A PROGRAM EVALUATION OF A RWANDAN MILK COLLECTION CENTER

A Thesis

by

MELANIE ELIZABETH BALINAS

Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Chair of Committee,	Gary Wingenbach
Committee Members,	Tracy Rutherford
	Ellen Jordan
Head of Department,	Jack Elliot

May 2014

Major Subject: Agricultural Leadership, Education, and Communications

ABSTRACT

The purpose of this descriptive, correlational study was to evaluate dairy farmers' adoption characteristics and use of a Milk Collection Center (MCC) in the Western province of Rwanda. A snowball sampling method was used to identify participants ($N = 53$). Farmers answered a research instrument related to their use and perception of the MCC and potential price points for educational services including, artificial insemination training, mastitis treatments, vaccinations at the MCC, training in milking techniques, on-site veterinarian services, and milk quality testing.

The study showed that Rwandan dairy farmers had agreeable attitudes toward the Gisenyi MCC and were influenced by distance to MCC, access to credit, and low cost of technologies. No significant relationships existed between farmers' adopter categories (early vs. late) and their overall attitude toward the MCC. However, relationships existed between individual adopter characteristics and overall attitude toward the MCC. Farmers were willing to pay for certain educational services, such as artificial insemination training and mastitis treatments. Vaccinations at the MCC and artificial insemination training were farmers' highest valued services. Positive relationships existed between price points and importance of educational services.

The MCCs must appeal to their target client, the dairy farmer, and listen to their wants and needs to be successful and have an impact. By drawing attention to the positive attributes of the MCC, participation increases amongst the farmers would

benefit the MCC and the Rwandan dairy market, in addition to helping dairy farmers have a more stable market to sell their product and receive the assistance needed.

ACKNOWLEDGEMENTS

I would like to thank my committee chair, Dr. Wingenbach, for his encouragement, guidance, and humor throughout my research process. I would also like to thank my committee members, Dr. Rutherford and Dr. Jordan, for their guidance and support throughout the course of this research.

Thanks also go to my friends and colleagues in the ALEC department for making my time at Texas A&M University a great experience. Thank you to my friends, professors, and mentors at the University of Wisconsin - Madison for the encouragement, advice, and impact you have had on my education and career decisions. Finally, thanks to my family for their support, understanding, and humor throughout the course of my education.

NOMENCLATURE

AI	Artificial Insemination
CIA	Central Intelligence Agency
EADD	East Africa Dairy Development
GDP	Gross Domestic Product
MCC	Milk Collection Center
MINAGRI	Ministry of Agriculture and Animal Resources
NISR	National Institute of Statistics of Rwanda
NGO	Nongovernmental Organizations
RWF	Rwandan Franc
USD	United States Dollar
USDA	United States Department of Agriculture

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

The United Nations created the Millennium Development Goals (MDGs) in 2000 to address eight international development issues. Of the eight goals, one is to eradicate extreme poverty and hunger (Food and Agriculture Organization [FAO], 2001). It is predicted that by 2050, the world population will grow by two billion, bringing the total to nine billion people (Foley, 2011). Global food production must increase by 40 to 70% to feed the additional population, in addition to those who are currently hungry (Godfray et al., 2010). A partial solution to address this goal may be the use of improved agricultural practices.

Agriculture can be used to address hunger and malnourishment issues worldwide. The development of agricultural practices has had an economic impact in reducing poverty and hunger in sub-Saharan Africa, although sub-Saharan Africa still has the highest rates of hunger and poverty worldwide (Pingali, Stamoulis, & Stringer, 2006). Africa has long been underdeveloped, leaving the smallholder farmer to inefficient forms of harvesting crops and products, ultimately reducing profit and food potential (Lynd & Woods, 2011).

The dairy industry can be an effective tool in reducing hunger and malnutrition. Dairy products are excellent sources of vitamins and minerals. Smallholder, or small scale, dairy farmers constitute a significant portion of all dairy farms in Africa (Muriuki & Thorpe, 2006), with an average production of more than 1,000 pounds of milk per

cow annually. Still, this production is only equivalent to one-fifth the world's average per cow milk production (Ndambi, Hemme, & Latacz-Lohmann, 2007).

The dairy market is developing in Rwanda, contributing approximately 6% to the gross domestic product (GDP) and 15% in the agricultural gross domestic product (AGDP), which is positive growth for the subsector since 2001 (National Institute of Statistics of Rwanda [NISR], 2012). While there is no true distinction between beef and dairy cattle farmers in Rwanda, there are an estimated 1.33 million cattle in country. The cattle herds are 72% Ankole, 20% crossbred, and 8% purebred bred, exotic to the region, mostly Jersey and Holstein-Friesian (NISR, 2012). Not all cattle are for milking purposes. While exact data are hard to find, approximately 14% of Rwandan cattle are exclusively kept for milking purposes. Farmers purchase maize, salt blocks, and tick and worm treatments for cattle (TechnoServe Rwanda, 2008).

The current milk production is 445 million liters per year (NISR, 2012) with an average daily yield of less than five liters per cow (TechnoServe Rwanda, 2008). Herd sizes range from a single cow to 100 or more, depending on the province. In the Western province, most dairy farmers own small herds of two to five cows, although there are a few large-scale operations (TechnoServe Rwanda, 2008).

Several issues limit the growth of the Rwandan dairy industry. Current infrastructures prevent milk from being delivered or properly stored, which causes spoilage. A lack of updated dairy knowledge prevents increased production, and Rwandan rainy seasons contribute to an uneven supply of dairy products (NISR, 2012).

Additionally, there is limited use of the formal dairy supply chain, with farmers opting to keep their milk or sell it informally (TechnoServe Rwanda, 2008).

The Rwandan government addresses dairy-related issues through various agricultural programs. “One Cow per Poor Household” was initiated in 2006 to boost dairy production and decrease poverty (TechnoServe Rwanda, 2008). Through this program, a family is gifted a heifer to rear, and upon producing a female calf, gifts that offspring to another qualified family. Program qualifications include not currently owning any cattle, having 0.75 hectares of land with 0.25 hectares of pasture, a shed, and food and water for the cow (Gorscak, 2011).

Rwanda has a low rate of milk consumption, high malnutrition, and low household income; therefore, the “One Cow per Poor Household” program aims to address those issues (Gorscak, 2011). Some success has been recorded from this program. More than 110,000 cattle have been gifted, milk production has increased, and milk sales have increased (Kanyandekwe, Morandini, Protos, & Sheikh, 2011). Challenges remain in supporting and educating families to properly maintain their cattle (Kanyandekwe et al., 2011). Additionally, program management has been an issue because of concerns with misappropriating funds by gifting local, instead of exotic, cattle, and farmers not passing the offspring to other families (TechnoServe Rwanda, 2008). Program advancement is slow because of long cattle gestation periods and the desire to only pass heifers, not bulls, to families.

Various non-governmental organizations (NGOs) work in Rwanda to improve different aspects of the dairy industry. The most notable NGO effort is the “East Africa

Dairy Development" project (EADD), funded by the Bill and Melinda Gates Foundation and Heifer International (Gates, 2011). The EADD project occurred from 2008 to 2012 and focused on assisting dairy farmers, increasing production and milk marketing, and improving the "Milk Collection Centers" throughout Rwanda, Kenya, and Uganda (NISR, 2012).

Rwanda's "Milk Collection Centers," sometimes referred to as "Milk Chilling Centers" (MCCs), are community milk storage centers where farmers, or their cowboy workers, deliver their milk (Nyabila, 2011). Milk is collected and taken to market for processing and sale, unless it does not meet quality standards or spoils before it can be sold. Some MCCs are privately owned and plan to invest in dairy education services and education for local farmers (Ministry of Agriculture and Animal Resources [MINAGRI], 2012).

The typical MCC contains one bulk tank, requires a one-time fee from farmers, and is sustained by milk revenues (TechnoServe, 2008). MCCs either own a milk shop in the capital city, Kigali, to sell milk or will sell directly to a transporter/supplier (TechnoServe, 2008). The average MCC earns a 6% profit margin due to the large expenses for salary and electricity (TechnoServe, 2008).

Education services such as artificial insemination training, on-site veterinarian, training in milking techniques, mastitis treatments, vaccinations, and milk quality testing could potentially be added to existing MCCs for farmer use with the end goal of increasing milk quality and quantity (MINAGRI, 2012). Those services have shown an impact in dairy markets in sub-Saharan Africa (Jaffee, Henson, & Diaz Rios, 2011). A

better understanding of what farmers do, what they think would be most beneficial, and how they adopt new practices, may increase the success of education services in the Rwandan dairy supply chain.

Country Profile

Rwanda, located in Central Africa, has 10,000 square miles of land and is a landlocked country. It has a population of 12 million, making it the most densely populated country in Africa (Central Intelligence Agency [CIA], 2013) with approximately 455 inhabitants per square kilometer. Land scarcity issues will increase with a growing population. Currently, 46% of Rwanda is cultivated (TechnoServe Rwanda, 2008). Of that land, the average farm household cultivates plots of one and a quarter acres (World Food Programme, 2012). The terrain consists of grassy uplands and hills and mountains toward the north. It has a moderate climate, occasionally receiving frost and snow, and two rainy seasons (February to April and November to January) (CIA, 2013).

The NISR (2012) revealed that 85% of the households were agriculturally based. Those households cultivate land and rely on agriculture as the primary or only source of income (World Food Programme, 2012). Food security and poverty issues persist with the current-levels of land scarcity and reliance on agriculture.

Approximately 45% of Rwanda's population lives in poverty (World Food Programme, 2012). The two poorest quintiles (bottom 40%) of households accounted for 74% of low food consumption households (World Food Programme, 2012). Those poor

households cannot afford nutritious meals on a regular basis, do not consume sufficient calories to live healthy lives, or invest in their livelihoods.

Rwanda is a low-income country with $570 USD in gross national income (GNI) per capita (CIA, 2013). Rwanda has a GDP of $6.95 billion USD with a growth rate of 7.7% (CIA, 2013). By sector, the service industry represents 52.9% of the GDP followed by agriculture (33.3%), and industrial (13.9%) (CIA, 2013).

In 2011, Rwanda imported $2 million USD of dairy products including yogurt, cheese, milk, and cream. The amount of imports has steadily increased since 2006. Dairy product exports are significantly less valued at $150,000 USD (IndexMundi, 2012).

Literature Review

Adopter Characteristics

The adoption process of an innovation can be described through Rogers' (2003) innovation decision model. Rogers' (2003) model posits that an individual advances from knowledge of an innovation, to forming an opinion about it, to accepting or rejecting the idea of adopting the innovation, and then to confirming the decision. This process is used in the diffusion of technologies, but targeting the audience by adopter categories is also part of the process and it takes time, depending on the individual.

Rogers (2003) noted that all adopters or non-adopters could be categorized into one of five groups: innovators, early adopters, early majority, late majority, or laggards. While innovators are educated, have large social circles, and are most likely to adopt technologies first, early adopters are more likely to be influential and become opinion leaders among peers (Rogers, 2003). Opinion leaders were found to be important in the

adoption of new technologies. Early and late majority adopters tend to be more skeptical and wait until there is more public opinion on the technology, while laggards wait until most others have adopted that technology, normally delaying until they have no other options (Rogers, 2003).

Rogers' model is generally accepted as the standard for describing adopters' characteristics in US-based situations. However, Smith and Findeis (2013) used Rogers' model in rural Mozambique with mixed results. While Rogers' model was applicable for certain aspects of their study, rural African farmers did not fit the model in all adopter categories. Therefore, adopters' characteristics and categories in international settings may be better described using other models.

Abdulai and Huffman (2005) argued that international farmers experienced technology adoption process equally, but only two adopter categories were evident. During the early stage of adoption, "early adopters" were positively influenced by a) low cost of new technologies, b) head of household's education level, and c) access to credit. Early adopters' were not influenced by a) head of household's age, b) distance to market, c) contact with extension agents, or d) number of other farmers who adopted technologies. During the late stage of the adoption process, "late adopters" were more likely to adopt technologies if they a) were close to markets, and b) had contact with extension services; however, price of technology did not affect late adopters (Abdulai & Huffman, 2005). It was also suggested that farmers who were more educated became early adopters because they saw potential profits earlier in the adoption process, than did late adopters.

Factors Influencing Adoption

Several common factors that influence adoption or non-adoption of a technology among smallholder farming groups in sub-Saharan Africa were revealed through the literature review. Knowledge of the technology transfer process should be used to better understand how to gain higher adoption rates among Rwandan dairy farmers.

Abdulai and Huffman (2005) showed that smallholder farming households located closer to local markets or product drop-off locations were more likely to adopt new technologies than were farmers in isolated locations. Lack of assets, such as education or equipment, limited adoption rates of new technologies (Muzari, Gatsi, & Muvhunzi, 2012). Farmers' relationships with area institutions and the financial, educational, and facility assistance provided by institutions had a positive influence on farmers adopting new technologies (Muzari et al., 2012). Muzari et al. (2012) confirmed Abdulai and Huffman's (2005) findings that access to education and contact with extension agents positively influenced adoption rates. Abdulai and Huffman (2005) showed that farmers with access to credit had higher rates of adoption than did farmers struggling to gain credit.

Chi and Yamada (2002) found that smallholder farmers chose to adopt or not adopt a technology based on their perception of its usefulness to their situation. Farmers had positive perceptions of technologies if improved outputs were demonstrated. Diffusion through word-of-mouth and demonstrations increased adoption rates (Chi & Yamada, 2002).

Education Services

Agricultural extension or educational services have long been used in sub-Saharan development. These services can be focused on improving production, training farmers, assisting farmer groups, and partnering with service providers and agencies for additional work (Davis, 2008). While impacts of educational services may be hard to measure in some cases, they have generally been shown to have effects on knowledge, production, and adoption of technology (Davis, 2008).

The addition of various extension, also called education services, such as artificial insemination and milking training, veterinary services, mastitis treatments, vaccinations, and milk quality testing could improve the reliability and production of the dairy industry in developing markets. Limited dairy growth and performance can be attributed to several factors including low farmer training and high cattle disease rates in Eastern African countries (Tebug et al., 2011).

Training farmers on proper milking and artificial insemination techniques, and providing greater access to vaccinations can make improvements (Njehu, Omore, Baltenweck, & Muriithi, 2011). Tebug et al. (2011) found that several of the restraints in the dairy industry in Malawi were related to inadequate training and veterinary services. Farmers in Malawi reported that lack of superior dairy genetics, poor animal health, low prices for milk, and poor farm management were major constraints to the growth of their dairy practices (Tebug et al., 2011). Those constraints were tied to several causes related to education and services available.

There is room for growth in African dairy markets, especially with new technologies and education of farmers. By improving the dairy industry, it is possible to have a greater impact on other sectors, such as health and poverty reduction.

Purpose of Study

The purpose of this study was to evaluate Rwandan dairy farmers' perceptions and use of the Gisenyi Milk Collection Center (MCC) in the Rubavu district. The research objectives were to:

1. Determine Rwandan dairy farmers' adopter characteristics;
2. Describe Rwandan dairy farmers' attitudes toward the Gisenyi MCC;
3. Determine if significant relationships exist between dairy farmers' attitudes and adopter characteristics;
4. Examine dairy farmers' price points of selected Gisenyi MCC educational services;
5. Rank the perceived importance of Gisenyi MCC educational services; and,
6. Determine if significant associations exist between dairy farmers' price points and perceived importance of selected Gisenyi MCC educational services.

Methods

A descriptive, correlational research design was used to conduct the study. Those methods were chosen to accurately describe the population sample and to allow for and identify potential relationships among selected variables of interest (Fraenkel & Wallen, 2009). This study was reviewed and approved by the Institutional Review Board in

compliance with Texas A&M University's Human Subject Research requirements (IRB2013-0227).

Population

Rwanda has an estimated population of 12 million people and is divided into five provinces: Eastern, Western, Northern, Southern, and the capital city of Kigali (NISR, 2012). An estimated population of 50,000 residents were in Gisenyi, and was equally distributed between males and females (NISR, 2012). The sample population for this study was all dairy farmers from Gisenyi who had the ability to participate in Rwanda's Milk Collection Centers in the Western province. The population, as defined by Fraenkel and Wallen (2009), was "the group in which the results should be generalized" (p. 102). It was important to correctly identify the population to form the sample.

A snowball sampling method (Babbie, 2012) was used. Snowball sampling was an appropriate method because there were no formal addresses, locations, or means of finding participants readily available (Babbie, 2012). The snowball sampling method allowed the researcher to survey participants, and then ask those participants who else should be surveyed (Babbie, 2012). The Gisenyi area Milk Collection Center (MCC) was chosen because it was active, working, and considering new education services for farmers. The sample was dairy farmers in Gisenyi village who had the ability to participate in the MCC. A sample size of 55 farmers was required to achieve a 95% confidence level with a 10% margin of error (Dillman, 2007).

Instrumentation

The research instrument was a modified version of Stellbauer's (2010) research (Appendix A), which was created for adult, Rwandan coffee farmers to assess their attitudes and opinions of their coffee cooperative. The instrument was modified to fit the objectives of this study. By changing statements from coffee production to milk production and detailing concerning educational services offered by the MCC. Some statements in each section were reverse coded to increase instrument reliability. The original instrument was edited for clarity and cultural sensitivity.

The research instrument was based on research manuals on African cooperatives and rural development planning and practices (Stellbauer, 2010). It was developed using Dillman's (2007) suggestions, such as making questions easy-to-understand, using multiple formats, and avoiding emotion-based questions. As noted by Stellbauer, "The completion of the draft instrument was followed by a thorough critique from those that would be involved in the survey implementation process. This critique served to verify the content validity of the instrument" (Stellbauer, 2010, p. 53). For the purpose of this study, a reliability coefficient of 0.70 was accepted because measures of personality/perception variables are hard to determine (Ary, Jacobs, Razavieh, & Sorensen, 2010).

The instrument included close-ended, four-point scales; it was administered in person by the researcher and a translator in Gisenyi, Rwanda. Response options of strongly agree, agree, disagree, and strongly disagree were used for the majority of

questions. Levels of agreement were coded as 1 = strongly disagree, 2 = disagree, 3 = agree, and 4 = strongly agree.

Six main sections comprised the research instrument. It contained questions and statements about farmers' perceptions and use of the Gisenyi MCC, their potential use of the MCC, and their thoughts toward educational services. Farmers were asked to provide background information on their farm and family, rank educational services, and assess monetary value of those services.

The first section focused on farm size, current use of the Gisenyi Milk Collection Center, and the Rubavu district. It contained three open-ended questions, one yes or no question, and five statements on the four-point (1 = strongly disagree…4 = strongly agree) scale. This section provided demographic data to help identify respondent's adopter characteristics and dairy farming impact on their livelihood.

Section two, Gisenyi Milk Collection Center, contained 20 statements to understand farmers' perception of the Gisenyi MCC on a four-point (1 = strongly disagree…4 = strongly agree) scale. It included statements such as, *Participation in the MCC allows me to be more competitive economically, I do not like how the MCC is operated,* and *I would use the MCC if a neighbor told me to use it.*

Section three, educational services, contained seven statements on the four-point (1 = strongly disagree…4 = strongly agree) scale about the use or addition of educational services to the MCC. This section's sample statements included *The MCC can continue to function without educational services, I am willing to use educational services if they*

are provided by the MCC, and *I would only use educational services if they were of no cost to me.*

A section on farmer willingness to pay for educational services was used to help identify education service perceived importance and price points. Section four, finances, included eight statements on a four-point (1 = strongly disagree…4 = strongly agree) scale that measured income from milk sales and included statements such as *Income from milk sales has allowed me to purchase more land, Does not allow me enough to buy cattle,* and *Makes me want to earn more money from milk sales at the MCC.* Willingness to pay gave farmers options of how much they would pay for various educational services. Respondents were instructed to select monetary values ($1USD = 645 RWF) from RWF 0, 1-500 ($0.01-0.78USD), 501-999 ($0.79-1.55), 1,000-2,999 ($1.56-4.65), 3,000-4,999 ($4.66-7.75), and 5,000+ ($7.76+) for each of the six potential education services: *artificial insemination (AI training, mastitis treatments, milk quality testing, on-site veterinarian, training in milking techniques*, and *vaccinations at the MCC.*

Identifying the importance of educational services was needed to rank services by farmer importance. The fifth section measured participants' frequency of MCC use or their potential future use of MCC educational services. Respondents ranked the importance of selected educational services (*AI training, mastitis treatments, milk quality testing, on-site veterinarian, training in milking techniques*, and *vaccinations at the MCC)* from 1 (most important) to 6 (least important).

The final section contained demographic questions about gender, education, farm size, and a request for other participants who should be interviewed. Completed instrument data was applied to adopter categories.

Data Collection

Data were collected from June through July 2013. The research instrument was conducted by a local Gisenyi Milk Collection Center manager because of the positive relationship already built with Gisenyi farmers, knowledge of the dairy industry, and knowledge of Rwanda. Having the survey conducted by a trusted person encouraged participants to be open and honest in their responses (Rogers, 2003).

Participants were given an information sheet and consent form to complete to begin the administration of the instrument. Interviews were approximately 30 minutes. The instrument was administered in the appropriate language of English, French, or Kinyarwanda. There is a national literacy rate of 74% (NISR, 2008); however, for illiterate participants, the MCC manager obtained verbal consent and read the instrument to each respondent. There were no exclusion criteria (gender, age, financial, or racial) for participation in this study. Participants' names and other identifying information were not included in the data analyses to ensure their confidentiality.

Data Analysis

Descriptive and correlational statistics were used to analyze and report the data. Means, standard deviations, and frequencies were reported. Correlation coefficients were appraised following Davis' (1971) guidelines (.01-.09 = negligible association, .10-.29 = low, .30-.49 = moderate, .50-.69 = substantial, and .70+ = very strong).

CHAPTER II

RWANDAN DAIRY FARMERS' CHARACTERISTICS AND ATTITUDES TOWARD MILK COLLECTION CENTERS

Introduction

Dairy farming provides benefits in developing countries, such as health benefits derived from the nutritional value of dairy products and potentially enhanced livelihoods from dairy sales (Makokha, Karugia, Staal, & Oluoch-Kosura, 2007; Nicholson & Thornton, 1999). Dairy products provide a source of energy, protein, and essential micro-nutrients (Nicholson & Thornton, 1999). The nutritional value can help improve health and balance diets of those in developing countries (Nicholson & Thornton, 1999). Additionally, dairy production leads to increased milk sales and income for farmers (Jaffee et al., 2011; Nicholson & Thornton, 1999).

Smallholder dairying has been a part of the growth of agricultural markets in developing countries. However, the dairy industry in many countries operates through informal markets with milk being sold roadside, in raw form, and/or with low quality standards (Jaffee et al., 2011). Further development of dairy industries can help formalize milk sales and increase industry success.

Rwanda has dairy product imports of more than $2 million USD in dairy products annually, differing from their $150,000 USD dairy product export values (IndexMundi, 2012). The Rwandan dairy market is small with only 14% of the 1.33 million cattle being used for milking purposes (TechnoServe Rwanda, 2008). The current level of milk production is 445 million liters per year (National Institute of

Statistics of Rwanda [NISR], 2012) with an average daily yield of five liters per cow (TechnoServe Rwanda, 2008).

Rwanda's "Milk Collection Centers" (MCCs), are community milk storage centers where farmers deliver and sell their milk (Nyabila, 2011). Milk is collected and taken to market for processing and sale, unless it does not meet quality standards or spoils before it can be sold (TechnoServe, 2008). There are more than 30 MCCs in the country, some more successful and functional than others (TechnoServe, 2008). The success of a MCC depends on local farmers' participation, conditions of the MCC facilities, and support from government or companies.

Rwandan Milk Collection Centers could play an important role in increasing milk sales countrywide, especially through formal milk markets; however, there is low farmer participation with the MCCs (TechnoServe, 2008). With a high rate of milk not going through the MCCs, farmers' adoption rates of the centers appear to be low (TechnoServe, 2008). Progress may be made in increasing participation by gaining an understanding of farmers' adoption characteristics and attitudes toward the Gisenyi MCC.

Literature Review

The adoption of a new technology can influence the success or failure of that technology or innovation. This adoption process can vary depending on the subject and location of the adoption. Rogers' (2003) model is generally accepted as the standard for describing adopters' characteristics in US-based situations. However, adopters'

characteristics and categories in international settings may be better described using other models.

Abdulai and Huffman (2005) argued that international farmers experienced technology adoption with only two adopter categories evident. During the early stage of adoption, "early adopters" were positively influenced by a) low cost of new technologies, b) head of household's education level, and c) access to credit. Early adopters' were not influenced by a) head of household's age, b) distance to market, c) contact with extension agents, or d) number of other farmers who adopted technologies. During the late stage of the adoption process, "late adopters" were more likely to adopt technologies if they a) were close to markets, and b) had contact with extension services; however, technology price did not affect late adopters (Abdulai & Huffman, 2005). It was also suggested that farmers who were more educated became early adopters because they saw potential profits earlier in the adoption process, than did late adopters.

The addition of various extension and education services such as artificial insemination and milking training, veterinary services, mastitis treatments, vaccinations, and milk quality testing could improve the reliability and production of the dairy industry in developing markets. Limited dairy growth and performance can be attributed to several factors including low farmer training and high animal disease rates in Eastern African countries (Tebug et al., 2011).

Purpose of Study

The purpose of this study was to determine Rwandan dairy farmers' likelihood of using Gisenyi Milk Collection Center (MCC) services in the Rubavu district. The research objectives were to:

1. Determine Rwandan dairy farmers' adopter characteristics;
2. Describe Rwandan dairy farmers' attitudes toward the Gisenyi MCC; and,
3. Determine if significant relationships exist between dairy farmers' adopter characteristics and farmers' attitudes toward the Gisenyi MCC.

Methods

A descriptive, correlational research design was used in this study. In compliance with Texas A&M University's Human Subject Research requirements, this study was reviewed and approved by the Institutional Review Board (IRB2013-0227).

Rwanda has an estimated population of 12 million people. There was an estimated 50,000 residents in Gisenyi and it was equally distributed between males and females (NISR, 2012). The population for this study was all dairy farmers from Gisenyi who had the ability to participate in Rwanda's Milk Collection Center. The sample, 55 farmers, was required to achieve a 95% confidence level with a 10% margin of error (Dillman, 2007). The final sample size of farmers willing to participate was ($N = 53$). A snowball sampling method was used (Babbie, 2012).

The research instrument was a modified version of Stellbauer's (2010) research instrument. The original instrument was created for adult, Rwandan coffee farmers to assess their attitudes and opinions of their coffee cooperative (Stellbauer, 2010). The

instrument was modified to better fit the objectives of this study. Modifications were made to change statements from coffee production to milk production and specifics concerning the educational services. The original instrument was edited for clarity and cultural sensitivity.

The research instrument contained three sections to satisfy the objectives of this study. For the first objective, data were collected on farmers' adopter categories. It contained three open-ended questions, one yes or no question, and five statements on a four-point (1 = strongly disagree…4 = strongly agree) scale; sample statements included *Farm location, Milking cattle are my most valuable agricultural enterprise,* and *I wish to milk more dairy cattle.*

Section one of the research instrument contained 20 statements on the four-point (1 = strongly disagree…4 = strongly agree) scale. The statements were based on the farmers' perceptions and attitudes toward the Gisenyi MCC. Sample statements included *Is located close to my household, Participation in the MCC allows me to be competitive economically,* and *I wish to use the MCC more often.*

The research instrument also contained a section to evaluate the importance level that farmers associated with selected educational services. Farmers were instructed to rank the six selected educational services (*artificial insemination (AI) training, mastitis treatments, milk quality testing, on-site veterinarian at MCC, training in milking techniques,* and *vaccinations at the MCC)* from 1 (most important) to 6 (least important).

Data were collected from June to July 2013 and the research instruments were administered in the appropriate language of English, French, or Kinyarwanda. The local

Gisenyi Milk Collection Center manager administered the instrument because of the positive relationship already built with the Gisenyi farmers, knowledge of the dairy industry, and knowledge of Rwandan culture. Participants can be more open and honest in their responses when someone they trust is administering the instrument (Rogers, 2003). Descriptive and correlational statistics were used to analyze the data.

Results

The first objective was to determine Rwandan dairy farmers' adopter characteristics. Demographic information was collected and is displayed in Table 2.1. As shown in Table 2.1, the majority was male (f = 49, 92.5%), lived 20 kilometers or closer to the MCC (f = 35, 72.9%), and were current users of the MCC (f = 44, 83%). The apparent uneven distribution of participant demographics may be attributed to the snowball sampling method. Farmers were asked to name someone else for the study, resulting in apparently a more homogenous group of participants. There was a somewhat even distribution of education level between those who had attended primary (f = 24, 49%) and secondary schooling (f = 20, 40.8%) and age, with half being less than 45 years old (f = 28, 52.8%).

Table 2.1

Demographic Profile of Participants ($N = 53$)

Variable	Category	f[a]	%
Gender	Male	49	92.5
	Female	4	7.5
Distance from MCC	More than 20km	35	72.9
	Less than 20km	10	27.1
Current MCC Use	Yes	44	83.0
	No	9	17.0
Education Level	Primary	24	49.0
	Secondary	20	40.8
	None	5	10.2
Age	30-45	28	52.8
	46-60	22	41.5
	61+	3	5.7

Note. [a]Frequencies may not total 53 because of missing data.

Completed demographics were used to categorize participants by their adopter characteristics (early or late adopters). Early adopters were participants who were educated, had greater access to credit, and were concerned with technology cost. Late adopters were current users of the MCC and lived 20 kilometers or closer to the MCC. The distribution of participants ($N = 53$) appeared even; 47.2% ($f = 25$) were identified as early adopters and 52.8% ($f = 28$) as late adopters.

The second objective was to describe Rwandan dairy farmers' attitudes toward the Gisenyi MCC. Participants completed 20 statements related to farmers' attitudes toward the Milk Collection Center and their familiarity with it. Table 2.2 displays the

means and standard deviations. A reliability coefficient of $\alpha = 0.71$ was achieved for the 20 statements.

Table 2.2

Rwandan Dairy Farmers' Attitudes Toward Gisenyi MCC (N = 53)

Statement	M^a	*SD*
I wish to use the MCC more often	3.53	.58
I am able to approach the MCC workers for assistance	3.40	.75
I am familiar with the MCC	3.38	.69
Has taught me new practices for milking	3.22	.98
Is respected in my community	3.19	.76
Participation in the MCC allows me to be competitive economically	3.13	.65
Is located close to my household	3.13	.86
Has helped my community grow	3.11	.78
I am familiar with the MCC	3.38	.99
The MCC is operating efficiently	3.08	.76
Has helped me achieve a sustainable livelihood	3.04	.39
Is located too far away from my household	3.04	1.04
Does not provide me better access to credit	2.85	1.12
I do not like how the MCC is operated	2.10	.88
I do not wish to use the MCC	1.72	1.04
I am not aware of the MCC	1.65	.90
I do not feel comfortable approaching the MCC for assistance	1.39	.85
I would use the MCC if a neighbor told me to use it	1.35	.57
Is not well liked in my community	1.18	.68
I do not use the MCC because my friends do not use the MCC	1.15	.50

Note. [a]All items measured on 4-point Likert-type scale: *1 = Strongly Disagree, 2 = Disagree, 3 = Agree, and 4 = Strongly Agree.*

Farmers agreed ($M = 2.51$-3.50) or strongly agreed ($M = 3.51$-4.0) with 13 of the statements. They agreed with statements such as "*Has helped my community grow*" ($M = 3.11$, $SD = 0.78$), "*Is respected in my community*" ($M = 3.19$, $SD = 0.76$), "*Has taught me new practices for milking*" ($M = 3.22$, $SD = 0.98$), and "*I wish to use the MCC more*

often" (M = 3.53, SD = 0.58). Participants disagreed with negatively worded statements, meaning they felt positively about those statements.

The third objective was to analyze if significant relationships existed between dairy farmers' adopter characteristics and their attitudes toward the Gisenyi MCC. To analyze possible statistical relationships between farmers' characteristics and their attitudes, attitudinal scaled scores for the Gisenyi MCC were summed. Prior to using the summed attitudinal score, an internal test of reliability was conducted on the 20 attitudinal statements using Cronbach's alpha (Gliem & Gliem, 2003); a reliability coefficient of $\alpha = 0.78$ was found for the attitudinal scale. A coefficient over 0.70 was acceptable because measures of personality/perception variables are harder to determine (Ary et al., 2010). Farmers' attitudinal summed scores averaged 52.41 (SD = 7.26); summed scores ranged from 36.00 to 65.00. This summed score suggested that farmers' agreed (M = 50.51 – 70.50) with the 20 statements relating to the Gisenyi MCC.

The summed attitudinal score was used in Spearman Rho and point-biserial correlation analyses with farmers' adopter characteristics (Table 2.3). There was a substantial correlation between farmers' attitudes and their use of the Gisenyi MCC (r_s = 0.54, p = .00). Additionally, there was a moderate correlation between MCC use and adopter category (r_s = 0.48, p = .00). A substantial negative correlation was found between farmers' attitudes and cost of technology (r_s = -0.53, p = .00).

Table 2.3

Relationships between Adopter Characteristics and Farmers' Attitudes

Characteristic	2	3	4	5	6
1 Use of MCC	-.27	-.27	.29*	.48*	.54*
2 Education (none, primary, secondary)	_	-.07	.24	-.20	-.28
3 Low cost of technology		_	-.02	-.14	-.53*
4 Access to credit			_	.38	.05
5 Adopter (early vs. late)				_	.14
6 Attitude[a]					_

Note. * $p \leq 0.05$, two-tailed.
[a]Summed score.

There were moderate and substantial correlations between farmers' distance to the MCC and their use of it ($r_{pb} = 0.29$, $p = .04$) and farmers' attitudes ($r_{pb} = 0.42$, $p = .00$). A substantial negative correlation was found between distance and adopter categories ($r_{pb} = -0.50$, $p = .00$). While correlations were found between individual characteristics and attitudes of farmers, no significant correlation existed between adopter categories (early or late) and their overall attitudes toward the MCC.

Conclusions and Recommendations

"Early adopters" were those who are positively influenced by a) low cost of new technologies, b) head of household's education level, and c) access to credit; while "late adopters" were more likely to adopt technologies if they a) were close to markets, and b) had contact with extension services. The results showed there was an apparent even distribution between early and late adopters with regard to their use of the Gisenyi area Milk Collection Center. The characteristics of distance from the MCC, current use, education level, access to credit and importance of low cost of new technology determined the categories and results of the farmer distribution.

Participants held agreeable attitudes toward the Gisenyi area MCC. While no significant relationship was found between farmers' attitudes toward the MCC and adopter categories, there were relationships between attitudes and adopter characteristics. Positive relationships were found between farmers' current use of the MCC and their distance to the MCC, access to credit, adopter category, and summed attitudinal scores. Additionally, a significant negative correlation between low cost of technology and the summed attitudinal score, which may suggest that cost of services and technologies was important to farmers.

These results are consistent with Abdulai and Huffman (2005) who found that farmers with greater access to local markets were more likely to adopt a new technology. There is an infrastructure and milk spoilage issue in the country (NISR, 2012), so closer and easier access to the MCC may help to reduce milk spoilage issues and improve the farmer attitude toward the center. Additionally, farmers were influenced by the low cost of technology and access to credit, which is consistent with research that showed farmers with positive relationships with area institutions and access to credit were more likely to adopt (Muzari et al., 2012).

This research revealed that different factors had an impact on Rwandan dairy farmers' attitudes toward the local Milk Collection Center. A focus on the positive factors, such as the low cost of a new technology and a short distance to the center, could increase the positive relationship between farmers and the MCC. With an increased positive relationship between MCCs and farmers, consistent use of the MCC may increase as well. Another study by Chi and Yamada (2002) found that adoption of

technology was based on perception of usefulness; therefore, an emphasis on the benefits and utility of the MCC could help to increase the adoption of it amongst the target farmer group.

The use of a larger and more heterogeneous sample of participants is recommended to provide a better representation of the population and greater validity and reliability of data. More research into the individual characteristics and motivation of adoption should be investigated to increase the understanding and implications of adoption theory in regards to farmers in developing countries. This research should be expanded and continued to develop a better understanding of farmers' adopter characteristics and categories in developing agricultural sectors.

CHAPTER III

RWANDAN DAIRY FARMERS' USE AND OPINIONS TOWARD EDUCATIONAL SERVICES IN THE GISENYI MILK COLLECTION CENTER

Introduction

Smallholder dairy has been a part of the growth of agricultural markets in developing countries and the Rwandan dairy sector is currently growing. With the assistance of various organizations, such as The Gates Foundation, Heifer International, and the Rwandan Ministry of Agriculture and Animal Resources, an emphasis on improving the dairy sector has been established (TechnoServe Rwanda, 2008). There are efforts to increase the number of cattle, the milk production, the value chain, and education and extension outreach.

Rwanda utilizes community milk collection or milk storage centers, called "Milk Collection Centers" (MCC). Farmers can deliver and sell their milk at the MCC for processing and sale to consumers (TechnoServe Rwanda, 2008). However, participation with MCCs is low for a variety of reasons. Milk produced is often consumed at home, sold through informal markets, wasted through spoilage, or too low of quality for MCCs (TechnoServe Rwanda, 2008).

The use of education services in sub-Saharan Africa has been shown to have an impact on the dairy markets (Jaffee et al., 2011). With the end goal of increasing milk quality and quantity amongst Rwandan dairy farmers, adding educational services could potentially be beneficial (Ministry of Agriculture and Animal Resources [MINAGRI], 2012).

Literature Review

Agricultural extension or educational services have long been used in sub-Saharan development. These services can be focused on improving production, training, assisting farmer groups, and partnering with service providers and agencies for additional work (Davis, 2008). Educational services have generally been shown to have positive effects on knowledge, production, and adoption of technology; even though the effects are sometimes hard to measure (Davis, 2008).

According to Davis (2008), different approaches to education/extension services have been implemented: fee-for-service, farmer field schools, farmer study circles, and others. Each approach has positive and negative aspects and different levels depending on the country and the situation (Davis, 2008).

Limited dairy growth and performance can be attributed to several factors including low farmer training and high animal disease rates in Eastern African countries (Tebug et al., 2011). The addition of various extension and education services such as artificial insemination and milking training, veterinarian services, mastitis treatments, vaccinations, and milk quality testing could improve the reliability and production of the dairy industry in developing markets.

Training farmers on proper milking and artificial insemination techniques, and providing greater access to vaccinations can make improvements (Njehu et al., 2011). Tebug et al. (2011) found that several of the constraints in the dairy industry in Malawi were related to inadequate training and veterinary services. Farmers in Malawi reported that superior dairy genetics, poor animal health, low prices for milk, and poor farm

management were major constraints to the growth of their dairy practices (Tebug et al., 2011). Those constraints were tied to several causes related to education and services available.

The accepted price point or willingness to pay for an educational service can help guide the implementation of that service (Horna, Smale, & Von Oppen, 2007). Therefore, by gaining knowledge of farmers' willingness to pay for educational services their interests and feasibility can be better understood (Horna, Smale, & Von Oppen, 2007).

Purpose of Study

The purpose of this study was to examine Rwandan dairy farmers' perceptions of potential Gisenyi Milk Collection Center education services and price points. The research objectives were

1. Examine dairy farmers' price points of selected Gisenyi MCC educational services;
2. Rank the perceived importance of Gisenyi MCC educational services; and,
3. Determine if significant associations exist between dairy farmers' price points and perceived importance of selected Gisenyi MCC educational services.

Methods

A descriptive, correlational research design was utilized for this study. In compliance with Texas A&M University's human subject research requirements, the

research instrument and documents were submitted for review and were approved by the Institutional Review Board (IRB2013-0227).

The sample population for this study was all dairy farmers in Gisenyi that had the ability to participate in the Gisenyi Milk Collection Center. A sample, 55 farmers, was required to achieve a 95% confidence level with a 10% margin of error (Dillman, 2007). The final sample size of farmers willing to participate was ($N = 53$). This sample was achieved through a snowball sampling method, which was selected because the sample population was hard to locate and there were no accurate records of farms or contact information.

The research instrument for this study was a modified survey from Stellbauer's (2010) research instrument. The original instrument was critiqued for validity and cultural appropriateness (Stellbauer, 2010). Modifications were made to the instrument to better align it with the topic and objectives of this study. The subject of the instrument was changed from Rwandan coffee farmers and their attitudes (Stellbauer, 2010) and opinions of a coffee cooperative to Rwandan dairy farmers and their attitudes and opinions toward the Gisenyi Milk Collection Center.

The research instrument included a section on the farmer willingness to pay for potential educational services to help identify education service perceived importance and price points. Farmers had the options of how much they would pay for the various educational services. They were instructed to select a monetary value between RWF 0, 1-500 ($0.01-0.78USD), 501-999 ($0.79-1.55), 1,000-2,999 ($1.56-4.65), 3,000-4,999 ($4.66-7.75), and 5,000+ ($7.76+) ($1USD = 645 RWF) for each of the six potential

education services: *AI training, mastitis treatments, milk quality testing, on-site veterinarian at MCC, training in milking techniques*, and *vaccinations at the MCC*.

Identifying the importance of the educational services was needed to rank the services by farmer importance. The other section asked participants how often they used the MCC or their potential future use of the MCC educational services. They ranked the importance of the selected educational services (*artificial insemination (AI) training, mastitis treatments, milk quality testing, on-site veterinarian at MCC, training in milking techniques*, and *vaccinations at the MCC)* from 1 (most important) to 6 (least important).

Data were collected from June to July 2013 and the research instrument was offered in the appropriate language of English, French, or Kinyarwanda. A local MCC manager collected the data and communicated with the participants. This method was chosen because of the existing relationship, trust, and shared culture and language the manager had with the participants. The existing relationship helped encourage more open and honest responses on the survey (Rogers, 2003). The survey took approximately 30 minutes to complete. To address illiteracy, participants opted out of the survey or had the MCC manager read the survey to them and mark their responses.

Descriptive and correlational statistics were used to analyze the data collected in this study. A reliability coefficient of 0.70 was deemed acceptable for this study because of the difficulty in assessing personality and opinion in survey research (Ary et al., 2010). Davis' (1971) convention for describing correlation coefficients was used (0.01-0.09 = negligible association, 0.10-0.29 = low, 0.30-0.49 = moderate, 0.50-0.69 = substantial, and 0.70+ = very strong).

Results

A majority of the respondents was male (*f* = 49, 92.5%), lived 20 kilometers or closer to the MCC (*f* = 35, 72.9%), were current users of the MCC (*f* = 44, 83%), and most were 45 or younger (*f* = 28, 52.8%) as shown in Table 3.1. Farmers were asked to provide the name of someone else for the study through the snowball sampling method. The snowball sampling method resulted in apparently a more homogenous group of participants.

Table 3.1

Demographic Profile of Participants (N = 53)

Variable	Category	*f*[a]	%
Gender	Male	49	92.5
	Female	4	7.5
Distance from MCC	More than 20km	35	72.9
	Less than 20km	10	27.1
Current MCC Use	Yes	44	83.0
	No	9	17.0
Age	30-45	28	52.8
	46-60	22	41.5
	61+	3	5.7

Note. [a]Frequencies may not total 53 because of missing data.

The first objective was to examine dairy farmers' price points of selected Gisenyi MCC educational services. Dairy farmers determined how much money they preferred to pay for each of the six potential education services (*AI training, mastitis treatments, milk quality testing, on-site veterinarian, training in milking techniques,* and

vaccinations at the MCC) at the Gisenyi MCC (Table 3.2). The values ranged from $0USD to $7.75USD or more for each service.

Table 3.2

Frequencies of Farmer Price Points for Potential Education Services (N = 53)

	Educational Services Monetary Value (in USD)											
	$0.00		$0.01-1.25		$1.26-1.54		$1.55-4.65		$4.66-7.99		$7.75+	
	f	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
A	7	13.2	4	7.5	10	18.9	10	18.9	10	18.9	12	22.6
B	13	24.5	9	17.0	2	3.8	12	22.6	0	0.0	17	32.1
C	13	24.5	31	58.5	2	3.8	7	13.2	0	0.0	0	0.0
D	43	81.1	6	11.3	1	1.9	0	0.0	0	0.0	3	5.7
E	44	83.0	3	5.7	2	3.8	3	5.7	0	0.0	1	1.9
F	46	86.8	5	9.4	2	3.8	0	0.0	0	0.0	0	0.0

Note. A = mastitis treatments, B = AI training, C = vaccinations at MCC, D = on-site veterinarian, E = milk quality testing, F = training in milking techniques.

Farmers price points for *artificial insemination training* (*f* = 17, 32.1%) and *mastitis treatments* (*f* = 12, 22.6%) had the highest potential price points, while *training in milking techniques* (*f* = 46, 86.8%) had the lowest.

The second objective was to examine farmers' perceived importance of MCC educational services. Farmers indicated their perceived importance for six potential educational services at the Gisenyi MCC. The six potential services were scaled with 1 = most important through 6 = least important (Table 3.3). Farmers were asked to use each value only one time per educational service; however, many respondents used one numerical value for multiple educational services, resulting in a slightly uneven distribution of perceived importance values.

Table 3.3

Frequencies for Perceived Importance of Potential Education Services (N = 53)

	Level of Importance of Selected Educational Services											
	1		2		3		4		5		6	
Service	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
A	30	56.6	3	5.7	6	11.3	4	7.5	2	3.8	8	15.1
B	40	75.5	10	18.9	3	5.7	0	0	0	0.0	0	0.0
C	42	79.2	5	9.4	4	7.5	2	3.8	0	0.0	0	0.0
D	33	62.3	9	17.0	5	9.4	3	5.7	0	0.0	3	5.7
E	38	71.7	8	15.1	0	0.0	5	9.4	0	0.0	2	3.8
F	18	34.0	3	5.7	1	1.9	14	26.4	5	9.4	12	22.6

Note. Six-point scale: *1 = most important…..6 = least important*,
A = mastitis treatments, B = AI training, C = vaccinations at MCC, D = on-site veterinarian, E = milk quality testing, F = training in milking techniques.

Farmers' perceived importance of potential educational services was calculated using frequencies and percentages (Table 3.3); rankings were calculated with summed scores ranging from 191 – 302 (Table 3.4). The results showed that farmers had a high perceived importance of *AI training* (*f* = 40, 75.5%) and *vaccinations at the MCC* (*f* = 42, 79.2%) as their top two choices.

Table 3.4

Ranking of Farmers' Perceived Importance of Potential Education Services

Service	Summed Score	Rank
AI training	302	1
Vaccinations at MCC	299	2
Milk quality testing	285	3
On-site veterinarian	275	4
Mastitis treatments	243	5
Training in milking techniques	191	6

A Spearman Rho correlation analysis was completed to determine if any relationships existed between price points of educational services and perceived importance of those educational services. Table 3.5 shows the relationships between price points and perceived importance; Davis' (1971) model was used to describe the magnitude of relationships: 0.01-0.09 = negligible association, 0.10-0.29 = low, 0.30-0.49 = moderate, 0.50-0.69 = substantial, and 0.70+ = very strong.

Table 3.5

Spearman Rho Correlations between Price Points and Perceived Importance of MCC Education Services

	Price Points for Selected Services[b]					
Perceived Importance[a]	1	2	3	4	5	6
1 AI training	.21	-.16	.31*	.34*	.33*	.27
2 Mastitis treatments	-.17	-.14	.13	.15	.22	-.08
3 Milk quality testing	.52*	.17	.23	-.00	.06	.01
4 On-site veterinarian	.27	.00	.22	.07	.21	.40*
5 Training in milking techniques	.11	-.12	-.41*	-.13	-.09	-.20
6 Vaccinations at MCC	.08	.00	.26	.51*	.32*	.12

Notes. *p ≤ .05, two-tailed.
[a]*1 = most important…..6 = least important*. [b]*1 = $7.75+…6 = $0.*

Substantial positive correlations were found between perceived importance of *milk quality testing* and price point for *artificial insemination training* (r_s = 0.52, p = .00) and between perceived importance of *vaccinations at the MCC* and price point for *on-site veterinarian* (r_s = 0.51, p = .00). A moderate negative correlation (r_s = -0.41, p = .00) was found between perceived importance of *training in milking techniques* and price point for *milk quality testing*.

Moderate positive correlations were found between perceived importance of *on-site veterinarian* and price point for *vaccinations at the MCC* ($r_s = 0.40$, $p = .00$); between perceived importance of *artificial insemination training* and price point for *milk quality testing* ($r_s = 0.31$, $p = .03$); between perceived importance of *artificial insemination training* and price point for *training in milking techniques* ($r_s = 0.33$, $p = .02$); between perceived importance of *vaccinations at MCC* and price point for *training in milking techniques* ($r_s = 0.32$, $p = .02$); and between perceived importance of *artificial insemination training* and price point for *on-site veterinarian* ($r_s = 0.34$, $p = .01$).

Conclusions and Recommendations

This study examined Gisenyi area dairy farmers' potential price points for educational services, perceived importance of those services, and relationships between price points and importance. The results showed that some farmers were willing to pay more than $7.75USD for their top two educational services, while they were not willing to pay anything for the other four services. Farmers valued educational services for *artificial insemination training* and *mastitis treatments* highest, followed by *vaccinations at the MCC*, *on-site veterinarian, milk quality testing,* and *training in milking techniques* lowest.

Consistent with those results was the perceived importance of education services. Farmers specified that *artificial insemination training* was the most important service, followed by *vaccinations at the MCC* as the second most important educational service.

Farmers placed low importance on services for which they were not willing to pay. For example, t*raining in milking techniques* was ranked as the least important service and farmers were not willing to pay for it.

Relationships existed between perceived importance and potential price points for educational services. Unsurprisingly, there were several correlations related to *artificial insemination training* and *vaccinations at the MCC*, which were the two most importance services according to the farmers. *Artificial insemination training* had positive correlations with *milk quality testing*, *on-site veterinarian,* and *training in milking techniques. Vaccinations at the MCC* had positive correlations with *on-site veterinarian* and *training in milking techniques.*

Overall, the value farmers placed on artificial insemination (AI) training could be related to the benefits of using AI on their cattle. Artificial insemination allows farmer access to better bull semen, reduces transfer of disease, and provides a safer insemination method (Vishwanath, 2003). Also, vaccinations for cattle are a valuable enterprise because disease can cause decreased production, abortions, or death of cattle (Rwembeho, 2011). The benefits from AI training and vaccinations may have been recognized by Gisenyi dairy farmers as being two services that could potentially have a greater benefit for animals and productivity.

Farmers currently produce low quality milk, which occasionally is rejected by the MCC. The low value farmers placed on veterinary services, milking training, mastitis treatments, and milk quality testing might be related to their milk quality. Those factors

can increase the quality of milk produced; however, farmers might not have the proper education to realize the impact it could have on their production.

Farmers had different perceived importance levels of potential educational services and price points they were willing to pay for those services. Gaining a better understanding of what drives farmers to use the MCC and what services would be beneficial may help increase their use of such centers. Additionally, the use of educational services has shown to be an effective tool in improving dairy markets in sub-Saharan Africa (Jaffee et al., 2011).

Consistent with previous research, having a better understanding of dairy farmers' interests and perceptions on educational services could guide the implementation of services and estimating costs (Horna et al., 2007). This research showed that there was a difference in the values farmers placed on certain services; knowledge of values in educational services might increase the feasibility of implementation because their needs are better understood.

Further research on farmers' perceptions of each educational service and their potential price points would be beneficial in understanding how to implement them for the MCCs. According to Abdulai and Huffman (2005), the cost of a new technology can influence whether a farmer will choose to use it. Therefore, understanding which services farmers are most interested in and their potential willingness to pay for them could lead to a greater level of adoption or success of that service amongst farmers.

Conducting research with a larger and more heterogeneous sample could provide a more holistic demographic profile. Additionally, research in different regions of the

country could provide different perspectives because farming sectors and farmers' financial situations may vary between regions, allowing for comparisons between groups.

CHAPTER IV

SUMMARY AND CONCLUSIONS

The purpose of this study was to evaluate Rwandan dairy farmers' perceptions and use of the Gisenyi Milk Collection Center (MCC) in the Rubavu district. The research objectives were to:

1. Determine Rwandan dairy farmers' adopter characteristics;
2. Describe Rwandan dairy farmers' attitudes toward the Gisenyi MCC;
3. Determine if significant relationships exist between dairy farmers' attitudes and adopter characteristics;
4. Examine dairy farmers' price points of selected Gisenyi MCC educational services;
5. Rank the perceived importance of Gisenyi MCC educational services; and,
6. Determine if significant associations exist between dairy farmers' price points and perceived importance of selected Gisenyi MCC educational services.

The purpose of this descriptive, correlational study was to evaluate dairy farmers' adoption characteristics and use of a Milk Collection Center (MCC) in the Western province of Rwanda. A snowball sampling method was used to identify participants (N = 53). Farmers answered the research instrument related to their use and perception of the MCC and potential price points for educational services including, artificial insemination training, mastitis treatments, vaccinations at the MCC, training in milking techniques, on-site veterinarian services, and milk quality testing.

This study found that Rwandan dairy farmers had agreeable attitudes toward the Gisenyi MCC and were influenced by distance to MCC, access to credit, and low cost of technologies. Farmers were more willing to pay for artificial insemination training and mastitis treatments than other potential educational services. Their perceived importance of artificial insemination training and vaccinations at the MCC was rated highest, while training in milking techniques was least valued. Additionally, positive relationships existed between price points and important educational services. These results are consistent with the adopter characteristics outlined by Abdulai and Huffman (2005) and with the education/extension services research by Horna et al. (2007) and Jaffee et al. (2011).

Many dairy farmers' struggles in developing countries are related to health and care of their dairy cattle (Tebug et al., 2011). The arrival of education/extension services to dairy farmers could provide some of the support needed to boost the industry. This study found that farmers were willing to pay for and valued some of the potential services.

The Rwandan government and agricultural NGOs want to increase the use of Milk Collection Centers. Their goal is working toward an increased quality and quantity of milk being produced and sold in country (MINAGRI, 2012). Dairy farmers have to have an agreeable opinion about the MCCs and be willing to use them regularly and influence neighbors and friends to increase use of the MCCs as well (Rogers, 2003).

The addition or use of educational/extension services in conjunction with the MCC, may have an impact on the quality and quantity of milk sold to the centers and the

number of farmers using it (MINAGRI, 2012). Centers should focus promotions on educational services based on what farmers noted as being the most important and the ones they were willing to pay for: artificial insemination training, vaccinations at the MCC, and milk quality testing.

The Milk Collection Centers must appeal to their target client, the dairy farmer, and listen to their wants and needs to be successful and have an impact. An increase in participation of MCCs would benefit them and the Rwandan dairy market, in addition to helping dairy farmers have a more stable market to sell their product and receive the assistance needed.

The MCCs should promote centers based on the positive attributes that farmers identified: close proximity, low cost of usage, and increased access to credit. Participation may increase amongst the farmers by drawing attention to the positive attributes of the MCC. Additionally, the MCC should promote services based on the relationship between the services. The pairing of milk quality testing and artificial insemination training was important to farmers, as was the relationship between vaccinations and on-site veterinarian. Those pairings could be promoted by the MCC as a package to help increase interest and adoption of those services.

There were some similarities between the results of this study and of the Stellbauer (2008) study from which the research instrument was derived. While changes were made to add educational services and price points related to dairy, the original study focused on Rwandan coffee farmers and a coffee cooperative. Similarities existed in the farmer attitude toward their respective center, MCC or coffee cooperative, in that

they both had positive attitudes and relationships with them. All farmers agreed the cooperative and MCC were beneficial for their agriculture sector and community. Additionally, both farmer groups had positive outlooks on their industry, but both also had additional agricultural enterprises. Coffee farmers felt passionately about coffee farming and had other agricultural ventures, such as cattle and dairy farmers had a positive outlook on the Rwandan dairy market, but also had other animals, such as chickens and goats. Last, Stellbauer (2008) recommended that the cooperatives be used as resource centers for the farmers, similar to the concept of educational services for the dairy farmers in this study. The largest point of differentiation between the two studies was that Stellbauer (2008) looked at how the Rwandan Genocide impacted coffee farmers, while this study looked at the price points and importance of specific educational services.

This study had a limited sample, with much homogeneity and a small geographical area from which participants were drawn. For future research, the sample should be expanded to provide a more diverse selection of farmers. Increasing the variety in demographics may provide new perspectives and broaden the implications of this research. Expansion to different regions of Rwanda could provide different data. New regions would contain a different farmer profile, education, wealth, and farm size. Data from farmers of different demographics could broaden the implications and generalizations of this research.

Longitudinal research (Fraenkel & Wallen, 2009) analyzing the rate of adoption of new technology, such as the addition of educational/extension services at MCCs,

would provide interesting data for further research. Understanding why and how long it takes farmers to start using the MCC or educational services would allow researchers and MCCs to learn how else to promote or change their methods. Qualitative research (Fraenkel & Wallen, 2009) with local farmers could provide insight into what causes their opinion to change or their use/lack of use of the MCC. More personal conversations with participants could allow researchers the opportunity to learn things that could not be gained through the existing research instrument. Through those additional future research suggestions, the implications and understanding of this research area could be greatly expanded.

REFERENCES

Abdulai, A. & Huffman, W. E. (2005). The diffusion of new agricultural technologies: The case of crossbred-cow technology in Tanzania. *American Journal of Agricultural Economics, 87*(3), 645-659. doi: 10.1111/j.1467-8276.2005.00753.x

Ary, D., Jacobs, L. C., Razavieh, A., & Sorensen, C. (2010). *Introduction to research in education* (8th ed.). Belmont, CA: Cengage Learning.

Babbie, E. R. (2012). *The practice of social research.* Belmont, CA: Wadsworth Pub. Co.

Chi, T. & Yamada, R. (2002). Factors affecting farmers' adoption of technologies in farming system: A case study in OMon district, Can Tho province, Mekong Delta. *Omonrice, 10,* 94-100. Retrieved from http://www.clrri.org

Central Intelligence Agency, CIA. (2013). World fact book. Retrieved from: https://www.cia.gov/library/publications/the-world-factbook

Davis, J. A. (1971). *Elementary survey analysis*. Englewood Cliffs, NJ: Prentice-Hall.

Davis, K. (2008). Extension in sub-Saharan Africa: Overview and assessment of past and current models, and future prospects. *Journal of International Agricultural and Extension Education, 15*(3), 15-28. Retrieved from https://www.aiaee.org/journal.html

Dillman, D. A. (2007). *Mail and internet surveys: The tailored design method*. Hoboken, NJ: John Wiley & Sons.

Food and Agriculture Organization, FAO. (2001). The world food summit goal and millennium development goals. *Proceedings of the twenty-seventh session of the Committee on World Food Security.* Retrieved from: http://www.fao.org/

Foley, J. A. (2011). Can we feed the world & sustain the planet? *Scientific American, 305*(5), 60- 65. doi: 10.1038/scientificamerican1111-60

Fraenkel, J. R. & Wallen, N. E. (2009*). How to design and evaluate research in education* (7th ed.). New York: McGraw-Hill.

Gates Foundation. (2011, August). Agricultural development: Strategy overview. Retrieved from the Bill and Melinda Gates Foundation website: https://docs.gatesfoundation.org/Documents/agricultural-development-strategy-overview.pdf

Godfray, H. C. J., Beddington, J. R., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., …Toulmin, C. (2010). Food security: The challenge of feeding 9 billion people. *Science, 327*(5967), 812-818. doi: 10.1126/science.1185383

Gorscak, K. (2011, June 17). US bovine genetics help increase milk production in Rwanda. Retrieved from http://blogs.usda.gov/2011/06/17/u-s-bovine-genetics-help-increase-milk-production-in-rwanda/

Horna, J. D., Smale, M., & Von Oppen, M. (2007). Farmer willingness to pay for seed-related information: Rice varieties in Nigeria and Benin. *Environment and Development Economics, 12*(6), 799-825. doi: 10.1017/S1355770X07003956

IndexMundi. (2012). Rwanda imports – commodities. Retrieved from http://www.indexmundi.com/

Jaffee, S., Henson, S., & Diaz Rios, L. (2011). Making the grade: Smallholder farmers, emerging standards, and development assistance programs in Africa. A Research Program Synthesis. Washington DC: World Bank. Report, (62324-AFR).

Kanyandekwe, C., Morandini, F., Protos, J., & Sheikh, M. (2011). Case study on narrowing the gaps for equity. Rwanda: One cow per poor family: Reaching the most marginalized in Rwanda. Retrieved from the United Nations Children's Fund website: http://www.unicef.org/equity/files/ICON_Equity_Case_Study_Rwanda_September_2011FINAL.pdf

Lynd, L. R. & Woods, J. (2011). Perspective: A new hope for Africa. *Nature*, *474*(7352), S20- S21. doi: 10.1038/474S020a

Makokha, S. N., Karugia, J. T., Staal, S. J., & Oluoch-Kosura, W. (2007). Valuation of cow attributes by conjoint analysis: A case study of Western Kenya. *African Journal of Agricultural and Resource Economics*, *1*, 95-113. Retrieved from http://www.afjare.org/

Ministry of Agriculture and Animal Resources, MINAGRI. (2012) National Dairy Policy and Strategy. Retrieved from the MINAGRI website: http://amis.minagri.gov.rw/sites/default/files/user/2013_National_Dairy_Stratey.pdf

Muriuki, H. G. & Thorpe, W. (2006). Smallholder dairy production and marketing in eastern and southern Africa: Regional synthesis. Presented in *The South-South Workshop on Smallholder Dairy Production and Marketing:* Nairobi, Kenya.

Muzari, W., Gatsi, W., & Muvhunzi, S. (2012). The impacts of technology adoption on smallholder agricultural productivity in Sub-Saharan Africa: A review. *Journal of Sustainable Development*, *5*(8), 69-77. Retrieved from http://www.ccsenet.org/journal/index.php/jsd

National Institute of Statistics of Rwanda, NISR. (2012) *2012 population and housing census: Provisional results.* Retrieved from the National Institute of Statistics of Rwanda website: http://www.statistics.gov.rw/publications/2012-population-and-housing- census-provisional-results

Ndambi, O.A., Hemme, T., & Latacz-Lohmann, U. (2007). Dairying in Africa-Status and recent developments. *Livestock Research for Rural Development, 19*(3). 111.

Nicholson, C. F. & Thornton, P. K. (1999, August). The impacts of dairy cattle ownership on the nutritional status of preschool children in coastal Kenya. Presented at the *1999 AAEA Annual Meeting*: Nashville, TN.

Njehu, A., Omore, A., Baltenweck, I., & Muriithi, B. (2011). Livestock disease challenges and gaps in delivery of animal health services (Survey Brief 4). Retrieved from International Livestock Research Institute website: http://cgspace.cgiar.org/handle/10568/3746

Nyabila, M. (2011). East Africa Dairy Development (EADD): A Heifer International consortium [PowerPoint slides]. Retrieved from http://agrilinks.org.202elwb01.blackmesh.com/sites/default/files/resource/files/June22ASC_East_Africa_Dairy_Nyabila_0.pdf

Pingali, P., Stamoulis, K., & Stringer, R. (2006). Eradicating Extreme Poverty and Hunger: Towards a Coherent Policy Agenda. Rome: FAO, Agricultural and Development Economics Division.

Rogers, E. M. (2003). *Diffusion of innovations.* New York, NY: Free Press.

Rwembeho, S. (2011, November 24). Over 45,000 cattle to be vaccinated. *The New Times.* Retrieved from http://www.newtimes.co.rw/news/views/article_print.php?14819&a=47499&icon=Print

Smith, R. A. & Findeis, J. L. (2013). Exploring audience segmentation: Investigating adopter categories to diffuse an innovation to prevent famine in rural Mozambique. *Journal of Health Communication, 18*(1), 1-14. doi: 10.1080/10810730.2012.688249

Stellbauer, R. (2010). Innovative cooperation and collaboration: A study on Rwandan coffee cooperatives (Master's thesis). Texas A&M University, College Station

Tebug, S., Kasulo, V., Chikagwa-Malunga, S., Wiedemann, S., Roberts, D. J., & Chagunda, M. G. G. (2011). Smallholder dairy production in northern Malawi: Production practices and constraints. *Tropical Animal Health Production 44*(55-62). Retrieved from http://link.springer.com/journal/11250

TechnoServe Rwanda. (2008). The dairy value chain in Rwanda. A report for the East Africa Dairy Development. Retrieved from the Consultative Group on International Agricultural Research (CGIAR) website:

http://cgspace.cgiar.org/bitstream/handle/10568/2410/Dairy%20Value%20Chain%20Rwanda%20Report.pdf?sequence=1

Vishwanath, R. (2003). Artificial insemination: The state of the art. *Theriogenology, 59*(2), 571-584. Retrieved from http://www.theriojournal.com/

World Food Programme. (2012). Comprehensive food security and vulnerability analysis and nutrition survey 2012. Retrieved from the World Food Programme website: http://www.wfp.org/food-security

APPENDIX A

GISENYI MILK COLLECTION CENTER ASSESSMENT

The purpose of this assessment is to determine your use of the Gisenyi Milk Collection Center. The more we know about your dairy farm needs, the better we can prepare educational services to meet those needs. Before asking specific questions about your dairy educational service needs, we need to know some basic information.

Please answer the following questions by filling in the appropriate response in the blank.

MCC Location _____
Farm Location _____
Do you use the Gisenyi MCC? _____
Why or why not? _____

Instructions: Think about your life in the Rubavu district. For each of the following statements, please mark the **one column** that best represents your answer for that statement.

Life in the Rubavu District:	Strongly Disagree	Disagree	Agree	Strongly Agree
I wish to milk more dairy cattle				
I would live worse if I didn't milk cattle				
Milking cattle are my most valuable agricultural enterprise				
Milking cattle are **not** my only agricultural enterprise				
I am living better because I milk cattle				

Instructions: Think about the Gisenyi Milk Collection Center. For each of the following statements, please mark the **one column** that best represents your answer for the statement.

Gisenyi Milk Collection Center:	Strongly Disagree	Disagree	Agree	Strongly Agree
Has helped my community grow				
Is respected in my community				
Has helped me achieve a sustainable livelihood				
I do **not** use the MCC because my friends do **not** use the MCC				
Is **not** well liked in my community				
Is located close to my household				
Is located **too far** away from my household				
Does **not** provide me better access to credit				
I am familiar with the Milk Collection Center				
I am **not** aware of the MCC				
I would use the MCC if my neighbors used it				
Participation in the MCC allows me to be competitive economically				
I wish to use the MCC more often				
I do **not** wish to use the MCC				
I do **not** like how the MCC is operated				
The MCC is operating efficiently				
I would use the MCC if a neighbor told me to use it				
I am able to approach the MCC workers for assistance				
I do not feel comfortable approaching the MCC for assistance				
Has taught me new practices for milking				

Instructions: Think about your use of the Gisenyi Milk Collection Center and educational services. For each of the following statements, please mark the **one column** that best represents your answer for the statement.

MCC Educational Services:	Strongly Disagree	Disagree	Agree	Strongly Agree
The MCC can continue to function without educational services				
The MCC will be better with educational services				
I am willing to use educational services if they are provided by the MCC				
I see the addition of educational services as important for the future of the MCC				
I would pay for the use of educational services				
I would only use educational services if they were of **no cost** to me				
I would **not** use the MCC if there was educational services				

Please indicate by checking **one amount**, how much you would pay for each of the potential Gisenyi MCC educational services.

	Cost (in RWF)					
Educational Services:	0	1-500	501-999	1,000-2,999	3,000-4,999	5,000+
Artificial Insemination Training						
Mastitis Treatments						
Milk Quality Testing						
On-site Veterinarian at MCC						
Training in Milking Techniques						
Vaccinations at the MCC						

Instructions: Think about the Gisenyi Milk Collection Center. For each of the following statements, please mark the **one column** that best represents your answer for the statement.

Income from Milk Sales:	Strongly Disagree	Disagree	Agree	Strongly Agree
Has allowed me to purchase more land				
Is **not** enough to maintain my lifestyle				
Helped me buy more cattle				
Allows me to have a savings account				
Does **not** allow me enough to buy cattle				
Is enough to provide veterinary care or treatments for my cattle				
Makes me want to earn more money from milk sales at the MCC				
Allows me greater access to credit				

How important would Gisenyi MCC educational services be to you if they were available? Please **rank** these options, using a scale of 1-6 (1= most important…6 = least important).

Artificial Insemination Training _____
Mastitis Treatments _____
Milk Quality Testing _____
On-site Veterinarian at MCC _____
Training in Milking Techniques _____
Vaccinations at the MCC _____

How often do you use the Gisenyi Milk Collection Center? Please **mark** the appropriate selection. If never, how often would you potentially use the Gisenyi Milk Collection Center?

Never _____
Once a month _____
Weekly _____
Daily _____

Follow up questions:
How many children do you have in your household? _____
Gender _____
Age _____
Education Level _____

Please indicate the number of livestock you currently own:
Non-milking Cattle _____
Milking Cattle _____
Chicken _____
Pig _____
Goat _____

Who do you believe should be surveyed for this assessment?
_____

Thank you!