hittleman & Simon, 2002).

Relative advantage

The composite means for the attribute construct "relative advantage" were 4.01 (*SD* = .677) for the online return group, 3.96 (*SD* = .498) for the hard copy return group and 3.99 (*SD* = .618) overall or when the groups' ratings were combined (Table 12). All three composite means were in the range of "agree." The *mean difference* between the two groups by method of survey instrument return was not statistically significant at an alpha level of .05 (*mean difference* = .070, $t(62.762) = .500$, $p = .619$, $d = .12$) (Table 12).

The means by item ranged from 3.67 to 4.17 for the online group, 3.64 to 4.20 for the hard copy group, and 3.64 to 4.19 when combined (Table 12). All individual item means were in the range of "agree." None of the mean differences for the relative advantage items were statistically significant at an alpha level of .05 (Table 12).

Compatibility

The composite means for the attribute construct "compatibility" were 3.85 (*SD* = .718) for the online return group, 3.49 (*SD* = .783) for the hard copy return group, and 3.72 (*SD* = .752) overall or when the groups' ratings were combined (Table 12). The composite means for the online return group and when calculated overall were in the range of "agree"; however, the composite mean of the hard copy return group was marginally in the range of "neutral." The mean difference between the two groups by method of survey instrument return was not statistically significant at an alpha level of .05 (*mean difference* = .372, $t(70) = 1.787$, $p = .078$, $d = .42$); however, the effect size was approaching "medium" (Table 12).

The means by item ranged from 3.70 to 3.98 for the online group, 3.20 to 3.62 for the hard copy group, and 3.54 to 3.84 when combined (Table 12). All individual item means, except for the item "compatible w/ all aspects of my work" (*M* = 3.20, *SD* = .816) for the hard copy group, were in the range of "agree." The mean rating for that item was in the "neutral" range. And, the item's *mean difference* of .502 ($t(70) = 2.404$, $p = .019$) was statistically significant (Table 12).

Complexity

The composite means for the attribute construct "complexity" were 3.84 (*SD* = .706) for the online return group, 3.89 (*SD* = .604) for the hard copy return group and 3.85 (*SD* = .668) overall or when the groups' ratings were combined (Table 12). All three composite means were in the range of "agree." The mean difference between the two groups by method of survey instrument return was not statistically significant at an alpha level of .05 (*mean difference* = .049, *t*(70) = -.298, *p* = .767, *d* = .07) (Table 12).

The means by item ranged from 3.79 to 3.89 for the online group, 3.64 to 4.12 for the hard copy group, and 3.74 to 3.92 when combined (Table 12). All individual item means were in the range of "agree." None of the mean differences for the complexity items were statistically significant at an alpha level of .05 (Table 12).

Trialability

The composite means for the attribute construct "trialability" were 3.20 (*SD* = .814) for the online return group, 2.69 (*SD* = .736) for the hard copy return group, and 3.02 (*SD* = .821) overall or when the groups' ratings were combined (Table 12). All three composite means were in the range of "neutral." The mean difference between the two groups by method of survey instrument return was statistically significant at an alpha level of. 05 (*mean difference* = .517, *t*(70) = 2.649, *p* = .010, *d* = .63); and, the effect size was between "medium" and "large" (Table 12).

The means by item ranged from 3.09 to 3.38 for the online group, 2.56 to 2.84 for the hard copy group and 2.92 to 3.10 when combined (Table 12). All individual item means were in the range of "neutral." The mean differences of two items, "I had adequate opportunities to try using ICTs to deliver higher education" (*mean difference* = .546,

$t(70) = 2.110$, $p = .038$) and "the ability to experiment using ICTs to deliver higher education" (*mean difference* = .823, $t(70) = 3.742$, $p = .000$) were statistically significant. (Table 12) at an alpha level of .05.

Observability

The composite means for the attribute construct "observability" were 3.33 (*SD* = .990) for the online return group, 2.34 (*SD* = .932) for the hard copy return group and 2.98 (*SD* = 1.074) overall or when the groups' ratings were combined (Table 12). Two composite means ─ online return and overall ─ were in the range of "neutral"; however, the composite mean of the hard copy return group was in the range of "disagree." The *mean difference* between the two groups by method of survey instrument return was statistically significant at an alpha level of .05 (*mean difference* = .989, $t(70) = 4.118$, $p = .000$, $d = .98$) (Table 12). The effect size for this difference was "large."

The means by item ranged from 3.23 to 3.49 for the online group, 2.08 to 2.56 for the hard copy group, and 2.83 to 3.17 when combined (Table 12). All individual item means for the online return group were in the range of "neutral" and all individual item means for the hard copy return group were in the range of "disagree" except for the item "seen others using ICTs to deliver higher education" (*M* = 2.56, *SD* = 1.003), which was in the range of "neutral." All of the *mean differences* for the four observability items, when compared by method of survey instrument return, were statistically significant at an alpha level of .05 (Table 12).

The grand mean of the attribute constructs for the online method of survey instrument return (*M* = 3.67, *SD* = .567) was in the range of "agree." However, the grand mean (*M* = 3.26, *SD* = .312) of the attribute constructs for the hard copy method of

survey instrument return was in the range of "neutral." The grand mean overall (combined) (M = 3.53, SD = .522) for the attributes was in the range of "agree," but only marginally. The *mean difference* between the grand means of the two groups by method of survey instrument return was statistically significant at an alpha level of .05 (*mean difference* = .371, $t(69.86) = 3.579$, $p = .001$, $d = .85$) (Table 12). The effect size for this difference was "large."

Table 12

International Graduate Students' Ratings of Selected Attributes Impacting the Diffusion of ICTs to Advance Higher Education in the Agricultural Sciences and Natural Resources in Developing Countries by Method of Returning the Survey Instrument and Overall Return (Combined)

Attributes	Online (n = 47)		Hard Copy (n = 25)		Overall (Combined) (n = 72)					
	M	*SD*	*M*	*SD*	*M*	*SD*	*Mean Diff.*	*t*	*df*	Sig.*
Relative advantage . . .										
Reach more students	4.09	.803	4.12	.881	4.09	.836	.035	-.170	70	.866
More flexible time schedule	4.17	.761	4.20	.816	4.19	.772	.030	-.154	70	.878
Improve my teaching effectiveness	3.67	1.044	3.64	.638	3.64	.907	.027	.132	67.303[a]	.895
Gives me more teaching resources	4.17	.851	3.88	.781	4.07	.846	.294	1.429	69	.157
Composite Mean	4.01	.677[b]	3.96	.498[b]	3.99	.618[b]	.070	.500	62.762 *d* =.12	.619
Compatibility . . .										
Compatible w/ my teaching work	3.83	.769	3.62	.875	3.76	.806	.201	.990	68	.326
Compatible w/ all aspects of my work	3.70	.858	3.20	.816	3.54	.879	.502	2.404	70	.019
Fits well with the way I like to work	3.85	.807	3.56	.870	3.77	.820	.291	1.418	70	.161
Fits into my work style	3.98	.906	3.60	1.041	3.84	.973	.378	1.593	69[a]	.116

Table 12 (continued)

International Graduate Students' Ratings of Selected Attributes Impacting the Diffusion of ICTs to Advance Higher Education in the Agricultural Sciences and Natural Resources in Developing Countries by Method of Returning the Survey Instrument and Overall Return (Combined)

Attributes	Online (n = 47)		Hard Copy (n = 25)		Overall (Combined) (n = 72)					
	M	*SD*	*M*	*SD*	*M*	*SD*	*Mean Diff.*	*t*	*df*	Sig.*
Composite Mean	3.85	.718[b]	3.49	.783[b]	3.72	.752[b]	.327	1.787	70 *d* = .42	.078
Complexity . . .										
Clear & I understand	3.87	.947	3.92	.493	3.89	.815	.048	-.281	69.992[a]	.780
Not frustrating	3.79	.858	3.64	.860	3.74	.856	.147	.693	70	.491
Easy to learn	3.89	.840	3.88	.600	3.89	.761	.014	.072	70	.943
Is practical	3.81	.947	4.12	.971	3.92	.960	.311	-1.317	70	.192
Composite Mean	3.84	.706[b]	3.89	.604[b]	3.85	.668[b]	.049	-.298	70 *d* = .07	.767
Trialability . . .										
I had adequate opportunities to try using ICTs to deliver higher education	3.11	1.088	2.56	.961	2.92	1.071	.546	2.110	70	.038

Table 12 (continued)

International Graduate Students' Ratings of Selected Attributes Impacting the Diffusion of ICTs to Advance Higher Education in the Agricultural Sciences and Natural Resources in Developing Countries by Method of Returning the Survey Instrument and Overall Return (Combined)

Attributes	Online (n = 47)		Hard Copy (n = 25)		Overall (Combined) (n = 72)					
	M	*SD*	*M*	*SD*	*M*	*SD*	*Mean Diff.*	*t*	*df*	Sig.*
Knowledge of where I can go to try using ICTs to deliver higher education	3.26	.988	2.80	.913	3.10	.981	.455	1.910	70	.060
The ability to experiment using ICTs to deliver higher education	3.38	.922	2.56	.821	3.10	.966	.823	3.742	70	.000
Enough people to help me try ICTs to deliver higher education	3.09	.952	2.84	.943	3.00	.949	.245	1.044	70	.300
Composite Mean	3.20	.814[b]	2.69	.736[b]	3.02	.821[b]	.517	2.649	70 *d* = .63	.010
Observability . . .										
Easy for me to observe others using ICTs to deliver higher education	3.23	1.108	2.08	1.077	2.83	1.222	1.154	4.249	70	.000
Easy for me to observe effects of ICTs on delivering higher education	3.23	1.088	2.40	.957	2.94	1.112	.834	3.225	70	.002
Seen others using ICTs to deliver higher education	3.49	1.249	2.56	1.003	3.17	1.245	.929	3.207	70	.002

Table 12 (continued)

International Graduate Students' Ratings of Selected Attributes Impacting the Diffusion of ICTs to Advance Higher Education in the Agricultural Sciences and Natural Resources in Developing Countries by Method of Returning the Survey Instrument and Overall Return (Combined)

Attributes	Online (n = 47)		Hard Copy (n = 25)		Overall (Combined) (n = 72)					
	M	*SD*	*M*	*SD*	*M*	*SD*	*Mean Diff.*	*t*	*df*	Sig.*
Seen others using ICTs to deliver higher education in off-campus or remote settings	3.36	1.150	2.32	1.108	3.00	1.233	1.042	3.705	70	.000
Composite Mean	3.33	.990[b]	2.34	.932[b]	2.98	1.074[b]	.989	4.118	70 d = .98	.000
Grand Mean	3.67	.567[b]	3.26	.312[b]	3.53	.522[b]	.371	3.579	69.86[a] d = .85	.001

Note. *Significant difference if $p < .05$. [a]Levene's test was significant at $p < .05$; so, *Equal variances not assumed.* [b]Standard deviation was calculated based on exclusion of cases analysis by analysis. Effect sizes: "small" (d = .20); "medium" (d = .50); "large" (d = .80) (Hittleman & Simon, 2002)

International Graduate Students' Ratings of Selected Barriers Impacting the Diffusion of ICTs

The fourth research question was to describe the participants' views or perceptions on selected barriers impacting the diffusion of ICTs in advancing agricultural sciences and natural resources education at colleges and universities in developing countries. The nine barrier constructs included "faculty compensation and time" (5 items), "credibility of ICTs" (4 items), "financial concerns" (4 items), "lack of needs" (4 items), "conflict with traditional education" (4 items), "fear of technology" (4 items), "lack of technical expertise" (4 items), "lack of administrative support" (5 items) and "lack of infrastructure" (4 items). The "real limits" of the scale used for the interpretation of the barrier findings were 1.00 to 1.49 = "No barriers"; 1.50 to 2.49 = "Weak barriers"; 2.50 to 3.49 = "Moderate barriers"; 3.50 to 4.49 = "Strong barriers"; and 4.50 to 5.00 = "Very strong barriers." Table 13 presents selected barrier constructs and their items.

Faculty compensation and time

The composite means for the barriers construct "faculty compensation and time" were 2.83 (*SD* = .767) for the online return group, 3.15 (*SD* = .936) for the hard copy return group, and 2.94 (*SD* = .835) overall or when the groups' ratings were combined (Table 13). All three composite means were in the range of "moderate barriers." The composite *mean difference* between the two groups by method of survey instrument return was not statistically significant at an alpha level of .05 (*mean difference* = .295, $t(70) = -1.439$, $p = .155$, $d = .34$) (Table 13).

The means by item, ranged from 2.74 to 2.96 for the online group, 2.76 to 3.76 for the hard copy group, and 2.84 to 3.16 when combined (Table 13). All individual item means, except the item "difficulty keeping current with technological change" (*M* = 3.76, *SD* = .831) for the hard copy group, were in the range of "moderate barriers." The mean rating for that item was in

the "strong barriers" range; the item's *mean difference* of .934 ($t(69) = -3.928$, $p = .000$) was statistically significant at an alpha level of .05 (Table 13).

Credibility of ICTs

The composite means for the barriers construct "credibility of ICTs" were 2.87 (*SD* = .885) for the online return group, 3.47 (*SD* = .804) for the hard copy return group, and 3.08 (*SD* = .895) overall or when the groups' ratings were combined. All three composite means were in the range of "moderate barriers." The composite *mean difference* between the two groups by method of survey instrument return was statistically significant at an alpha level of .05 (*mean difference* = .571, $t(70) = -2.686$, $p = .009$, $d = .64$) (Table 13).

The means by item ranged from 2.83 to 3.04 for the online group, 2.96 to 3.80 for the hard copy group, and 2.86 to 3.30 when combined (Table 13). Individual item means, except two items from the hard copy group, "concerns on evaluation, testing, assessment of student work" (*M* = 3.80, *SD* = .1.041) and "concerns that ICTs lower quality of courses/programs, students admitted, or expectations for student learning" (*M* = 3.80, *SD* = .913), were in the range of "moderate barriers." The mean ratings for those items were in the "strong barriers" range; the items' *mean differences* of .757 ($t (70) = -2.939$, $p = .004$) and .952 ($t(69) = -3.862$, $p = .000$), respectively, were statistically significant at an alpha level of .05.

Financial concerns

The composite means for the barriers construct "financial concerns" were 3.50 (*SD* = .942) for the online return group, 3.85 (*SD* = .535) for the hard copy return group, and 3.62 (*SD* = .837) overall or when the groups' ratings were combined (Table 13). All three composite means were in the range of "strong barriers." The composite *mean difference* between the two

groups by method of survey instrument return was statistically significant at an alpha level of .05 (*mean difference* = .350, $t(69.632) = -2.009$, $p = .048$, $d = .48$) (Table 13).

The means by item ranged from 3.06 to 4.09 for the online group, 3.60 to 4.32 for the hard copy group, and 3.26 to 4.17 when combined (Table 13). All individual item means, except for two items, i.e., "student tuition rate" and "revenue sharing with department or institutional business units," from the online group ($M = 3.34$, $SD = .1.166$; $M = 3.06$, $SD = .965$) and overall ($M = 3.43$, $SD = 1.059$; $M = 3.26$, $SD = .934$), were in the range of "strong barriers." Four of the six mean ratings for those two items were in the "moderate barriers" range. The *mean difference* of .576 ($t(70) = -2.589$, $p = .012$) for the item "revenue sharing with department or institutional business units" was statistically significant at an alpha level of .05.

Lack of needs

The composite means for the barriers construct "lack of needs" were 3.17 ($SD = .885$) for the online return group, 3.82 ($SD = .900$) for the hard copy return group, and 3.40 ($SD = .938$) overall or when the groups' ratings were combined. Two of the three composite means were in the range of "moderate barriers." The composite mean for the hard copy group (3.82) was in the "strong barriers" range. The composite *mean difference* between the two groups by method of survey instrument return was statistically significant at an alpha level of .05 (*mean difference* = .658, $t(70) = -2.989$, $p = .004$, $d = .71$) (Table 13).

The means by item ranged from 3.06 to 3.36 for the online group, 3.44 to 4.04 for the hard copy group, and 3.21 to 3.59 when combined (Table 13). All individual item means for the online group were in the "moderate barriers" range. However, all items from the hard copy group except one, "lack of identified needs for ICTs" ($M = 3.44$, $SD = 1.261$), were in the range of "strong barriers." The mean rating for the item "lack of identified needs for ICTs" was in the

"moderate barriers" range. Three of the four overall item means were in the range of "moderate barriers" as well, i.e., excluding the item "lack of strategic planning for ICTs in higher education," which was in the range of "strong barriers" (*M* = 3.59) (Table 13). The mean differences for three of the items were statistically significant at an alpha level of .05, including "lack of shared vision for the role of ICTs in the educational organization," "lack of strategic planning for ICTs in higher education," and "lack of a 'champion' for ICTs in the educational organization" (Table 13).

Conflict with traditional education

The composite means for the barriers construct "conflict with traditional education" were 2.77 (*SD* = .778) for the online return group, 2.73 (*SD* = 1.228) for the hard copy return group, and 2.76 (*SD* = .950) overall or when the groups' ratings were combined (Table 13). All three composite means were in the range of "moderate barriers." The composite *mean difference* between the two groups by method of survey instrument return was not statistically significant at an alpha level of .05 (*mean difference* = .037, *t*(34.508) = .139, *p* = .890, *d* = .04) (Table 13).

The means by item ranged from 2.30 to 3.19 for the online group, 2.44 to 3.20 for the hard copy group, and 2.44 to 3.21 when combined (Table 13). Nine of the individual item means, including by methods of instrument return and overall, were in the range of "moderate barriers" (Table 13). However, two items yielded mean scores in the range of "weak barriers": "competition w/ on-campus offerings or for students" per the hard copy return group (*M* = 2.44, *SD* = 1.583) and "traditional academic calendar/schedule hinders use of ICTs in higher education" in the case of the online return group (*M* = 2.30, *SD* = .916) and overall (*M* = 2.44, *SD* = 1.079), respectively (Table 13). None of the *mean differences* ─ online versus hard copy return ─ for the four items comprising this barriers construct were statistically

significant at an alpha level of .05 (Table 13).

Fear of technology

The composite means for the barriers construct "fear of technology" were 2.76 (*SD* = .844) for the online return group, 3.14 (*SD* = .907) for the hard copy return group, and 2.89 (*SD* = .878) overall or when the groups' ratings were combined. All three composite means were in the range of "moderate barriers." The composite *mean difference* between the two groups by method of survey instrument return was not statistically significant at an alpha level of .05 (*mean difference* = .374, $t(70) = -1.744$, $p = .086$, $d = .41$) (Table 13).

The means by item ranged from 2.62 to 2.98 for the online group, 2.84 to 3.52 for the hard copy group, and 2.82 to 2.97 when combined (Table 13). All individual item means, except the item "threat to instructors' sense of competence and authority" for the hard copy group (*M* = 3.52, *SD* = .963), were in the range of "moderate barriers." The mean rating for this item was in the "strong barriers" range marginally. The item's *mean difference* of .839 ($t(70) = - 3.648$, $p = .001$) was statistically significant at an alpha level of .05. The *mean difference* of the item "Isolation felt by instructors using ICTs" (*mean difference* = .583 ($t(70)$ -2.087, $p = .040$) was also statistically significant (Table 13).

Lack of technical expertise

The composite means for the barriers construct "lack of technical expertise" were 3.30 (*SD* = 1.012) for the online return group, 4.09 (*SD* = .620) for the hard copy return group, and 3.58 (*SD* = .968) overall or when the groups' ratings were combined. Two of the three composite means were in the range of "strong barriers." The composite mean for the online group (3.30) was in the "moderate barriers" range. The composite *mean difference* between the two groups by

method of survey instrument return was statistically significant at an alpha level of .05 (*mean difference* = .796, $t(67.904) = -4.103$, $p = .000$, $d = .99$) (Table 13).

The means by item ranged from 3.22 to 3.43 for the online group, 3.92 to 4.24 for the hard copy group, and 3.50 to 3.67 when combined (Table 13). All individual item means for the online group were in the "moderate barriers" range, and all items from the hard copy group and overall were in the range of "strong barriers." All of the items' *mean differences* when comparing the online and hard copy return groups were statistically significant at an alpha level of .05 (Table 13).

Lack of administrative support

The composite means for the barriers construct "lack of administrative support" were 3.06 ($SD = .984$) for the online return group, 3.37 ($SD = .570$) for the hard copy return group, and 3.17 ($SD = .871$) overall or when the groups' ratings were combined. All three composite means were in the range of "moderate barriers." The composite *mean difference* between the two groups by method of survey instrument return was not statistically significant at an alpha level of .05 (*mean difference* = .311, $t(70) = -1.455$, $p = .150$, $d = .34$) (Table 13).

The means by item ranged from 2.74 to 3.46 for the online group, 2.75 to 3.80 for the hard copy group, and 2.75 to 3.59 when combined (Table 13). All individual item means for the online group were in the range of "moderate barriers." The individual item means for the hard copy group included two items in the range of "strong barriers": "lack of student services support (admissions, financial aid, library services and technical training)" ($M = 3.80$, $SD = .816$) and "lack of advisement and counseling support " ($M = 3.80$, $SD = .645$) (Table 13). Four of the five item means overall were in the range of "moderate barriers." The exception was the item "lack of student services support (admissions, financial aid, library services and technical training &

technical training)" (*M* = 3.59, *SD* = 1.102), which was in the range of "strong barriers" marginally (Table 13). And, three items were in the range of "moderate barriers": "copy right/fair use issues regarding use of ICTs in higher education" (*M* = 3.04, *SD* = 1.098), "difficulty recruiting students to learn using ICTs" (*M* = 2.75, *SD* = 1.294), and "difficulty recruiting faculty to teach courses using ICTs" (*M* = 3.44, *SD* = .768) (Table 13). The items "lack of advisement & counseling support" (*mean difference* = .561, *t*(68.924) = - 2.620, *p* = .011) and "difficulty recruiting faculty to teach courses using ICTs" (*mean difference* = .589, *t*(68.424) = -2.469, *p* = .016) (Table 13) were statistically significant at an alpha level of .05.

Lack of infrastructure

The composite means for the barriers construct "lack of infrastructure" were 3.85 (*SD* = 1.062) for the online return group, 4.29 (*SD* = .792) for the hard copy return group, and 4.00 (*SD* = .995) overall or when the groups' ratings were combined. All three composite means were in the range of "strong barriers." The composite *mean difference* between the two groups by method of survey instrument return was statistically significant at an alpha level of .05 (*mean difference* = .454, *t*(62.153) = -2.052, *p* = .044, *d* = .52) (Table 13).

The means by item ranged from 3.66 to 4.00 for the online group, 4.04 to 4.56 for the hard copy group, and 3.80 to 4.21 when combined (Table 13). All individual item means, except one item from the hard copy group, "lack of adequate ICTs-enhanced classrooms, labs, or infrastructure" (*M* = 4.56, *SD* = .768), were in the range of "strong barriers." The mean rating for that item was in the "very strong barriers" range and its *mean difference* of .560 (*t*(70) = -2.260, *p* = .027) was statistically significant at an alpha level of .05. Two of the three barriers grand means, i.e., the online return group (*M* = 3.12, *SD* = .627) and overall (*M* = 3.26, *SD* = .587), were in the range of "moderate barriers" (Table 13). Finally, the *mean difference* of .420

($t(68.663) = -3.530$, $p = .001$, $d = .85$) between the two groups based on the method of survey instrument return was statistically significant at an alpha level of .05 (Table 13). The effect size for this difference was "large."

Table 13

International Graduate Students' Ratings of Selected Barriers Impacting the Diffusion of ICTs to Advance Higher Education in the Agricultural Sciences and Natural Resources in Developing Countries by Method of Returning the Survey Instrument and Overall Return (Combined)

Barriers	Online (n = 47)		Hard Copy (n = 25)		Overall (Combined) (n = 72)					
	M	*SD*	*M*	*SD*	*M*	*SD*	*Mean Diff.*	*t*	*df*	Sig.*
Faculty compensation & time . . .										
Concerns on faculty compensation, incentives, workload, promotion, & recognition	2.87	1.002	2.76	1.393	2.84	1.141	.110	.347	37.815[a]	.730
Increased time commitment	2.96	.999	2.96	1.083	2.96	1.028	.001	.003	69	.997
Difficulty keeping current w/ technological changes	2.83	1.018	3.76	.831	3.16	1.060	.934	-3.928	69	.000
Information overload	2.74	.855	3.12	.971	2.91	.910	.381	-1.709	69	.092
Difficulty keeping high turnover rate of faculty down	2.74	.920	3.04	1.172	2.87	1.035	.295	-1.177	70	.243
Composite Mean	2.83	.767[b]	3.15	.936[b]	2.94	.835[b]	.295	-1.439	70 *d* = .34	.155

Table 13 (continued)

International Graduate Students' Ratings of Selected Barriers Impacting the Diffusion of ICTs to Advance Higher Education in the Agricultural Sciences and Natural Resources in Developing Countries by Method of Returning the Survey Instrument and Overall Return (Combined)

Barriers	Online (n = 47)		Hard Copy (n = 25)		Overall (Combined) (n = 72)					
	M	*SD*	*M*	*SD*	*M*	*SD*	*Mean Diff.*	*t*	*df*	Sig.*
Credibility of ICTs . . .										
Lack of ongoing credibility of ICTs w/ the public, lawmakers, or community	2.85	1.122	3.32	.945	3.00	1.082	.469	-1.779	70	.080
Lack of professional prestige for ICTs	2.83	1.239	2.96	1.098	2.86	1.187	.130	-.441	70	.661
Concerns on evaluation, testing, assessment of student work	3.04	1.042	3.80	1.041	3.30	1.101	.757	-2.939	70	.004
Concerns that ICTs lower quality of courses/programs, students admitted, or expectations for student learning	2.85	1.032	3.80	.913	3.18	1.086	.952	-.3.862	69	.000
Composite Mean	2.87	.885 [b]	3.47	.804 [b]	3.08	.895 [b]	.571	-2.686	70 *d* = .64	.009
Financial concerns . . .										
Student tuition rate	3.34	1.166	3.60	.816	3.43	1.059	.260	-1.101	64.634 [a]	.275

Table 13 (continued)

International Graduate Students' Ratings of Selected Barriers Impacting the Diffusion of ICTs to Advance Higher Education in the Agricultural Sciences and Natural Resources in Developing Countries by Method of Returning the Survey Instrument and Overall Return (Combined)

Barriers	Online (n = 47)		Hard Copy (n = 25)		Overall (Combined) (n = 72)					
	M	*SD*	*M*	*SD*	*M*	*SD*	*Mean Diff.*	*t*	*df*	Sig.*
Technology fees	3.51	1.196	3.84	.688	3.63	1.054	.329	-1.483	69.485[a]	.143
Revenue sharing w/ department or institutional business units	3.06	.965	3.64	.757	3.26	.934	.576	-2.589	70	.012
Lack of money to implement ICTs in higher education	4.09	1.080	4.32	.945	4.17	1.035	.235	-.916	70	.363
Composite Mean	3.50	.942[b]	3.85	.535[b]	3.62	.837[b]	.350	-2.009	69.632[a] *d* = .48	.048
Lack of needs…										
Lack of identified needs for ICTs	3.06	1.092	3.44	1.261	3.21	1.158	.376	-1.319	70	.192
Lack of shared vision for the role of ICTs in the educational organization	3.13	. 947	4.04	.978	3.46	1.040	.912	-3.849	70	.000

Table 13 (continued)

International Graduate Students' Ratings of Selected Barriers Impacting the Diffusion of ICTs to Advance Higher Education in the Agricultural Sciences and Natural Resources in Developing Countries by Method of Returning the Survey Instrument and Overall Return (Combined)

Barriers	Online (n = 47)		Hard Copy (n = 25)		Overall (Combined) (n = 72)					
	M	*SD*	*M*	*SD*	*M*	*SD*	*Mean Diff.*	*t*	*df*	Sig.*
Lack of strategic planning for ICTs in higher education	3.36	.942	4.00	1.000	3.59	1.008	.638	-2.679	70	.009
Lack of a 'champion' for ICTs in the educational organization	3.11	1.080	3.80	.957	3.35	1.084	.691	-2.678	69	.009
Composite Mean	3.17	.885[b]	3.82	.900[b]	3.40	.938[b]	.658	-2.989	70 *d* = .71	.004
Conflict w/ traditional education . . .										
Competition w/ on-campus offerings or for students	2.74	1.188	2.44	1.583	2.63	1.344	.305	.844	38.719[a]	.404
Disruption of the classroom's traditional social organization	2.83	1.110	2.60	1.323	2.76	1.189	.230	.782	70	.437
Traditional academic calendar/schedule hinders use of ICTs in higher education	2.30	.916	2.68	1.314	2.44	1.079	.376	-1.271	36.969[a]	.212

Table 13 (continued)

International Graduate Students' Ratings of Selected Barriers Impacting the Diffusion of ICTs to Advance Higher Education in the Agricultural Sciences and Natural Resources in Developing Countries by Method of Returning the Survey Instrument and Overall Return (Combined)

Barriers	Online (n = 47)		Hard Copy (n = 25)		Overall (Combined) (n = 72)					
	M	*SD*	*M*	*SD*	*M*	*SD*	*Mean Diff.*	*t*	*df*	Sig.*
Lack of person-to-person contact when using ICTs	3.19	1.076	3.20	1.190	3.21	1.107	.009	-.031	70	.976
Composite Mean	2.77	.778 [b]	2.73	1.228 [b]	2.76	.950 [b]	.037	.139	34.508 *d* = .04	.890
Fear of technology . . .										
Threat to instructors' sense of competence & authority	2.68	.911	3.52	.963	2.97	1.007	.839	-3.648	70	.001
Faculty feel job security is threatened	2.79	1.102	3.00	1.225	2.86	1.142	.213	-.750	70	.456
Concern for legal issues	2.98	1.113	2.84	1.106	2.93	1.105	.139	.505	70	.615
Isolation felt by instructors using ICTs	2.62	1.171	3.20	1.041	2.82	1.155	.583	-2.087	70	.040
Composite Mean	2.76	.844 [b]	3.14	.907 [b]	2.89	.878 [b]	.374	-1.744	70 *d* = .41	.086

Table 13 (continued)

International Graduate Students' Ratings of Selected Barriers Impacting the Diffusion of ICTs to Advance Higher Education in the Agricultural Sciences and Natural Resources in Developing Countries by Method of Returning the Survey Instrument and Overall Return (Combined)

Barriers	Online (n = 47)		Hard Copy (n = 25)		Overall (Combined) (n = 72)					
	M	*SD*	*M*	*SD*	*M*	*SD*	*Mean Diff.*	*t*	*df*	Sig.*
Lack of technical expertise . . .										
Lack of technical support for ICTs	3.22	1.246	4.08	.640	3.54	1.138	.863	-3.853	68.870[a]	.000
Lack of training programs for ICTs	3.27	1.195	4.24	.723	3.61	1.146	.973	-4.242	67.412[a]	.000
Lack of knowledge about ICTs, negative comments & lack of support from administration	3.26	1.063	3.92	.909	3.50	1.060	.659	-2.620	69	.011
Lack of right people to implement ICTs in higher education	3.43	1.205	4.12	.726	3.67	1.113	.685	-2.987	68.170[a]	.004
Composite Mean	3.30	1.012[b]	4.09	.620[b]	3.58	.968[b]	.796	-4.103	67.904 d = .99	.000
Lack of administrative support . . .										
Lack of student services support (admissions, financial aid, library services & technical training)	3.46	1.224	3.80	.816	3.59	1.102	.343	-1.411	65.953[a]	.163
Lack of advisement & counseling support	3.24	1.158	3.80	.645	3.43	1.050	.561	-2.620	68.924[a]	.011

Table 13 (continued)

International Graduate Students' Ratings of Selected Barriers Impacting the Diffusion of ICTs to Advance Higher Education in the Agricultural Sciences and Natural Resources in Developing Countries by Method of Returning the Survey Instrument and Overall Return (Combined)

Barriers	Online (n = 47)		Hard Copy (n = 25)		Overall (Combined) (n = 72)					
	M	*SD*	*M*	*SD*	*M*	*SD*	*Mean Diff.*	*t*	*df*	Sig.*
Copyright/fair use issues regarding use of ICTs in higher education	3.02	1.189	3.04	1.098	3.03	1.175	.019	.065	70	.948
Difficulty recruiting students to learn using ICTs	2.74	1.255	2.75	1.294	2.75	1.265	.011	.034	68	.973
Difficulty recruiting faculty to teach courses using ICTs	2.85	1.251	3.44	.768	3.06	1.149	.589	-2.469	68.424[a]	.016
Composite Mean	3.06	.984[b]	3.37	.570[b]	3.17	.871[b]	.311	-1.455	70 d = .34	.150
Lack of infrastructure . . .										
Lack of adequate ICTs-enhanced classrooms, labs, or infrastructure	4.00	1.103	4.56	.768	4.21	1.027	.560	-2.260	70	.027
Lack of equal access by students to ICTs, e.g., computers & Internet	3.87	1.209	4.32	.852	4.04	1.114	.448	-1.825	64.379[a]	.073
Lack of equal access by instructors to ICTs, e.g., computers & Internet	3.66	1.185	4.04	.889	3.80	1.103	.380	-1.535	61.933[a]	.130

Table 13 (continued)

International Graduate Students' Ratings of Selected Barriers Impacting the Diffusion of ICTs to Advance Higher Education in the Agricultural Sciences and Natural Resources in Developing Countries by Method of Returning the Survey Instrument and Overall Return (Combined)

Barriers	Online (n = 47)		Hard Copy (n = 25)		Overall (Combined) (n = 72)					
	M	*SD*	*M*	*SD*	*M*	*SD*	*Mean Diff.*	*t*	*df*	Sig.*
Lack of library access or materials services delivery	3.83	1.060	4.24	.926	3.97	1.028	.414	-1.640	69	.106
Composite Mean	3.85	1.062 [b]	4.29	.792 [b]	4.00	.995[b]	.454	-2.052	62.153[a] d = .52	.044
Grand Mean	3.12	.627[b]	3.54	.381[b]	3.26	.587[b]	.420	-3.530	68.663[a] d = .85	.001

Note. *Significant difference if $p < .05$. [a]Levene's test was significant at $p < .05$; so, *Equal variances not assumed.* [b]Standard deviation was calculated based on exclusion of cases analysis by analysis. Effect sizes: "small" (d = .20); "medium" (d = .50); "large" (d = .80) (Hittleman & Simon, 2000

Comparing Early and Late Respondents

Independent samples *t*-tests were calculated to compare differences between early and late respondents' attributes scores by items, constructs, and grand means. No significant differences were detected at $p < .05$ for any of the tests. So, the overall (combined) mean scores of items as well as construct means and their standard deviations, as reported in Table 12, can be used to describe the international graduate students' views on selected attributes (Rogers, 2003) associated with impacting the diffusion of ICTs to advance higher education in the agricultural sciences and natural resources in developing countries. Moreover, per Miller and Smith (1983), these findings describing the respondents' perceptions of attributes associated with ICTs may be generalized to the non-respondent portion of the study's target population.

In the case of respondents' views on barriers associated with impacting the diffusion of ICTs to advance higher education in the agricultural sciences and natural resources in developing countries, significant differences ($p < .05$) were found for four of the 38 items and one of the nine constructs (Table 14). For the construct "financial concerns," significant differences existed between the early ($M = 3.95$, $SD = .936$; $M = 3.48$, $SD = .969$) and late ($M = 3.17$, $SD = 1.053$; $M = 2.97$, $SD = .809$) respondent groups for two items, "technology fees," *mean difference* = .786, $t(70) = 3.333$, $p = .001$, and "revenue sharing w/ department or institutional business units," *mean difference* = .510, $t(70) = 2.353$, $p = .021$, and between the construct's composite means ($M = 3.85/3.30$, $SD = .813/.772$; *mean difference* = .551, $t(70) = 2.894$, $p = .005$, $d = .69$) depending on time of reply (Table 13). Significant differences also existed between the early ($M = 2.64$, $SD = 1.100$; $M = 2.57$, $SD = 1.085$) and late ($M = 3.33$, $SD = .994$; $M = 3.17$, $SD = 1.177$)

respondent groups for two of the four items that comprised the construct "fear of technology": "concern for legal issues," *mean difference* = .690, $t(70) = -2.731$, $p = .008$, and "isolation felt by instructors using ICTs," *mean difference* = .595, $t(70) = -2.215$, $p = .030$. These findings should not be generalized to the investigation's target population, which is a limitation of this study.

Furthermore, no significant differences ($p < .05$) were found between the early and late respondent groups for the remaining 34 barrier items, the other eight barrier constructs (i.e., "financial concerns" excluded), or the grand means depending on time of reply. So, these overall (combined) mean scores and standard deviations, as reported in Table 13, can be used to describe the international graduate students' views on barriers impacting the diffusion of ICTs to advance higher education in the agricultural sciences and natural resources in developing countries. In addition, according to Miller and Smith (1983), these findings describing the respondents' perceptions of barriers associated with ICTs may be generalized to the non-respondent portion of the study's target population.

Table 14

Early versus Late Respondents' Views on Barriers Impacting the Diffusion of ICTs to Advance Higher Education in the Agricultural Sciences and Natural Resources in Developing Countries: Comparisons of Items and Constructs for which Significant Differences Existed ($p < .05$)

Barriers	Early (n = 42)		Late (n = 30)		Overall (Combined) (n = 72)					
	M	*SD*	*M*	*SD*	*M*	*SD*	*Mean Diff.*	*t*	*df*	Sig.*
Financial concerns . . .										
Student tuition rate	3.62	1.081	3.17	.986	3.43	1.059	.452	1.815	70	.074
Technology fees	3.95	.936	3.17	1.053	3.63	1.054	.786	3.333	70	.001
Revenue sharing w/ department or institutional business units	3.48	.969	2.97	.809	3.26	.934	.510	2.353	70	.021
Lack of money to implement ICTs in higher education	4.36	.906	3.90	1.155	4.17	1.035	.457	1.881	70	.064
Composite Mean	3.85	.813[a]	3.30	.772[a]	3.62	.837[a]	.551	2.894	70 *d* = .69	.005
Fear of technology . . .										
Threat to instructors' sense of competence & authority	2.98	.975	2.97	1.066	2.97	1.007	.010	.039	70	.969
Faculty feel job security is threatened	2.74	1.170	3.03	1.098	2.86	1.142	.295	-1.083	70	.283
Concern for legal issues	2.64	1.100	3.33	.994	2.93	1.105	.690	-2.731	70	.008

Table 14 (continued)

Early versus Late Respondents' Views on Barriers Impacting the Diffusion of ICTs to Advance Higher Education in the Agricultural Sciences and Natural Resources in Developing Countries: Comparisons of Items and Constructs for which Significant Differences Existed ($p < .05$)

Barriers	Early (n = 42)		Late (n = 30)		Overall (Combined) (n = 72)					
	M	*SD*	*M*	*SD*	*M*	*SD*	*Mean Diff.*	*t*	*df*	*Sig.**
Isolation felt by instructors using ICTs	2.57	1.085	3.17	1.177	2.82	1.155	.595	-2.215	70	.030
Composite Mean	2.73	.839[a]	3.12	.894[a]	2.89	.878[a]	.392	-1.904	70 *d* = .45	.061

Note. *Significant difference if $p < .05$. [b]Standard deviation was calculated based on exclusion of cases analysis by analysis. Effect sizes: "small" (d = .20); "medium" (d = .50); "large" (d = .80) (Hittleman & Simon, 2002)

Relationships Between International Graduate Students' Perceptions of Attributes Associated with ICTs and Their Perceived Innovativeness Regarding the Use of ICTs

Correlation coefficients (i.e., Spearman Rank Order) were computed between all attribute constructs and the perceived innovativeness of the participants regarding their use of ICTs. Relationships between three of the attribute constructs, "relative advantage" (*rs* = .388), "compatibility" (*rs* = .418), and "complexity" (*rs* = .361) and participants' perceived innovativeness regarding their use of ICTs were moderate and positive (Table 15). The relationship between the attribute construct "trialability" (*rs* = .239) and participants' perceived innovativeness was low and positive (Table 15). These four relationships were significant at an alpha level of .05. Although the relationship between the attribute construct "observability" (*rs* = .171) and perceived innovativeness was low and positive, it was not significant at an alpha level of .05 (Table 15).

Finally, the relationship between the grand mean of the attribute constructs and participants' perceptions of their innovativeness was moderate and positive (*rs* = .421) (Table 15). The relationship was significant at an alpha level of .05. As participants' perceptions of their innovativeness regarding the use of ICTs increased so did their ratings of agreement with the five attributes most frequently associated with the diffusion of innovations (i.e., per Rogers, 2003).

Table 15

Relationships[a] between International Graduate Students' Perceptions of Attributes Associated with ICTs and Their Perceived Innovativeness Regarding the Use of ICTs (n = 72)

	Perceived Innovativeness
Attribute Constructs	
Relative advantage[b]	.388*
Compatibility[b]	.418*
Complexity[b]	.361*
Trialability[b]	.239*
Observability[b]	.171
Grand mean of attribute constructs[b]	.421*

Note. Analysis based on composite scores of the constructs. [a]Spearman rank order correlation coefficient; *$p < .05$. [b]Scale items: "1" = "strongly disagree"; "2" = "disagree"; "3" = "neutral" "4" = "agree"; "5" = "strongly agree"

Additional correlation coefficients (i.e., Spearman Rank Order) were computed between the nine barrier constructs, the grand mean of the barrier constructs, and the perceived innovativeness of the participants regarding their use of ICTs. Seven of the nine relationships (i.e., by construct) were either negligible or low and negative (Table 16). Two of the relationships were negligible and positive, i.e., "financial concerns" (*rs* = .092) and "fear of technology" (*rs* = .002) when correlated with the participants' perceived innovativeness (Table 16). However, two relationships were found to be statistically significant at an alpha level of .05. The relationships between the "credibility of ICTs" and participants' perceived innovativeness was low, negative

(*rs* = -.239) and significant. Moreover, when the mean for the barriers construct "conflict with traditional education" was correlated with participants' perceived level of innovativeness, the relationship was moderate, negative (*rs* = -.339) and significant (Table 16).

The association between the grand mean of barrier constructs and participants' perceived innovativeness was low and negative (*rs* = -.146) but not statistically significant (Table 16). Generally, with the exception of two barrier constructs, as participants' perceptions of the strength of barriers to the diffusion of ICTs to advance tertiary education in the agricultural sciences and natural resources in developing countries increased, views on their perceived innovativeness regarding use of such technologies decreased. In two cases, these inverse relationships were significant at an alpha level of .05.

Table 16

Relationships[a] between International Graduate Students' Perceptions of Barriers Associated with ICTs and Their Perceived Innovativeness Regarding the Use of ICTs (n = 72)

	Perceived Innovativeness
Barrier Constructs	
Faculty compensation and time[b]	-.002
Credibility of ICTs[b]	-.239*
Financial concerns[b]	.092
Lack of needs[b]	-.157
Conflict with traditional education[b]	-.339*
Fear of technology[b]	.002
Lack of technical expertise[b]	-.145
Lack of administrative support[b]	-.080
Lack of infrastructure[b]	-.016
Grand mean of barrier constructs[b]	-.146

Note. Analysis based on composite scores of the constructs. [a]Spearman rank order correlation coefficient; *$p < .05$. [b]Scale items: "1" = "no barrier"; "2" = "weak barrier"; "3" = "moderate barrier"; "4" = "strong barrier"; "5" = "very strong barrier"

Relationships Between Construct Means and Grand Means of Attributes and Barriers Associated with the Diffusion of ICTs

To examine the relationships between construct means and grand means of attributes and barriers associated with the diffusion of ICTs to advance tertiary education in colleges and universities in developing countries, Spearman rank order correlation coefficients were calculated. No significant relationships ($p < .05$) were revealed between

the construct mean of the attribute "relative advantage" and the construct means of the nine barriers associated with the diffusion of ICTs as operationalized in this study (Table 17). However, when the attribute construct "compatibility" was correlated with the nine barrier constructs, a low and negative relationship between "compatibility" and "conflict with traditional education" was found (*rs* = -.238) (Table 17). The association was significant at an alpha level of .05. The relationship between participants' perceptions of "complexity" regarding the adoption of ICTs and the barriers construct "conflict with traditional education" was found to be moderate and negative (*rs* = -.310) (Table 17). The association was significant at an alpha level of .05.

Moderate and negative relationships were found between the participants' perceptions on the construct of "trialability" regarding the diffusion of ICTs and the barrier constructs "credibility of ICTs" (*rs* = -.389) and "lack of technical experience" (*rs* = -.377). A low and negative relationship existed between the participants' views on "trialability" and the barriers construct "lack of administrative support" (*rs* = -.286) (Table 17). In the case of all three, the associations were statistically significant at an alpha level of .05.

Low and negative relationships were revealed between the attribute construct "observability" and the barrier constructs "faculty compensation and time" (*rs* = -.276) and "lack of needs" (*rs* = -.275) (Table 17). Moreover, moderate and negative relationships existed between "observability" and the barrier constructs "credibility of ICTs" (*rs* = -.366), "fear of technology" (*rs* = -.300), and "lack of technical expertise" (*rs* = -.441) (Table 17). In the case of all five, the associations were statistically significant at an alpha level of .05.

The grand mean of attribute constructs was found to correlate significantly ($p < .05$) with three barrier constructs: relationship with the "credibility of ICTs" was moderate, negative ($rs = -.320$) and significant; relationship with the "fear of technology" ($rs = -.247$) was low, negative and significant; and relationship with the "lack of technical expertise" ($rs = -.344$) was moderate, negative and significant at an alpha level of .05 (Table 17).

The grand mean of barrier constructs was found to correlate significantly ($p < .05$) with two attribute constructs: relationship with "trialability" ($rs = -.345$) was moderate, negative and significant; relationship with "observability" ($rs = -.298$) was low, negative and significant (Table 17). A low and negative relationship ($rs = -.252$) between the grand means of the attribute and barrier constructs also existed (Table 17). The association was statistically significant at an alpha level of .05.

Generally, excluding a few positive relationships that were not statistically significant (Table 17), as participants' perceptions of agreement with the five attributes most frequently associated with the diffusion of innovations (i.e., per Rogers, 2003) increased, their ratings for the strength of barriers regarding the use of ICTs decreased.

Table 17

Relationships[a] between Construct Means and Grand Means of Attributes and Barriers Associated with the Diffusion of ICTs to Advance Tertiary Education in the Agricultural Sciences and Natural Resources in Developing Countries as Perceived by International Graduate Students (n = 72)

	Attribute Constructs					
Barrier Constructs	Relative Advantage	Compatibility	Complexity	Trialability	Observability	Grand Mean
Faculty compensation and time	-.101	.192	.022	-.183	-.276*	-.155
Credibility of ICTs	-.090	-.137	.047	-.389*	-.366*	-.320*
Financial concerns	.136	.177	.199	-.103	-.048	.063
Lack of needs	.013	.118	.149	-.200	-.275*	-.125
Conflict with traditional education	-.197	-.238*	-.310*	-.086	.173	.159
Fear of technology	-.014	-.148	-.231	-.134	-.300*	-.247*
Lack of technical expertise	.006	-.059	-.052	-.377*	-.441*	-.344*
Lack of administrative support	.065	-.130	-.175	-.286*	-.059	-.231

Table 17 (continued)

Relationships[a] between Construct Means and Grand Means of Attributes and Barriers Associated with the Diffusion of ICTs to Advance Tertiary Education in the Agricultural Sciences and Natural Resources in Developing Countries as Perceived by International Graduate Students (n = 72)

	Attribute Constructs					
Lack of infrastructure	.247	.149	.080	-.104	-.173	.012
Grand Mean	-.008	-.004	-.027	-.345*	.298*	-.252*

Note. [a]Spearman rank order correlation coefficient; *$p < .05$

Relationships Between International Graduate Students' Views on Recommending the Use of ICTs to Others in the Context of Tertiary Education and the Grand Means of Attributes and Barriers Associated with ICTs

A moderate and positive relationship (*rs* = .458) existed between the grand mean of attributes associated with impacting the diffusion of ICTs in the context of tertiary education and the participants' willingness to "recommend the use of ICTs to others" (Table 18). The relationship was statistically significant at an alpha level of .05. A negligible relationship (*rs* = .079) existed between the grand mean of barriers associated with impacting the diffusion of ICTs and the participants' willingness to "recommend the use of ICTs to others" (Table 18).

Table 18

Relationships[a] between International Graduate Students' Views on Recommending the Use of ICTs to Others in the Context of Tertiary Education in the Agricultural Sciences and Natural Resources and Grand Means of Attributes and Barriers Associated with ICTs (n = 72)

	Recommend Use of ICTs to Others[b]
Attributes	.458*
Barriers	.079

Note. Analysis based on grand means of attributes and barriers. [a]Spearman rank order correlation coefficient. [b]Scale: "1" = "Definitely not"; "2" = "Probably not"; "3" = "Not sure/Uncertain"; "4" = "Probably yes"; "5" = "Definitely yes." *$p < .05$

Relationships Between Selected Personal and Professional Characteristics of the International Graduate Students and Grand Means of Attributes and Barriers Associated with Impacting the Diffusion of ICTs

To describe relationships between selected personal and professional characteristics of the participants and their perceptions on the attributes and barriers impacting the diffusion of ICTs in agricultural colleges and universities in developing

countries, point biserial correlation coefficients were calculated. According to Field (2005), if one of the variables to be correlated is dichotomous and discrete, point biserial (r_{pb}) is the appropriate correlational analysis to use. None of the relationships between gender, degree pursuing, major field of study, anticipated professional position, anticipated work region, region in which current highest degree was earned and grand means of participants' views on attributes and barriers impacting the diffusion of ICTs in agricultural colleges and universities in developing countries were statistically significant ($p > .05$) (Table 19).

Table 19

Relationships[a] between Selected Personal and Professional Characteristics of the International Graduate Students and Grand Means of Attributes and Barriers Associated with the Diffusion of ICTs to Advance Tertiary Education in the Agricultural Sciences and Natural Resources in Developing Countries (n = 72)

	Grand Mean Attributes	Grand Mean Barriers	Sig.
Personal and Professional Characteristics			
Gender[b]	-.095	.086	*ns*
Degree pursuing[c]	-.120	-.153	*ns*
Major field of study[d]	.048	.048	*ns*
Anticipated professional position[e]	.061	.123	*ns*
Anticipated work region[f]	-.200	.059	*ns*
Region in which current highest degree was earned[f]	-.150	-.173	*ns*

Note. [a]Point biserial correlation coefficient; one tailed.
Coding of variables: [b]male = 1, female = 2; [c]master = 1, doctoral = 2; [d]social sciences = 1, technical sciences = 2; [e]not tertiary education = 1, tertiary education = 2; [f]developing world = 1, developed world = 2

Relationships Between International Graduate Students' Intent to Pursue a Terminal Degree and Grand Means of Attributes and Barriers Associated with the Diffusion of ICTs

Spearman rank order correlation coefficient was used to describe the relationships between the participants' views on pursuing a terminal degree and grand means of the attributes and barriers impacting the diffusion of ICTs to advance tertiary education in colleges and universities in developing countries. The relationships, although positive, were not significant at an alpha level of .05 (Table 20).

Table 20

Relationships[a] between International Graduate Students' Intent to Pursue a Terminal Degree and Grand Means of Attributes and Barriers Associated with the Diffusion of ICTs to Advance Tertiary Education in the Agricultural Sciences and Natural Resources in Developing Countries (n = 44[b])

	Grand Mean Attributes	Sig.	Grand Mean Barriers	Sig.
Pursue terminal degree	.076	.624	.226	.140

Note. [a]Spearman rank order correlation coefficient. [b]Only the respondents who were pursuing master's degrees answered the question.

Associations Between Selected Personal and Professional Characteristics of the International Graduate Students

To examine associations between selected personal and professional characteristics of the international graduate students, Cramer's *V* was calculated. Cramer's *V* was used because one of the variables had four categories of response and the other variables were binominal (Field, 2005).

No significant association was found between a participants' gender and his or her choosing to "pursue a terminal degree" (Cramer's $V = .187$, sig. = .672) (Table 21).

About the same proportion of each gender indicated either "probably yes" or "definitely yes" regarding the intent to pursue a terminal degree.

Table 21

Association of International Graduate Students' Gender and Their Intent to Pursue a Terminal Degree

Gender	Pursue Terminal Degree[a]				Total	Cramer's *V** sig.
	Probably Not	Not Sure/ Uncertain	Probably Yes	Definitely Yes		
Male	1	7	11	10	29	
Female	1	3	8	3	15	
Total	2	10	19	13	44	.187 .672

Note. *Cramer's *V* ranges in value from -1 to +1
Values near 0 indicate a very weak relationship, and values near 1 indicate a very strong relationship. Cramer's *V* = .10 (small effect size); Cramer's *V* = *.30* (medium effect size*);* Cramer's *V* = .50 (large effect size) (Green, Salkind, & Akey, 1997). [a]Only the international graduate students who were master's level answered this question.

Association of International Graduate Students' Region of Education and Their Intent to Pursue a Terminal Degree

The association between participants' "region of education" (i.e., before enrolling at OSU) and "their intent to pursue a terminal degree" was not significant (Cramer's *V* = .307, sig.= .245) (Table 22). The participants' commitment to pursuing a terminal degree was not associated with whether they were educated in the "developing world" or the "developed world." However, nearly eight-in-ten of the graduate students had received their education in the developing world.

Table 22

Association of International Graduate Students' Region of Education and Their Intent to Pursue a Terminal Degree

Region of Education	Pursue Terminal Degree[a]				Total	Cramer's *V** sig.
	Probably Not	Not Sure/ Uncertain	Probably Yes	Definitely Yes		
Developing World	1	6	17	10	34	
Developed World	1	4	2	3	10	
Total	2	10	19	13	44	.307 .245

Note. *Cramer's *V* ranges in value from -1 to +1
Values near 0 indicate a very weak relationship, and values near 1 indicate a very strong relationship. Cramer's *V* = .10 (small effect size); Cramer's *V* = *.30* (medium effect size*);* Cramer's *V* = .50 (large effect size) (Green, Salkind, & Akey, 1997). [a]Only the international graduate students who were master's level answered this question.

Association of International Graduate Students' Work Region and Their Intent to Pursue a Terminal Degree

The association between participants' "work region" and "their intent to pursue a terminal degree" was not significant (Cramer's *V* = .129, sig. = .877) (Table 23). An international graduate student's work region, i.e., "developing world" versus "developed world," was not associated with their intent to pursue a terminal degree.

Table 23

Association of International Graduate Students' Work Region and Their Intent to Pursue a Terminal Degree

Work Region	Pursue Terminal Degree[a]				Total	Cramer's *V** sig.
	Probably Not	Not Sure/ Uncertain	Probably Yes	Definitely Yes		
Developing World	1	6	14	7	28	
Developed World	1	3	5	4	13	
Total	2	10	19	11	41	.129 .877

Note. *Cramer's *V* ranges in value from -1 to +1
Values near 0 indicate a very weak relationship, and values near 1 indicate a very strong relationship. Cramer's *V* = .10 (small effect size); Cramer's *V* = *.30* (medium effect size*);* Cramer's *V* = .50 (large effect size) (Green, Salkind, & Akey, 1997). [a]Only the international graduate students who were master's level answered this question.

Association of International Graduate Students' Academic Major and Their Intent to Pursue a Terminal Degree

No significant association existed between the participants' "academic major" when dichotomized as "social sciences" and "technical sciences" and "their intent to pursue a terminal degree" (Cramer's *V* = .166, sig. = .750) (Table 24). For the purpose of this analysis, students who indicated they were studying in the departments of agricultural economics and agricultural education, communications and leadership as well as the interdisciplinary program, international agriculture, were combined as "social sciences." The other international graduate students were combined to form the "technical sciences" category.

Table 24

Association of International Graduate Students' Academic Major and Their Intent to Pursue a Terminal Degree

Academic Major	Pursue Terminal Degree[a]				Total	Cramer's *V** sig.
	Probably Not	Not Sure/ Uncertain	Probably Yes	Definitely Yes		
Social Sciences	1	6	8	5	20	
Technical Sciences	1	4	11	8	24	
Total	2	10	19	13	44	.166 .750

Note. *Cramer's *V* ranges in value from -1 to +1
Values near 0 indicate a very weak relationship, and values near 1 indicate a very strong relationship. Cramer's *V* = .10 (small effect size); Cramer's *V* = *.30* (medium effect size*);* Cramer's *V* = .50 (large effect size) (Green, Salkind, & Akey, 1997). [a]Only the international graduate students who were master's level answered this question.

Association of International Graduate Students' Anticipated Professional Position and Their Intent to Pursue a Terminal Degree

The association between international graduate students' "anticipated professional position" and "their intent to pursue a terminal degree" was not significant (Cramer's *V* = .354, sig. = .161) (Table 25). The graduate students' anticipated professional position, i.e., becoming a faculty member at a tertiary institution or working outside of academia, was not associated with the "intent to pursue a terminal degree." However, proportionately, more of the "not tertiary faculty" participants indicated they were "not sure/uncertain" about their intention.

Table 25

Association of International Graduate Students' Anticipated Professional Position and Their Intent to Pursue a Terminal Degree

Anticipated Professional Position	Pursue Terminal Degree[a]				Total	Cramer's *V** sig.
	Probably Not	Not Sure/ Uncertain	Probably Yes	Definitely Yes		
Not Tertiary Faculty	2	7	8	5	22	
Tertiary Faculty	0	2	11	6	19	
Total	2	9	19	11	41	.354 .161

Note. *Cramer's *V* ranges in value from -1 to +1
Values near 0 indicate a very weak relationship, and values near 1 indicate a very strong relationship. Cramer's *V* = .10 (small effect size); Cramer's *V* = *.30* (medium effect size*);* Cramer's *V* = .50 (large effect size) (Green, Salkind, & Akey, 1997). [a]Only the international graduate students who were master's level answered this question.

Summary

The design of this study was descriptive-correlational (Best, 1970; Ary, Jacobs, & Razavieh 2002). One aspect of this study was to determine the perceptions of international graduate students from developing countries on the diffusion of ICTs to advance agricultural education at colleges and universities in the developing world. The second aspect was to describe the personal and professional characteristics of international graduate students from developing countries who were studying agricultural sciences and natural resources at Oklahoma State University during the fall semester of 2010. Five research questions guided the study. Data analysis included the calculation of descriptive statistics, including selected bivariate correlational analyses.

The study's participants ranged in age from 21 to 47 years with a mean age of 30.28. The genders of the participants were 62.5% male and 37.5% female. Almost one-half (44.5%) of the master's students intended to pursue a terminal degree. Most of the graduate students came from China, Nepal, India and Mexico.

A majority of the respondents received financial support from their academic departments. The highest degree earned by the majority of the respondents (56.9%) before coming to OSU was a bachelor's degree, with most of those degrees earned in Asia. Nearly two-thirds of the respondents held a profession position before coming to OSU; their experience ranged from 1 to 20 years with the mean years of experience being 3.43.

A majority of the participants (80.6%) were studying in the departments of Agricultural Economics, Biosystems and Agricultural Engineering, Plant and Soil Sciences and Entomology and Plant Pathology. Slightly more than one-half of the respondents (51.4%) were pursuing a master of science degree and most of the remainder a doctoral degree. In addition, most of the graduate students had completed two, three or four semesters in their respective programs and had one year or less remaining to graduation.

One-half of the respondents (50.7%) had not taken courses using ICTs as the primary mode of delivery. However, more than one-half (54.2%) of the participants would recommend others take courses using ICTs. Nearly one-half of the respondents (48.6%) anticipated working in tertiary institutions as a faculty member or an administrator, and 65% anticipated working in their countries' of citizenship. Most (80.6%) anticipated working in Asia, the USA or Sub-Saharan Africa.

Regarding the graduate students' perceived levels of innovativeness for the use of ICTs, the overall (combined) mean score for all respondents was 2.53 (*SD* = 1.198) (Table 11). When mean scores were compared for the participants depending on their method of survey instrument return, no statistically significant differences were found (Table 11). So, as a group, the graduate students were between "unpersuaded" and persuaded" (Rogers, 2003) regarding their adoption of ICTs for use in tertiary education.

Five selected attributes, as per Rogers (2003) ("relative advantage," "compatibility," "complexity," "trialability," and "observability"), impacting the diffusion of ICTs were rated by the respondents. They "agreed" (*M* = 3.99, *SD* = .618) that ICTs had "relative advantage" in advancing agricultural education in tertiary institutions in the developing world. The participants' responses regarding the attribute constructs "compatibility" (*M* = 3.72, *SD* = .752; Table 12) and "complexity" (*M* = 3.85, *SD* = .668; Table 12) were also in the "agree" range. The other attribute constructs, "trialability," and "observability," were rated as "neutral" by the respondents (Table 12). Statistically significant ($p < .05$) and practically significant differences existed for two of the five attribute constructs (i.e., "trialability," and "observability") and the overall means by method of survey instrument return (Table 12).

The nine barrier constructs, (i.e., "faculty compensation and time," "credibility of ICTs," "financial concerns," "lack of needs," "conflict with traditional education," "fear of technology," "lack of technical expertise," "lack of administrative support," and "lack of infrastructure") impacting the diffusion of ICTs were also rated by the international graduate students. Overall, the participants indicated that six barrier constructs, "Faculty compensation and time," "credibility of ICTs," "lack of needs," "conflict with traditional

education," "fear of technology," and "lack of administrative support" were "moderate barriers" to the diffusion of ICTs to advance agricultural education in tertiary institutions in the developing world (Table 13). Three barrier constructs (i.e., "financial concerns," "lack of technical expertise," and "lack of infrastructure") were perceived to be "strong barriers" by the respondents. Statistically significant ($p < .05$) and practically significant differences existed for five of the nine barrier constructs (i.e., "credibility of ICTs," "financial concerns," "lack of needs," "lack of technical expertise," and "lack of infrastructure") and the overall means by method of survey instrument return (Table 13).

Independent samples *t*-tests (Table 14) revealed no significant differences ($p < .05$) between early and late respondents regarding the five attributes. Therefore, the attributes' findings may be generalized to the non-respondents (Miller & Smith, 1983). However, in the case of barriers, significant differences ($p < .05$) were found for four items and one construct. So, these findings should not be generalized to the portion of the study's target population who did not respond.

Selected relationships (i.e., correlations and associations) between participants' characteristics and their perceptions on attributes associated with ICTs and their perceived innovativeness were computed. The relationship between the grand mean of the attribute constructs and the participants' perceptions of their innovativeness was moderate and positive ($rs = .421$) as well as significant at an alpha level of .05 (Table 15). As participants' perceptions of their innovativeness regarding the use of ICTs increased, so did their ratings of agreement with the five attributes most frequently associated with the diffusion of innovations (i.e., per Rogers, 2003).

Additional correlations were computed between the nine barrier constructs and the perceived innovativeness of the participants regarding the diffusion of ICTs. The associations between the grand mean of barrier constructs and participants' innovativeness was low and negative (*rs* = -.146) but not statistically significant (Table 16). Generally, with the exceptions of two barrier constructs (i.e., "financial concerns" and "fear of technology"), as participants' perceptions of the strength of barriers to the diffusion of ICTs to advance tertiary education in the agricultural sciences and natural resources in developing countries increased, views on their perceived innovativeness regarding use of such technologies decreased (Table 16). With few exceptions, the relationships between participants' views on attributes associated with ICTs and their perceptions of barriers were similarly inverse (Table 17).

In addition, as participants' views on attributes (i.e., their "agreement") associated with the use of ICTs increased, they were more likely to recommend using ICTs to others in the context of tertiary education (Table 18). Finally, for the relationships and associations tested between participants' "intent to pursue a terminal degree" and the grand means of attributes and barriers as well as selected personal and professional characteristics, no statistically significant findings ($p < .05$) emerged (Tables 20, 21, 22, 23, 24, & 25).

CHAPTER V

SUMMARY, CONCLUSIONS, RECOMMENDATIONS, IMPLICATIONS AND DISCUSSION

This chapter has four major sections: summary, conclusions, recommendations, implications and discussion. Each section consists of several sub-sections: The first section, summary, presents eight sub-sections: purpose of the study, research questions, significance of the study, population and sample, research design, survey instrument, data collection, data analysis, and findings. The second section, conclusions, includes an analysis of the findings regarding the study's five research questions. The third section, recommendations, presents the recommendations for future research and future practice. The fourth section, implications and discussion, speculates on aspects of the researcher's findings and conclusions.

Summary

Purpose of the Study

The purpose of this study was to determine the perceptions of international graduate students from developing countries in the College of Agricultural Sciences and Natural Resources (CASNR) at Oklahoma State University on the diffusion of information communications technologies (ICTs) to advance agricultural education at colleges and universities in developing countries. A secondary purpose was to describe the personal and professional characteristics of international graduate students from

developing countries who were studying agricultural sciences and natural resources at Oklahoma State University. The period of data collection was the fall semester of 2010.

Research Questions

From the purpose of the study, the following research questions were developed:

1. What were selected personal and professional characteristics of graduate students from developing countries who were studying in CASNR at Oklahoma State University?
2. What were the study participants' perceived levels of "innovativeness" regarding their use of ICTs for academic learning?
3. What were the study participants' views on selected **attributes** impacting the diffusion of ICTs to advance agricultural education at colleges and universities in developing countries?
4. What were the study participants' views on selected **barriers** impacting the diffusion of ICTs to advance agricultural education at colleges and universities in developing countries?
5. What **relationships** existed between selected personal and professional characteristics of the study participants and their perceptions on variables impacting the diffusion of ICTs to advance agricultural education at colleges and universities in developing countries?

Significance of the Study

The world's population is approximately 6.7 billion and 80% of that population resides in developing countries (Coast, 2002; Redding, 2007). More than one-half of the world's populations are youth and a majority is found in developing countries, where

agriculture is the main source of most individuals' livelihoods (Cleveland, 2008; Malhan & Rao, 2007; Redding, 2007).

Growing youth populations pose many challenges to the provision of tertiary education in developing countries, especially in the sector of agriculture (Haji, 2007). Only about one-third of qualified students are accepted into tertiary institutions leaving out the majority (Anami, 2011; Sawyerr, 2004). Overcrowded classrooms coupled with the exodus of young faculty to the developed world and little financial support from governments in developing countries have exacerbated the situation by having inferior instruction and learning environments in many colleges and universities (Chacha, 2004; Musisi, & Muwanga, 2003; UNESCO, 1998; World Bank, 2008).

These problems call for change in teaching delivery strategies and practices (Chacha, 2004; Sawyerr, 2004), including education in the agricultural sciences and natural resources (ASNR). Integration of ICTs for training and education in the agricultural sector is vital (Dione, Weber, Staatz & Kelly, 2004). The results of this study will help higher education institutions in developing countries reform their curricular and design infrastructure based on the views of future faculty who may aspire to use ICTs when designing and planning their teaching, research and extension efforts. Furthermore, youth, who qualify to pursue tertiary education but suffer from lack of classrooms and teachers, may be served more effectively (Eicher, 2006).

Population and Sample

International graduate students (N = 120) from developing countries were identified by their respective departments (9) and programs (2) in CASNR during the fall semester of 2010. This constituted a "judgment" or purposeful selection of study

participants (Babbie, 2007; Creswell, 2005). A portion of the study's "accessible population" (Ary et al., 2002) was contacted using electronic mail addresses provided by some of the departments and programs. The remainder of the population was contacted on behalf of the researcher by officials from their respective departments regarding participation in the study.

Research Design

This was a descriptive-correlational study (Best, 1970; Ary et al., 2002). The study was descriptive-correlational because it sought to describe the perceptions of aspiring faculty on diffusion of ICTs in tertiary institutions in developing countries, especially their views on attributes and barriers as well as associations between selected personal and professional characteristics and those views (Ary et al., 2002).

Selection and Development of the Study's Survey Instrument

After reviewing the scholarly literature and consulting with the researcher's dissertation chair, a survey instrument was identified, modified and used to collect the data for this study. The survey instrument, modified from Li and Lindner's (2007) study, had four parts with a total of 84 items, including 64 statements and 20 questions (Appendices D & E). The first part asked participants their "level of innovativeness" regarding the use of ICTs, the second part had statements intended to describe a respondent's views on attributes associated with the use of ICTs to advance agricultural education, and the third part had statements intended to describe potential barriers associated with the use of ICTs. Parts II and III of the instrument employed five-point, summated rating scales to gather participants' responses, i.e., level of agreement and

views on the strength of barriers. The fourth part of the survey instrument had questions to describe selected personal and professional characteristics of the study's participants.

Face and content validity of the survey instrument was reviewed by a panel of experts from the Department of Agricultural Education, Communications and Leadership at Oklahoma State University. Reliability estimates of the instrument, per Cronbach's alpha, ranged from .717 to .915 for the five attribute constructs and from .808 to .949 for the nine barrier constructs. To improve clarity of the survey instrument, a field test was conducted using the hard copy version of the instrument (Appendix E). International graduate students from developing countries in the College of Human and Environmental Sciences at Oklahoma State University served as field test participants.

Data Collection

Data were collected using a survey instrument that was administered both electronically (online) and through a hard copy version to the participants. Seventy participants were sent the instrument via electronic mail. A hard copy (paper) version of the instrument was delivered to 50 participants in three CASNR departments whose leadership requested this method of contact with their students. Of the 120 graduate students who were potential respondents, 47 responded electronically and 25 completed and returned the hard copy instrument (Figure 1). The total number of respondents was 72, for a 60% response rate overall (Figure 2).

Data Analysis

Data were analyzed descriptively using SPSS, version PASW statistics 18: frequencies, percentages, means, *mean differences* and standard deviations were

calculated. Selected relationships were measured using Cramer's *V*, Spearman's rho and point biserial correlation coefficients.

Findings

An analysis of the findings regarding the study's five research questions formed a basis of the summary offered by the researcher:

Findings for Research Question # 1

What were selected personal and professional characteristics of graduate students from developing countries who were studying in CASNR at Oklahoma State University?

A majority of the respondents were male and their average age was 30.28 (Table 2) years. A majority of the respondents were not on study leave. Most of the graduate students who were enrolled in a master's degree program and indicated they intended to pursue a terminal degree (Table 2). Most were from the countries of China, Nepal, India and Mexico (Table 3). More than one-half of the respondents indicated that their academic departments at OSU were sources of funding support for their graduate education (Table 4). A majority of the students held a professional position prior to graduate studies at OSU with their years of experience averaging 3.43, and they had attained a bachelor's degree as the highest level of education. More of the respondents had earned those degrees in Asia than elsewhere in the world (Table 5).

A majority of the respondents were pursuing master's of science degrees, and more were enrolled in the Department of Agricultural Economics (Table 6) than in other academic units. Most of the respondents had completed two, three or four semesters at OSU and anticipated the amount of time remaining to their graduation to be one year or

less (Table 6). One-half of the respondents had never taken a course whose primary means of delivery was through ICTs. However, more than one-third indicated they would recommend others to take courses using ICTs as a primary mode of delivery (Table 7). Regarding their anticipated professional positions after graduation, nearly one-half indicated they intended to work in tertiary education. Almost two-thirds of the respondents anticipated working in their countries of citizenship after completing formal schooling, and their preferred region of work was in Asia followed closely by the United States of America and Sub-Saharan Africa (Table 8).

Findings for Research Question # 2

What were the study participants' perceived levels of "innovativeness" regarding their use of ICTs for academic learning?

The study's respondents indicated varying degrees of innovativeness regarding their use of ICTs for academic learning. More of the respondents indicated that ICTs *may be* a good way to overcome limited access to higher education in developing countries than any other response category, followed by the respondents who indicated that ICTs *are* a good way to overcome this problem (Table 9). Those who had previous experience teaching using ICTs were willing to continue with the practice to overcome the problem of students accessing educational opportunities in developing countries (Table 9). The participants who completed the online version of the survey instrument were more innovative (i.e., self-perceived) than those who completed the hard copy version (Table 9, 10, & Figure 3). However, when the instrument return groups' mean scores for innovativeness were compared (Table 11), no significant difference (i.e., $p < .05$) was found. Finally, the combined mean for the group overall (2.53) indicated that, as a group,

the graduate students were midway between "unpersuaded" and "persuaded" (Rogers, 2003) regarding the use of ICTs to advance agricultural education in tertiary institutions in developing countries.

Findings for Research Question # 3

What were the study participants' views on selected **attributes** impacting the diffusion of ICTs to advance agricultural education at colleges and universities in developing countries?

The five attributes examined included "relative advantage," "compatibility," "complexity," "trialability," and "observability" (Rogers, 2003). The respondents "agreed" overall that the attributes "relative advantage," "compatibility," and "complexity" had a positive impact on diffusing ICTs in colleges and universities to advance agricultural education in developing countries (Table 12). The respondents' views were "neutral" on the attributes "trialability" and "observability." However, overall, the respondents "agreed" that the five attributes had a positive impact on diffusing ICTs in tertiary institutions to advance agricultural education in developing countries (Table 12). A deeper review of the data revealed some statistically significant differences ($p < .05$) for some attribute items and constructs by method of instrument return, however (Table 12).

Findings for Research Question # 4

What were the study participants' views on selected **barriers** impacting the diffusion of ICTs to advance agricultural education at colleges and universities in developing countries?

Nine barrier constructs were examined that included “faculty compensation and time” (5 items), “credibility of ICTs” (4 items), “financial concerns” (4 items), “lack of needs” (4 items), “conflict with traditional education” (4 items), “fear of technology” (4 items), “lack of technical expertise” (4 items), “lack of administrative support” (5 items), and “lack of infrastructure” (4 items).

Overall, the respondents’ viewed the barrier constructs “faculty compensation & time,” “credibility of ICTs,” “lack of needs,” “conflict w/ traditional education,” “fear of technology,” and “lack of administrative support” as “moderate barriers” to diffusing ICTs in tertiary institutions to advance agricultural education in developing countries (Table 13). The respondents perceived the barrier constructs “financial concerns,” “lack of technical expertise,” and “lack of infrastructure” as “strong barriers” to diffusing ICTs in tertiary institutions to advance agricultural education in developing countries (Table 13). The respondents perceived the barrier constructs to be “moderate barriers” overall to diffusing ICTs. A deeper review of the data revealed some statistically significant differences ($p < .05$) for some barrier items and constructs by method of instrument return, however (Table 13).

Independent samples *t*-tests were calculated to compare differences between early and late respondents’ attributes scores by items, constructs, and grand means; no significant differences were detected ($p < .05$). So, these findings may be generalized to the study’s target population (Miller & Smith, 1983). In the case of respondents’ views on barriers, significant differences ($p < .05$) were found for four of the 38 items (Table 14). These findings should not be generalized to the investigation’s target population, which is a limitation of this study. No significant differences ($p < .05$) were found

between the early and late respondent groups for the remaining 34 barrier items, the other eight barrier constructs or the grand means. So, these findings may be generalized to the non-respondents (Miller & Smith, 1983) (Table 13).

Research Question # 5

What relationships existed between selected personal and professional characteristics of the study participants and their perceptions on variables impacting the diffusion of ICTs to advance agricultural education at colleges and universities in developing countries?

The relationship between the grand mean of the attribute constructs and participants' perceptions of their innovativeness regarding the use of ICTs was moderate and positive (*rs* = .421) (Table 15). This relationship was significant at an alpha level of .05. As participants' perceptions of their innovativeness regarding the use of ICTs increased, so did their ratings of agreement with the five attributes most frequently associated with the diffusion of innovations (i.e., per Rogers, 2003). The association between the grand mean of barrier constructs and participants' perceived innovativeness was low and negative (*rs* = -.146) but not statistically significant (Table 16). Excluding two barrier constructs, as participants' perceptions of the strength of barriers increased, views on their perceived innovativeness decreased. In two cases, these inverse relationships were significant at an alpha level of .05 (Table 16).

The grand mean of attribute constructs was found to correlate significantly ($p < .05$) with three barrier constructs: "credibility of ICTs" (moderate and negative); "fear of technology" (low and negative); and "lack of technical expertise" (moderate and negative) (Table 17). The grand mean of barrier constructs was found to correlate

significantly ($p < .05$) with two attribute constructs: "trialability" (moderate and negative) and "observability" (low and negative) (Table 17). A low and negative relationship between the grand means of the attribute and barrier constructs also existed (Table 17) and was statistically significant. Excluding a few positive relationships that were not statistically significant (Table 17), as participants' perceptions of agreement with the five attributes most frequently associated with the diffusion of innovations (i.e., per Rogers, 2003) increased, their ratings for the strength of barriers regarding the use of ICTs decreased.

A moderate, positive and statistically significant ($p < .05$) relationship existed between the grand mean of attributes associated with ICTs and the participants' willingness to "recommend the use of ICTs to others" (Table 18). In addition, a negligible relationship existed between the grand mean of barriers associated with ICTs and the participants' willingness to "recommend the use of ICTs to others" (Table 18). None of the relationships between participants' gender, degree pursuing, major field of study, anticipated professional position, anticipated work region, region in which current highest degree was earned, and grand means of their views on attributes and barriers were statistically significant (i.e., $p > .05$) (Table 19).

The relationships between international graduate students' intent to pursue a terminal degree and grand means of attributes and barriers associated with the diffusion of ICTs, although positive, were not significant (Table 20). Further, no significant associations were found between a participants' gender and his or her choosing to "pursue a terminal degree" (Table 21). Finally, no significant associations ($p < .05$) were found between participants' "region of education," "work region," "academic major," or"

anticipated professional position" and "their intent to pursue a terminal degree" (Tables 22, 23, 24, & 25).

Conclusions

An analysis of the findings regarding each of the study's research questions formed a basis for the conclusions offered by the researcher:

Research Question #1

What were selected personal and professional characteristics of graduate students from developing countries who were studying in CASNR at Oklahoma State University?

Based on the findings of this study, it was concluded that a majority of the international graduate students were male. The graduate students tended to be young adults averaging 30 years of age with a mean of 3.43 years of professional work experience (Table 2). A majority of the students had attained a bachelor's degree only as their highest level of education. Nearly four-in-ten had earned their degrees from institutions in Asia (Table 5). Most of the students were pursuing a master degree; however, slightly more than four-in-ten were doctoral students.

More than one-half of the graduate students were supported financially by their various departments. Nearly four-in-ten of the respondents indicated that agricultural economics was their major field of study, followed by biosystems and agricultural engineering, and plant and soil sciences. About six-in-ten of the graduate students had completed two to four semesters at OSU (Table 6) and most anticipated they had one year or less remaining to graduation.

One-half of the graduate students had not experienced a course in which the primary mode of delivery was through ICTs, and a similar number were "uncertain" or indefinite (i.e., indicated "probably yes") about whether they would recommend that kind of course to others (Table 7). Fewer than one-in-four of the students were on study leave (Table 2) and more of them came from China and Nepal than from other countries.

Nearly one-half of the respondents anticipated professional careers in tertiary education institutions after graduation, with almost two-thirds preferring to work in their country of citizenship. The regions in which most of the respondents anticipated working after graduation were Asia, the United States of America and Sub-Saharan Africa, respectively. So, many of the respondents were young adults from Asia mostly who had a few years of professional experience. In addition, about one-half of them anticipated working in tertiary institutions after graduation, and a majority intended to work in their home countries.

Research Question #2

What were the study participants' perceived levels of "innovativeness" regarding their use of ICTs for academic learning?

Per Rogers' (2003) "stages of the innovation-decision process" (p. 138), as a group, the participants perceived their levels of innovation regarding the use of ICTs in academic learning to be about halfway between "unpersuaded" and "persuaded." The participants' overall (combined) mean score was 2.53 (Table 11). Closer examination of the findings revealed a significant association (Cramer's $V = .381$, sig. .034; Table 10) between graduates' method of returning the study's survey instrument and their perceived levels of innovativeness regarding ICTs. Notably, all of the participants who indicated

they were the most "innovative" (i.e., 8) were found in the online return group (Table 10).

Using crosstabulation (Table 9), it was "expected" that only five participants from the online group would have indicated that response as well as three of the hard copy respondents. However, in the case of the latter return group, none indicated that level of innovativeness (Tables 9 & 10). Although the *mean difference* (Table 11) between the two groups by method of return was not statistically significant ($p > .05$), it was only respondents in the online return group who had used ICTs to teach and, moreover, indicated they would "continue that practice" in the future. However, as a group, the respondents were not particularly "innovative" in their perspectives regarding use of ICTs to advance agricultural education in tertiary institutions in developing countries, i.e., per Rogers' (2003) "stages of the innovation-decision process," many of the study's participants were in the "persuasion" or attitude formation stage of the process.

Research Question #3

What were the study participants' views on selected **attributes** impacting the diffusion of ICTs to advance agricultural education at colleges and universities in developing countries?

The graduate students' views on the five attributes of innovations, i.e., "relative advantage," "compatibility," "complexity," "trialability" and "observability" (Rogers, 2003), associated with impacting the diffusion of ICTs to advance agricultural education at colleges and universities in developing countries, were collected and analyzed descriptively. Conclusions regarding the participants' views were based on this analysis. The "real limits" of the scale used for interpretation of the findings were 1.00 to 1.49 =

"Strongly disagree"; 1.50 to 2.49 = "Disagree"; 2.50 to 3.49 = "Neutral"; 3.50 to 4.49 = "Agree"; and 4.50 to 5.00 = "Strongly agree." In addition, the results of independent samples *t*-tests (i.e., *mean differences*) were considered significant at an alpha level of $p < .05$. The practical significance of the mean differences were interpreted as "small," "medium," and "large" (Hittleman & Simon, 2002). The conclusions for research question three are presented below by attribute construct and overall.

Relative advantage

The three composite means – online return group, hard copy return group, and overall (combined) – for the attribute construct "relative advantage" were in the range of "agree" (Table 12). The mean difference between the two groups by method of survey instrument return was not statistically significant at an alpha level of .05 (Table 12). All individual item means for this attribute were in the range of "agree" and none of the mean differences for the construct's items were statistically significant (Table 12). So, the participants in this study "agreed" that the "relative advantage" of ICTs, as perceived by potential adopters (i.e., aspiring faculty members in the agricultural sciences and natural resources), impacted the diffusion of ICTs in institutions of tertiary education in developing countries.

Compatibility

The composite means for the attribute construct "compatibility" regarding the online return group and overall (combined) were in the range of "agree" but the composite mean of the hard copy return group was marginally in the range of "neutral" (Table 12). The *mean difference* between the two groups by return method was not

statistically significant ($p > 05$); however, the effect size for that difference was approaching "medium" (i.e., $d = .42$) (Table 12).

All individual item means, except for the item "compatible w/ all aspects of my work" for the hard copy group, were in the range of "agree." That item was rated in the "neutral" range by the hard copy respondents; moreover, the item's *mean difference* by method of return was statistically significant ($p < .05$) (Table 12).

The participants in this study mostly "agreed" that the "compatibility" of ICTs, as perceived by potential adopters (i.e., aspiring faculty members in the agricultural sciences and natural resources), impacted the diffusion of ICTs in institutions of tertiary education in developing countries. However, the participants who returned the study's survey instrument as a hard copy were less certain or more "neutral" in their views on the "compatibility" of ICTs, including one item for which their perceptions were significantly different than the online respondents' views.

Rogers (2003) asserted that the more "compatible" an innovation is perceived to be by a potential adopter vis-à-vis his or her existing practice or behavior, the more likely an individual is to adopt. Furthermore, the success and sustainability of ICTs in developing countries will depend on how appropriate the technology is, including its compatibility with local conditions and needs (Acker & Gasperini, 2008; Reijswoud, 2009; Rogers, 2003). So, the views of potential adopters regarding the "compatibility" of ICTs per the phenomenon under study should be considered by change agents and other relevant stakeholders interested in increasing the diffusion of ICTs (Rogers, 2003) in the developing world's tertiary education institutions.

Complexity

The three composite means – online return group, hard copy return group, and overall (combined) – for the attribute construct "complexity" were in the range of "agree" (Table 12). The *mean difference* between the two groups by method of survey instrument return was not statistically significant at an alpha level of .05 (Table 12). All individual item means for this construct were in the range of "agree" and none of the *mean differences* for the construct's items were statistically significant (Table 12). So, the participants in this study "agreed" that the "complexity" of ICTs, as perceived by potential adopters (i.e., aspiring faculty members in the agricultural sciences and natural resources), was not such that it would impact their diffusion in institutions of tertiary education in developing countries. (Notably, per Rogers, 2003, "complexity" has an inverse relationship with an innovation's rate of diffusion, i.e., the more complex its use is perceived to be, the lower or "slower" the innovation's rate of adoption. However, in the case of this study, the items for the construct "complexity" were stated positively, e.g., "clear & I understand" and "not frustrating" [see Appendices D & E and Table 12]. So, higher mean scores indicated lower perceptions of complexity, which bodes well for the diffusion of ICTs in the context described).

Trialability

The three composite means – online return group, hard copy return group, and overall (combined) – for the attribute construct "trialability" were in the range of "neutral" (Table 12). The *mean difference* between the two groups by method of survey instrument return was statistically significant at an alpha level of .05, and the effect size for that difference was between "medium" and "large" (i.e., $d = .63$) (Table 12).

All individual item means for the attribute construct were in the range of "neutral." However, the *mean differences* of two items by respondents' method of survey instrument return, i.e., "I had adequate opportunities to try using ICTs to deliver higher education" and "the ability to experiment using ICTs to deliver higher education," were statistically significant ($p < .05$) (Table 12).

The participants' views on the "trialability" of ICTs were "neutral" regarding its role in impacting the diffusion of ICTs for agricultural education at tertiary institutions in developing countries. Although in the "neutral" range, significant differences, statistically and practically, existed by return group. The hard copy return respondents agreed less that they had experienced opportunities to "try" ICTs. According to Rogers (2003), opportunities for potential adopters to use or "try" an innovation increase the likelihood of their adopting it in the future. However, many colleges and universities in developing countries have neither enough computers for students or faculty to be connected to the Internet sufficiently for learning and teaching purposes (Hare, 2007). So, many of the study's participants may need more opportunities, such as increased access to computers and the Internet, as well as attending ICTs seminars and conferences (Giltrow & Pannen, 1992), to learn more about the use of ICTs to deliver higher education via distance.

Observability

Two composite means ─ online return and overall ─ for the attribute construct "observability" were in the range of "neutral" but the composite mean of the hard copy return group was in the range of "disagree" (Table 12). The *mean difference* between the two groups by return method was statistically significant at an alpha level of .05 (Table 12), and the effect size for this difference was "large" (i.e., $d = .98$).

The individual item means for the online return group were in the range of "neutral." However, three of four individual item means for the hard copy return group were in the range of "disagree." The *mean differences* for the four observability items, by method of survey instrument return, were statistically significant (Table 12).

Differences in participants' views, statistically and practically, were the "sharpest" or most transparent for the attribute construct "observability." Even though the overall composite mean of this construct was in the "neutral" range it was the lowest of the five constructs. Moreover, the hard copy return respondents "disagreed" with the position that they had experienced opportunities to "observe" the use of ICTs. According to Rogers (2003), opportunities for potential adopters to observe the use of an innovation increases the likelihood of it being adopted in the future. So, providing adopters with sufficient opportunities (Giltrow et al., 1992) for "observability" is very important if increasing an innovation's rate of diffusion is an institution's goal, including colleges and universities. Therefore, similar to the need for increased opportunities regarding "trialability," aspiring faculty of tertiary institutions in the developing world should be given more chances to observe the use of ICTs to deliver post-secondary learning in the agricultural sciences and natural resources.

Attribute Constructs' Grand Means by Method of Survey Instrument Return and Overall

The grand means of the attribute constructs for the online method of survey instrument return group and overall (combined) were in the range of "agree." However, the grand mean of the attribute constructs for the hard copy method of survey instrument return group was in the range of "neutral" (Table 12). The *mean difference* between the grand means of the two groups by return method was statistically significant (Table 12)

and had an effect size of "large" (i.e., d = .85). The practical significance of the *mean difference* between the two return groups notwithstanding, i.e., more "innovative" respondents populated the online return group proportionately (Table 9, 10, & Figure 3) but unintentionally, the combined group's overall view of "agree" led the researcher to conclude the diffusion of ICTs in tertiary institutions should be pursued by relevant policymakers and leaders in developing countries.

Comparing Early and Late Respondents: Attributes

Independent samples *t*-tests were calculated to compare differences between early and late respondents' attributes scores by items, constructs, and grand means. No significant differences were detected at $p < .05$ for any of the tests. So, the overall (combined) mean scores of items as well as construct means and their standard deviations, as reported in Table 12, can be used to describe the international graduate students' views on selected attributes (Rogers, 2003) associated with impacting the diffusion of ICTs to advance higher education in the agricultural sciences and natural resources in developing countries. Moreover, per Miller and Smith (1983), these findings describing the respondents' perceptions of attributes associated with ICTs may be generalized to the non-respondent portion of the study's target population.

Research Question #4

> What were the study participants' views on selected **barriers** impacting the diffusion of ICTs to advance agricultural education at colleges and universities in developing countries?

The participants' views on selected barriers impacting the diffusion of ICTs to advance agricultural education at colleges and universities in developing countries were

collected and analyzed descriptively. Conclusions regarding the participants' views were based on that analysis. The nine barrier constructs were "faculty compensation and time," "credibility of ICTs," "financial concerns," "lack of needs," "conflict with traditional education," "fear of technology," "lack of technical expertise," "lack of administrative support," and "lack of infrastructure." The "real limits" of the scale used for interpretation of the findings were 1.00 to 1.49 = "Strongly disagree"; 1.50 to 2.49 = "Disagree"; 2.50 to 3.49 = "Neutral"; 3.50 to 4.49 = "Agree"; and 4.50 to 5.00 = "Strongly agree." In addition, the results of independent samples *t*-tests (i.e., *mean differences*) were considered significant at an alpha level of $p < .05$. The practical significance of the mean differences were interpreted as "small," "medium," and "large" (Hittleman & Simon, 2002). The conclusions for research question four are presented below by barrier construct and overall.

Faculty compensation and time

The three composite means – online return group, hard copy return group and overall (combined) – for the barriers construct "faculty compensation and time" were in the range of "moderate barriers." The composite *mean difference* between the two groups by method of survey instrument return was not statistically significant at an alpha level of .05 (Table 13). All individual item means, except the item "difficulty keeping current with technological change" for the hard copy group, were in the range of "moderate barriers." That item was rated in the "strong barriers" range, and its *mean difference* was statistically significant (Table 13).

According to Clark, (2006), Loxley, (2004), Richardson, (2011), and the World Bank (2008), those developing countries that have contributed little financial support to

their universities have hampered the institutions' abilities to be more technologically innovative and incentivize their faculty regarding the use of ICTs. To that end, most of the participants in this study perceived the construct "faculty compensation and time" to be a "moderate barrier" to the diffusion of ICTs.

Credibility of ICTs

The three composite means – online return group, hard copy return group, and overall (combined) – for the barriers construct "credibility of ICTs" were in the range of "moderate barriers." However, the composite *mean difference* between the two groups by method of survey instrument return was statistically significant at an alpha level of .05 (Table 13). Individual item means, except two items from the hard copy group, "concerns on evaluation, testing, assessment of student work" and "concerns that ICTs lower quality of courses/programs, students admitted, or expectations for student learning," were in the range of "moderate barriers." Those items were rated in the "strong barriers" range, and their *mean differences* were statistically significant (Table 13).

According to McDonald, (2002), Shachar and Neumann (2003), and Shomaker (1998), many people, including lecturers and leaders in developing countries, view the quality of students produced through distance education to be suspect. Based on the findings of this study, the participants shared this "concern" or view.

Financial concerns

The three composite means – online return group, hard copy return group, and overall (combined) – for the barriers construct "financial concerns" were in the range of "strong barriers." The composite *mean difference* between the two groups by method of survey instrument return was statistically significant at an alpha level of .05 (Table 13).

All individual item means, except for two items, i.e., "student tuition rate" and "revenue sharing with department or institutional business units" from the online group and overall, were in the range of "strong barriers." Four of the six mean ratings for those two items were in the "moderate barriers" range, and the *mean difference* for the item "revenue sharing with department or institutional business units" was statistically significant (Table 13). So, participants in this study viewed the financial aspects of diffusing ICTs in tertiary institutions to be a significant barrier to diffusion occurring successfully.

Lack of needs

Two of the three composite means – online return group and overall (combined) – for the barriers construct "lack of needs" were in the range of "moderate barriers." The composite mean for the hard copy group was in the "strong barriers" range. The composite *mean difference* between the two groups by method of survey instrument return was statistically significant at an alpha level of .05 (Table 13). All individual item means for the online group were in the "moderate barriers" range. However, all items from the hard copy group except one, "lack of identified needs for ICTs," were in the range of "strong barriers." That item was in the "moderate barriers" range.

The overall item means were also in the range of "moderate barriers" except for the item "lack of strategic planning for ICTs in higher education," which was rated as a "strong barrier" (Table 13). The *mean differences* for the items "lack of shared vision for the role of ICTs in the educational organization," "lack of strategic planning for ICTs in higher education," and "lack of a 'champion' for ICTs in the educational organization" were statistically significant (Table 13). Based on these findings, the participants'

perceived that a lack of institutional need identification or "shared vision" existed regarding the diffusion of ICTs to advance agricultural education in tertiary institutions (Malhan et al., 2007; World Bank, 2003).

Conflict with traditional education

The composite means – online return group, hard copy return group, and overall (combined) – for the barriers construct "conflict with traditional education" were in the range of "moderate barriers." The composite *mean difference* between the two groups by method of survey instrument return was not statistically significant at an alpha level of .05 (Table 13). Nine of the individual item means, including by methods of instrument return and overall, were in the range of "moderate barriers" (Table 13). However, two items were rated as "weak barriers": "competition w/ on-campus offerings or for students" per the hard copy return group and "traditional academic calendar/schedule hinders use of ICTs in higher education" by the online return group and overall (Table 13). None of the *mean differences* for the construct's four items by method of return were statistically significant (Table 13).

Some stakeholders in developing countries have accepted distance education as an alternative to the face-to-face study mode of traditional education (Tait & Mills, 1999; Zhao, Lei, Yan, Lai & Tan, 2005). In support, participants in this study viewed the barrier "conflict with traditional education" as less of an obstacle to diffusing ICTs than the other constructs examined.

Fear of technology

The composite means – online return group, hard copy return group, and overall (combined) – for the barriers construct "fear of technology" were in the range of

"moderate barriers." The composite *mean difference* between the two groups by method of survey instrument return was not statistically significant at an alpha level of .05 (Table 13). All individual item means, except the item "threat to instructors' sense of competence and authority" for the hard copy group, were in the range of "moderate barriers." This item's mean rating was in the "strong barriers" range marginally, and its *mean difference* was statistically significant. The *mean difference* of the item "Isolation felt by instructors using ICTs" was also statistically significant (Table 13).

Some universities have not embraced ICTs because they prefer the status quo (Tanzer, 2007). In some cases, teachers and administrators have been resistant to ICTs because of misconceptions about ICTs replacing manpower (Nair et al., 2002), and some parents have apathy toward the introduction of ICTs in schools because they believe Internet activities are unnecessary and impart immoral behaviors to their children (Komen, 2011). The participants in this study viewed fear of technology" as a "moderate barrier" more or less; so, this apprehension should be taken into account by change agents who may work with tertiary faculty on their adoption and use of ICTs.

Lack of technical expertise

Two of the three composite means – hard copy return group and overall (combined) – for the barriers construct "lack of technical expertise" were in the range of "strong barriers." The composite mean for the online group was in the "moderate barriers" range. The composite *mean difference* between the two groups by method of survey instrument return was statistically significant at an alpha level of .05 (Table 13). The four item means for the online group were in the "moderate barriers" range;

however, all item means from the hard copy group and overall were in the range of "strong barriers." The items' *mean differences* by method of return were statistically significant (Table 13).

According to Tiene (2004), expertise in developing and using ICTs to teach online classes in developing countries' tertiary institutions has been a challenge. This is due to the lack of technical expertise on the part of many faculty (Berge, Muilenburg, & Van Haneghan, 2002; Haber, 2006; Li & Lindner, 2007; Maguire, 2005; Murphy & Terry, 1998; Roberts & Dyer, 2005). So, it is crucial that faculty understand the fundamental and complex challenges as well as the skills they must acquire to avoid frustrations that could lead them to abandoning the technology or "rejecting" it (Eastmond, 2000; Rogers, 2003). The findings of the study support the need for capacity building (i.e., training and professional development) of faculty toward that end (Harder & Lindner, 2008; Li & Lindner, 2007).

Lack of administrative support

The composite means – online return group, hard copy return group, and overall (combined) – for the barriers construct "lack of administrative support" were in the range of "moderate barriers." The composite *mean difference* between the two groups by method of survey instrument return was not statistically significant at an alpha level of .05 (Table 13). All individual item means for the online return group were in the range of "moderate barriers." The individual item means for the hard copy return group included two items in the range of "strong barriers": "lack of student services support (admissions, financial aid, library services and technical training)" and "lack of advisement and counseling support." Four of the five items overall were rated "moderate barriers,"

excluding the item "lack of student services support (admissions, financial aid, library services and technical training & technical training)," which was in the range of "strong barriers" marginally (Table 13).

Three items for the hard copy return group received ratings in the range of "moderate barriers": "copy right/fair use issues regarding use of ICTs in higher education," "difficulty recruiting students to learn using ICTs," and "difficulty recruiting faculty to teach courses using ICTs" (Table 13). And, the items "lack of advisement & counseling support" and "difficulty recruiting faculty to teach courses using ICTs" had *mean differences* that were statistically significant (Table 13).

Many people, such as lecturers, administrators, parents and politicians in developing countries, have been resistant to new technologies, including ICTs in institutions of higher learning, as they perceive face-to-face learning to be superior to other modes of education delivery (McDonald, 2002; Shachar & Neumann, 2003; Shomaker, 1998). However, ICTs have been embraced and adopted rapidly in developed countries where they have reformed the public and private sectors (Loxley, 2004). Creating awareness about the importance of ICTs among the educational and political leaders of developing countries may augment the innovation-decision process espoused by Rogers (2003). Findings of this study support that approach, especially regarding the need to "educate" or influence administrators and other leaders of tertiary agricultural institutions in developing countries.

Lack of infrastructure

The composite means – online return group, hard copy return group, and overall (combined) – for the barriers construct "lack of infrastructure" were in the range of

"strong barriers." The composite *mean difference* between the two groups by method of survey instrument return was statistically significant at an alpha level of .05 (Table 13). All individual item means, excluding an item from the hard copy group, "lack of adequate ICTs-enhanced classrooms, labs, or infrastructure," were in the range of "strong barriers." The mean rating for that item was in the "very strong barriers" range and its *mean difference* was statistically significant (Table 13).

Policies to improve ICTs in developing countries are not effective because they are fragmented, making the implementation capacity within the institutions of higher learning weak and under-performing (Malhan et al., 2007). "Capacity" in this area includes aspects of infrastructure supporting the diffusion of ICTs, i.e., the lack of infrastructure frequently, which the participants in this study viewed as a "strong" to "very strong barrier."

Barrier Constructs' Grand Means by Method of Survey Instrument Return and Overall

Two of the three barrier grand means – online return group and overall – were in the range of "moderate barriers." However, the hard copy return group's grand mean was in the range of "strong barriers" (Table 13). The *mean difference* between the two groups, based on method of instrument return, was statistically significant (Table 13) with a "large" effect size.

Six barrier constructs, including "faculty compensation and time," "credibility of ICTs," "lack of needs," "conflict w/ traditional education," "fear of technology," and "lack of administrative support," were perceived by the study's participants generally as "moderate barriers" (Table 13) to diffusing ICTs in tertiary institutions to advance agricultural education in developing countries. Moreover, the participants perceived that

three barrier constructs, including "financial concerns," "lack of technical expertise," and "lack of infrastructure," were "strong barriers" (Table 13) to diffusing ICTs in tertiary institutions to advance agricultural education in developing countries. The respondents perceived the strength of barriers overall to be "moderate" (Table 13). If the diffusion of ICTs in tertiary agricultural institutions in the developing world is the aim of relevant stakeholders, then those barriers found to hold "moderate" or greater magnitude in this study should be mitigated.

Comparing Early and Late Respondents: Barriers

In the case of respondents' views on barriers associated with impacting the diffusion of ICTs to advance higher education in agriculture in developing countries, significant differences ($p < .05$) were found for four of the 38 items and one of the nine constructs (Table 14). So, these findings should not be generalized to the study's target population. However, no significant differences ($p < .05$) were found between the early and late respondent groups for the other 34 barrier items, the other eight barrier constructs, or the grand means depending on time of reply. So, conclusions based on these findings may be generalized to the non-respondent portion of the study's target population (Miller & Smith, 1983).

Research Question #5

> What **relationships** existed between selected personal and professional characteristics of the study participants and their perceptions on variables impacting the diffusion of ICTs to advance agricultural education at colleges and universities in developing countries?

Relationships, as determined by Spearman rank order correlation coefficients (*rs*), between the attribute constructs "relative advantage," "compatibility," and "complexity" and participants' perceived innovativeness regarding their use of ICTs were moderate and positive (Table 15). The relationship between the attribute construct "trialability" and participants' perceived innovativeness was low and positive (Table 15). These four relationships were statistically significant at an alpha level of .05. The relationship between the attribute construct "observability" and perceived innovativeness was also low and positive but it was not significant. Moreover, the relationship between the grand mean of the attribute constructs and participants' perceptions of their innovativeness was moderate, positive and statistically significant (Table 15). So, as participants' perceptions of their innovativeness regarding the use of ICTs increased, so did their ratings of agreement with the five attributes most frequently associated with the diffusion of innovations (i.e., per Rogers, 2003).

Additional analyses revealed that seven of the nine relationships between the barrier constructs, the grand mean of the barrier constructs, and the perceived innovativeness of the participants regarding their use of ICTs were either negligible or low and negative. Two of the relationships were negligible and positive (Table 16). Two relationships were found to be statistically significant at an alpha level of .05 (Table 16).

The association between the grand mean of barrier constructs and participants' perceived innovativeness was not statistically significant (Table 16). Generally, excluding the two abovementioned barrier constructs, as participants' perceptions of the strength of barriers to the diffusion of ICTs to advance tertiary education in the

agricultural sciences and natural resources in developing countries increased, views on their perceived innovativeness regarding the use of such technologies decreased.

Spearman rank order correlation coefficients were calculated to examine the relationships between construct means and grand means of attributes and barriers associated with the diffusion of ICTs. No significant relationships ($p < .05$) were revealed between the construct mean of the attribute "relative advantage" and the construct means of the nine barriers (Table 17). A low, negative and significant relationship existed between the attribute construct "compatibility" and the barrier construct "conflict with traditional education" (Table 17). A moderate, negative and significant relationship was found between the attribute construct "complexity" and the barrier construct "conflict with traditional education" (Table 17).

Moderate and negative relationships were found between the attribute construct "trialability" and the barrier constructs "credibility of ICTs" and "lack of technical experience." A low and negative relationship existed between the attribute construct "trialability" and the barriers construct "lack of administrative support" (Table 17). All three associations were statistically significant ($p < .05$).

Low and negative relationships were found to exist between the attribute construct "observability" and the barrier constructs "faculty compensation and time" and "lack of needs" (Table 17). Moderate and negative relationships existed between "observability" and the barrier constructs "credibility of ICTs," "fear of technology," and "lack of technical expertise" (Table 17). The five associations were statistically significant ($p < .05$).

The grand mean of attribute constructs was correlated significantly (p <.05) with three barrier constructs: "credibility of ICTs," "fear of technology," and "lack of technical expertise" (Table 17). Moreover, the grand mean of barrier constructs correlated significantly (p < .05) with two attribute constructs: "trialability" and "observability" (Table 17). Finally, a low, negative and significant relationship between the grand means of the attribute and barrier constructs also existed (Table 17). Generally, excluding a few positive relationships that were not statistically significant (Table 17), as participants' perceptions of agreement with the five attributes most frequently associated with the diffusion of innovations (i.e., per Rogers, 2003) increased, their ratings for the strength of barriers impacting the use of ICTs decreased.

The relationship between the grand mean of attributes associated with impacting the diffusion of ICTs in the context of tertiary education and the participants' willingness to "recommend the use of ICTs to others" was moderate, positive and statistically significant at p < .05 (Table 18). A negligible relationship existed between the grand mean of barriers and the participants' willingness to "recommend the use of ICTs to others" (Table 18).

Point biserial correlation coefficients (r_{pb}) were calculated for associations in which one of the variables was dichotomous and discrete (Field, 2005). Based on the findings of this study, none of the relationships between gender, degree pursuing, major field of study, anticipated professional position, anticipated work region, region in which current highest degree was earned and grand means of attributes and barriers were statistically significant (Table 19). Although the relationships between the participants'

views on pursuing a terminal degree and grand means of the attributes and barriers were positive, they were not significant (Table 20).

It was also concluded that no significant associations (i.e., per Cramer's *V*) existed between the variables gender, "region of education" or "work region" before enrolling at OSU (i.e., "developing world" versus "developed world"), "academic major" ("social sciences" or "technical sciences"), or "anticipated professional position" in academia or otherwise when correlated with the participants' "intent to pursue a terminal degree" (Tables 21, 22, 23, 24, & 25). (Those participants who were enrolled as doctoral students already did not respond to the item intended to describe an individual's "intent to pursue a terminal degree.")

Recommendations

Based on the conclusions derived from this study, the following are recommendations for future research:

Recommendation for Future Research

- The researcher recommends that investigators in other Colleges of Agriculture at land-grant institutions in the United States conduct a similar study with their international graduate students to ascertain if similarities or differences with this study's findings exist.
- The target population for this research study included international graduate students from the developing world who were studying in a university (OSU) in a developed country (the United States). The researcher recommends that this research study be replicated at agricultural colleges and universities in developing countries to describe those graduate students' views on the attributes and barriers impacting the diffusion

of ICTs to advance education in the agricultural sciences and natural resources. Thereafter, the results could be compared and additional recommendations proffered.

- The findings of this study indicated that male international graduate students outnumbered females by almost two to one. Research should be conducted to understand better the factors affecting the participation of female international graduate students in the agricultural sciences and natural resources.
- In the main, participants in this research study "agreed" that the five attributes associated frequently with impacting the diffusion of innovations (Rogers, 2003) were also applicable to the adoption of ICTs to advance agricultural education in colleges and universities in developing countries. However, the graduate students' views on the attribute constructs "trialability" and "observability" were "neutral"; and, in the case of the latter construct were "disagree" for some of its items depending on participants' method of returning the study's survey instrument. This result may have been because of some participants' lack of opportunities to "observe" and "try" ICTs for the purpose of academic learning. However, additional research designed to explicate aspects of those attributes and the views of potential adopters is warranted.
- This study found that the respondents' viewed barriers to the diffusion of ICTs as being "moderate" in strength generally; and, in the case of some items, even "strong." Nevertheless, the researcher also recommends exploring the feasibility of developing distance learning programs in which ICTs are used to deliver tertiary education to students who are studying agriculture in the developing world. However, additional investigations should be conducted to describe the views of aspiring faculty on how these barriers could be overcome in colleges and universities in the developing world.

A similar study should target the administrators of these institutions as well as policymakers and other government officials who oversee them.

- An investigation should be conducted to identify factors affecting survey results, which may be confounding, when using both online and hard copy versions of a research instrument to gather data from a given target population.
- Fewer than one-in-four of the international graduate students were on study leave (Table 2) and the governments of developing countries sponsored (i.e., provided financial support) for very few of them (Table 4). The researcher recommends conducting an inquiry to understand better the rationale developing countries follow when deciding to sponsor students for advanced studies in the agricultural sciences and natural resources.

Recommendations for Future Practice

- The researcher recommends that governments of developing countries develop policies supporting the use of ICTs to advance agricultural sciences and natural resources education in their colleges and universities (Chacha 2004; Clark, 2006).
- Three barrier constructs ("financial concerns," "lack of technical expertise," and "lack of infrastructure") were perceived by the respondents as "strong barriers." The researcher recommends that developing countries create enabling environments for the adoption and diffusion of ICTs in their tertiary educational institutions by increasing financial support for this purpose (Loxley et al., 2004).
- Information and communication technologies (ICTs) are at the leading edge of innovation and discovery. Effective use and development of these technologies are vital to creating and strengthening the infrastructure, and human capital, by which

both developed and developing countries can respond to the demand and challenges of today and tomorrow. The researcher recommends that partnerships be forged between institutions of higher learning in developed and developing countries for the purpose of sharing knowledge and skills among faculty members and students regarding the use of ICTs for tertiary learning, discovery and outreach (Avgerou, 2003; Richardson, 2011).

- For the benefits of ICTs to be available equitably, such as making it possible for more marginalized students to access higher education, the researcher recommends that governments, corporations and non-governmental organizations collaborate to strengthen the diffusion of ICTs in their nations' institutions of higher learning (Clark, 2006; Loxley, 2004).
- In this study, the barrier construct "financial concerns" was found to be a "strong barrier" to diffusing ICTs. In Ethiopia, 40% of the import tariffs are imposed on ICT equipment (Postnote, 2006) making it expensive for the poor to access the Internet and other ICTs-related services. So, the researcher recommends that developing countries' governments subsidize the use of ICTs, either partially or entirely, so that more of their citizens can afford to access these innovations (Chacha, 2004; UNESCO, 1998).
- One-half of the graduate students surveyed had not experienced a course in which the primary mode of delivery was through ICTs, and many were "uncertain" about recommending such a course to others. Accordingly, the researcher recommends the governments of developing countries implement policies calibrated to introduce the use of ICTs for learning at all levels of their education systems--primary

schools, secondary schools and tertiary institutions. This initiative could be part of a broader reform effort involving curriculum redesign and teacher training to address the human capital needs of developing countries, including their agricultural sectors.

- Lack of infrastructure coupled with inadequate technical expertise and ongoing financial constraints plague developing countries, as evidenced by the views of this study's participants regarding the diffusion of ICTs. So, the researcher recommends that international aid donors play a greater role in supporting the diffusion of ICTs to advance tertiary education in the agricultural colleges and universities of developing countries. Targeting youth particularly could have significant multiplier effects because "young people are often 'first adopters' of new technology" (Halewood & Kenny, 2007, p. 1).
- The researcher had limited control over the data collection methods used for this study (i.e., by online or hard copy versions of the survey instrument). This was because their departments and interdisciplinary programs of CASNR controlled access to the contact information of the targeted population. The researcher recommends that officials at Oklahoma State University provide other sources of the population frame's contact information for studies of this kind in the future.
- The academic departments and interdisciplinary programs of CASNR at Oklahoma State University should make it a priority to introduce their international graduate students from developing countries to ICTs for the purpose of providing tertiary level instruction as well as augmenting research and outreach (e.g., nonformal training to farmers and other agricultural entrepreneurs).

- The participants of this study shared the "concern" or view that, face-to-face learning was superior to other modes of education delivery (McDonald, 2002; Shachar & Neumann, 2003; Shomaker, 1998). The researcher recommends that institutions of higher learning in developing countries expose their faculty members, students and staff more to aspects of ICTs and distance education (e.g., conferences and seminars) for capacity building purposes (Clark, 2006; Giltrow & Pannen, 1992; Loxley, 2004)
- Investing in ICTs will not do much if the work force and businesses have no capacity to use them productively (Nair & Prasad, 2002). So, the researcher recommends that governments in developing countries develop policies for both public and private investments in their people (i.e., human resources), and engage universities as well as research and development centers to support this endeavor (Malhan et al., 2007; World Bank, 2003).
- The researcher recommends that governments in developing countries conduct awareness campaigns (Rogers, 2003) about the value of ICTs, so that their citizens will be more knowledgeable and informed better on ICTs and their potential for improving access to tertiary education (Ebrahimian, 2003; McHale, 2010).

Implications and Discussion

This section points out the major implications drawn from the study's conclusions and how they relate to the goal of diffusing ICTs in tertiary institutions in developing countries to advance agricultural education.

The finding on gender showed that men outnumbered women almost two-to-one in this study. This finding led the researcher to conclude that men are more "dominant" in

agriculture and may be more likely to occupy very important decision-making positions in developing countries than women. As it is well documented (United Nations, 2007b), the role of women in developing countries in the agricultural sector is crucial as they are involved in producing much of the food and doing such under extremely difficult conditions more often than not.

The researcher was left wondering whether the contribution being made by women in developing countries is not understood or appreciated fully and that is why many of them are being left out when it comes to graduate education in agriculture. Furthermore, no significant association was found between a participant's gender and his or her choosing to "pursue a terminal degree" (Table 21). Therefore, does it mean that when diffusing ICTs in tertiary institutions in developing countries men should be targeted because they are more likely to dominate faculty and leadership roles in agricultural institutions? Or because women may be under-represented, is it they who should be targeted for recruitment. Moreover, because a pool of female graduate students would be drawn from women undergraduates, it appears that significant recruitment efforts would need to occur at the secondary school level if not before, assuming gender equity among graduate students was the goal.

A majority of the participants were not on study leave, and most were being funded by their respective academic departments at Oklahoma State University. However, more than six-in-ten anticipated working in their countries of citizenship after they graduated even though they may not be compelled to return home. These findings led the researcher to conclude the participants had strong ties to their countries. What needs to be explored further is whether the participants follow through with their

anticipation of returning home after they graduate. Furthermore, a need exist to establish whether they stay permanently when they return home or find their way back to developed countries (i.e., a continuation of the "brain drain" phenomenon). Many qualified, early-career faculty members have left their developing countries, due to poor remunerations and inferior working conditions, for developed countries where more enabling professional environments have been established (Chacha, 2004; Loxley, 2004; Musisi & Muwanga, 2003; Sawyerr, 2004; UNESCO, 1998; World Bank, 2008).

One-half of the respondents had never taken a course whose primary means of delivery was by ICTs, and yet a majority indicated they would recommend others to take such courses (Table 7). However, until these or similar individuals observe and try ICTs, they may not know exactly what they are recommending. So, it appears that many developing countries are lagging behind in the adoption of ICTs for educational purposes, and need to develop policies and strategies to promote such technologies, if they are going to compete internationally. The study's findings support the need for aspiring tertiary faculty to have more experiences with ICTs. However, the question remains whether they will maintain or change their views on recommending ICTs to others after undergoing such experiences.

A significant association existed between international graduate students' perceived level of innovativeness regarding the use of ICTs and their method of returning the study's survey instrument (Table 9). The uniqueness of this finding left the researcher to consider what was responsible for this difference in innovativeness. For example, did the online return participants come from developing countries that were ahead of others and thus they had more opportunities to experience ICTs? Were these participants living

in urban areas where accessibility to ICTs is more common than in rural areas? These questions may warrant additional study.

A majority of the respondents (52.8%) identified their academic departments as the primary source of funding support (Table 4). This finding led the researcher to conclude that without the financial support of a U.S. institution of higher learning, many of the international students who were enrolled in CASNR would not have been. It also implies that the United States is playing a pivotal role in preparing human resources for the agricultural sector regarding a number of developing countries. The little or no financial support these participants received from their respective governments to support their education leaves a lot to be desired. Was it that these developing governments did not have the financial resources to support the international graduate students or were their priorities elsewhere (ESCAP, 1999; South Commission, 1990)?

The issue of qualified human resources in tertiary education systems in developing countries is troubling because far too few faculty and staff have the required qualifications (Chacha, 2004; Chen, Sok, & Sok, 2007; Loxley, 2004). However, developing countries' governments are spending less on their tertiary institutions (Clark, 2006; Richardson, 2011; World Bank, 2008). Do developing countries' governments have strategies in place to meet the enrollment crisis manifested by the swelling number of secondary school graduates (Mwapachu, 2010)? Moreover, do they have the human capital necessary to support national development plans for the 21st century (Ndulu et al., 2007)?

The need exists for developing countries to build the skills and expertise of their citizens relevant to the current (and future) environment by linking educational

curriculum and its delivery to their nations' priorities and needs (ESCAP, 1999, South Commission, 1990). Therefore, governments of developing countries should increase investments in their citizens' education, including those who aspire to serve as educators in tertiary agricultural institutions.

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APPENDICES

APPENDIX A

INSTITUITIONAL REVIEW BOARD APPROVAL

Oklahoma State University Institutional Review Board

Date:	Tuesday, September 07, 2010
IRB Application No	AG1033
Proposal Title:	Attributes and Barriers Impacting the Diffusion of Information Communication Technologies (ICTs) in Agricultural Colleges and Universities in Developing Countries: Views of Aspiring Faculty
Reviewed and Processed as:	Exempt

Status Recommended by Reviewer(s): Approved Protocol Expires: 9/6/2011

Principal Investigator(s):

Patrick Lumumba Saisi
444 Ag Hall
Stillwater, OK 74078

Michael Craig Edwards
456 Ag Hall
Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☒ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 219 Cordell North (phone: 405-744-5700, beth.mcternan@okstate.edu).

Sincerely,

Shelia H. Kennison

Shelia Kennison, Chair
Institutional Review Board

APPENDIX B

INSTITUITIONAL REVIEW BOARD

HARD COPY DISTRIBUTION MODIFICATION APPROVAL

Oklahoma State University Institutional Review Board

Date:	Tuesday, September 28, 2010	**Protocol Expires:**	**9/6/2011**
IRB Application No:	AG1033		
Proposal Title:	Attributes and Barriers Impacting the Diffusion of Information Communication Technologies (ICTs) in Agricultural Colleges and Universities in Developing Countries: Views of Aspiring Faculty		
Reviewed and Processed as:	Exempt **Modification**		

Status Recommended by Reviewer(s) **Approved**

Principal Investigator(s):

Patrick Lumumba Saisi
444 Ag Hall
Stillwater, OK 74078

Michael Craig Edwards
456 Ag Hall
Stillwater, OK 74078

The requested modification to this IRB protocol has been approved. Please note that the original expiration date of the protocol has not changed. The IRB office MUST be notified in writing when a project is complete. All approved projects are subject to monitoring by the IRB.

☒ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

The reviewer(s) had these comments:

The request to allow hard copy distribution of the survey is approved.

Signature :

Shelia H. Kennison

Shelia Kennison, Chair, Institutional Review Board

Tuesday, September 28, 2010
Date

APPENDIX C

INSTITUITIONAL REVIEW BOARD

DATA COLLECTION EXTENSION MODIFICATION APPROVAL

Oklahoma State University Institutional Review Board

Date:	Tuesday, November 16, 2010	**Protocol Expires:**	**9/6/2011**
IRB Application No:	AG1033		
Proposal Title:	Attributes and Barriers Impacting the Diffusion of Information Communication Technologies (ICTs) in Agricultural Colleges and Universities in Developing Countries: Views of Aspiring Faculty		
Reviewed and Processed as:	Exempt **Modification**		

Status Recommended by Reviewer(s) **Approved**

Principal Investigator(s):

Patrick Lumumba Saisi
444 Ag Hall
Stillwater, OK 74078

Michael Craig Edwards
456 Ag Hall
Stillwater, OK 74078

The requested modification to this IRB protocol has been approved. Please note that the original expiration date of the protocol has not changed. The IRB office MUST be notified in writing when a project is complete. All approved projects are subject to monitoring by the IRB.

☒ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

The reviewer(s) had these comments:

The request to extend the data collection period is approved.

Signature :

Shelia Kennison, Chair, Institutional Review Board

Tuesday, November 16, 2010
Date

APPENDIX D

ONLINE SURVEY INSTRUMENT

College of Agricultural Sciences and Natural Resources - Department of Agricultural Education, Communications, and Leadership

USING INFORMATION COMMUNICATION TECHNOLOGIES (ICTs) TO IMPROVE TERTIARY EDUCATION IN THE DEVELOPING WORLD

Important: The intended target audience for this questionnaire includes international graduate students studying agricultural sciences and natural resources in the College of Agricultural Sciences and Natural Resourcesat Oklahoma State University. Because you fit in this category, you have been identified as an appropriate participant for this study. By completing this questionnaire, you will be helping us to improve tertiary education in the developing world.

Please, read carefully the instructions before answering this questionnaire.

For the purpose of this study, we define Information Communications Technology (ICT) as follows:

> Information and communications technology is an umbrella term that includes all types of technologies for the communication of information. It encompasses any medium to record and broadcast information as well as technologies for communicating information through voice, sound, and/or images. Information technology (IT) has become a hub for communicating information, most often using computers. (Swanson, 2010, p. 181)

Please, consider this definition when expressing your views on the use of ICTs to advance the teaching of agricultural sciences and natural resources at colleges and universities in developing countries.

Part I. STAGES OF THE INNOVATION-DECISION PROCESS

Limited access to higher education is a big problem for students (or aspiring students) in many developing countries. Based on the abovementioned problem, please, select ONE statement below that best describes your attitude about ICTs.

- ○ I know very little about whether Information Communication Technologies (ICTs) could be used to overcome this problem.
- ○ ICTs may be a good way to overcome this problem.
- ○ ICTs are a good way to overcome this problem.

○ I have not used ICTs to teach but intend to use them to overcome this problem in the future.

○ I have used ICTs to teach and will continue that practice to overcome this problem in the future.

○ I have used ICTs to teach but they were not a good way to overcome this problem.

Part II. ATTRIBUTES IMPACTING DIFFUSION OF ICTs TO DELIVER HIGHER EDUCATION

Following is a list of attributes that may impact the diffusion of ICTs for the delivery of higher education. Please, read each item carefully and indicate your perception about the influence of the item on the use of ICTs to advance the teaching of agricultural sciences and natural resources at colleges and universities in developing countries.

Relative advantage **Using ICTs to deliver higher education ...**	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
could reach more students	○	○	○	○	○
could have a more flexible time schedule	○	○	○	○	○
could improve my teaching effectiveness	○	○	○	○	○
gives me more teaching resources	○	○	○	○	○
Compatibility **Using ICTs to deliver higher education ...**	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
is compatible with my teaching work	○	○	○	○	○
is compatible with all aspects of my work	○	○	○	○	○
fits well with the way I like to work	○	○	○	○	○
fits into my work style	○	○	○	○	○
Complexity **My personal interaction with ICTs ...**	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
is clear and understandable	○	○	○	○	○
is not so frustrating	○	○	○	○	○
is easy for me to learn overall	○	○	○	○	○
is practical	○	○	○	○	○
Trialibility **At my home college/university, I have ...**	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
had adequate opportunities to try using ICTs to deliver higher education	○	○	○	○	○
the knowledge of where I can go to satisfactorily try using ICTs to deliver higher education	○	○	○	○	○
the ability to experiment with using ICTs to deliver higher education	○	○	○	○	○

enough people to help me try using ICTs to deliver higher education	○	○	○	○	○
Observability At my home college/university, ...	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
it is easy for me to observe others using ICTs to deliver higher education	○	○	○	○	○
it is easy for me to observe the effect of ICTs to deliver higher education	○	○	○	○	○
I have seen others using ICTs to deliver higher education	○	○	○	○	○
I have seen others using ICTs to deliver higher education in off-campus or remote settings	○	○	○	○	○

PART III. BARRIERS TO DIFFUSION OF ICTs TO DELIVER HIGHER EDUCATION

Following is a list of possible barriers to diffusion of ICTs for the delivery of higher education. Please, read each item carefully and indicate your perception about the influence of the item on the use of ICTs to advance the teaching of agricultural sciences and natural resources at colleges and universities in developing countries.

Faculty compensation and time ...	**No Barrier**	**Weak Barrier**	**Moderate Barrier**	**Strong Barrier**	**Very Strong Barrier**
Concern about faculty compensation, incentives, workload, promotion and recognition, or awards	○	○	○	○	○
Increased time commitment (e.g., exploration of new materials, course development, training release time needed)	○	○	○	○	○
Difficulty keeping current with technological changes	○	○	○	○	○
Information overload	○	○	○	○	○
Difficulty keeping high turnover rate of faculty down	○	○	○	○	○
Credibility of ICTs ...	**No Barrier**	**Weak Barrier**	**Moderate Barrier**	**Strong Barrier**	**Very Strong Barrier**
Lack of ongoing credibility of ICTs with the public, lawmakers, or community	○	○	○	○	○
Lack of professional prestige for ICTs	○	○	○	○	○
Concerns about evaluation, testing, assessment and outcomes of student work involving ICTs	○	○	○	○	○
Concerns that ICTs lowers the quality of courses/programs, students who are admitted, or expectations for student learning	○	○	○	○	○

Financial concerns ...	**No Barrier**	**Weak Barrier**	**Moderate Barrier**	**Strong Barrier**	**Very Strong Barrier**
Student tuition rate	○	○	○	○	○
Technology fees	○	○	○	○	○
Revenue sharing with department or institutional business units	○	○	○	○	○
Lack of money to implement ICTs in higher education	○	○	○	○	○
Lack of needs ...	**No Barrier**	**Weak Barrier**	**Moderate Barrier**	**Strong Barrier**	**Very Strong Barrier**
Lack of identified need (perceived or real) for ICTs in higher education	○	○	○	○	○
Lack of shared vision for the role of ICTs in the education organization (my home campus)	○	○	○	○	○
Lack of strategic planning for ICTs in higher education	○	○	○	○	○
Lack of a 'champion' for ICTs in the education organization	○	○	○	○	○
Conflict with traditional education ...	**No Barrier**	**Weak Barrier**	**Moderate Barrier**	**Strong Barrier**	**Very Strong Barrier**
Competition with on-campus offerings, or competition for existing students	○	○	○	○	○
Disruption of the classroom's traditional social organization	○	○	○	○	○
Traditional academic calendar/schedule hinders use of ICTs in higher education	○	○	○	○	○
Lack of person-to-person contact when using ICTs (i.e., lack of face-to face interaction with students; difficulty building rapport with students learning at a distance)	○	○	○	○	○
Fear of technology ...	**No Barrier**	**Weak Barrier**	**Moderate Barrier**	**Strong Barrier**	**Very Strong Barrier**
Threat to instructors' sense of competence and authority	○	○	○	○	○
Faculty feel job security is threatened	○	○	○	○	○
Concern for legal issues (e.g., computer crime, hackers, software piracy, computer viruses)	○	○	○	○	○
Isolation felt by instructors using ICTs	○	○	○	○	○
Lack of technical expertise ...	**No Barrier**	**Weak Barrier**	**Moderate Barrier**	**Strong Barrier**	**Very Strong Barrier**
Lack of technical support for ICTs	○	○	○	○	○

Lack of training programs for ICTs	○	○	○	○	○
Lack of knowledge about ICTs, negative comments made by, or lack of support or encouragement from, administrators	○	○	○	○	○
Lack of right people to implement ICTs in higher education	○	○	○	○	○
Lack of administrative support ...	**No Barrier**	**Weak Barrier**	**Moderate Barrier**	**Strong Barrier**	**Very Strong Barrier**
Lack of student services support (e.g., admissions, financial aid, library services, and technical training)	○	○	○	○	○
Lack of advisement/counseling support for students learning at a distance using ICTs	○	○	○	○	○
Copyright/fair use issues regarding use of ICTs in higher education	○	○	○	○	○
Difficulty recruiting students to learn using ICTs	○	○	○	○	○
Difficulty recruiting faculty to teach courses using ICTs	○	○	○	○	○
Lack of infrastructure ...	**No Barrier**	**Weak Barrier**	**Moderate Barrier**	**Strong Barrier**	**Very Strong Barrier**
Lack of adequate ICTs-enhanced classrooms, labs, or infrastructure	○	○	○	○	○
Lack of equal access by students to ICTs, e.g., computers and Internet	○	○	○	○	○
Lack of equal access by instructors to ICTs, e.g., computers and Internet	○	○	○	○	○
Lack of library access or materials services delivery	○	○	○	○	○

PART IV. PERSONAL and PROFESSIONAL CHARACTERISTICS

1. Gender: ○ Male ○ Female

2. Age: [ ]

3. What is your Nationality/Country of Citizenship? [ ]

4. What is your highest degree earned prior to studies at OSU?

- ○ Associate's
- ○ Bachelor's
- ○ Master's
- ○ Doctor of Education (EdD)

- ○ Doctor of Philosophy (PhD)
- ○ Other: [ ]

5. From which region of the world did you earn the degree?

- ○ USA
- ○ Canada
- ○ Europe
- ○ Australia/New Zealand
- ○ North Africa
- ○ Sub Saharan Africa
- ○ Asia
- ○ Latin America
- ○ Other: [ ]

6. Did you hold a professional position prior to graduate studies at OSU? ○ Yes ○ No

7. Years of professional work experience (if applicable) [ ]

8. As per CASNR, identify your major field of study (Department):

- ○ Agricultural Economics
- ○ Agricultural Education, Communications & Leadership
- ○ Animal Science
- ○ Biochemistry & Molecular Biology
- ○ Biosystems & Agric. Engineering
- ○ Entomology & Plant Pathology
- ○ Natural Resource Ecology & Mgt.
- ○ Horticulture & Landscape Architecture
- ○ Plant & Soil Sciences
- ○ Environmental Sciences
- ○ International Programs in Agriculture
- ○ Other: [ ]

9. What degree are you pursuing at OSU?

- ○ MAG
- ○ MS
- ○ PhD
- ○ EdD
- ○ Other: [ ]

10. How many semester(s) have you completed to date in your current program at OSU?

- This is my 1st semester at OSU
- 1 semester
- 2 semesters
- 3 semesters
- 4 semesters
- 5 semesters
- 6 semesters
- 7 semesters
- 8 or more semesters
- I have graduated

11. What is your anticipated time remaining to complete studies at OSU?

- 1 semester
- 1 year
- 1.5 years
- 2 years
- 2.5 years
- more than 3 years
- I have graduated

12. How many courses have you taken using ICTs as the primary means of course delivery?

- 0
- 1
- 2
- 3
- 4
- 5 or more

13. Would you recommend others take courses using ICTs as the primary means of course delivery?

- Definitely not
- Probably not
- Not sure/Uncertain
- Probably yes
- Definitely yes

14. If your answer is definitely or probably not to the above question, please, explain why:

15. Are you on study leave from a college, university or government entity in your home country? ○ Yes ○ No

16. How are/were you funded primarily? (If you have more than one source of funding, please, select the choice that provides *most* of your support to attend OSU).

- ○ Home country, Ministry of Education
- ○ Home country, Ministry of Agriculture
- ○ My "home" University
- ○ Family funding
- ○ Ford Foundation
- ○ Fulbright
- ○ Support from an academic department at OSU
- ○ Scholarships
- ○ International Institution or a 3rd Country Agency
- ○ Funding from employer or a business
- ○ Other funding source: [ ]

17. What is your anticipated professional position after graduation?

- ○ Faculty/Lecturer
- ○ College or University Administrator
- ○ Private Sector Employee
- ○ Self-Employed/Consultant
- ○ Other: [ ]

18. Do you anticipate working in your country of citizenship after completing all of your formal schooling (whether at OSU or another institution)?

- ○ Yes
- ○ No
- ○ Not sure

19. After completing school, in which region of the world do you anticipate working primarily?

- ○ USA
- ○ Canada
- ○ Europe
- ○ Australia/New Zealand
- ○ Asia
- ○ North Africa
- ○ Sub Saharan Africa
- ○ Latin America

○ Other: [ ]

20. If a master's student, do you intend to pursue a terminal degree (e.g., PhD, EdD) before returning to your home country?

○ Definitely not
○ Probably not
○ Not sure/Uncertain
○ Probably yes
○ Definitely yes

SUBMIT

Oklahoma State University
459 Agriculture Hall
Stillwater, Oklahoma 74078
(405) 744-2972
patrick.saisi@okstate.edu

APPENDIX E

HARD COPY SURVEY INSTRUMENT


College of Agricultural Sciences and Natural Resources (CASNR)
Department of Agricultural Education, Communications & Leadership

INFORMED CONSENT & QUESTIONNAIRE

Dear students,

We would like to invite you to participate in this research study by completing the accompanying questionnaire. The purpose of the study is to determine **your perceptions about diffusing Information Communications Technologies (ICTs)** for advancing agricultural education at colleges and universities in developing countries.

The questionnaire has four parts. The first part is a statement about your attitude toward ICTs. The second part includes statements about the attributes of ICTs impacting their diffusion in higher education in developing countries; the third part has statements about barriers to diffusion of ICTs to deliver higher education in developing countries. The fourth part includes a few questions about you.

Your participation in the research study is strictly voluntary but it would be **greatly appreciated** by us and our Department of Agricultural Education, Communications, and Leadership**.**
In no way will your answers be revealed as the questionnaire will be anonymous. All results will be summarized and reported as a group.

The purpose of this research study is to help higher education institutions in developing countries to reform their curricula and design infrastructure to support the integration of ICTs to advance agricultural education and extension.

DO NOT write your name on the white questionnaire booklet!!! When you begin completing the questionnaire, please, write directly on it. Please, remember, we are asking for your honest opinion and current knowledge about the statements and questions**.**

Please, place the completed questionnaire booklet in the brown envelope provided and return it to your respective head of Department's office, no later than December 3, 2010.

We thank you for your consideration to participate in this research study.

Sincerely

Patrick Saisi
PhD Student

M. Craig Edwards, PhD
Professor

Principal Investigator (PI) Co- Principal Investigator

Important: The intended target audience for this questionnaire includes international graduate students studying agricultural sciences and natural resources in the College of Agricultural Sciences and Natural Resources. Since you fit in this category, you have been identified as one of the respondent for the purpose of this study. By completing this questionnaire, you will be helping us to improve tertiary education in developing world.

Please, read carefully the instructions before answering this questionnaire.

For the purpose of this study, we define Information Communications Technology (ICT) as follows:

> Information and communications technology is an umbrella term that includes all types of technologies for the communication of information. It encompasses any medium to record and broadcast information as well as technologies for communicating information through voice, sound, and/or images. Information technology (IT) has become a hub for communicating information, most often using computers. (Swanson, 2010, p. 181)

Please, consider this definition when expressing your views on the use of ICTs to advance the teaching of agricultural sciences and natural resources at colleges and universities in developing countries.

Limited access to higher education is a big problem for students (or aspiring students) in many developing countries.

Based on the abovementioned problem, please, select <u>ONE statement below</u> that best **describes your attitude about ICTs. Mark an X in the blank space provided before the statement**.

<u>Statements</u>

___I know very little about whether Information Communication Technologies (ICTs) could be used to overcome this problem.

___ICTs may be a good way to overcome this problem.

___ICTs are a good way to overcome this problem.

___I have not used ICTs to teach but intend to use them to overcome this problem in the future.

___I have used ICTs to teach and will continue that practice to overcome this problem in the future.

___I have used ICTs to teach but they were not a good way to overcome this problem.

PART II: ATTRIBUTES IMPACTING DIFFUSION OF ICTs TO DELIVER HIGHER EDUCATION

Following is a list of attributes that may impact the diffusion of ICTs for the delivery of higher education. Please, read each item carefully and indicate your perception about the influence of the item on the use of ICTs to advance the teaching of agricultural sciences and natural resources at colleges and universities in developing countries.

Please, use the following scale to indicate your response. Circle the best response.

1=Strongly Disagree (SD)
2=Disagree (D)
3=Neutral (N)
4=Agree (A)
5=Strongly Agree (SA)

Relative advantage Using ICTs to deliver higher education……..	**SD**	**D**	**N**	**A**	**SA**
could reach more students	1	2	3	4	5
could have a more flexible time schedule	1	2	3	4	5
could improve my teaching effectiveness	1	2	3	4	5
gives me more teaching resources	1	2	3	4	5
Compatibility Using ICTs to deliver higher education…….	**SD**	**D**	**N**	**A**	**SA**
is compatible with my teaching work	1	2	3	4	5
is compatible with all aspects of my work	1	2	3	4	5
fits well with the way I like to work	1	2	3	4	5
fits into my work style	1	2	3	4	5

Complexity My personal interaction with ICTs……	**SD**	**D**	**N**	**A**	**SA**
is clear and understandable	1	2	3	4	5
is not so frustrating	1	2	3	4	5
is easy for me to learn overall	1	2	3	4	5
is practical	1	2	3	4	5
Trialability At my home college/university, I have……..	**SD**	**D**	**N**	**A**	**SA**
had adequate opportunities to try using ICTs to deliver higher education	1	2	3	4	5
the knowledge of where I can go to satisfactorily try using ICTs to deliver higher education	1	2	3	4	5
the ability to experiment with using ICTs to deliver higher education	1	2	3	4	5
enough people to help me try using ICTs to deliver higher education	1	2	3	4	5
Observability At my home college/university, ……	**SD**	**D**	**N**	**A**	**SA**
it is easy for me to observe others using ICTs to deliver higher education	1	2	3	4	5
it is easy for me to observe the effect of ICTs to deliver higher education	1	2	3	4	5
I have seen others using ICTs to deliver higher education	1	2	3	4	5
I have seen others using ICTs to deliver higher education in off-campus or remote settings	1	2	3	4	5

PART III: BARRIERS TO DIFFUSION OF ICTs TO DELIVER HIGHER EDUCATION

Following is a list of possible barriers to diffusion of ICTs for the delivery of higher education. Please, read each item carefully and indicate your perception about the influence of the item on the use of ICTs to advance the teaching of agricultural sciences and natural resources at colleges and universities in developing countries.

Please, use the following scale to indicate your response. Circle the best response.

1=No Barrier (NB)
2=Weak Barrier (WB)
3=Moderate Barrier (MB)
4=Strong Barrier (SB)
5=Very Strong Barrier (VSB)

Faculty compensation and time	**NB**	**WB**	**MB**	**SB**	**VSB**
Concern about faculty compensation, incentives, workload, promotion and recognition, or awards	1	2	3	4	5
Increased time commitment (e.g., exploration of new materials, course development, training release time needed)	1	2	3	4	5
Difficulty keeping current with technological changes	1	2	3	4	5
Information overload	1	2	3	4	5
Difficulty keeping high turnover rate of faculty down	1	2	3	4	5
Credibility of ICTs	**NB**	**WB**	**MB**	**SB**	**VSB**
Lack of ongoing credibility of ICTs with the public, lawmakers, or community	1	2	3	4	5
Lack of professional prestige for ICTs	1	2	3	4	5
Concerns about evaluation, testing, assessment and outcomes of student work involving ICTs	1	2	3	4	5
Concerns that ICTs lowers the quality of courses/programs, students who are admitted, or expectations for student learning	1	2	3	4	5
Financial concerns	**NB**	**WB**	**MB**	**SB**	**VSB**
Student tuition rate	1	2	3	4	4
Technology fees	1	2	3	4	5
Revenue sharing with department or institutional business units	1	2	3	4	5
Lack of money to implement ICTs in higher education	1	2	3	4	5

Lack of needs	**NB**	**WB**	**MB**	**SB**	**VSB**
Lack of identified need (perceived or real) for ICTs in higher education	1	2	3	4	5
Lack of shared vision for the role of ICTs in the education organization (my home campus)	1	2	3	4	5
Lack of strategic planning for ICTs in higher education	1	2	3	4	5
Lack of a "champion" for ICTs in the education organization	1	2	3	4	5
Conflict with traditional education	**NB**	**WB**	**MB**	**SB**	**VSB**
Competition with on-campus offerings, or competition for existing students	1	2	3	4	5
Disruption of the classroom's traditional social organization	1	2	3	4	5
Traditional academic calendar/schedule hinders use of ICTs in higher education	1	2	3	4	5
Lack of person-to-person contact when using ICTs (i.e., lack of face-to face interaction with students; difficulty building rapport with students learning at a distance)	1	2	3	4	5
Fear of technology	**NB**	**WB**	**MB**	**SB**	**VSB**
Threat to instructors' sense of competence and authority	1	2	3	4	5
Faculty feel job security is threatened	1	2	3	4	5
Concern for legal issues (e.g., computer crime, hackers, software piracy, computer viruses)	1	2	3	4	5
Isolation felt by instructors using ICTs	1	2	3	4	5
Lack of technical expertise	**NB**	**WB**	**MB**	**SB**	**VSB**
Lack of technical support for ICTs	1	2	3	4	5
Lack of training programs for ICTs	1	2	3	4	5
Lack of knowledge about ICTs, negative comments made by, or lack of support or encouragement from, administrators	1	2	3	4	5
Lack of right people to implement ICTs in higher education	1	2	3	4	5

Lack of administrative support	**NB**	**WB**	**MB**	**SB**	**VSB**
Lack of student services support (e.g., admissions,	1	2	3	4	5

financial aid, library services, and technical training)					
Lack of advisement/counseling support for students learning at a distance using ICTs	1	2	3	4	5
Copyright/fair use issues regarding use of ICTs in higher education	1	2	3	4	5
Difficulty recruiting students to learn using ICTs	1	2	3	4	5
Difficulty recruiting faculty to teach courses using ICTs	1	2	3	4	5
Lack of infrastructure	**NB**	**WB**	**MB**	**SB**	**VSB**
Lack of adequate ICTs-enhanced classrooms, labs, or infrastructure	1	2	3	4	5
Lack of equal access by students to ICTs, e.g., computers and Internet	1	2	3	4	5
Lack of equal access by instructors to ICTs, e.g., computers and Internet	1	2	3	4	5
Lack of library access or materials services delivery	1	2	3	4	5

PART IV: Personal and Professional Characteristics

1. Gender: (**mark one**) Male_____ Female____ 2. Age_____

3. What is your Nationality/Country of Citizenship? _____

4. What is your highest degree earned prior to studies at OSU? (**Circle one response**)

Associate's *Bachelor's* *Master's* *Doctor of Education (EdD)*

Doctor of Philosophy (PhD) *Other*

5. From which region of the world did you earn the degree? (**Circle one response**)

USA *Canada*

Europe *Australia/New Zealand*

North Africa *Sub Saharan Africa*

Asia *Latin America*

Other

6. Did you hold a professional position prior to graduate studies at OSU? (**Circle one response)**

Yes *No*

7. Years of professional work experience (if applicable) _____

8. As per CASNR, identify your major field of study (Department): **(Circle one response)**

Agricultural Economics

Agricultural Education, Communications & Leadership

Animal Science

Biochemistry & Molecular Biology

Biosystems & Agric. Engineering

Entomology & Plant Pathology

Natural Resource Ecology & Mgt.

Horticulture & Landscape Architecture

Plant & Soil Sciences

Environmental Sciences

International Programs in Agric.

Other

9. What degree are you pursuing at OSU? **(Circle one response)**

MAG *MS* *PhD* *EdD* *Other*

10. How many semester(s) have you completed to date in your current program at OSU? **(Circle one response)**

    1 semester *2 semesters* *3 semesters* *4 semesters*

    5 semesters *6 semesters* *7 semesters* *8 or more semesters*

    I have graduated

11. What is your anticipated time remaining to complete studies at OSU? **(Circle one response)**

    1 semester *1 year* *1.5 years* *2 years* *2.5 years*

    more than 3 years *I have graduated*

12. How many courses have you taken using ICTs as the primary means of course delivery? **(Circle one response)**

    0 *1* *2* *3* *4* *5 or more*

13. Would you recommend others take courses using ICTs as the primary means of course delivery? **(Circle one response)**

    Definitely not *Probably not* *Not sure/Uncertain*

    Probably yes *Definitely yes*

14. If your answer is definitely or probably not to the above question, please, **explain why:**

_____

_____

_____

_____

15. Are you on study leave from a college, university or government entity in your home country? (**Circle one**)

    Yes *No*

16. How are/were you funded primarily? (If you have more than one source of funding, **please**, **circle the choice that provides most of your support to attend OSU).**

    ***a**. Home country, Ministry of Education* ***b**. Home country, Ministry of Agriculture*

    ***c.** My "home" University* ***d**. Family funding*

    ***e**. Ford Foundation* ***f**. Fulbright*

    ***g**. Support from an academic department at OSU* ***h**. Scholarships*

    ***i**. International Institution or a 3rd Country Agency*

    ***j**. Funding from employer or a business* ***k**. Other funding source*

17. What is your anticipated professional position after graduation?**(Circle one response)**

    Faculty/Lecturer *College or University Administrator*

    Private Sector Employee *Self-Employed/Consultant* *Other*

18. Do you anticipate working in your country of citizenship after completing all of your formal schooling (whether at OSU or another institution)? **(Circle one response)**

    Yes *No* *Not sure*

19. After completing school, in which region of the world do you anticipate working primarily? **(Circle one response)**

    USA *Canada* *Europe*

    Australia/New Zealand *Asia* *North Africa*

    Sub Saharan Africa *Latin America* *Other*

20. If a master's student, do you intend to pursue a terminal degree (e.g., PhD, EdD) before returning to your home country? **(Circle one response)**
    Definitely not *Probably not* *Not sure/Uncertain* *Probably yes* *Definitely yes*

APPENDIX F

ONLINE INFORMED CONSENT FORM

Informed Consent Document for Online Research Study Participants

Please, help us to improve tertiary education in the developing world!

Dear students,

We would like to invite you to participate in this survey. It is a dissertation research study of the Department of Agricultural Education, Communications and Leadership. The purpose of the survey is to determine your perceptions about diffusing Information Communications Technologies (ICTs) for advancing agricultural education at colleges and universities in developing countries.

Your participation in the research study is strictly voluntary; however, your participation is highly appreciated for this study to succeed. It is estimated that the questionnaire will require about 25 minutes of your time to complete. Please, complete the questionnaire in one sitting and do not check with any external resources while completing it.

The questionnaire has four parts. The first part is a statement about your attitude toward ICTs. The second part includes statements about the attributes of ICTs impacting their diffusion in higher education in developing countries; the third part has statements about barriers to diffusion of ICTs to deliver higher education in developing countries. The fourth part includes a few questions about you.

Your participation in this research study will not jeopardize your privacy as the answers will be kept completely confidential. There will be no stress or psychological, social, physical, or legal risks that are greater than those ordinarily encountered in daily life during this study. The link below allows you to participate in the study's online questionnaire; by clicking the link, you are giving your consent for participation in the research study:

http://www.survey.com

If you have any questions, please, contact Patrick Saisi at 444 Agricultural Hall, Stillwater, OK 74078, 405-744-3036, or at patrick.saisi@okstate.edu or Dr. M. Craig Edwards via phone number 405-744-8141. If you have a question about your rights as a research volunteer, you may contact Dr. Shelia Kennison, IRB Chair, 219 Cordell North, Stillwater, OK 74078, 405-744-3377 or irb@okstate.edu

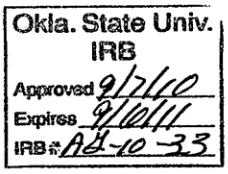
We thank you in advance for accepting to participate in this research study!

Sincerely,

Patrick Saisi
PhD Student
Principal Investigator (PI)

M. Craig Edwards, PhD
Professor
Co-principal investigator and academic adviser

Department of Agricultural Education, Communications & Leadership



APPENDIX G

INFORMED CONSENT FOR HARD COPY SURVEY INSTRUMENT

Q2.a.3 Script (delivery message for hard copy version of the research study questionnaire)

Dear students,

I would like to invite you to participate in this research study by filling the accompanying questionnaire. The purpose of the research study is to determine **your perceptions** about **diffusing Information Communications Technologies (ICTs)** for advancing agricultural education at colleges and universities in developing countries. **If you have participated in this research study by completing the questionnaire online, please, do not fill this hard copy version!**

The questionnaire has four parts. The first part is a statement about your attitude toward ICTs. The second part includes statements about the attributes of ICTs impacting their diffusion in higher education in developing countries; the third part has statements about barriers to diffusion of ICTs to deliver higher education in developing countries. The fourth part includes a few questions about you.

Your participation in the research study is strictly voluntary but it would be **greatly appreciated** by my Department of Agricultural Education, Communications, and Leadership and me. **In no way will your answers be revealed as the questionnaire will be kept completely confidential in a locked file cabinet in my office.** All results will be summarized and reported as a group.

However, we hope that this research study will help higher education institutions in developing countries to reform their curricula and design infrastructure to support the integration of ICTs to advance agricultural education and extension.

If you are going to participate, please, read the WHITE informed consent information on the cover sheet before you start completing the questionnaire. As stated on that form, your answers will be entirely confidential.

DO NOT write your name on the yellow questionnaire booklet!!! When you begin filling in the questionnaire, please, write directly on it.

Please, remember, we are asking for your honest opinion and current knowledge about the statements and questions.

Please, place the completed questionnaire booklet in the brown envelope provided, and place it in the campus mail.

Thank you
Patrick Saisi
PhD. Student
Principal Investigator (PI)

APPENDIX H

ONLINE, FOLLOW-UP REMINDER MESSAGE

Follow-up Message to Online Research Study Participants

Dear student,

You may have previously received an e-mail from us in regards to completing a survey questionnaire on diffusing ICTs in developing countries to advance agricultural education. **This is because we value your experience and expertise in this area.**

We would like to remind you to take a moment and fill the questionnaire that is at the link below and click on submit button when you are done.

Your participation is very important to us as the success of this research study hinges on that. We hope the study will provide some insights on how colleges and universities in developing countries can use ICTs to advance agricultural education. By clicking the link below, you are giving your consent for participation in the research study:

http://www.survey.com

Please, remember that participating in this research study will in no way violate your privacy. Furthermore, your participation in the survey is voluntary. We appreciate greatly your participation in this research study because it will add value to the outcome.

Thank you,

Patrick Saisi (PhD student & Principal Investigator)
Department of Agricultural Education, Communications & Leadership
451 Agricultural Hall
Stillwater, OK 74078
405-744-8036

VITA

Patrick Lumumba Saisi
Candidate for the Degree of

Doctor of Philosophy/Agricultural Education

Thesis: ATTRIBUTES AND BARRIERS IMPACTING THE DIFFUSION OF INFORMATION COMMUNICATION TECHNOLOGIES (ICTs) IN AGRICULTURAL COLLEGES AND UNIVERSITIES IN THE DEVELOPING WORLD: VIEWS OF ASPIRING FACULTY

Major Field: Agricultural Education

Biographical:

Personal Data: Born in Jeptulu Village, Vihiga County, Western Region, Kenya, March 19, 1961, son of Daudi Khagai Saisi and Ruth Muhatia Saisi

Education:

Completed the requirements for the Doctor of Philosophy/Agricultural Education at Oklahoma State University, Stillwater, Oklahoma in July, 2011.

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Name: Patrick Lumumba Saisi Date of Degree: July, 2011
Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: ATTRIBUTES AND BARRIERS IMPACTING THE DIFFUSION OF INFORMATION COMMUNICATION TECHNOLOGIES (ICTs) IN AGRICULTURAL COLLEGES AND UNIVERSITIES IN THE DEVELOPING WORLD: VIEWS OF ASPIRING FACULTY

Pages in Study: 245 Candidate for the Degree of Doctor of Philosophy

Major Field: Agricultural Education

Scope and Method of Study: The sample for this descriptive-correlational study included 72 international graduate students from developing countries who were enrolled in the College of Agricultural Sciences and Natural Resources (CASNR) at Oklahoma State University in the Fall semester of 2010. The study assessed the perceptions of the participants on the attributes and barriers impacting the diffusion of information communications technologies (ICTs) to advance agricultural education in colleges and universities in developing countries. The study also described the relationships between selected personal and professional characteristics of the study's participants and their perceptions on variables impacting the diffusion of ICTs. A survey instrument was used to collect data.

Findings and Conclusions: A majority of the study's participants were males who averaged 30 years of age and 3.43 years of professional experience. Many of the respondents were from Asia and about one-half of them anticipated working in tertiary institutions in their home countries after graduation. Per Rogers' (2003) "stages of the innovation-decision process" (p. 138), as a group, the participants perceived their levels of innovativeness regarding the use of ICTs in academic learning to be between "unpersuaded" and "persuaded." The participants' views overall on the attributes associated with impacting the diffusion of ICTs in colleges and universities in developing countries were in the range of "agree." Although the respondents "agreed" that the attributes measured had the ability to advance the diffusion of ICTs, their views on two of the five attribute constructs (i.e., trialability and observability) were "neutral." The participants' perceptions overall regarding nine barrier constructs were in the range of "moderate." However, the participants perceived three barrier constructs (i.e., "financial concerns," "lack of technical expertise," and "lack of infrastructure") to be "strong barriers" individually. Excluding a few positive relationships that were not statistically significant, as participants' perceptions of agreement with the five attributes most frequently associated with the diffusion of innovations (i.e., per Rogers, 2003) increased, their ratings for the strength of barriers regarding the use of ICTs decreased.

ADVISER'S APPROVAL: Michael Craig Edwards