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From the Editors

Welcome to Volume 4, of *IK: Other Ways of Knowing*.

We are very pleased to bring you a special issue of *IK* that contains five articles from a study commissioned by the Canadian branch of the International Development Research Centre (IDRC). The aim of the study is to increase women's participation in economic activities, productivity, and employment options in poor, rural communities in Rwanda and Tanzania. Researchers identified indigenous knowledge, technology, and traditional enterprise practices in which women were involved. The University of Dar es Salaam and the University of Rwanda worked in partnership to implement the project. In addition to these papers, the study also produced a documentary titled *Abagorè*, which means “women” in Kinyarwanda. It describes examples of successful indigenous technologies used by women, such as vegetable production, traditionally fermented yogurt, banana wine, and sorghum beer.

The peer reviewed articles in this issue deal with economic empowerment of rural women as they use indigenous knowledge to create various beverages, leather products, and grow and store indigenous vegetables and foods. The articles examine how this contributes to increased income and opportunities in improving their economic situation. There are also two board reviewed articles. One is a field report by Megan McDonie that discusses the realities of living in a post-earthquake Mexico and the outcome of property conflicts that ensued after the fall 2017 earthquake. Preliminary findings reveal that knowledge concerning the volcanic topography influenced the outcome of property conflicts in favor of indigenous litigants. The other report, by Lucy Harbor, discusses her ethnographic research process while studying an indigenous population in Santiago Atitlán, Guatemala as they handle the growing tourism boom.

The editors would like to welcome Taylor Hayes to the editorial team. Taylor is a 2018-2019 Bednar Intern majoring in English.

We hope you enjoy this issue.



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Indigenous Beverage Production and Economic Empowerment of Rural Women in Rwanda

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Across sub-Saharan Africa, indigenous non-alcoholic and alcoholic beverages are produced from locally available materials such as cereals, fresh milk, fruits, and vegetables. Women are usually the custodians of the indigenous technology needed to produce indigenous beverages. If properly harnessed, indigenous beverage production can grant rural women the economic power needed to enable them to realize their potential. This paper examines four beverages in Rwanda produced with the use of indigenous technology. The study looks at how the indigenous technology-based production of beverages created from banana and sorghum contributes to increased income and enhanced access for rural women. It also explores trends, challenges, and opportunities in improving the economic situation of rural women who are engaged in such business in Rwanda. The aim is to determine the contribution of this sector to the economic empowerment of rural women and how existing institutions and practices impede or create conditions for further advancement.

Keywords: Indigenous Beverages, Rural Women, Economic Empowerment, Rwanda, African Development

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1.0 Introduction

Indigenous beverages are popular in many African communities. Several social, religious, health, and therapeutic values are associated with indigenous beverages, making them a critical and integral part of the communities that produce and consume them (Aka et al. 2008; Djè et al. 2000; Nwachukwu et al. 2010). Across

sub-Saharan Africa, indigenous non-alcoholic and alcoholic beverages are produced from locally available materials such as cereals, fresh milk, fruits, and vegetables. In many instances, these raw materials are subjected to a fermentation or brewing process, often to improve one or more of the following: taste, nutrition, shelf life, alcoholic content, appearance, texture, etc. In more recent times, religious beliefs restrict the consumption of traditional beverages among some Africans to the non-alcoholic variety. Traditionally however, a segment of the population in Africa, including children, pregnant women, and the elderly, prefer non-alcoholic beverages or are customarily expected to consume such; alcoholic beverages are preferred or expected to be consumed by the male members. Alcoholic beverages play a dominant role in the social life across the region with palm wine, millet, maize, sorghum, honey, banana, and cassava usually utilized as raw materials in their production.

Rural women's economic empowerment can hardly be discussed without an understanding of the place of indigenous technology in acting as a resource with which rural women are able to achieve some form of financial independence and contribute to family upkeep. In traditional Africa, women are usually the custodians of the indigenous technology needed for the production of indigenous beverages. Usually working from home or in cooperatives, women produce for domestic use, selling to neighbors, or purely for commercial purposes. Indigenous beverage production can grant rural women the economic power needed to enable them to realize their maximum potential. An economically empowered woman is equipped with the necessary skills and resources to advance equally by being able to compete in markets and to access economic institutions (Markel and Jones 2014).

This paper examines four beverages in Rwanda produced with the use of indigenous technology, with a view to determining their contribution to the economic empowerment of rural women and how existing institutions and practices impede or create conditions for further advancement. Sorghum is a staple in the traditional diet, and one popular alcoholic and one popular non-alcoholic beverage made from sorghum are studied. Sorghum beer, *ikigage*, is a popular fermented beverage that is especially used during celebrations such as marriage, birth, and during festivals. *Ubushera* is the non-alcoholic beverage made using sorghum as raw material. Banana is another food that is widely consumed across Rwanda. Banana wine, *urgwagwa*, and the banana non-alcoholic drink, *umutobe*, are two different products made using banana as raw materials that are also studied. Although these drinks are traditional to Rwanda and previously widely consumed, they are losing market to imported drinks or locally manufactured sodas. The study looks at how the indigenous technology-based production of beverages from banana and sorghum contributes to increased income and enhanced access for rural women, and explores trends, challenges, and opportunities in improving the economic situation of rural women who are engaged in such business in Rwanda.

Key research questions the paper seeks to answer include: To what extent is indigenous technology a viable route to the economic empowerment of women in rural areas in sub-Saharan Africa? What are

economic benefits that accrue to women producing local beverages in rural Rwanda? What are impediments to the economic empowerment of women producers of indigenous beverages in rural Rwanda? Using indigenous technology, what avenues exist for the scaling-up of the production capacity of women producing local beverages in Rwanda?

As far as methods are concerned, the study used in-depth personal and focus group interviews to collect data from 100 rural producers of *urwagwa* (banana wine), *umutobe* (banana juice), *ubushera* (sorghum soft drink), and *ikigage* (sorghum beer). These producers oftentimes double as middlemen and retailers, and occupy small lock-up shops fitted with tables and chairs where consumers are served. Also interviewed were 10 producers of *umutobe* who bottle and sell their products to middlemen and distributors. This is, in addition to interviews conducted with government departments and other agencies, involved with the economic development of rural women, mainly to gain insight into policy and the understanding of government towards indigenous beverage production in rural Rwanda.

Although hugely popular among consumers in rural areas in Rwanda, little support is given to women producers of traditional beverages who utilize indigenous technology in their production processes. This is a huge gap that needs to be bridged, and this paper is, therefore, helpful for researchers, policy makers, and stakeholders involved or interested in rural development and in the economic empowerment of women.

This paper begins with a conceptual clarification of indigenous technology and its relationship with rural development. The economic empowerment of rural women is next discussed within the ambit of indigenous technology, followed by an analysis of the challenges of indigenous technology. Section three explores indigenous beverage production in Africa, with emphasis on products made with sorghum and banana. Section four is a presentation of the empirical research that focuses on the production and sale of indigenous beverages in rural Rwanda, with attention paid to the availability of resources, access to production materials and infrastructure, production standards, and capacity building. The final segment looks at more options for improving the lives of rural women via indigenous technology and is followed by the conclusion.

2.0 Indigenous Technology and Development

Indigenous technology refers to the technology that is localized and can be sustained by a community without the need for any form of importation of parts or expertise. In many instances, indigenous technology is either developed from scratch within a community over many years or imported and adapted to the available materials and needs of a community. Indigenous technology is indivisible from the culture and livelihood of local communities who often utilize it in their quest to survive and thrive (World Bank 1998; Senanayake 2006). Indigenous technology is easy to access, affordable, locally owned and managed, and found to be efficient and able to spur innovation and growth (Gorjestani 2000). The

global conference on indigenous knowledge held in Toronto in 1997 encouraged the World Bank and other donors to learn from local communities to ensure long-term development, noting that for sustainable development and for the identification of development needs, local people should be involved in their problem-solving mostly by utilizing locally available resources and know-how (Gorjestani 2000).

2.1 Indigenous Technology and the Economic Empowerment of Rural Women

Rural development refers to the improvement of the quality of life for rural dwellers. Rural areas thrive on the use of indigenous technology since small-scale local knowledge-based industries support the processing capacity of rural dwellers with available raw materials. The availability of raw materials for indigenous technology and the affordability of manufactured products to local communities lead to economic development that is based on the use of local human and material resources.

During the World Economic Forum in Davos in 2013, Christine Lagarde, Managing Director of the International Monetary Fund, noted that “when women do better, economies do better.” Research has established that when women have increased control over household resources, either through their own earnings or cash transfers, it enhances the possibilities of national growth and advancement. Evidence from countries as varied as Brazil, China, India, South Africa, and the United Kingdom shows that greater spending on family nutrition and the education of children can be achieved when women have greater access to household income (World Bank 2011). Women, especially in rural areas, are the storehouse of indigenous knowledge and utilize indigenous technology in agriculture and food processing, land use management, family healthcare, and other day-to-day survival activities (Olatokun and Ayanbode 2009). In Mali, for instance, rural women are involved in extracting oil from a plant called *Jatropha curcas*. This plant is also used as medicine: seeds are used in preventing bleeding and different kinds of infections, while leaves are used for the treatment of malaria. It is also used in soap production (Henning 2002). These activities in which women are involved have resulted in the ability of women to send more children to school, especially girls, provided more nutritious food for families, and cut down on time spent doing household chores (World Bank 2011).

2.2 Challenges Faced by Indigenous Technology

Although rural women widely utilize indigenous technology in their search for livelihood, there is a general preference for imported western technology across sub-Saharan Africa, with consumers often holding a preference for imported products or those manufactured using imported machinery. Several reasons adduce for this, including a general perception that indigenous technology-based processing industries do not meet some international standards (Aworh 2008). Some indigenous products have a short shelf life, ranging from one to seven days. This limits both the availability of products and interest in investing in those products. Another reason why there is little interest in developing indigenous technology is that poor rural dwellers, who often hold the technological know-how, have insufficient

capital and limited access to finances (Aworh 2008). As a result, more societies are losing knowledge and complex indigenous technology in favor of imported and sometimes ill-fitting western techniques, which most of the time add pressure to the environment, for instance, the use of chemicals in agriculture (Senanayake 2006).

3.0 Indigenous Beverage Production in Africa

The production of indigenous beverages is common in African countries. Millions of people, especially women, depend on indigenous beverages as a source of food and income. Though modern commercial alcoholic beverages are widely consumed, indigenous beverages are still produced and widely consumed in many parts of Africa, especially in rural areas. These beverages are produced mostly by women, constitute payment for labor, and serve as an important cash income for producers (Aka et al. 2014). Studies posit that in East Africa alone, the consumption of indigenous alcoholic beverages accounts for about 80 percent of the entire consumption of alcohol in the region. Apart from economic gains, indigenous beverages are also attached to various sociocultural aspects. These beverages are also consumed for various health benefits, including the provision of calories, proteins, and vitamin B (Lyumugabe et al. 2012).

Africans use various traditional methods and a number of raw materials to process indigenous beverages. In many local communities, a wide range of cereals and raw materials, such as sorghum, millets, banana, etc., are used to produce foods and a wide variety of alcoholic and non-alcoholic beverages (Monang 2011). In the past, indigenous alcoholic and non-alcoholic beverages were largely manufactured and consumed by local communities during social and religious feasts, such as celebrations for naming new babies and New Year harvests; and they were thus hardly produced for commercial purposes (Djè et al. 2000). However, in the past few decades, due to the increase in market demands for such products and pressure from governments on local producers to abide by health standards, indigenous alcoholic beverages are industrially produced and commercially available in many markets. This commercial production makes indigenous beverages more acceptable to urban dwellers and restricts the consumption of beverages produced using indigenous technology to the urban poor and rural dwellers.

Indigenous technology-produced beverages hold remarkable economic, social, and health benefits for the empowerment of rural women, but numerous challenges exist. Safety concerns, limited lifespan, storage, packaging, and preservation difficulties have combined to make some African countries adopt policies that, at best, encourage the formation of beverage processing associations and cooperatives for the production of better quality beverages. Unfortunately, there is an outright policy ban and discouragement of individual processors who produce little quantities with difficulties, and who do not respect all safety and health market standards (Kanyana et al. 2013).

3.1 Sorghum Drinks in Rwanda

Sorghum is a crop with strong cultural ties to Rwanda. Sorghum is featured alongside the sun, coffee, a basket, a cog wheel, and two shields as Rwanda's national symbols. In many social events, sorghum beer is still used, though not necessarily consumed, as a symbol of unity and family cohesion. Both in the ancient and modern history of Rwanda, sorghum drinks, *ubushera* (non-alcoholic) and *ikigage* (alcoholic), were produced by thousands of Rwandan families and used during various ceremonies like new baby naming, marriage, and sundry religious rituals.¹ Sorghum drinks are also used for health reasons in Rwanda. Sorghum porridge is given to little babies and is believed to be very rich in vitamins. In rural communities, school children, laborers, and workmen take sorghum drinks early in the morning as their breakfast, and many of them can work throughout the day without taking their lunch until dinner time. Furthermore, during the period of extreme famine, *impengeri*, sorghum cooked in hot water, usually serves as the staple food.

In the past, Rwanda was self-sufficient in sorghum production; however, recent reports indicate that even though sorghum is still grown in all districts, and an estimated 1,200 kilograms can be harvested per hectare, the country is now a net importer of sorghum. Recent reports predict that sorghum will lose its place to other cereals in Rwanda since the production of sorghum has dwindled due lack of cultivation knowledge, geographically unfavorable conditions, the invasion of weeds, such as *Striga*, that attack and affect the cereal, and some unfavorable government policies (Niyibigira et al. 2013). However, efforts are being taken by Rwanda Agriculture Board (RAB) in collaboration with various stakeholders to improve the production of sorghum.

3.2 Banana Drinks in Rwanda

The banana has a long history in Rwanda. Researchers and experts in Rwandan history are in agreement that bananas might have been introduced to the country between 1411-1444 CE, during the reign of Mibambwe I—the 11th King of Rwanda. It is narrated that after *Abanyoro* (troops from a neighboring country) defeated the Rwandan troops, and the latter scattered, *Abanyoro* started planting bananas across the areas they occupied (Kagame 1972). Since then, new varieties of bananas have been introduced to match the land and weather requirements, as well as with their ability to face pests, diseases, and plant nutritional problems.

The banana is a preferred crop in Rwanda and is consumed as food, dessert, and used to produce traditional beverages. Banana wine, *urwagwa*, and the banana non-alcoholic drink, *umutobe*, are two different products made using bananas as a raw material, but subjected to different processes. In the past, it was a common cultural practice for brides to include bananas in wedding packages because they are used to produce a local banana food called *matoke*, which is believed to be very important to the health of women. Women were also expected to ensure that a well-prepared *urwagwa* is served to their husband for

every meal and whenever the family receives important guests. In addition, banana leaves are culturally used by women as plates during new baby naming events and are also used as the covers of traditional pots during cooking.

Bananas were a highly sustainable crop in Rwanda, but with the introduction of various diseases and pests in the last 10 to 20 years, production has fallen by over 40 percent (Nsabimana et al. 2008). Indeed, Rwanda was among the top producers of banana in the East African Great Lakes Region. The rate of banana beverages consumption was higher two decades ago, but due to the fact that growing bananas requires large amounts of arable land that Rwanda lacks, the government of Rwanda has started sensitizing citizens to grow important food products other than bananas (Gaidashova et al. 2005). However, banana foods and traditional banana beverages are still consumed by a great number of Rwandans, and banana products constitute sources of income for many women producers in rural areas.

4.0 Production and Sale of Indigenous Beverage in Rural Rwanda: An Overview

The government of Rwanda, through several policy actions, has shown commitment to the development of rural communities. Through such programs as the Girinka ('One-cow-per-poor-family'), Ubudehe, Vision 2020, Umurenge, etc., many in rural Rwanda have transcended extreme poverty over the years. The government of Rwanda supports medium-scale bottlers of traditional beverages through regular trainings from the Ministry of Trade and Industry (MINICOM), Rwanda Bureau of Standard (RBS), and Private Sector Federation (PSF) on production processes, entrepreneurship, packaging and hygiene, branding and marketing, and financial literacy. These medium-scale producers also receive support from the government by way of endorsement should they wish to borrow from financial institutions. However, the government of Rwanda has not shown much support for rural women producers of indigenous beverages. On the part of major development partners in Rwanda, such as the United Nations and its agencies, World Bank, DFID, USAID, JICA, EU, Sida, and South Korea, projects embarked upon are usually crafted alongside government officials, and since the government has not indicated interest in empowering rural women producing indigenous beverages, none of these organizations are actively involved in supporting them.

To determine the economic situation of rural women who produce indigenous beverages, interviews were conducted among 100 women producers of 4 traditional beverages—*urwagwa* (banana wine with an alcohol content of 12 to 14 percent), *umutobe* (non-alcoholic banana juice), *ubushera* (non-alcoholic sorghum), and *ukigage* (sorghum beer with an alcohol content of between 2 to 4.5 percent). These women produce and sell using 20-liter containers (jerry cans). The shelf life of their products is usually an average of 3 days, as emphasis is on the freshness of the product. Many retail directly to consumers, while some also produce and sell to middlemen and consumers. Purposive sampling was used to identify these women in the Musanze and Burera districts in Rwanda. Most women did not complete primary education,

and the age range varied from women in their 20s who had been in the business for less than 5 years, to those in their 60s who had been in the business for decades. In order to compare the situation of the majority poor rural producers with their wealthier and more organized counterparts, additional interviews were conducted among 10 women bottlers of the alcoholic beverages who bottle and sell across Rwanda and sometimes export to neighboring countries. The shelf life of the latter products is between 1 and 3 years. While analyzing the responses of the poor rural producers, references where necessary will be made to these bottlers of indigenous beverages. Some government officials were also interviewed to determine the response of policy makers to the poor rural women producing these indigenous beverages.

4.1 Production Process

4.1.1 Steps in Sorghum Beer and Drink Production in Rwanda

Beer production in Rwanda undergoes three main steps, which are: production of malt (*amamera*), production of yeast (*umusemburo*), and brewing (*kwenga*).

Malting

Malting is the preliminary step in beer production and is comprised of three main steps: soaking, germination, and drying. Sorghum grains are first soaked for about twelve hours, and then drained and spread on a mat where a mixture of ash and water is generously sprayed on the grains, giving the sorghum a black color. Sprouting is induced by spreading sorghum grains on banana leaves and covering them with the same mixture. Sprouting takes about two to five days, depending on the temperature. Sprouting activates enzymes that help to hydrolyze starch (non-fermentable sugar) into fermentable sugars. Sprouted sorghum is known as *amamera*.

The next step is the drying process, where sprouted sorghum grains are dried under the sun, usually within an average period of three days. During the drying process, enzymes continue to hydrolyze starch, thereby increasing sugar content (fermentable sugars or simple sugars). Successful drying is determined by chewing, after which rootlets are removed and the sorghum grains are winnowed using a winnowing basket (*intara*) and stored for further use.

Production of Yeast

Yeast is a necessary ingredient in beer production, and *umusemburo* is the local yeast used in rural Rwanda for sorghum beer preparation. The first step of *umusemburo* preparation is called *gusabika*. It involves thoroughly mixing about 2 jerry cans (20 L capacity) of heated water with about 5 kg of malt flour, using a wooden stick called a *umwuko*. The mixture is allowed to cool in a clay pot for between 3 days to 1 week, and the product obtained is called *umusabike*. Thereafter, *umusabike* is taken and heated by strong fire until only one-third of it remains, and the product obtained is called *umuteke*. *Umuteke* is

allowed to cool in a clay pot for one day. Then, about 5 kg of malt is added. The mixture is observed for signs of gas production. If there is no sign of gas production, then a bad beer has been produced, which often leads to it being discarded. If the product shows signs of gas production, then about 8 kg of malt is added the next day and thoroughly mixed in. The end product is *umusemburo*, which is the brewer's yeast.

Brewing

In the brewing process, water is boiled and flour from malt is added. Then cold water is added, followed by hot water, before being mixed using a wooden stick (some brewers skip adding the cold water). More cold water is added to the mixture, which is thoroughly stirred with the wooden stick (the amount of water added may vary from one producer to another). The product obtained at this stage is called *umusururu*. *Umusururu* is transferred to another container and allowed to cool. After cooling, the yeast, *umusemburo*, is added, and the container is closed in such a way as to allow gas produced during fermentation to escape. Fermentation is left to occur overnight, and the product is served in a fermenting state the next day since producers do not know how to halt fermentation once it has begun.

4.1.2 Processing of Non-alcoholic Sorghum Drink

The non-alcoholic sorghum beverage known as *ubushera* follows all the steps mentioned above, with the omission of yeast addition. After getting malt from sorghum, milling is done to obtain flour.

4.1.3 Steps in Banana Wine and Juice Production (*Urwagwa* and *Umutobe*)

Production of banana wine (*urwagwa*) begins with collection of matured bananas. Bananas of different varieties have different sugar contents, and while some producers are selective, others are not. A pit called *urwina* is dug and heated with fire after which banana leaves are spread inside and the matured bananas added. The pit is then covered with leaves and soil in a process called *gutara*. Smoking the pit cover is done twice a day—morning and evening. Smoke induces production of ethylene, which is a form of ripening gas. Once ripened, banana is removed from the pit, peeled, and put into a wooden container called a *umuvure*. Grasses called *ishinge* are added to stimulate juice extraction, and mixing is done with hands until juice (*umutobe*) is obtained. However, in the process of extraction, sometimes no juice comes out, which is called *gutema*. This is because *vacuole*, which contains juice, is not broken to release juice. Producers do not have any control over this situation and are left with no option but to incur a loss, although using enzymes called *pectinase* can help. The juice can be separated with other materials by filtration, and water is added to the remaining mixture and mixed again so more juice can be obtained. The two juices have different sugar content and can be mixed or kept separately. For those who do not drink alcohol, the product is ready and can be heated and consumed. After the juice has been obtained, it is put in clay pot, which is also deposited in a pit (*urwina*). On the top of juice, coarse ground roasted

sorghum flour is added, and the product is covered well with banana leaves and soil. Fermentation takes place for about two days, after which the product is filtered and served.

All products are transported to their final destinations using 20 L jerry cans and usually served to consumers using open bottles for *urwagwa* or *umutobe*, and cups for *ikigage* or *ubushera*. For the fermented products, one of the main challenges is that producers are not able to control the fermentation process. The products are served while fermentation is still ongoing, which is thought to be the origin of short shelf life of the products. The products that are not meant to be fermented also end up being fermented because they are exposed to the air, which is also thought to be a reason of short shelf life.

5.0 Indigenous Beverage and Availability of Resources to Rural Women in Rwanda

5.1 Access to Income

Women who produce indigenous beverages in Rwanda have access to income through the sale of such products and are able to invest their profits in taking care of family needs, and sometimes further reinvest profits to grow their businesses. Since, traditionally, “women earn less and are less economically productive than men almost everywhere across the world” (Ana and Sudhir 2012, 40), the availability and easy access of indigenous technology to rural Rwandan women as a source of income should be of interest to development stakeholders.

Initial start-up capital for embarking on the sale of indigenous beverages is usually money saved up over a period of time or borrowed from family members or cooperatives. Women who produce *ikigage* (sorghum beer) make an average of \$1 per 20 L jerry can sold. Depending on patronage, women producers who restrict their sale to only consumers can sell between 3 and 10 jerry cans. Those who sell to middlemen, in addition to retailing directly to consumers, can sell up to 40 jerry cans per week.

Women who produce *ubushera* (sorghum drink) make an average of forty cents for each jerry can sold and, depending on location and patronage, sell an average of seven jerry cans daily for direct retailers, and up to sixteen jerry cans per day for those who sell to middlemen as well as directly to consumers.

Women who produce *umutobe* (banana juice) make an average of \$1 per jerry can sold, and, depending on patronage, can sell an average of 40 jerry cans per week. *Umutobe* juice makers totaling 90 percent sell to middlemen, who are usually small-scale bottlers of banana juice.

Women who produce *urgwagwa* (banana wine) make an average of one dollar per jerry can sold, and, depending on patronage, those who sell directly to consumers may sell an average of seven jerry cans per week, while those who also sell to middlemen may sell an average of fourteen jerry cans a week.

In a country where 80 percent of the population is made up of rural peasant farmers, who earn roughly the equivalent of \$0.82 per day, the extra income of an average \$20 per week provided by production of indigenous beverages is a needed addition to household income. Rural women consider the business of producing indigenous beverages to be profitable, and they are able to take care of basic household needs as a result of the business. These rural producers of indigenous beverages also employ labor depending on the volume of production, sometimes hiring up to 5 temporary workers per day.

Essentially, production of indigenous beverages allows rural women in Rwanda, who usually work more as unpaid family laborers, farm on smaller plots, and cultivate less profitable crops in comparison to their male counterparts, to have access to finances. Most of these women are able to purchase health insurance for their families, pay school fees, buy nutritious foods, and ensure the general wellbeing of their households from proceeds made from the indigenous technology-based production of traditional beverages.

5.2 Access to Financial Services

Extending access to financial services to poor rural women entrepreneurs is known to be a “key factor of successful rural development strategies. Designing appropriate financial products for women to be able to save, borrow and insure is essential to strengthen women’s role as producers and widen the economic opportunities available to them” (Fletschner and Kenney 2011). Rural women producers of indigenous beverages in Rwanda do not receive any form of support from government or financial institutions. Government officials who were interviewed acknowledged that there is no known policy that supports the extension of financial services to rural women producers of banana and sorghum beverages who use indigenous technology. Respondents totaling 90 percent noted that they can expand their business if they have access to more capital. So, lack of access to credit facility is a major impediment to business expansion.

Access to finances for rural women producers of indigenous beverages could take the form of “a menu of loans that takes into account the diversity of women’s needs and constraints: What are they trying to finance? How much will they need? What is a reasonable repayment schedule?” (Fletschner and Kenney 2011, 20). Rural women producers of indigenous beverages also note that their business is seasonal; therefore, it is important that loan conditions match seasonal production. Additionally, the government should consider “expanding the menu of acceptable collateral to also include social collateral and the type of physical assets women are more likely to own or control. Offer incremental loans based on individual repayment behavior to reach out to women who might not be able to provide collateral. Ensure women can apply for loans without their husbands’ or other male approval” (Fletschner and Kenney 2011, 20).

5.2.1 Taxes

According to a research output from the National Bureau of Economic Research, around the world, “women are less financially literate than men and are aware of this shortfall” (Lusardi and Mitchell 2011). Even for the well-educated business person in urban areas, navigating the terrain of tax preparation can prove a daunting task, and this is much more difficult for rural women producers of indigenous beverages. A respondent noted that her greatest challenge in the business is that, “when it is time to give tax, it becomes difficult, it interrupts business.” There is no training offered to these women on how to prepare taxes. The Rwanda Revenue Authority has implemented several reforms aimed at a simplification of the tax laws and procedures; however, many rural dwellers still find it difficult to navigate the tax reporting and payment processes. Some women resort to a dependence on their husbands for tax preparation, which can lead to the man having greater access to and control of her profit and even capital. It has been argued that, “it is important that development strategies that aim to boost rural women’s productive capacity must enhance women’s direct access to financial services, i.e. not mediated through their husbands” (Fletschner and Kenney 2011, 2). Beyond emphasizing that these rural women producers pay their sales tax, there is need for training and rendering of assistance to these women to help them in tax preparation.

Another related challenge is that although there is no policy support that ensures increased financial access for female indigenous beverage producers in rural Rwanda, this segment of the population does have to pay very high taxes on their businesses. In the words of a producer, “consumers are not many, but tax is high.” Rwanda’s sales tax rate is presently 18 percent, and most of the women in question consider this to be quite high, after they have taken care of production costs and shop rent. In this regard, it is necessary that in deciding the tax rate of poor rural women, consideration should be given to the fact that “low-income families experience far greater income fluctuations than higher-income families and, as a result, taxation of annual income disproportionately burdens low-income families” (Lily 2003).

5.3 Access to Production Materials

Access to raw materials for the production of sorghum and banana beverages is increasingly becoming a huge constraint to the advancement of the business of indigenous beverage production by rural women. According to a respondent, “sometimes, I am not able to supply enough to my customers due to lack of bananas.”

The growing dearth of bananas and sorghum in Rwanda might be connected with the government of Rwanda’s agricultural land use consolidation policy. Rwanda suffers from low agricultural output and the government of Rwanda is convinced that this is mostly due to production inefficiency occurring as a result of the preponderance of small farms. The government of Rwanda, in response to this challenge, instituted the Agricultural Land Use Consolidation Policy in 2008, with the aim of increasing “output of

all types of agricultural products with emphasis on export products, which have high potential and create large amounts of rural employment; this, under sustainable modes of production” (MINAGRI 2009).

The Agricultural Land Use Consolidation Policy mandates farmers in Rwanda to consolidate agricultural land and to uniformly cultivate assigned crops (Musahara et al. 2014, 8). This practice is known as regional ‘crop specialization,’ which refers to a situation where certain crops are allocated to regions where the terrain is considered best for their cultivation. The government of Rwanda promotes pure specialization, sometimes known as “mono cropping,” where one single crop is encouraged per region. Musahara et al. (2014) note that the government of Rwanda enacted the Land Use Consolidation Policy with the conviction that, “joining these small plots together to farm as a single unit would deliver important economies of scale in the acquisition of inputs, processing and marketing as well as efficiencies in access to extension services” (Musahara et al. 2014, 6).

In Rwanda, regional crop specialization is based on seven crops pre-selected by the government, which are maize, rice, wheat, beans, soybean, Irish potato, and cassava—all allocated to different rural localities in the country. These seven crops are exclusive of several of Rwanda’s indigenous foods such as bananas, sorghum, sweet potatoes, and pulses, which form the staples of the rural population. The market-oriented approach in selecting the crops for regional specialization means that raw materials like bananas and sorghum are increasingly losing state support, and producers of indigenous beverages are struggling.

Rather than discourage the cultivation and promotion of these two traditional crops, there is a need for the government of Rwanda to invest in research on how to improve them due to their economic importance to rural women. Diseases increasingly attack banana and sorghum plantations, so the government needs to step up investment in these crops for the indigenous beverage production sector to thrive. There is also a need to improve access to certain varieties of bananas, such as *kainji*, which is known to yield a lot of juice. The price of sorghum also widely fluctuates as a result of the lack of constant availability, thereby affecting the overall profit margin of these producers.

Another major challenge to the sourcing of production materials is firewood. In 2010, Rwanda’s Director of Forestry Field Programmes in the National Forestry Authority noted that the nation faces the threat of desertification, as only 533,000 hectares, or 20 percent, of the country was covered by forests (FAO 2011). Firewood and charcoal usage are recorded to be highest in the rural areas of Rwanda, and approximately 85 percent of Rwandans depend on biomass for household cooking (FAO 2011). The annual fuelwood consumption in Rwanda is at 2.8 million tons, while it is estimated that charcoal, when converted into wood usage, accounts for up to 50 percent of total wood-fuel consumption in the country (World Bank 2012). On average, households spend between 10 and 15 percent of their monthly incomes on the purchase of fuelwood and charcoal (FAO 2011).

In response to the high usage of wood and the depletion of Rwanda's forests, the government of Rwanda established the National Domestic Biogas Programme (NDBP) in 2007 to improve the provision of biogas to meet the cooking and lighting needs of households that own a minimum of 2 cows. Since its establishment, NDBP has installed domestic biogas in 4,600 households and has trained 555 masons in household biogas construction and maintenance, out of which 195 have registered businesses (REG 2014). In order to more readily assist these female indigenous beverage producers, there might be a need for NDBP to specifically create avenues that will encourage them to acquire biogas. Presently, the government of Rwanda heavily subsidizes biogas installation for rural dwellers, and the subsidy can be increased for such entrepreneurs.

5.4 Market Access for Products

The ability of rural women to access markets for their products can be hampered by several factors. These include transportation, gender norms like restricted mobility, and infrastructure (good roads). In the case of sorghum and banana beverage producers of rural Rwanda, impediments to market access include the lack of access to adequate capital. According to one respondent, "I have a big market, the constraint is capital. Once capital increases, I can sell it [*umutobe*] in different towns." Another says, "If I have enough capital, I can open new places to sell my product." *Umutobe* producers totaling 50 percent supply their products to bottling companies in their district of operation; however, there are times when there are too many sellers of banana wine, and this causes reduction in the amount paid by the banana wine bottling company. Some women, however, think that the market size is too small for growth to occur and feel restricted by the size. This is especially true for those who sell beverages with a shorter shelf life such as *ikigage*. However, rural women agree that if the government can work with them through the process of establishing cooperatives for the purpose of production and packaging of beverages, they will be able to both access more markets and still service their local customers adequately.

6.0 Indigenous Technology Production Standards Among Rural Women

6.1 Quality of End-product

The quality of indigenous beverages produced by rural women has been a source of concern for governments and consumers. Rural women producers of indigenous beverages in Rwanda who were interviewed acknowledge that there is much room for improving the quality of their products. When asked, most respondents pointed to the lack of adequate finances as being responsible for the oftentimes poor quality of their beverages. However, through closer and more in-depth interviewing, it began to emerge that poor quality can be attributed to several factors outside of access to finances. For instance, many respondents were skeptical as to the affordability of higher quality products by their patrons. According to one respondent, "Yes, I can improve the quality, but it will also affect the price, and our customer may not afford high prices." For another respondent, "Yes, I can use small amount of water

[instead of the large amount she presently uses] during dilution, but it can affect the price [increase it], and my customers cannot buy much at that price.”

The quality of raw materials is also a challenge. Many banana producers note that they increasingly face the challenge of buying bananas that do not produce juice. Respondents totaling 90 percent note that *biratema* (juiceless bananas) are a challenge that pervades and affects the quantity of juice produced, which can lead to excess dilution of end products. Further, due to the agricultural land use consolidation and crop specialization policies of the government of Rwanda, many producers of sorghum beverages now buy sorghum from neighboring Democratic Republic of Congo and from Uganda. They note that these products can be low quality and lacking in freshness, especially from Congo. According to one respondent, “Sometimes if you use bad quality of sorghum, you get bad product.”

6.2 Health and Safety

The hygienic standards of the production of indigenous beverages is a source of concern for governments and consumers. In Rwanda, there have been several reported cases of deaths and injuries to internal organs occurring as a result of consumption of traditional beverages produced and sold under unhygienic conditions. A Hazard Analysis and Critical Control Points (HACCP) based study of microbiological and physico-chemical quality of banana juice and beer was conducted on samples collected from indigenous producers across 4 localities in Rwanda. Results indicated “high total bacterial counts of 9.02-9.86 log₁₀ cfu mL⁻¹ with yeast and moulds as well as lactic acid bacteria being the predominant microbes. Coliform counts were high in artisanal processed banana beer, 7.65-8.11 log₁₀ cfu mL⁻¹ but were low or undetected in semi-industrial processed beer samples” (Kanyana et al. 2013).

Although all respondents claimed that they maintain the highest hygienic standards while preparing their beverages, most conceded that they can do with more training in that area. This is an area of particular interest to the government and is usually used as a reason for little or no support for traditional brewed drinks, if not outright hostility against traditional brewers of local beverages. One point to note here is that every industry in existence can be overtaken by irresponsible individuals who can endanger the life of the public, but only if not properly regulated. Rather than a blanket denial of support to such a viable and economically lucrative sector for rural women, the government of Rwanda might do better by first training the women on acceptable hygienic standards, in addition to increasing regulatory oversight of that sector. Since these traditional beverages are taxed, part of the tax levied on the beverages could go to supporting government departments that are directly involved in the regulation of the sector. Rural women who were interviewed conceded their lack of training in hygienic handling of the brewing process and requested government assistance in upgrading their knowledge.

6.3 Shelf Life and Packaging

The texture, flavor, appearance, and nutrition levels of foods can drop significantly over time, and worse still, such food can become microbiologically unsafe even prior to displaying physical signs of deterioration. International standard practice demands that in cases where consumer approval of food will be affected by deterioration, without any impact on consumer's safety and health, a best before date is applied to the product. According to the New South Wales Food Authority:

The length of the use by time for foods can be determined by using storage trials to estimate the physical, chemical and microbiological stability of the food. Interpretation of results requires technical experience and competence. Some products will require additional studies such as computer models of microbial growth or challenge studies. It is the manufacturer's responsibility to determine shelf life. Reliable use by or best before times cannot be determined by guesswork or by copying the shelf life of a competitor's product (NSW Food Authority 2010).

The shelf life of all four studied products averages about 3 days; *ikigage* has the shortest, which is 1 day, and *umutobe* has the highest, which is 5 days. Many respondents noted that they usually do not throw away expired products. Some mix it with freshly made products and sell it, which can be a health hazard, although it does not significantly lower the shelf life of the freshly made product. Others give or sell the expired products to owners of pigsties. All respondents decried the losses incurred as a result of not being able to sell off all products within applicable shelf life. None of the respondents package their products, and about 90 percent say it is because they lack both capital and knowledge to do so. Sale of products is restricted within the immediate vicinity of the producer and is seasonal. Sorghum drink producers, for instance, note that few clients patronize their businesses during the rainy season. For other beverages, farmers form the bulk of their customers, and during planting time when farmers do not have much money, patronage is drastically reduced. However, some respondents are not keen on packaging their products since, according to them; their patrons cannot afford the price of packaging. This introduces a new dimension to the widespread clamor for indigenous beverages to be packaged, as locals will then be unable to afford the drinks.

7.0 Capacity Building for Rural Women Producer

7.1 Training

An article published by the World Farmers' Organization (WFO) has noted that training rural women is critical to enhancing their use of natural resources in a sustainable manner and to increasing production and productivity (Mucavele 2017). Most rural women in Rwanda who engage in the production of

indigenous beverages learned their skills from family or friends and as apprentices or hired laborers of producers. There is no formal training process either supported by government or NGOs for established, up-and-coming, or would-be entrepreneurs. Rural women, however, understand the need for training and acknowledge that training is necessary in order to make any progress in the business. Training needs include the right production methods to ensure consistency of output; according to one respondent, “Sometimes I can produce beer which is not good. In that case nobody drinks it, which causes loss.” For another respondent, “When ripening process is not well done, there is a failure in juice extraction (*gutema*), which induces loss.” Rural women producers of indigenous beverages also need training in entrepreneurship and financial management. One respondent said, “Sometimes I may use money for other priorities and miss money for business.” Other training needs include courses on, for example, storage, hygiene, packaging, and marketing.

8.0 Infrastructure, Indigenous Technology, and Rural Women Economic Empowerment

8.1 Electricity

Globally, it is estimated that 1.2 billion people lack access to electricity, while sub-Saharan Africa is amongst the poorest served (IEA 2016). Reasons for this poor performance include a penchant by national governments to focus on the recovery of the cost of rural electrification, especially in cases where such has been financed by private interests. Recovering electricity costs is often nearly impossible from rural households with historically very low-income levels, and national governments have found it difficult to “effectively design tariffs and adapt regulatory systems that can make electricity more affordable to poorer communities” (IEA 2016).

Several studies have linked electricity to a growth in income (Ozturk 2010; Wolde-Rufael 2009). An empirical study conducted in rural Kenya directly linked increased electricity availability with increased productivity of studied enterprises (Kirubi et al. 2008). In rural Rwanda, women producers of indigenous beverages report that a lack of constant electricity is an impediment to their business since “power can go off which impedes functionality of hammer mills (used in grinding).” Additionally, women who wish to utilize the night time to produce beverages while their children are asleep cannot do so due to lack of electricity. Their workload is heavier during the day, which affects their productivity and output.

8.2 Transport

Although considered a lifeline for rural communities, rural roads are often in bad shape, making transportation extremely difficult, and at best, quite expensive for many rural dwellers, especially women. Studies carried out in Southeast Asia established that “villages provided with road access produced more than they did before” (O'Neill 2011). Many rural women in Rwanda point to bad roads and expensive transportation as reasons for their lack of business expansion; many women resort to selling beverages

from their homes. For one respondent, “If I have means, I can buy a vehicle, which will help me in transportation of my products.” For progress to be made, there is a need to improve rural road networks across Rwanda. The government of Rwanda already has this as a top developmental priority, according to the Government’s Vision 2020 document.

9.0 Gender Norms and Attitudes

About 90 percent of respondents report that a great challenge in selling is being owed money by their patrons over an extended period of time. Rwandan culture, especially in the rural areas, is traditional in nature, and women are not expected to be forward in relationships, including between customers and clients. Women are unable to aggressively pursue creditors who, knowing they are dealing with women, do not often feel any urgency to pay outstanding bills. Rwandan culture demands respect in every interaction, thus, a creditor, although he or she owes payment, can still expect to be respectfully attended to by the female entrepreneur during his next visit.

The husbands of these indigenous beverage sellers would have come in handy in dealing with such customers, however, rural women often do not wish that their husbands be privy to most of their financial transactions. This is not peculiar to Rwanda, as studies across countries and continents reflect the same reality:

Ashraf (2009) finds that spouses in the Philippines sometimes choose to keep savings in accounts their spouses cannot access. Doss (2001) finds that households in Ghana do not fully pool risk, and Duflo and Udry (2004) report that spouses in Cote d’Ivoire do not fully insure each other against rainfall-induced fluctuations in income. Robinson’s (2008) field experiment in Kenya suggests that risks are not shared efficiently within the household. And Fletschner (2009) reports that 15 percent of the women she surveyed in Paraguay said they were credit constrained even though their husbands claimed to have adequate access to credit (Fletschner and Kenney 2011, 9).

From the above it can be said that rural Rwandan women who have not shown much interest in doing business with their husbands are not the exception.

10.0 Improving the Lives of Rural Women through Indigenous Beverage Production

10.1 Can the Market be Brought to the Beer Parlors?

The possibility of bringing the market to these indigenous producers of beverages by making them tourist attractions for both domestic and international tourists should be considered. Countries have achieved the

status of geographical indication² for some traditional products. In *Local Development and Heritage: Traditional Food and Cuisine as Tourist Attractions in Rural Areas*, Jacinthe Bessiere (1998) notes that in the coming decades, “the heritage component, and more particularly food, is likely to be a factor in tourist attraction, integration and social dynamization.”

With good reason, much emphasis is laid by government and stakeholders on the fact that rural women producers of indigenous beverages should be assisted in packaging and selling their drinks to expand their market. This stance, however, excludes the huge possibilities inherent in freshly-made indigenous beverages served in traditional Rwandan parlors for encouraging both domestic and international tourism. For instance, one travels to Italy and visits a pizzeria to experience fresh Italian pizza and pasta; buying frozen pizza from off the shelf in Italy does not provide that experience. The same can be said of Chinese foods. Visiting China and eating fresh Chinese food does not equate to buying pre-packaged Chinese food off the shelf. Equally, many tourists will say that they prefer to eat local food consumed by the masses if they are sure of the hygienic standards rather than in high-brow restaurants. International tourists believe that it is in “street” food, which locals eat, that one can find the real taste of a territory. Even domestic consumers have a taste for fresh beverages and can drive for miles from the city to the villages to purchase them despite widespread availability of the packaged variety in the city. Nigerian palm wine is a case in point.

Rwanda has consistently ranked among the top three countries in Africa on the Ease of Doing Business Index Report for the past four years, and according to a recent World Bank report, Rwanda’s private sector is to be commended for playing a crucial role in the nation’s economic growth. The report reads in part, “Private sector development has played a catalytic role in Rwanda’s economic growth. The Government has undertaken measures to foster private sector participation in the country’s key industries, such as tourism” (World Bank 2016).

The government of Rwanda, private sector, and other stakeholders can work with rural women producing indigenous beverages to attract both domestic and international tourists, through, for instance, conducting training on hygiene, improved ambience³ and service (using traditional items), and customer service. The government of Rwanda can mandate the compulsory and unscheduled supervision of premises and production processes in order to ensure compliance. The government can identify some champions across sectors and *umudugudus* for training and assisting in scaling up their businesses not necessarily to metamorphose into packaged drinks, but as beer parlors where both domestic and international visitors can drive to reinvigorate with freshly brewed drinks. Those that the government has identified and assisted will serve as reference points for other practitioners in the rural areas to aspire towards improved quality, safety, hygiene, and branding. Marketing these champion outlets should also be part of the package, where exceptional rural Rwandan women producers of indigenous beverages can be marketed as

part of Rwanda's cultural heritage. Efforts to obtain international geographical indication for these products can also be started by Rwanda's Ministry of Trade and Commerce.

Beer parlors act as places of congregation for rural communities where socialization takes place and women are able to network, gain information for markets, and build social capital. Tourists, in addition to tasting freshly made local drinks, can interact with locals in their own community. Although one may argue that beer parlors could be stocked with packaged beverages, packaging leaves a lot of room for patrons to buy and consume products at home, or to send their wards to make purchases for home consumption. Serving freshly made beverages in beer parlors increases social bonding across communities. Therefore, rural women can cater to the taste for fresh beer/beverages, while medium-scale manufacturers cater to packaged products. Interviewed rural women make it clear that once packaged, the cost of the products will go beyond what the majority of their patrons can afford. It would make little sense to alienate rural consumers in the efforts to expand the market, as they also constitute a market themselves. Further, while there is much to be gained from packaging indigenous beverages, including expanded market access, the capital and other necessary resources required to make this possible have proven a challenge. Bottlers of indigenous beverages note the high cost of purchasing bottles, an inability to brand products, and high tax payment.

10.2 Cooperating Towards Expansion

The UN, EU, and major development partners active in sub-Saharan African have all stressed the importance of self-help and nation-led development strategies. Cooperatives straddle the private and public spheres since they are made up of individuals who are also civil society members and are often strongly recognized, even supported by the state. Globally, cooperatives have a good reputation as platforms for the promotion of women's economic empowerment. In India, the Self Employed Women Association (SEWA) is a good example of how women can develop a voice and unite to form a veritable channel for the fulfillment of the progressive aspirations of women. In Namibia, the Edufano women's cooperative has created and sustained successful international businesses for women farmers over the course of well over four decades. The government of Rwanda strongly supports the establishment of cooperatives, although rural women producers of indigenous beverages in Rwanda have not yet been able to form cooperatives. The women themselves recognize this as a big challenge and according to one respondent, "There are many people in this business, and the business is not well organized." Setting up cooperatives will enable rural women producers of indigenous beverages to form a strong network in order to more effectively tackle the numerous challenges that they face.

11.0 Conclusion

Indigenous technology is widely applied by rural women across Africa in both their domestic and commercial endeavors. Many of these women have leveraged the income generated from the production

of indigenous beverages to invest in livestock, health insurance, children's education, and other family needs. In order to be effective, efforts for the economic empowerment of rural women ought to take into consideration the present situation of rural women and their current level of access to technology: technology transfer has often proven unsustainable, especially in rural communities. Many rural women in Rwanda engage in the production of indigenous beverages using indigenous methods. While they experience high patronage from rural consumers, there is little or no support from the government of Rwanda and NGOs involved in rural development. The government appears to be skeptical of the rural, indigenous technology-based beverage industry, owing to unhygienic practices and a possible overriding perception of indigenous technology as unprogressive, even backward. However, the rural indigenous technology-based beverage sector has proven to be a sustainable source of income for rural women. Many challenges encountered by these women can only be addressed with a collaboration of the rural women themselves, their communities, and the strong support of the Rwandan government, including its agencies and development partners, since it is cultures, societies, and institutions that "create conditions that facilitate or undermine the possibilities for empowerment" (Markel and Jones 2014, 2).

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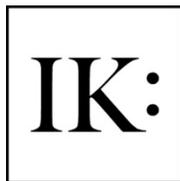
Endnotes

¹ In Rwanda, sorghum has played an important role during the celebration of the annual harvest day event known as *Umuganura*, which is held on August 1. *Umuganura* is one among 17 Rwandan rituals known as *Inzira z'Ubwiru*, and in the olden days, apart from the national celebration held at the King's court, other celebrations were held at the family level. Every woman was expected to prepare a very special sorghum beer for her husband so that when the king launched the celebration at the national level, families would also do the same (Byaruhanga 2016). On this occasion, mothers usually prepare the local homemade bread dish made from the sorghum flour, *rukacarara*, for

children. Although the celebration of *Umuganura* is gradually losing its significance across Rwanda, drinking and sharing sorghum beer are still part of the Rwandan tradition that is still observed and respected, especially in rural areas.

² According to the World Intellectual Property Organization (WIPO), “A geographical indication (GI) is a sign used on products that have a specific geographical origin and possess qualities or a reputation that are due to that origin. In order to function as a GI, a sign must identify a product as originating in a given place. In addition, the qualities, characteristics or reputation of the product should be essentially due to the place of origin. Since the qualities depend on the geographical place of production, there is a clear link between the product and its original place of production” (WIPO 2018).

³ Aesthetically, the shops where these beverages are sold will hardly appeal to a non-rural dweller as a place of relaxation and refreshment. Cut out wooden benches and tables serve as furniture, while drinks are served in stainless steel cups, or iron cups painted over and chipped in several places. Interior decoration is almost non-existent, and drinks are served often directly from 20 L yellow jerry cans positioned behind a wooden shelf. Rural women can be trained to form cooperatives and use traditional decorations that cost little, but appeal to the senses to decorate their parlors. Regarding hygiene, indigenous beverage producers need training, follow-up, and clearly stated guidelines and regulations to assist them in ensuring that products sold to consumers meet the highest standards. Trainings on measurements and production standards will also help to ensure consistency in quality.



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Stepping Up Traditional Knowledge and Technologies for Higher Women Employment and Income: A Case of Women Milk Producers in Arumeru and Hai Districts in Tanzania

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This study sheds light on the potential benefits of stepping up the use of indigenous knowledge for women milk producers in rural areas of the Arumeru and Hai districts. The findings indicate that milk is socially and traditionally regarded as a good produced by women since they have the largest stake in its management at the household level. Income differences were also witnessed in both districts. Women engaged in milk production faced challenges such as: low milk prices and poor infrastructures—especially in regards to rural roads, lack/shortage of veterinary services, lack of access to capital, high costs of animal needs, pests and diseases affecting productivity of the livestock, and poor cow breeds. Findings show that indigenous knowledge of milk production, processing, value addition, and marketing in the Hai District was advanced compared to the Arumeru District. The study recommends women engaged in dairy projects should be trained with knowledge on the best practices using improved indigenous knowledge and the resources available in their areas.

Keywords: Indigenous Knowledge, Milk Production, Rural Women Employment and Income

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1.0 Introduction

There is no standard definition of indigenous knowledge. Some people define it as "local knowledge that is unique to a given culture or society"(Warren 1991) or simply "local knowledge," (Grenier 1998), and even "information base for a society" (Flavier et al. 1995). There is,

however, a consensus that various communities, cultures, and societies have indigenous knowledge systems. In this study, the knowledge on milk production acquired over generations by rural communities in the Arumeru and Hai districts is defined as indigenous knowledge.

Several studies have established local or indigenous technology as foundational in the drive towards widespread and enduring innovation, entrepreneurship, and in sustainable economic growth and development (Los and Timmer 2003; Warren 1991; West 2000; Horak 2005). The 2014 United Nations Report on Sustainable Development Goals (SDGs), which fed into the UN Post-2015 Development Agenda, summarized the submissions of several researchers across the world and emphasized indigenous knowledge and technology in the areas of education, environment, and job creation (United Nations 2014).

Agriculture contributes about 20 percent of the Gross Domestic Product (GDP) in Tanzania, and the national income estimates show that around 34 percent of GDP comes from the informal economy (Becker 2004; ESRF 2010; Aikaeli and Mkenda 2014). These statistics make a clear macroeconomic argument for policy research on the employment of women in different dimensions because their contribution to both the rural economy and the informal sector is quite reasonable in Tanzania as in most other sub-Saharan African countries. According to NBS (2015), 50.5 percent of people who are employed in agriculture in Tanzania are women. The survey also shows that women make up 50.9 percent of informal employees in the country, most of whom are in the rural areas. Therefore, upgrading indigenous knowledge and technology, resetting systems, and improving working conditions for women in rural areas to engage better in employment can significantly enhance growth and social wellbeing.

In different countries, there are several cases of women in adverse employment situations, and Tanzania follows suit. Women shoulder the bulk of unpaid work, including household maintenance, care of children and the sick, *inter alia*; and they do this in addition to – and to some degree, at the expense of – their involvement in economic work (ILO 2010; NBS 2015). A good number of these women are not in standard employment relationships. The reports show that the percent of adult women aged 15 years and above who are not in the labor force (or not reported altogether) in Tanzania is 11.6 percent, while that of men is 9.8 percent. Yet, using the international standard definition¹ of unemployment, URT National Bureau of Statistics (2007) argues that the unemployment rate of females is 6.2 percent, which is twice that of males (3 percent). Even though these reports both show worse conditions for women, they leave some information to be desired. Nonetheless, the central point is that women are facing a critical employment problem, especially those in the rural areas.

Rural women in Tanzania need innovative, sustainable job creation techniques. Previous studies on job creation among rural women in sub-Saharan Africa focused mostly on generating more

farm and non-farm employment opportunities that are oftentimes not founded on scaling up the local knowledge or technology within communities (IFAD, FAO, and ILO 2010; IFAD 2010; CEDAW 2013). This approach has proven unsustainable over time, as it requires much external support from the government or NGOs. Some studies done in Nigeria, South Africa, and countries in Asia have established that indigenous technology, when scaled up in collaboration with local communities, can be a springboard for further innovations and entrenches sustainable entrepreneurship (Oyewole 2009; IFAD 2004; Seleti and Gaoshebe 2014).

This article explored the possibilities of creating employment among rural women in Tanzania through scaling up indigenous technology. The focus is on the Arumeru and Hai districts, which were selected deliberately. Most rural women in these two districts (Hai in the Kilimanjaro Region and Arumeru in the Arusha Region) are engaged in traditional agriculture and animal husbandry; and they have proven to be quite entrepreneurial. These districts have similar weather and women engage in the same economic activities—notably milk production for subsistence and commercial purposes. However, the women in these districts do use different marketing strategies, which provide them with different dividends.

Upgrading technology, resetting systems, and improving working conditions for women to engage better in employment can significantly enhance growth as well as poverty reduction. Such changes, however, demand the availability of proven, quality information from research to craft policies that will generate a tangible impact on women's work.

1.1 Study Areas

This study was conducted in the Arumeru and Hai districts in the Arusha and Kilimanjaro regions, respectively. The Arumeru district had a slightly higher number of respondents (51.3 percent) as compared to the Hai district with 48.7 percent of respondents.

1.1.1 Arumeru District

Arumeru District is in the Arusha Region. It is bordered by the Monduli District to the north, west, and southwest, while to the southeast, it is bordered by the Arusha district. Kilimanjaro Region neighbors Arumeru District to the east. It covers roughly 2,900 square kilometers. The district surrounds Mount Meru, the fifth highest mountain in Africa, with a height of nearly 5,000 meters above sea level.

Agro – Economic Zones

According to Carlsson (1996) and UNEP (2002), three agricultural zones based on altitude and rainfall can be distinguished in Arumeru District as follows:

	Agro-Economic/Ecological Zone		
	High Altitude (Sub-humid)	Middle Altitude (Intermediate)	Low Altitude (Semi-arid)
Altitude (Meters) Above Sea Level	1900-1550	1550-1300	1300-1200
Rainfall per Year (mm)	2000	1000	500-700
Population Density (People per Sq. Kilometer)	High	Low	Less than 50
Significance of Dairy Cattle in the Zone	Very Significant	Significant	Fairly Significant
Most Common Cattle Breeds	Friesian and Jersey	Friesian, Jersey, and Zebu	Zebu
Most Common Grazing Practices Used	Intensive Zero grazing Livestock System	Semi-extensive Cattle Rearing System	Extensive Livestock Rearing System

Table 1a: Agro-Economic/Ecological Zones in Hai District

1.1.2 Hai District

Hai District is located in Kilimanjaro Region, and it covers an area of 1,011 square kilometers (101,100 hectares). The district was established in 1975 from a division of Moshi District. It borders the Moshi Rural district to the east, the Arumeru and Siha districts to the west, Simanjiro District to the south, and Kilimanjaro National Park and the Rombo District to the north.

Agro – Economic Zone

The district is divided into four main agro-ecological zones. The highest, Mount Kilimanjaro Peak, is uninhabited and does not support dairy farming. The remaining three are briefly described in the table below:

	Agro-Economic/Ecological Zone		
	Upper Zone	Middle Zone	Lowland Zone
Altitude (Meters) Above Sea Level	1,666 - 1,800	900 - 1666	Below 900
Rainfall per Year (mm)	1250 - 1750	700 - 1250	500 - 700
Population Density (People per Square Kilometer)	650	250	Less Than 50
Significance of Dairy Cattle in the Zone	Very Significant	Very Significant	Significant
Most Common Cattle Breeds	Exotic Breeds: Ayrshire, Holstein Friesian, and Jersey	Ayrshire, Holstein Friesian, and Jersey	Zebu
Most Common Grazing Practices Used	Zero grazing	Semi-extensive Cattle Rearing System	Free Grazing in Uncultivated Areas and Seasonal Grazing

Table 1b: Agro-economic/Ecological Zones in Hai District

1.2 Women Employed in the Arumeru and Hai Districts

On average, in all regions of the country, rural men have higher earnings than rural women. The majority of the rural employed population works mainly on their own farm, particularly in the case of women. The agricultural sector is by far the main sector of employment, especially for rural women. About 90 percent of women and 85 percent of men in the rural areas are employed in agriculture as their main occupation. In addition, there is slightly more diversification among male workers, in terms of their economic activities, than among female workers (Osorio 2014),

Around 78 percent of the rural working population indicated that they work on their own farms. Furthermore, the majority of those who work on their own farms are subsistence farmers, according to the findings of the agriculture sector. Although working predominantly on their own farms, men have slightly more opportunities than women to participate in other categories of employment, such as paid or self-employment in non-agricultural work sectors. The largest gender-based wage gaps can be seen in the northern regions, where men earn 2.9 times more than women. After self-employed farming, unpaid family work in agriculture is the second most prominent type of employment for both rural men and women in Tanzania (Osorio 2014).

1.3 Research Problem

Going through the social context of the employment of rural women in Tanzania, particularly in the Arumeru and Hai districts, there are unanswered questions that necessitate research. The working environment for women has been widely studied and the literature has been quite thorough in explaining challenges faced by women in terms of securing and maintaining decent employment. Measures such as the promotion of non-agricultural industries, including service industries and commerce, have advanced towards the development of rural women (ILO 2011), however, the actual benefits accrued to women have not yet been realized. Other studies have also called for the development of rural infrastructure and market access, improved access to reliable and affordable energy services, and Information and Communication Technology (ICT) (Samuel 2011). Some previous research conducted posits that creating employment for rural women is possible if adequate provision of extension services and education are seriously considered (Gaaya 1994). Other researchers believe that the development of cooperatives and support for the building of social capital, including the provisions of access to credit and agricultural insurance, especially to rural women, will be beneficial in closing the employment gap (Fletschner and Kenney 2011). Still, others have argued for efforts to concentrate on the provision and promotion of equitable access to water, land, and other resources (Gunda et al. 2013).

Despite this wealth of existing literature on improving employment opportunities for rural women, there has been very little research on how traditional and indigenous technologies can be utilized in concert with modern technology to create sustainable rural development.

While women in both the rural Arumeru and Hai districts engage in traditional zero grazing milk production, they use different sales and marketing approaches, which render differences in their financial outcomes. In Arumeru District, most women sell milk at home or in the regular weekly local markets. They may sell to local consumers who purchase milk for subsistence, or to middlemen who purchase and sell it to the milk processing industries in Arusha. This is a traditional way of selling milk in Arumeru, and in some villages of Hai District as well. Nevertheless, in Hai District, there are instances of villages, with specialized cooperatives of women that deal with milk marketing, sales, and value addition. The cooperatives organize purchases of milk from women farmers, then sell the milk at wholesale prices in Moshi and pay women on a monthly basis according to their respective sales amounts. They also process some milk to create products like cheese that may be sold at higher prices. Production is done individually, but sales and processing to add value are done collectively in an organized way. It is not clear which of these two methods has proven to engage more women and deliver better returns to the women involved. In view of these dimensions of production, sales, and value

addition, the method proven to engage more women and to deliver better returns to respective women is not well established. This article addresses differences in production techniques, value addition, marketing for better returns, and hence the possibility for the creation of incentive for women to better engage in employment and production in these districts.

Among unanswered research questions is: How can assets for women safeguard their employment and craft new, decent employment opportunities for them out of existing local or indigenous knowledge be appropriately created? Examples of these assets of various forms are skills and knowledge, requisite capital, energy, social-economic infrastructure—including those for sales and marketing—to mention a few. While many studies look at the problems women face in employment, scant literature, based on the already-existing indigenous technology, exists on how to transform the economic realities of women in the rural economy in Tanzania.

In both the Arumeru and Hai districts, women are mainly employed in agriculture and dairy farming. Milk production is one of the main outputs of dairy farming, and dairy farming itself is considered a woman's activity; thus, dairy farming employs a good number of women in these districts. The main challenge that women face is the inability to set the price of milk and other dairy products. For example, in some villages of Hai District, women have cooperatives that process milk and produce other value-added dairy products. These cooperatives seek markets for their products, and sell them on behalf of the individual women. In doing this, the value of milk and related products increases, thus attracting good prices. Members of the cooperative (who are strictly women) are paid monthly, per the amount of milk they supply to the cooperative. In Arumeru, it is not quite the same; the applied marketing and sales techniques are mostly traditional, so milk producers do not directly access the wholesale market, and they lack negotiation power amid limited value addition.

Can women organizations be improved to step up their traditional production, sales, and marketing practices for higher incomes, and therefore help to increase employment in these rural areas? Can the society and/or government diffuse hindrances to the creation of decent employment and improve the working conditions for rural women? This research seeks to explore answers to these questions in the two districts under the study.

1.4 Study Objective and Research Questions

The major objective of this research is to address the challenge of unemployment for rural women, with an emphasis on how to leverage existing indigenous technology to create opportunities and improve working conditions. The study intended to answer the following questions as specific objectives:

- (i) What are the employment and income differences of women engaged in milk production in the Arumeru and Hai districts?
- (ii) What challenges do women milk producers face in the Arumeru and Hai districts?
- (iii) How can women be organized to increase value addition and to improve their traditional selling practices for higher employment and incomes?

2.0 Policy Background—Theoretical and Empirical Perspectives

In its national development agenda, Tanzania has an emphasis on improvement of the employment conditions for women. Different policy statements have clauses attempting to give due weight to this issue. A number of policy statements stressed the question of the creation of quality employment for women, including the following, inter alia: (i) National Employment Policy (2008), which explicitly states one of its objectives is to promote equal access to decent employment opportunities and resource endowments for vulnerable groups of women, youth, and people with disabilities; (ii) Policy on Women in Development in Tanzania (1992), which emphasizes changing structures and procedures in use for employing people, with the aim of creating more vacancies for employment of women; (iii) National Population Policy (1992), which was reviewed in 2006 and states one of its directions is to promote women's employment opportunities and job security; and (iv) Sustainable Industrial Development Policy, (1996-2020), which prioritizes creating employment in the informal sector where women are largely employed.

Nevertheless, the missing link among these are scientifically researched options for the fruitful implementation of the stated goals of these policies. Therefore, the focus of this study is directed towards bridging this critical knowledge gap. Achieving the stated objectives of this project is useful for proper implementation of existing policies. The study also highlights critical areas for national policies to give more attention to regarding the employment of rural women;

[Rural women] make essential contributions to agricultural and rural economies in all developing countries. Their roles vary considerably between and within regions, and are changing rapidly in many parts of the world, where economic and social forces are transforming the agricultural sector. Rural women often manage complex households and pursue multiple livelihood strategies. Their activities typically include producing agricultural crops, tending animals, processing and preparing food, working for wages in agricultural or other rural enterprises, collecting fuel and water, engaging in trade and marketing, caring for family members, and

maintaining their homes. Many of these activities are not defined as economically active employment in national accounts, but they are essential to the well-being of rural households (SOFA 2011).

From the theoretical literature front, whether indigenous or some other knowledge that can be counted as erudite understanding, what matters is not its origin but its contribution to productive activity. The only difference is that the former entails subjugated knowledge in view of historical treatise of contemporary functionalist and formal systemization though its relevance continues to exist (Foucault 1980). While there may be alternative ways to increase employment of women in rural areas, women's indigenous knowledge (IK) already serves to improve their productivity and participation by creating engagement opportunities. Indigenous knowledge and technology are useful to the compensation of and production by rural women since the knowledge referred to as "modern" knowledge is either largely too expensive or inaccessible to women. There is also no guarantee that the perceived "modern" method or approach would always be a good fit for a specific society. In view of this, the subjugated view on the indigenous knowledge is a matter of perception and context; for that reason, it is important to focus on the certain types of knowledge that have been in existence, and the ways we could improve them for better results. While certain types of knowledge may be considered to be of a lower status in some socio-economic conditions, in other places that same knowledge may be cutting-edge. Foucault underscores the fact that from the late 1960s on, there has been an upsurge in the understanding of the essential association between indigenous knowledge and the new knowledge acquired in school or through reading; therefore, a recent appreciation has grown for the high place IK holds in the hierarchy of knowledge and science (Foucault 1980).

Indigenous knowledge has a role in the development process of societies as part of social capital for production and livelihood (Harding 1998). While the world is advancing in terms of science and technology, it is known that adoption of new means and approaches in different societies is taking place gradually, and, in some communities, identity is preserved in such a way that the process of change is still more gradual. While the gradual change in technology may not necessarily be the case for the Hai and Arumeru districts, we should acknowledge the possibility of a leap forward in development if improvement in indigenous knowledge is taken as a matter of course within the theory of change (which looks at the preceding base of knowledge as a foundation to the present and future of knowledge). Along these lines, enhancing indigenous knowledge should create a better foundation for the acquisition of complementary modern knowledge. Using one sort of knowledge does not necessarily rule out the use of another type. Although there is this argument about complementarity, there is an equally important argument about the substitution of heuristically gained indigenous knowledge where modern knowledge acquired in school or through reading is not comprehended, inaccessible, relatively too costly,

customarily unacceptable, and so forth. Looking at the diversity of knowledge, it becomes clear that indigenous knowledge that is directed towards economic activities in African communities should be appreciated, studied, improved, and preserved to guarantee contributions to the livelihoods of those in the communities.

According to the theory of access (Ribot and Peluso 2003), access to resources and markets may be a problem to some stakeholders. Ribot and Peluso define access as “the ability to derive benefits from things.” This understanding is used in our study, which presupposes the idea that the marketing and selling milk and dairy products in the Hai and Arumeru districts is underpinned by women’s ability to derive benefits from the market, which we regard here as a “resource” for the facilitation of value flow from buyers to the makers/sellers. Access is regarded here as a matter of “power,” rather than “right,” to participate in the market effectively. Understanding the factors, means, and processes that limit women from deriving adequate benefits from market opportunities constitutes a major part of the objective of this study. Our concern, on the women’s side, regards their inability to participate in the production, marketing, and selling of their milk in the manner that is most effective and lucrative, given the knowledge and technology available within their localities. If women can be organized, in a way that can enhance the possibility of better products, to command higher prices and, therefore, receive commensurate returns, women will be more incentivized to participate in milk production; therefore, their employment rates will scale up, and incomes will rise. This study attempts to show that this organization needs not necessarily to be of the modern sort— it can arise from women’s very own indigenous forms of mobilization, learning, and sharing of synergies.

As outlined earlier, some of the villages included in the study are Ng’uni and Nronga in Hai District, where marketing and sales of milk are organized in cooperative form. In a “modern” economy, the activities of thousands of people and resources, which are scattered over thousands of miles, all contribute to producing and distributing a single product, such as a loaf of bread. The contributions are made over a period of many years, with past contributions embedded in capital goods, knowledge, institutional structure (including firm organization), and inventories. Coordinating these contributions, when, at each step of the production distribution sequence, information and mechanisms of control are imperfect, is a central economic problem (United States Department of Agriculture 1989). In this view, and in the context of developing economies, we look at the production and marketing organizations conducted by women in the Arumeru and Hai districts as a valuable research front for uncovering the way traditional organizational structure can be scaled up. The goal is to create better dividends for women’s initiatives in these areas and craft lessons for other places in the country and beyond;

Economists studying cooperative theory through 1980 tended to view the farmer cooperative in three distinct ways: (i) as a form of vertical integration by otherwise independent firms, (ii) as an independent business enterprise, which could be analyzed as a variant of the investor-owned firm (IOF), and (iii) as a coalition of firms, in which there was a revocable substitution of collaboration for independent competition (USDA 1989).

The context of the Arumeru and Hai districts fits well with these views, and especially the second perspective, since women operate in their own independent cooperatives (especially in Hai District). Whether a cooperative organization makes better outcomes in production and marketing than the traditional itinerant sales, is a matter of empirical analysis.

Cooperatives can be thought of in two main ways:

(i) the broad sense, which refers to the coordinated activity of agents pursuing different objectives and seeking to establish common rules; and (ii) the strict sense, which refers to the institutionalized practices of cooperative enterprises (Draperi 2006).

Regardless of the way we take in the reference to women's organization in the rural areas, the central point is "cooperative as mutual learning that produces innovations and democratic forms of control" (Nembhard 2014; Draperi 2005). Cooperatives put their founding rationale on collective innovation and bargaining power. These are necessary for the development of rural economies, which means that women in the study area could use such forms of organization to positively influence innovation and production capacity in their communities. Women can secure employment if their related productive activities are improving and providing opportunities and higher incomes.

The other important point, as one considers the production of different types of products and their feasibility given competing alternatives, is whether there is some substitutability that could undermine one product at the expense of the other. Women do not traditionally produce only milk; they engage in the production of other goods as well. Assuming there are only two competing goods, namely milk (m) and some other good (k), then in the production space of these two goods, if women are maximizing production, there exists the possibility of scaling up milk production by reducing production of the good k , which in this case could be counted a composite product—representing everything else.

This substitution in production is important for three things to be achieved: the maximum amount of output that can be produced from any specified set of inputs, given existing technology; technical efficiency, which entails achieved output when the maximum amount of output is produced with a given combination of inputs; and economic efficiency, implying achieved output when a business is producing a given output at the lowest possible total cost. The question of women producing milk and marketing their production in these districts must be analyzed based on these aspects, particularly while putting emphasis on technical efficiency. Available technology limits output to a maximum achievable level. If technology is changed or improved, the cooperative theory makes clear that the level of achievable output will subsequently rise. Among the concerns that this study wants to explore are the knowledge and technology that women apply, and the way to improve that available traditional knowledge and technology to yield the best possible outcomes for women in rural areas.

We can write a short-run production function $Q = f(L, K)$, where L is labor input, and K is capital input. Assuming that K is given, this production function reduces to $Q = f(L)$. The setting of the production function with one factor of production (labor) is appropriate for the case under study since the assumption we are making is that other factors are given. Recognizing that knowledge imparted to women and the technology these women use influence human production capacity, and would enhance production, even if other factors remain unchanged, there is good reason to study the role that the improvement of knowledge and technology can play in relation to women's output, and, furthermore, to employment and the women's incomes. Therefore, our study will focus on human production capacity and its impact on women's outputs in the production and marketing of milk products. The capacity of interest in this study is that which comes from indigenous knowledge, taking into account the initial state of that knowledge, evidence of an improvement in the knowledge, and the outcomes in terms of women's employment and incomes.

The empirical literature shows that traditional dairy farming is practiced around the world at different levels of scale. The benefits of dairy farming (at various scales) range from food security, to profit making, to provision of employment; this last benefit is mostly for women in rural areas, especially in areas with zero grazing farming methods like the Arumeru and Hai districts.

As long as traditional breeding stock (of low milk production potential) continues to be the major source of milk production for the rural peoples of the Southern and Eastern African region, traditional milk processing in this region will continue to be a household activity, revolving around the natural fermentation of milk, traditional butter churning methods (which are appropriate to the small quantities of milk processed), and ghee preparation. The production of

cottage cheese from sour buttermilk is, with the exception of Ethiopia, generally not done. While improvements to existing household-level technologies may be made (O'Mahony 1985), the introduction of new and more efficient milk processing techniques, equipment (centrifugal milk separators, wooden/metal butter churns), and products (boiled curd cheese) will require the installation of milk processing units at the village (community) level. Such village-based dairy processing units will enable more economically efficient processing of larger quantities of milk, and will be more in line with the historical role of dairy creameries in the process of the dairy industry's development in developed countries. Such a strategy is being applied in Ethiopia with some success (O'Mahony 1987a) and is thus worth emulating in other countries after considering the peculiar cultural conditions of each community.

3.0 Traditional Milk Processing Techniques

Naturally fermented milk is the basis of traditional milk processing in Africa. In most African societies, special processing methods involving the application of wood smoke have evolved, resulting in products with unique flavor and an extended shelf life at ambient temperatures. Kurwijila (1989) points out that the practice is so widespread that it warrants much closer attention by researchers than has hitherto been given to it, and that unlike the smoking of fish and meat products (FAO 1975), there have been no studies on the traditional smoking of milk.

The interaction of wood smoke constituents with milk components (especially proteins) under the conditions of traditional smoking techniques needs to be investigated with a goal of understanding the effect of these interactions on the nutritive value of milk and the milk's bacterial flora, and further, whether the improvement in shelf life of traditional fermented milk is due to selective bacteriostasis or bactericidal effects. Information so obtained could be used:

- i. To identify suitable and unsuitable wood types and conditions of pyrolysis
- ii. To identify the benefits of smoke application practices and give appropriate recommendations
- iii. To modify the smoking technique to suit, for example, the use of standard smoke condensates from approved wood types in the industrial production of sour milk products bearing traditional flavor and taste, in cases where this is more desirable than conventional sour milk products

When the processing of milk involves only 2 to 20 liters, then the extraction of fat through the churning of fermented milk is, under prevailing conditions in the rural areas, both practical and most appropriate. The efficiency of fat recovery may be improved through churning at

temperatures slightly below 20°C (traditionally strived for through churning in the early morning hours) or by attachment of internal agitators to traditional vessels (O'Mahony 1985). The overall efficiency in fat extraction can only be effected through the introduction of centrifugal separators and wood/metal churns of larger capacity and better design than the traditional clay pot. Because of the high investment costs involved, this strategy calls for the establishment of village dairy centers to be operated on a cooperative basis or by individual entrepreneurs willing to pay pastoralists a good price for their surplus milk.

4.0 Methodology

4.1 Study Population

The population of this study consisted of women involved in dairy milk production who were also members of milk and associated product cooperatives in the Arumeru and Hai districts.

4.2 Sample Size and Sampling

Since the population size of female dairy milk producers in the Arumeru and Hai districts is not known, the sample size for this study was estimated using the following formula (Kothari 2004):

$$n = \frac{z^2 p q}{e^2}$$

Where $q = 1 - p$, therefore the above equation becomes:

$$n = \frac{z^2 p (1 - p)}{e^2}$$

Where:

$z = 1.96$, critical value

$p = 0.5$, assumed probability of female dairy milk producers

$e = 10$ percent (0.1), confidence interval

Substituting these values,

$$n = \frac{(1.96)^2 \times 0.5 \times (1 - 0.5)}{(0.1)^2} = 96$$

Through this formula, we found 96 to be our minimum appropriate sample size, and subsequently aimed to have 120 respondents. We adopted a combination of multi-stage sampling approach and simple random sampling.

The northern zone was selected because of the significant presence of women engaged in dairy milk production in the rural areas of both the Arusha and Kilimanjaro regions, which use zero grazing farming methods within similar locations, but traditionally use a few different approaches, especially in feeding and marketing of the dairy products. From each region, two districts were selected. In Arumeru District, three villages hosting women dealing with dairy milk production were selected. In Hai District, two villages were selected that both host women who produce milk and milk products and are organized in marketing cooperatives. In these villages, women were selected from households using purposeful sampling.

We opted for these methods because of their effectiveness in primary data collection from geographically dispersed populations when face-to-face contact is required. In addition, they are cost and time effective, and have a high level of flexibility.

4.3 Data Collection

The study used both secondary and primary data as detailed below.

4.3.1 Primary Data

Most of the primary data were collected through a structured questionnaire, formulated with standard questions for all respondents. Interviews were also conducted to seek specific information from women dairy milk producers in the Arumeru and Hai districts.

4.3.2 Secondary Data

The material for data resources included published and unpublished materials, reports, and reliable internet sites. Secondary data have also been used in the discussion to compare and contrast the findings of this study.

4.3.3 Data Analysis

The data collection tools were coded to make quantitative data entry and processing simple. After data entry, the Statistical Package for Social Sciences (SPSS) was used to aid the analysis of primary data, which was then organized and analyzed in relation to the specific research objectives. Descriptive statistics frequency tables, 3-D columns, cylinders, and cones were used;

cross tabulation tables were also developed; and since some questions had more than one response, multiple analysis was done to simplify data interpretation.

To process qualitative data, the information and knowledge accruing from milk producers in the Arumeru and Hai districts were put into technical or social scientific language to make it more meaningful and useful to readers. The researchers compared information collected from Hai District, where traditional milk production had been improved, with the information collected from Arumeru. Comparisons between the two were made using both qualitative data and quantitative data analyses, as shown in section four. Comparisons and contrasts focused on improvements in indigenous knowledge for milk production, focusing on:

- i. Transitioning from natural breeding to artificial insemination
- ii. Improved cow sheds and feeding
- iii. Establishment of milk cooperatives
- iv. Value addition and production of milk products in terms of processing, packaging, storage and preservation methods, and distribution
- v. Employment and income creation
- vi. Ownership of cows and milk income across genders

Data analysis enabled researchers to draw lessons on how the improved traditional milk production at Nronga Milk Cooperative Society in the Hai district could improve milk production in other areas under study.

5.0 Findings and Discussions

5.1 Milk Producers' Demographic Information

It is important to note from the outset, and before looking at the results, that milk, as a product in the Arumeru and Hai districts, is socially and traditionally regarded as a good produced by women since they have the largest stake in the management of milk in households. While men are largely entitled to other rights such as the production of cash crops and large-scale food crops, women are engaged in milk production as their household economic activity. Although the household may assist in taking care of zero-grazed cows, the right of ownership and milk production is generally vested to women. This has been a long-time division of labor in both the Arumeru and Hai districts.

The findings show that the modal age group in both districts was above 55 years old, which accounted for 45.9 percent in Arumeru and 40.4 percent in Hai. This implies that milk production is mainly conducted by relatively old women in both districts. Only about 27.9 percent of milk producers in Arumeru and 28.1 percent in Hai were aged less than 35 years old.

The findings further show that the female household heads in Arumeru comprised of 52.5 percent of respondents and 59.6 percent in Hai District. The remaining households were headed by males. Of all respondents in Arumeru, 82 percent were married, 14.8 percent were widows, and 3.2 percent were single. In the Hai district, 75.4 percent of respondents were married, 12.3 percent were widows, 8.8 percent were single, and 3.5 percent were divorced/separated. The findings showed that there were no divorced/separated respondents in Arumeru District.

As far as education qualification is concerned, the trend was similar in both districts. The primary school graduates were 73.8 percent of respondents in Arumeru and 75.4 percent in Hai; secondary school graduates were 21.3 percent in Arumeru and 14 percent in Hai. Only 1.6 percent in Arumeru and 5.3 percent in Hai had tertiary education. The rest (3.3 percent in Arumeru and 1.8 percent in Hai) had no formal education.

5.2 The Employment and Income Differences of Women Engaged in Milk Production in the Arumeru and Hai Districts

5.2.1 Economic Activities

In Arumeru District, some people are employed in the formal sector and others in the informal sector; however, a large proportion of the population is engaged in agricultural activities. The major crops grown in these districts are coffee, bananas, maize, and beans, while minor crops are wheat, barley, finger millet, pigeon peas, sunflowers, and paddy. Horticultural crops, such as tomatoes, onions, cabbages, and Irish potatoes, are also grown. Most farmers in Arumeru keep cattle on the mountain slopes, where they are stall-fed, and in the lowlands, where they are open grazed.

In Hai District, the main economic activities include crop and animal husbandry, micro and small businesses, and employment in the government and private sectors. In this district, both dairy and beef cattle are reared. The district is endowed with 38,000 dairy cattle, which are kept on zero grazing units on southern slopes of Mount Kilimanjaro. It is estimated that over 40 million liters are milked annually. Some of this milk is consumed locally, while some is sold to urban areas of Moshi, Hai, and Arusha as raw or cultured milk.

Dairy farming, which was studied, is among the major agricultural subsectors in the two districts. The findings show that 51.9 percent of respondents in Hai District and 44.4 percent in Arumeru District were engaged in dairy farming. In addition, using the same respondents who were also engaged in crop farming, the findings show that crop farming is their next largest economic activity with 45.3 percent of respondents in Hai and 41.1 percent of respondents in Arumeru. The rest were engaged in business and other activities as shown in Table 2:

<i>Economic Activities</i>	Arumeru		Hai	
	N	Percent	N	Percent
Crop Farming	51	41.1	48	45.3
Dairy Farming	55	44.4	55	51.9
Business	14	11.3	2	1.9
Other	4	3.2	1	0.9
Total	124	100	106	100
<i>Method of Dairy Farming</i>				
Zero Grazing	60	88.2	57	98.3
Outdoor Pastoralism	7	10.3	1	1.7
Both	1	1.5	0	-
Total	68	100	58	100
<i>Cattle Caretaker</i>				
Wife/Female	24	37	33	54.1
Husband/Male	4	6	6	9.8
Household	30	46	18	29.5
Household Helper	7	11	4	6.6
Total	65	100.0	61	100
<i>Source of Animal Feed</i>				
Planted in the Farm/Fodder	32	50.8	51	58.6
Naturally Cuts from the Uncultivated Areas and Jungle	30	47.6	24	27.6
Buying	1	1.6	12	13.8
Total	63	100	87	100
<i>Marketing Channels</i>				
Telephone (Calls and/or WhatsApp)	7	10.8	1	2
Word of Mouth	58	89.2	44	77
Other	-	-	12	21
Total	65	100	57	100

Table 2: Dairy Farming and Other Economic Activities in Arumeru and Hai Districts

Zero grazing is the common method of dairy farming in both districts, with 98.3 percent in Hai and 88.2 percent in Arumeru. The findings show that 54.1 percent of women in Hai care for the cows as compared to 36.9 percent of women in Arumeru District. About 46.2 percent of households in Arumeru raise cows as compared to 29.5 percent in Hai. Generally, few men and house-helpers care for cows in both districts, as shown in Table 2.

The main source of livestock feed was planted fodder, which accounts for 58.6 percent of feed in Hai and 50.8 percent in Arumeru. The next significant proportion, with 47.6 percent in Arumeru and 27.6 percent in Hai, is natural grasses cut from the uncultivated areas and jungles. A small proportion of livestock feed is bought. These results show some difference in feeding approaches between Arumeru and Hai. Although a large proportion of female milk producers in Hai feed cattle with planted fodder, they do somewhat supplement with natural grasses cut from bushes. The type of planted fodder used is specialized for dairy cows because it includes rich carbohydrates and proteins. This implies an advancement from the very traditional method that did not allow significant portions of farms to be used for livestock fodder production.

Further, marketing in Arumeru depends mostly on word of mouth. In Hai, marketing depends on the organized cooperative method (captured under "other responses" that were not listed in the questionnaire), which is somewhat of an evolution from the traditional method of selling in itinerant occasional markets where the word-of-mouth, beliefs, and rapports of the individual sellers tremendously matter. Word-of-mouth was the marketing channel used by 89.2 percent and 77.2 percent in Arumeru and Hai, respectively. Telephone calls and WhatsApp were used by 10.8 percent of milk producers in Arumeru, while only 1.8 percent of women milk producers in Hai District used these marketing tools.

5.2.2 Number of Cows Owned and Milked

In terms of the number of milk cows owned and milked, the trend looks similar in both districts. As indicated in Figure 1, most female milk producers own two or three cows. A similar trend was observed in India (Punjabi 2016), where millions of small, marginal dairy farmers, who own two to four animals and produce an average of five liters per day, comprise a critical portion of India's dairy industry.

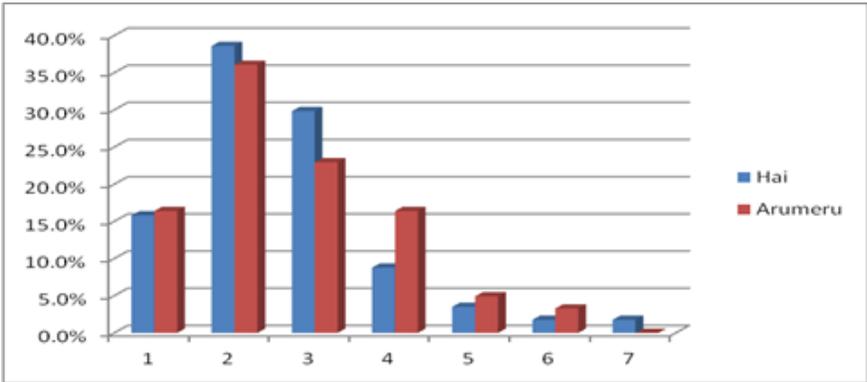


Figure 1: Percentage Distribution of Number of Dairy Cows Owned in Arumeru and Hai

Livestock development in general, and dairy development activities in particular, are key components in support of poor people in the rural areas because livestock distribution is much more equitable than land distribution. Thus, improvement in the dairy farming environment has important implications for smallholder farmers and poverty reduction.

The majority (59.6 percent and 55.7 percent) of respondents in Hai and Arumeru had only one milk-producing cow at the time of data collection; 29.8 percent and 29.5 percent of respondents had two milk-producing cows, respectively (Figure 2).

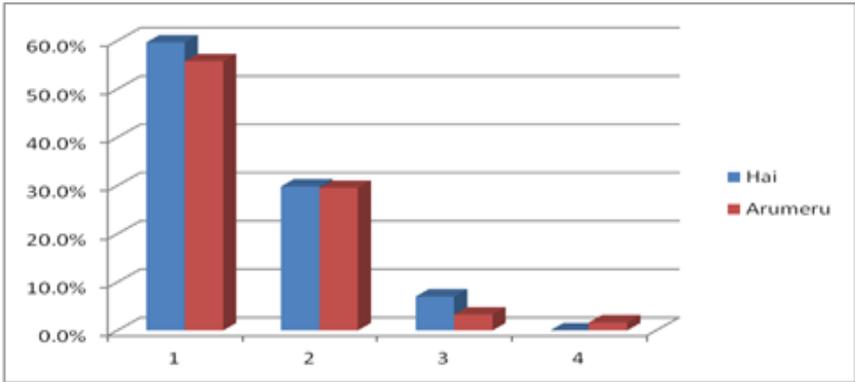


Figure 2: Proportion of Dairy Cows Currently Producing Milk in Arumeru and Hai

The numbers of cows owned is on the lower side of what could economically be profitable if women wanted to create a full-time job in this channel of production. The small number of owned cows is partly due to the shortage of land for fodder production within the zero grazing environment in the two districts, where land availability is a great challenge.

5.2.3 Amount of Milk Produced and Sold

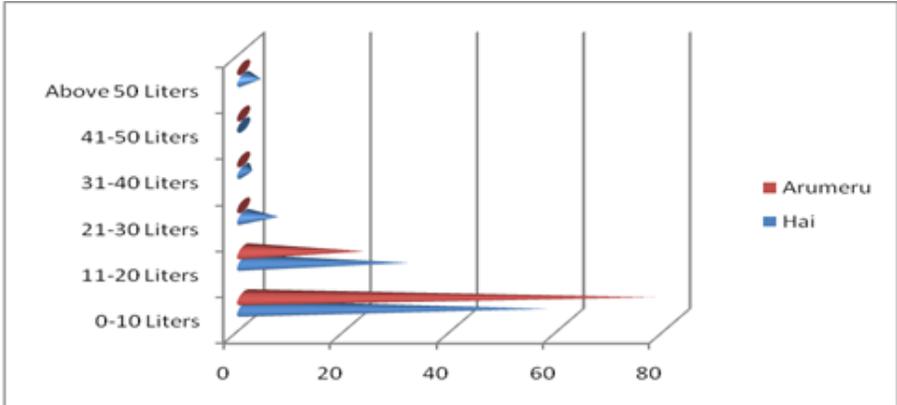


Figure 3: Amount of Milk Produced Per Day in Liters in Arumeru and Hai Districts

According to the findings presented in Figure 3, the majority of women in both districts produced less than 10 liters of milk per day; this is true for 77.2 percent of women farmers in Arumeru, and 57.4 percent in Hai.

About 31 percent of women farmers in the Hai District produce between 10 and 20 liters of milk, compared to 22.8 percent of their counterparts in the Arumeru District. In Arumeru, there was no milk production above 20 liters per day, but a small proportion of women farmers produced more than 20 liters of milk per day in the Hai District.

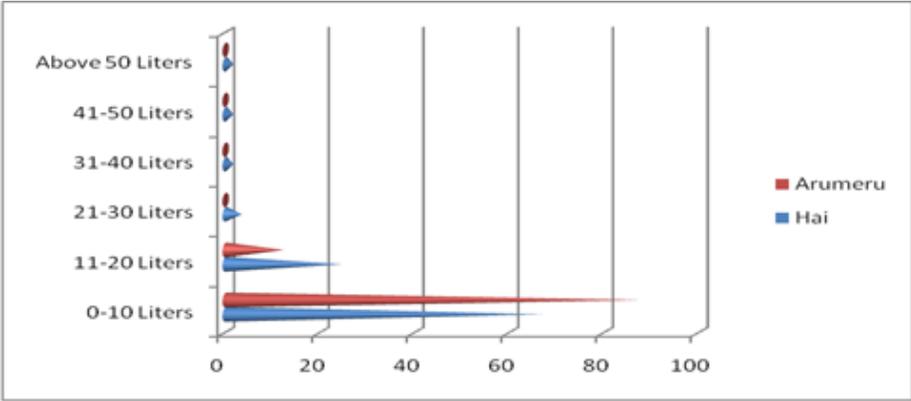


Figure 4: Amount of Milk Sold Per Day in Liters in Arumeru and Hai Districts

Figure 4 shows the percentage of milk sold per day: 87.7 percent of women milk producers in the Arumeru District sell less than 10 liters, compared to 67.2 percent in the Hai district. It is important to note that some of the main differences between women milk producers in the Arumeru and Hai districts are related to the sales approaches used in these respective places. In Hai, milk production is commercialized in a cooperative fashion, while in Arumeru, commercialization that has taken place so far is more on an individual basis than a cooperative organization model. Proportionately, more women sold between 10 and 20 liters of milk per day in Hai (24.6 percent) than in Arumeru District, where only 12.3 percent of women milk producers sold milk at this rate. There were no women milk producers selling above 20 liters per day in Arumeru, but in Hai, a small proportion of milk producers sold more than 20 liters per day.

5.2.4 Milk Selling Points

The study shows that about 45.9 percent of women milk producers in Arumeru sold their milk in the local market. In Hai District, only 5.3 percent of women milk producers sold their milk in the local market.

Apart from selling their milk in the local markets in both districts, women sold milk at home, in cooperatives, and in other outlets. While a substantial proportion (27.9 percent) of milk producers in Arumeru sold milk at home, only 1.8 percent of their counterparts in Hai District sold their milk at home. The primary reason is because, in Hai, there is a cooperative society marketing model leading a large proportion (93 percent) of milk producers selling through cooperatives, compared to their counterparts in Arumeru, where only 9.8 percent of milk is sold in cooperatives. The findings further show that about 16.4 percent of milk producers in Arumeru sold to groups, like “Limanumbe,” which is an organized group of micro and small milk business owners, and local shops (Figure 5):

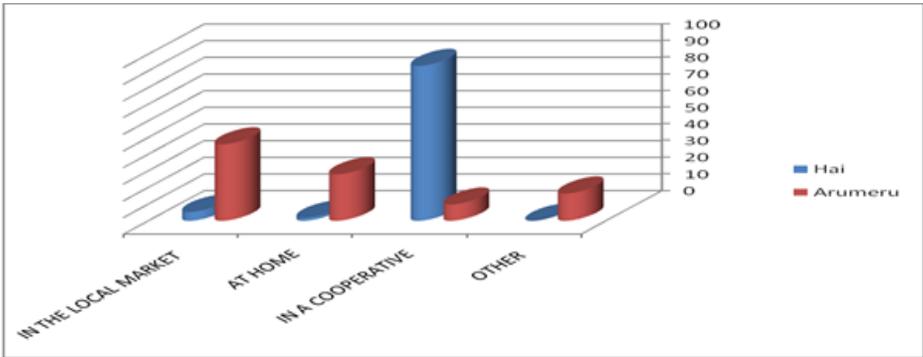


Figure 5: Percentage Distribution of Milk Selling Points

5.2.5 Payment Duration

Figure 6 shows that payment terms in the milk business of these 2 regions were primarily monthly: 98.3 percent of respondents in Hai District and 73.8 percent of respondents in Arumeru received payment on a monthly basis:

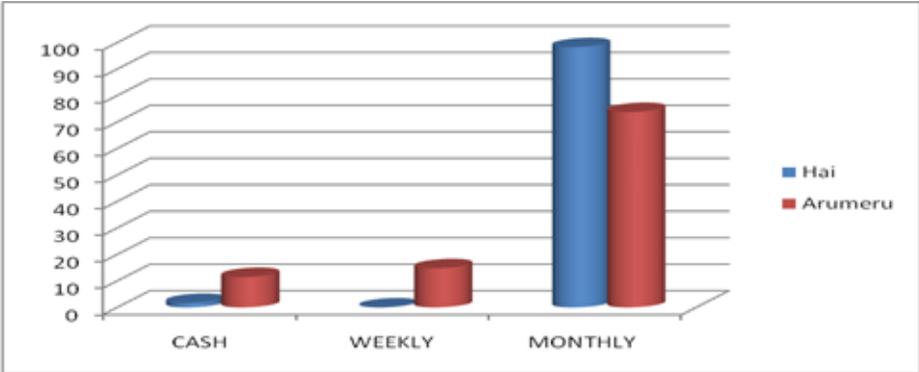


Figure 6: Percentage Distribution of Payment Methods

Monthly payments are more preferred to cash payments because most household budgets are done on monthly bases, and most bills are either paid at the beginning or at the end of month. However, a small proportion (1.7 percent) of farmers accepted cash payments. The study reveals that there were no weekly payment terms in Hai District.

In Arumeru District, about 11.5 percent of respondents accepted cash payments, and 14.8 percent accepted weekly payments. In Hai District, the most common payment period is the monthly payment, just like a usual salary. Every time a woman sells milk, a special card must be filled out indicating the amount of milk, then she is provided with a receipt showing the same amount for her records. Cash disbursement is done cumulatively at the end of the respective month.

These differences are once again caused by milk producers in Hai organizing their marketing and sales in cooperative mode, while milk producers in Arumeru sell on an individual itinerant basis as noted.

5.2.6 Uses of Milk Revenue

A growing body of research indicates that women's economic empowerment is positively correlated with improved family welfare and nutrition, higher education levels for girls, and improved economic growth for the society (IFC 2007).

The findings in Table 3 show that both districts had the same proportion of milk revenue used to buy food—20.2 percent in Arumeru and 21.8 percent in Hai. This agrees with the beliefs of Okali (2011), who states that milk revenue has trickled down to the family to sustain household food security and other social needs.

Uses of Milk Revenue	Arumeru			Hai		
	N	Mean (Tshs)	%	N	Mean (Tshs)	%
Food	57	77,544	20.2	49	51,318	21.8
Housing	17	20,294	5.3	3	15,000	6.4
Utility Bills	36	22,916	6.0	29	11,862	5.0
Clothing	25	21,200	5.5	22	29,272	12.4
Health Care Expenses	27	21,407	5.6	24	24,375	10.4
Savings	22	85,000	22.2	20	21,985	9.3
Entertainment	14	22,142	5.8	14	20,643	8.8
Other Uses	55	112,909	29.4	53	60,777	25.8

Table 3: Uses of Milk Revenue in Arumeru and Hai Districts

IFAD (2010) reveals that rural livelihoods and rural life in developing countries can overcome poverty when surveys based on the household and village level focused on economic and consumption indicators. While a substantial proportion (22.2 percent) of milk revenue is saved in Arumeru, only 9.3 percent of milk revenue is saved in Hai. For Hai District, saving rates are low largely due to higher spending on healthcare and clothing compared to the case of Arumeru. Milk revenue is also used to pay for housing costs, utility bills, buying clothes, health care expenses, entertainment, and other uses as indicated in Figure 7; therefore, milk production contributes significantly to the social welfare of the people in these areas.

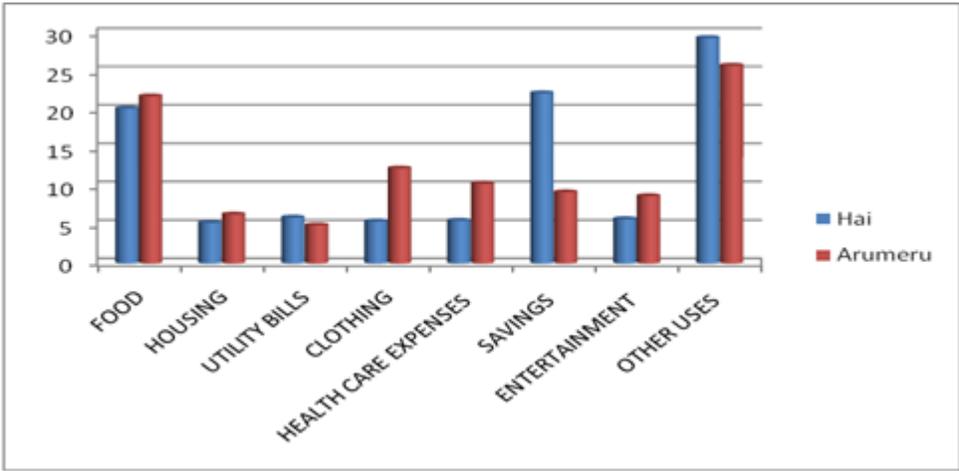


Figure 7: Percentage Distribution of Uses of Milk Revenue in Arumeru and Hai Districts

5.2.7 The Role of Milk Cooperatives

Generally, dairy marketing cooperatives are owned, operated, and controlled by the dairy farmers who are women and who benefit from their services. Members finance the cooperative and share the profits they earn in proportion to the volume of milk they market through the cooperative. Kulkarni’s (1979) study, “Collection of Milk: Some Lacunae and Remedies,” reveals that the lack of sufficient milk collection by cooperatives in the rural areas, malpractices in weigh mint and quality testing, inconvenient timings of milk collection, spoilage during the rains and warm seasons, and inadequate extension services were some of the lacunae in milk collection from the producers.

The findings show that the milk cooperatives, formally organized by women, in the studied areas were established in 1987 and 1988 at Ng’uni and Nronga villages, respectively, in the Hai District. The only milk cooperative in Nguruma, one of the visited villages in Arumeru, was established in 2001.

Farmers in Arumeru sold an average of 200 liters of milk per day to the cooperative, using their own means of transport. The cooperative buys fresh milk at Tshs. 800 (i.e., USD 0.37) per liter and sells about 30 percent at Tshs 1000 (i.e., USD 0.46) per liter. The remaining milk is used to make yogurt, which is also sold to the final consumers, including schools. The cooperative has five employees: 2 women and 3 men. The cooperative retains 5 percent of the total sales revenue to meet operational costs. The milk producers who are members of the cooperative rarely receive training. The findings further show that the cooperative needs improvement in the areas of milk processing equipment, bar codes for easy identification and selling in the supermarkets, Tanzania

Bureau of Standards mark, expansion of milk cooling tanks capacity, an extension officer in villages to provide technical advice to individual farmers and the cooperatives, and a quality breed of cows with a high milk yield capacity.

Farmers in Hai supplied about 500 liters of milk per day to the Ng'uni cooperative and 850 liters to the Nronga cooperative, using their own means of transport. The purchase price ranges from Tshs. 600 to 750 per liter, and they sell between Tshs. 800 and 1,200 per liter. Cooperatives use milk cooling tanks with storage capacities of 1,300 liters and 3,000 liters in Ng'uni and Nronga, respectively. The cooperatives sell milk to middlemen and to the final consumers, including educational institutions. Some of the milk is used to produce yogurt and butter, using modern equipment. These milk products are sold to milk traders. Both cooperatives reported that it has been difficult to access training on how to manage their projects more effectively. Veterinary services can be accessed, but they are expensive in comparison to revenue generated from milk sales.

Milk production in Hai District was found to be a potential employment opportunity for women in not only direct employment in the cooperatives, where 4 women and 9 men were employed, but in the entire milk marketing and sales chain. The cooperatives retain an average of 2 percent of revenue from sales, and in return, they support milk producers who are their members by supplying them with good, supplementary animal feeds, like cereals and minerals, and encouraging the production of high quality cattle breeds through artificial insemination.

When asked about necessary improvements needed for better outcomes from milk production and sales, the cooperatives in Hai mentioned the need for a vehicle to transfer milk and milk products, supplementary mineral feeds for the cows of their members, milk-processing training, road maintenance in their areas of operation, packaging materials, and the introduction of other high-breed milk cows.

5.3 The Challenges Facing Women Milk Producers in Arumeru and Hai Districts: Shortage of Market and Low Milk Prices

The demand for milk in Arumeru and Hai was lower than the supply. Farmers complained of not being able to sell milk, especially in the high season. In high seasons (during and just after rains) the natural vegetation used as animal feed is plentiful, and the supply of milk increases; consequently, the price of milk decreases.

The price of milk per liter in the Hai District ranged between Tshs 500 and Tshs 800 (i.e., USD 0.23 and USD 0.37) as shown in Table 4. The price of milk per liter in Arumeru ranged between Tshs 600 and Tshs 1,000 (i.e., USD 0.27 and USD 0.47). The price difference in Arumeru and

Hai is attributed to the market forces of demand and supply since Arusha (a market for Arumeru) has a larger population than Moshi (a market for Hai). This implies that if women in Arumeru were able to improve their production of milk, the market would not be a challenge.

Price per Liter (Tshs)	Frequency	Percent
500	1	1.8
600	36	63.0
700	18	31.6
750	1	1.8
800	1	1.8
Total	57	100

Table 4: Price of Milk per Liter in Hai District

According to the study’s findings, the rural infrastructure, particularly the road network, was poor in both districts. Poor rural roads limit farmers' access to markets, increasing the time and cost of transport, which often results in the deterioration of milk quality as it takes time to reach markets. Another challenge concerns pests and diseases that affect the productivity of the livestock. Although there are private veterinary officers, they are not sufficient, and in the locations where they are available, they charge high prices for services and medicines. The veterinary shops (for veterinary services and supplies) are also not available in the rural areas. If women want to purchase medicines and equipment, they have to go to urban centers. According to respondents, the management and control of pests and diseases of cows increase the costs of production, and hence reduce their incomes.

In regards to capital access, and according to IFC (2007), women often shoulder the double burden of both work and family responsibilities, and still face particular challenges in accessing credit to expand their businesses. This was also found in the study areas where 52.5 percent and 59.6 percent of households were headed by women in Arumeru and Hai districts, respectively. Nevertheless, while women play such important roles in sustaining households, they face a critical constraint regarding lack of capital to scale up their economic base. Even though banks and microfinance institutions exist in these districts, the conditions set to access loans do not favor female milk producers. Lack of collateral was mentioned as the leading hindrance to credit access. This was partly caused by the fact that women do not inherit land and other immovable household properties. As a result, 85.2 percent of women producing milk in Arumeru made use of capital from their own savings, compared to 82.8 percent of women milk producers in Hai District. A small proportion (14.8 percent) in Arumeru and a similar number (15.8 percent) in Hai were assisted by parents and other sources, such as friends and relatives.

The other constraints in livestock production include lack of improved high-yield breeds, lack of cheap supplementary feed, inadequate livestock extension resources, lack of appropriate managerial skills for both women farmers and cooperatives, poor technology, weak livestock veterinary services, and lack of animal husbandry training. Of these, lack of good quality feed at affordable prices seems to be the primary problem. With low productivity, milk production contributes less than its potential to the households' welfare in the Arumeru and Hai districts.

The challenges mentioned above are similar to those discussed by Minde (2014), who found that cattle in Arumeru were affected by diseases, lack of supplemental feeds, inadequately sized land for grazing, and veterinary drugs' high prices. In addition, the withdrawal of the government from provision of veterinary services in the 1980s led to the emergence of new and resurgent livestock diseases. A majority (56 percent) of respondents were forced to travel or walk far distances for veterinary services, which affected women's participation in the management of dairy cattle production.

In his study, Kurwijila (1991) states that the distance to livestock extension services played a significant role in dairy cattle production. Furthermore, the number of visits done by village livestock extension officers per month in the Kurwijila's study area was unsatisfactory. In the village Nshupu, 20 percent of respondents reported no visit from the extensions at all. The majority, (60 percent) from Ndatu and (40 percent) from Nshupu, said they only get one visit per month, and that sometimes they may not get any visit from extension officers.

5.4. Organizing Women to Step Up Value Addition and to Improve Their Traditional Milk Production and Selling Practices for Higher Employment and Incomes

This section focuses on suggestions on how to scale up indigenous knowledge regarding milk production in the Akheri, Nguruma, and Nkoanrua villages in Arumeru District, and in the village Ngu'ni in Hai District. These suggestions are a result of what researchers found on indigenous methods (knowledge and technology) used at the village of Nronga and could be enhanced or improved for better outcomes, benefitting women in terms of employment and income. They would be cheaper than if these women were to adopt modern technology, which they cannot afford.

5.4.1 Feeding Methods

Milk producers in Nronga have shifted from feeding their cows with natural grass collected from uncultivated areas or farms to a more effective method of producing animal feed (fodder) on demarcated pieces of land. In the other villages studied, most women did not have good feeding methods. Some of them depended on natural grasses collected from uncultivated areas and farms

that are declining with time because of increasing cow population and the increasing demand for land to produce food crops. The open feeding method in which cows are grazed is also faced with shortage of areas dedicated solely for cows.

It is worth noting that for cows to be healthy and productive, quality feeding is important. The methods used in Nronga, where farmers have committed some land for fodder production, can be done in Ng'uni and other villages in Arumeru. The main advantages of fodder are quality and quantity since it can be measured according to the size and number of cows. It can also be stored for use in dry seasons. In Nronga, fodder harvested for cattle feeding has replaced grazing. Any fodder crop surplus can grow to a more mature stage. Then, it is dried in the sun for hay. Dry fodder is then stacked under cover, if the hay is made before the rains, or on the roof, if the rainy season is over. Doing these tasks in the other villages could improve the quality of feeding, which can consequently improve the quality, quantity, and value of milk.

5.4.2 Weaning the Calves

Weaning is an important activity in dairy farming; however, it is not needed when cattle are raised only for meat. Beef calves are allowed to stay with the mother and feed for as long as they want, but dairy calves are separated from the cow soon after being born. This practice allows most of the milk to be collected and sold by the farmer, rather than being consumed by the calf.

When asked how calves were fed with milk, 55 percent and 85.7 percent of respondents from Ng'uni and Nronga villages, respectively, said that the calves are fed by the caretakers. By contrast, respondents from the Akheri, Nguruma, and Nkoanrua villages said that 96.2 percent, 85.7 percent, and 85.6 percent of calves feed themselves by sucking from their mothers. If the calf is freely fed as much milk as it wants for a long time, it will not have a strong, early appetite for dry feed. Its stomach development will be slow, and it will not grow well when it has to rely on grazing. So, weaning must also involve the feeding of dry feed or roughage to the calf. The latter villages could adopt methods used by their counterparts in Hai District to improve the efficacy of the weaning process.

5.4.3 Milk Production

As shown by statistics above, milk production is higher in Nronga compared to Ng'uni, Akheri, Nguruma, and Nkoanrua villages, which were also studied. While several factors, such as nutritious feed, the milk production quality of cows, and the availability of veterinary services, could contribute to high milk production, the same factors were either short or lacking in Ng'uni, Akheri, Nguruma, and Nkoanrua villages. These other villages can, therefore, step up their traditional feeding methods, and also improve the milk production quality of cows through

crossbreeding/artificial insemination. Crossbreeding is recommended here as a good practice because, as just one of the distinguishing factors, Hai uses artificial insemination more than Arumeru and consequently produces more milk than Arumeru (see sub-section 5.4.5).

5.4.4 Milk Preservation and Value Addition

Naturally fermented milk is the basis of traditional milk processing in many rural areas of Tanzania. In other parts of Arumeru, like Ulong'a and Ngarenanyuki, special processing methods involving the application of wood smoke have evolved, resulting in extended shelf life at moderate temperatures. The commonly used hardwood in the smoking of milk is *Olea africana* (or *kireeni* in the Meru language). No study known to researchers assessed the impact of the smoke derived from this hardwood in order to understand the possible health effects of smoke application in milk. However, in the Akheri, Nguruma, Nkoanrua, and Ng'uni villages, women sell fresh milk and yogurt, which is traditionally made by allowing fresh milk to ferment for two to three days. No preservatives are added/used, and the yogurt cannot last for more than three days before it spoils. Fresh milk must, therefore, get to the market and be sold as soon as possible, or made into yogurt that should also get to the market as soon as possible and be sold immediately before it spoils.

The village of Nronga is using improved traditional methods through which they process yogurt similar to the milk processed in the modern milk processing industries like Tanga Fresh, which can last for many days. They also produce cheese from milk. The production of yogurt and cheese from milk preserves value of this milk product and increases durability. Nronga has stepped up to the level of using deep freezers to preserve milk and some milk products.

On the continent of Asia, similar indigenous milk processing methods are found in the near and Middle East where yogurt and cheese are manufactured in urban and rural areas, respectively. For example, according to Tuszyński (1983), shops—including artisanal processing shops equipped with the simplest locally made equipment, such as cans, vats, pots, tables, molds, simple cheese presses, etc., with neither electric power nor steam—can process milk. In these shops, energy is used only for heating: to bring the temperature of milk to the level required for fermentation (yogurt) or re-netting (cheese). Wood, coal, gas, or liquid fossil fuels are used, usually in simple stoves with energy conversion efficiency between 10 and 15 percent. Cheese manufacturing of a similar kind can also be found in some Latin American countries. In the Far East, sweetened condensed milk is produced under basic conditions in rural areas, where milk with sugar is kept at boiling temperature, or close to it, with constant manual stirring to evaporate part of the water.

5.4.5 Breeding Methods

The study findings showed that the natural breeding method is mainly practiced by farmers in Arumeru villages, 73.1 percent, 64.3 percent, and 66.7 percent in the Akheri, Nguruma, and Nkoanrua villages, respectively. By contrast, artificial insemination is mainly practiced by farmers in Hai District, with 75 percent and 71.4 percent in the Ng'uni and Nronga villages, respectively. This implies that the use of bulls was more widespread than the use of artificial insemination in Arumeru District compared to Hai District. To scale up their breeding knowledge and improve the quality of milk producing cows, women milk producers in Arumeru could use the practices of their counterparts in Hai District. This could be implemented by making use of the Artificial Insemination Centre located close to Meru District Counsel at Usa River. The development of milk cooperatives could also hasten the availability of artificial insemination for members.

5.5 Lessons Derived from Nronga Women Dairy Cooperative Society Limited

During data collection, researchers observed that Nronga Women Dairy Cooperative Society Limited (NWDCS) was more advanced than two other milk cooperatives operating in the Ng'uni and Nguruma villages. Therefore, other villages can learn from this society to step up their indigenous milk production and processing skills. According to Ulicky (2013), the NWDCS was formed in March 1988 to provide the following to the Nronga women and community in general:

- i. Buying milk from all dairy farmers in the village
- ii. Promoting milk consumption through school milk nutrition programs
- iii. Offering saving and credit facilities to the community (by way of a village community bank)
- iv. Providing artificial insemination of dairy cows, also for neighboring villages
- v. Promoting slow combustion wood stoves to reduce environmental impact

The cooperative collects milk that is cooled in electric-powered cooling tanks before being processed or sold unpasteurized to wholesalers or consumers in urban areas of the Kilimanjaro and Arusha regions. Milk is utilized in the following products:

- i. 36 percent fresh whole milk
- ii. 36 percent skimmed cultured milk
- iii. 24 percent whole cultured milk in packets (500 ml for ordinary market and 200 ml for school distribution)

- iv. 2 percent pasteurized butter
- v. 2 percent yogurt

All these products are made manually using local facilities and rudimentary skills to produce and market competitive products. Although researchers did not investigate in detail how local facilities and skills are used to add value to milk, we can still draw some lessons that can help women milk producers in other villages as mentioned next:

- i. Women can come together to form a milk cooperative society. Only 75 women in Nronga mobilized and formed an organization that has grown and now serves the whole community. By the time of data collection, NWDCS had more than 400 members.
- ii. They started out by collecting small amounts of milk (200 liters total per day) from members, which was simply sold untreated to food shops in Moshi, as they had no milk coolers, processing machines, or office. During the time of this study's data collection, the cooperative was collecting more than 850 liters of milk per day.
- iii. Their cooperative belongs to women. It is managed by leaders elected from the members and by the members. The leaders keep records and are responsible for fortnightly payments in an open area on the Nronga primary school playing grounds.
- iv. The cooperative has made a business out of dairy production, which was once considered a subsistence activity.
- v. About 650 women are self-employed through dairy farming and supply milk to NWDCS.
- vi. Through NWDCS, it has been possible to introduce other appropriate technologies to the community, such as energy saving firewood stoves. In addition, the animal waste from zero-grazed cattle is put in an environment without oxygen, and when breaks down, it produces gaseous fuel or biogas.
- vii. It has been possible to manually, using local facilities and limited skills, produce market competitive products like:
 - skimmed cultured milk
 - whole cultured milk in packets
 - pasteurized butter
 - yogurt

6.0 Conclusion and Recommendations

6.1 Conclusion

In the Arumeru and Hai districts, the keeping of dairy cows by women contributes a great deal to the employment of women and improves not only food security, but the revenues needed for household welfare in terms of nutrition, shelter, income generation, and other social services, such as education and medication.

With regards to the employment and income differences of women engaged in milk production in the Arumeru and Hai districts, the study shows that women in both districts were engaged in dairy cow milk production mainly done in zero grazing; however, the production of milk was higher in Hai District compared to Arumeru District. More milk was also sold to cooperatives in Hai compared to the milk sold in Arumeru. A large proportion (93 percent) of milk producers in Hai District sold their milk in cooperatives, compared to the women producing milk in Arumeru, where only 9.8 percent sold their milk in a cooperative. The payment terms in the milk business were mainly monthly, which accounted for 98.3 percent of respondents in Hai District and 73.8 percent of respondents in Arumeru.

A number of challenges facing women milk producers in the Arumeru and Hai districts were reported: high operating costs, which were caused by low quality cattle breeds, poor road networks that make it difficult to transport animal feed and milk, shortage and high costs of extension services, low milk prices, and shortage of markets, especially during high season.

Milk producers in the village of Nronga were feeding their cows with animal feed (fodder) they produced and processed from the fields or portions of farms set apart for that particular purpose. In other villages that were studied in Arumeru District, many milk producers did not have farms dedicated to producing animal feed; they rather depended on natural grasses collected from uncultivated areas, uncultivated farms, and a few of them were grazing their cows.

Findings showed that, traditionally, milk producers in the studied villages allowed the calves to feed themselves with milk from their mothers; however, a majority of milk producers in Hai District improved this practice by appointing a caretaker to feed calves with milk and implement the weaning process, which "saves" milk for sale.

Milk production in Hai District was higher compared to Arumeru because of good animal feeding, the breeding quality of cows, and the availability of veterinary services. Cross-breeding, which can improve the milk production quality of indigenous cows, is done through artificial insemination by farmers in Hai District.

As detailed in section 5.4.4 above, value addition and shelf life of milk and its products were improved at Nronga village, where they produce more advanced and processed yogurt that can last for many days, and also produce cheese from milk. In other villages, more traditional processing methods involving the application of wood smoke have evolved, resulting in extended shelf life at moderate temperatures.

6.2. Policy Implications

This section presents policy implications derived from the findings of this study, focusing on stepping up indigenous knowledge for women employed in milk production.

- i. The findings indicated that women in milk cooperatives were doing well compared to women milk producers who were not members of any milk cooperative. Milk cooperatives coordinate the collection, processing, and marketing of milk and its products; promote milk consumption through school milk nutrition programs; and offer saving and credit facilities to members. This indicates that the establishment of women milk producer cooperatives will boost the production, value addition, and marketing of milk and milk products. It will also give women milk producers collective bargaining power. These milk cooperatives can bargain with financial institutions for easy access to loans for their members.

In stepping up indigenous knowledge for milk production, women should be supported to learn from the most developed cooperatives, e.g. Nronga Women Dairy Cooperative Society Limited, which is more advanced in traditional feeding methods, weaning calves, improving quality of cows through artificial insemination, availability of veterinary services, milk production, and value addition, etc. This includes providing artificial insemination services to the areas concerned.

- ii. The infrastructure environment in which women are running their milk production projects causes many challenges; poor roads limit farmers' access to markets, increase time and cost of transport, and often result in the deterioration of milk quality as it takes time to reach markets. This calls for improvement of road networks, especially in the rural areas.
- iii. The availability of veterinary services, including artificial insemination, are either insufficient or unavailable in some of the villages studied, thus making it difficult for women to get medicines and equipment for the necessary care of their cows. This calls for government intervention to establish these services in rural areas, especially where women are engaged in dairy projects.

- iv. Women engaged in dairy projects should be trained with knowledge on the best practices, using improved indigenous knowledge and the resources available in their areas.

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Notes

¹ The International Labour Organization (ILO) standard definition of unemployment comprises all persons above a specific age who, during the reference period (survey), were: (a) "without work," i.e., were not in paid employment or self-employed; (b) "currently available for work," i.e., were available for paid employment or self-employment during the reference period, and (c) "seeking work," i.e., had taken specific steps in a specified reference period to seek paid employment or self-employment."



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Challenges in Harnessing Indigenous Knowledge Systems through Creation of Employment for Rural Women in Tanzania: The Case Study of Barabaig Leather Products in Manyara Region

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This study examines opportunities and challenges in harnessing indigenous knowledge (IK) for employment creation and poverty reduction in rural Tanzania. The study is underpinned by literature review and descriptive analysis focusing on leather products made by Barabaig women in Hanang, Tanzania. During the study, a sample of one hundred households was selected and interviewed. Data were collected from the administered interviews that were structured like a questionnaire. The literature details the challenges IK faces, including: the threat of extinction due to lack of recording, with much focus on IK that has a direct cash benefit only and the ignored “non-cash” knowledge; considered as part of a residual, traditional, and backward way of life that is easily brushed off on the ground that it cannot be trusted; and not inclusive. The IK drive in Tanzania lacks one unifying policy. Inadequate tanning training, expensive modern tanning inputs, low quality hides and skins associated with poor animal husbandry, poor quality local inputs and tools, low quality output, and lack of markets are among the inhibiting factors faced by Barabaig women using IK to create leather products. Poor roads, inadequate supply of clean water and health services, and lack of electricity is another set of hurdles Barabaig women face. Apart from leather products, Barabaig women also produce other traditional products such as blankets, shawls, bracelets, and neck and waist ornaments. This study argues that Tanzania needs a comprehensive IK policy, and that local governments are better custodians of IK than the central government. There is a need to scale up training on tanning technology, improve animal husbandry, increase the availability of affordable chemical and non-chemical inputs, unlock marketing constraints, encourage producer associations/groups, and address rural bottlenecks such as poor roads, access to electricity, and long distance travel for water and healthcare services.

Keywords: *Barabaig Women, Indigenous Knowledge, Traditional Leather Products, Income and Employment, Rural Tanzania*

1.0 Background and the Problem

Since 2001, Tanzania has experienced revamped economic growth. The economy grew around 7 percent from 2001-2014. The relatively high growth rate over the past 10 years emanated from reform measures adopted since the mid-1980s. The services sector has the largest share in Gross Domestic Product (GDP) — averaged 47.6 percent per annum between 1999 and 2014. The share of agriculture in total GDP has declined gradually since 1999 (29 percent) to 22.9 percent in 2014, while that of the industrial sector has increased from 18 percent to 22.1 percent during the same period. One of the reasons for this shift in composition is that the agricultural sector only grew at 4.3 percent on average over the last two decades, due to low productivity.

Unfortunately, there has been a growth-poverty mismatch in this period, since the impressive growth attained in the past decade or so has failed to address the challenges of inclusiveness, poverty and inequality reduction, and the creation of decent jobs, especially for women and youths in rural areas. One of the critical issues is that the growth quality has failed to address the challenge of structural transformation in terms of employment creation and improved social services. The limited trickle-down effects emanated from the limited growth of agriculture (which is the mainstay of about 80 percent of Tanzanians) and low elasticity of employment in sectors, such as communication, financial services, and construction, that drive the growth of the economy (Mashindano et al. 2013).

Poverty, especially in rural areas, is still high and has increased among unemployed rural women and youth. Between 2000/01 and 2007, the percentage of households in rural Tanzania living below the poverty line only declined marginally, from 38.7 percent to 37.6 percent. Moreover, there is a greater recognition that productive employment and decent work play a key role in promoting inclusive growth and serve as the critical link between growth and poverty reduction.

According to the 2014 Integrated Labor Force Survey (ILFS), the working age population (15 years and above) in Tanzania was about 25.7 million in 2014. Of these people, 86.7 percent were economically active, while 13.3 percent were inactive. The employed economically active population was 89.7 percent, while unemployed¹ was 10.3 percent. The female population led the unemployed and inactive sub-groups by 60.1 percent and 61.7 percent, respectively. In the employed population, paid employees accounted for only 13.9 percent; self-employed workers comprised the largest percentage (86.1 percent). The private sector holds the majority of paid workers (74.5 percent).

In 2006, 93.3 percent of employed persons were working informally; the share decreased slightly to 92.1 percent in 2014 (Table 1). More women than men were engaged in informal employment (96.3 and 90.2 percent, respectively) in 2006 as well as in 2014, when 94.9 percent of employed women and 89.4 percent of employed men were engaged in informal employment. Vulnerable employment rates were also high;

87.1 percent of Tanzania's working population engaged in the more precarious statuses of own-account workers (self-employed) or contributing to family labor workers in 2014². The share of vulnerable employment was as high as 91.1 percent for women (compared to 83.2 percent for men) and 95.5 percent for workers in rural areas (compared to 71.6 percent in urban centers).

The situation is exacerbated by less training of employable skills for women than men — 87 percent of men were reported as likely to get basic education in 2012, but that number was only 76 percent for women (NBS 2012). Moreover, in rural areas women are also typically engaged in pursuit of traditional low productivity activities, such as long walking distances each day to fetch water and collect firewood, (Lardechi 2009) and small-scale farmers are predominantly women (FAO 2011).

	2006					2014				
	Total	Male	Female	Urban	Rural	Total	Male	Female	Urban	Rural
	Standard Definition									
Informal Employment*	93.3	90.2	96.3	82.1	97.0	92.1	89.4	94.9	82.5	97.3
Vulnerable Employment	88.6	83.5	93.4	69.3	95.0	87.1	83.2	91.1	71.6	95.5

Source: ILO, 2010 and ILFS, 2014

*Informal employment includes contributing to family workers, own-account workers on own farm, and paid employees and self-employed workers in informal enterprises or household units.

Table 1: Working Population Aged 15 Years and Above by Type of Employment

The apparent item in the labor market indicators in Tanzania relates that employment continues to bring little return to the majority of workers in terms of quality and security, and that women are particularly at a disadvantage. The high percentages of informal and vulnerable employment, especially in rural areas, are of particularly great concern. In combination with a high employment-to-population ratio, this implies that an increasing number of people have to work in low quality and/or insecure jobs in order to make a living. Thus, IK represents possible alternative sources of employment and income generation among the poor rural women and youth. According to Dube and Musi (2002), research on sustainable solutions to the development and technology problems that continue to confront developing countries has led to renewed interest in the potential contribution of IK to research and development activities. Proper application of IK is deemed an appropriate solution for the creation of employment and increases incomes of the rural women and youth.

However, IK has not been properly mainstreamed into development research and policies in Tanzania. It has not been given its deserved weight in development initiatives, despite rural women being the sole custodians of IK. It is against this background that this study attempts to uncover IK challenges and opportunities in Tanzania. The study is organized in four sections. Section two dwells on theoretical and

empirical literature. Section three presents IK in Tanzania, with a primary focus on traditional Barabaig leather products, and includes study methodology, data analysis, findings, opportunities, and challenges. Study conclusion and policy implications are in section four.

2.0 Selected Literature Review

2.1 IK Definition

IK is the basis for local-level decision making in agriculture, health care, food preparation, education, natural resource management, and a host of other activities in rural communities (Warren 1991). The wisdom and skills maintained by keepers of indigenous knowledge are based on a dynamic and sophisticated understanding of their local surroundings. Change in the use of this knowledge is predicated upon conscious efforts by people to define their problems and seek solutions through local experiments and innovation, including evaluating and learning from appropriate technologies elsewhere (Lalonde 1991; Mugabe 1998). Indigenous information systems are dynamic and are continually influenced by internal creativity and experimentation, as well as by contact with external systems (Flavier et al. 1995). IK serves communities, households, and individuals by functioning as a base of knowledge to help process information, to promote efficient allocation of resources, and to help in production decision (Materer et al. 2002).

2.2 Indigenous Knowledge and Rural Empowerment

There are relatively few studies explaining the relationship between IK and employment creation, regarding women in particular. Johnson (2007) explains the relationship in terms of resource utilization, such as IK for the development process. In his study, Johnson reveals that IK is an underutilized resource in the rural development process. He further argues that a majority of people in rural areas, especially women lacking resources, depend on IK to sustain their households and livelihoods since it provides the basis for problem-solving strategies in local communities. In this regard, IK is considered as one of the important inputs for rural household development.

In the same dimension, IK is considered as a possible alternative development avenue among the rural poor. Recognizing the role of IK, the World Bank (1997) emphasizes that development initiatives should start by looking at the local efforts. In this setting, indigenous institutions, indigenous technology, and low cost approaches can enrich the efficiency of development programs because IK is a locally owned and managed resource. Through IK, cost effective and sustainable mechanisms for poverty alleviation that are locally manageable and meaningful can be identified. “Grossly, the role of IK in employment creation and sustainable poverty alleviation can be achieved through increased and enhanced livelihood options, the revived agriculture, increased food security, improved health, and better environment” (Chiwanza et al. 2013). Integration between development assistance and IK improves understanding of local conditions and provides a productive context for activities designed to help the communities; increases

responsiveness to clients; adapts international practices to the local setting; helps improve the impact and sustainability of development assistance; enhances cross-cultural understanding and promotes the cultural dimension of development; and most importantly, can help to reduce poverty (World Bank 1998).

Initiatives to promote IK can be particularly effective in helping to reach the poor part of the population since IK is often the only asset they control, and certainly one with which they are very familiar. Utilizing IK helps to increase the sustainability of development efforts because the IK integration process provides for mutual learning and adaptation, which, in turn, contributes to the empowerment of local communities. Since efficiency, effectiveness, and sustainability are key determinants of the quality of development work, there is a clear case for harnessing indigenous knowledge for use in development (Gorjestani 2000). Moreover, when IK is supported with the right policy and strategy, as well as resources, it provides better services and has been very successful in different parts of the world. For example, in 1996, a collaborative effort in the Iganga district of Uganda, involving the United Nations Population Fund (UNFPA) and Ugandan Ministry of Health, strived to improve communication and transportation links between traditional birth attendants and health posts in order to create timelier referrals and strengthen healthcare delivery. The results of the collaborative effort reduced maternal mortality by more than 50 percent over 3 years (World Bank 2009).

Olatokun and Ayanbode's (2007) study on rural women and IK in Ogun State of Nigeria identifies different types and the extent of IK use and impact on community development. Findings reveal that the majority of rural women were illiterate, but rich in knowledge concerning traditional medicine and the use of oral IK in food production and security, cultural transfer and preservation, saving and money lending, and population control and child care, which all have a positive impact on sustainable development and poverty reduction in Ogun State. In recognizing the role of IK in Tanzania, Mascarenhas (2003) observed in his study that agriculture supports over 70 percent of the population, but that it is a "simple tradition bound subsistence agriculture." The researcher noticed that, in the absence of local and indigenous knowledge, Tanzania would have been much poorer. The study further observes that most communities in Tanzania solve their pest challenges locally. Using traditional healers, some of the communities appear to record success by applying traditional medicine in familiar problems; however, in cases of unfamiliar problems, the impact seems to be catastrophic. The study concludes that both local and indigenous knowledge should be used, and thus a need exists for dedicated efforts to integrate the two.

IK in Africa is gaining ground and space in political, cultural, and academic contexts; however, there remain a host of external and inherent challenges. Mapara (2009) observes that IK is passed on through generations by word of mouth rather than in written form, and, therefore, is vulnerable to development processes, migration, and changes or displacements. There is a lot of focus on IK with direct cash benefit only while "non-cash" knowledge is ignored. For example, there is more interest in medicinal plants, which attract large pharmaceutical industries, compared to studies on traditional dances, rituals, and languages (Msuya 2007). Briggs (2005) observes that IK is too place-specific to be generalized much or

to be developed beyond its areas of origins; considered as part of a residual, traditional, and backward way of life; and non-inclusive differentiations are often by age, experience, wealth, political power, and gender. IK can easily be neglected or brushed off by competitors on the ground that it cannot be trusted (Schroeder 1999; Bell 1979); European epistemology remains central in the African education system (Kazemi et al. 2003; Msuya 2007).

3.0 Indigenous Knowledge in Tanzania

3.1 Initiatives to Promote Indigenous Knowledge

In recognizing the roles of IK — which include among others, being the basis of livelihood for farmers and pastoralists; being the backbone for biodiversity and food security (natural resource management); and supporting rural livelihoods and rural primary health care — Tanzania has mounted substantial efforts in promoting IK. Such initiatives include, among others, ring-fencing IK related issues in national policies, financing and participating in IK related workshops and conferences; establishing the Tanzania Indigenous Knowledge Database; launching a World Bank publication on IK; joining the Local Pathway to Global Development—a program in the Africa region of the World Bank that is aimed at learning from the knowledge embedded in the practices of local communities; and subscribing to IK international conversions such as Rio 1992, where a global consensus was to equitably share benefits arising from the utilization of indigenous knowledge in forest conservation to local communities.

The following policies address sector-specific IK issues in Tanzania:

- i) National Agriculture Policy of 2013 and National Livestock Policy of 2006 — address issues related to agro-production, food security, water conservation, etc.
- ii) National Health Policy (2007) — recognizes traditional healers and birth attendants. Act. No. 23 of 2002 on traditional medicines encourages the improvement of traditional medicine use and control.
- iii) The Wildlife Policy of 2007 — addresses the conservation of indigenous plants and animals on land and sea.
- iv) National Forest Policy of 2008 — stipulates a need for traditional healers to harvest medicinal plants in a sustainable manner.
- v) National Environmental Policy of 1997 — recognizes best local practices on land utilization and conservation.
- vi) Tanzania Social Action Fund (TASAF) issued Draft TASAF III Indigenous Peoples Policy Framework 2012 in which the Hadzabe, Masai and, Barabaig are initially listed.

3.2 Case Study of Barabaig Traditional Leather Gowns and Skirts in the Hanang District

The Barabaig occupy the northern volcanic highlands near Mount Hanang and the Rift Valley in the Hanang District of the Manyara Region. The Barabaig speak Datoga and are 1 of the 2 tribes in Tanzania with the largest number of pastoralists and agro-pastoralist groups. The Barabaig total population was estimated at 50,000 in 2012 (URT 2012). The Barabaig are traditionally semi-nomadic and herd cattle, sheep, and goats; however, over time, they have become agro-pastoralists and now also farm maize, beans, and millet. The Barabaig have, to a large extent, kept their traditional culture and customs, including their traditional way of dressing and their own language. Cattle are an important part of the Barabaig's status, identity, culture, and worldview. According to the Barabaig culture, traditional leather dresses/gowns are worn by all age groups, while traditional leather skirts are for married women only.

The Indigenous Peoples Policy Framework (2012), issued by the government's Social Action Fund (TASAF), recognized the Barabaig as an indigenous people, along with the Hadzabe and Masai. These indigenous peoples have a long and ongoing history of land dispossession and socioeconomic and cultural marginalization. Their dispossession and marginalization have taken place in the name of nation building, agricultural development, and nature and wildlife conservation, but also because policymakers have failed to understand and value the indigenous livelihood systems' crucial contribution to the national and local economy (URT 2012).



Figure 1: Barabaig Women in Traditional Gowns



Figure 2: Barabaig Women



Figure 3: Barabaig Gown



Source: Raymond Foley

Figure 4: Barabaig Men in Traditional Blankets



Figure 5: Producing a Barabaig Traditional Skirt



Figure 6: Barabaig Traditional Product (Vikoi)

The frequency and intensity of drought periods in the northern part of the country, coupled with reduced mobility due to scarcity of land and limited access to natural resources, have increased vulnerability and poverty among the Barabaig community. The sources of poverty include land dispossession, climate change, population growth, increased competition for scarce resources, deterioration of the livestock sector, and the removal of subsidies in all service sectors and extension services during the economic reforms of the mid-1980s. This made livestock rearing, their main occupation, expensive and unaffordable for low income earners. As a result, the Barabaig are forced to look to alternative livelihoods for survival. The situation of girls, children, and women has been worsened by several human rights violations, such as denial of education and other social services, female genital mutilation, early marriages, non-recognition of their legal rights, and domestic violence. Apart from human rights violations, the Barabaig women are exposed to economic barriers, such as transport bottlenecks in their interior rural areas and language problems. These constraints drag Barabaig women and youth further into poverty. Nevertheless, some women have been able to overcome these obstacles by forming small groups and NGOs that enable them to speak collectively and confront relevant authorities in order to unlock their problems with one voice.

Making leather products, such as dresses (gowns) and skirts, among other products, represents efforts made by Barabaig women to add value to hides and skins. Creating these products uses traditional knowledge to surpass rural poverty by creating employment opportunities, increasing income, and reducing food insecurity.

3.2.1 Study Methodology

The study set out with a wide coverage on both theoretical literature and empirical evidences on IK, and adopted a descriptive survey research method on the case study of the Barabaig women's traditional leather products. The population of the study comprised Barabaig women located in Hanang District of

the Manyara Region. The Barabaig ethnic nationality was chosen amongst other ethnic groups in Manyara Region because it has a large population of women with an appreciable use of indigenous knowledge. The random sampling technique was used to select one hundred households.

3.2.2 Data Source and Description

The study data were collected using a structured questionnaire. The questionnaires were administered to 100 households with the help of 4 research assistants and 1 field supervisor in June 2016. The low level of literacy among the majority of the rural women necessitated the use of an interviewer in administering the questionnaire, and, in some cases, language problems were circumvented with the services of Ms. Mary Gitagino who acted as an intermediary and interpreter. The questionnaires were administered in different parts of the Barabaig community in the Hanang District, including the Ming'enyi, Mogitu, Katesh, Endasaki, and Gehando wards (Table 2 shows the specific villages). The respondents were all women, and the number of respondents varied from one locality to the other.

Village/Area	Frequency	Percent
Balangdalalu	14	14
Dawari	2	2
Dirma	19	19
Dumbeta	2	2
Ganana	11	11
Kateshi	11	11
Lamay	3	3
Ming'enyi	27	27
Mogitu	4	4
Mureru	4	4
Muongano	3	3
Total	100	100

Table 2: Responding Rural Communities in Hanang

Gender and Marital Status

Married respondents totalled 70 percent of the respondents, 19 percent were widows, and single respondents made up only 7 percent (Table 3) of the sample. Most of the respondents were the head of their household (76 percent), with only 24 percent of the respondents' households headed by males.

Marital Status	Gender of the Head of Household		Total
	Female	Male	
Single	7	0	7
Married	47	23	70
Divorced	4	0	4
Widows	19	0	19
Total	77	23	100

Table 3: Marital Status and Household Headship

The literacy level was very low among respondents. The results in Table 4 show that a large proportion (60 percent) of the respondents had no formal education. While 28 percent and 10 percent of the respondents had reached, respectively, primary and secondary school levels, only 2 percent had tertiary education. Figure 2 shows that the majority of the respondents were between the age of 31-40 years (28 percent) and 41-50 years (25 percent).

Level of Education	Frequency	Percent
No Formal Education	60	60
Primary School	28	28
Secondary School	10	10
Tertiary School	2	2
Total	100	100

Table 4: Educational Levels of Respondents

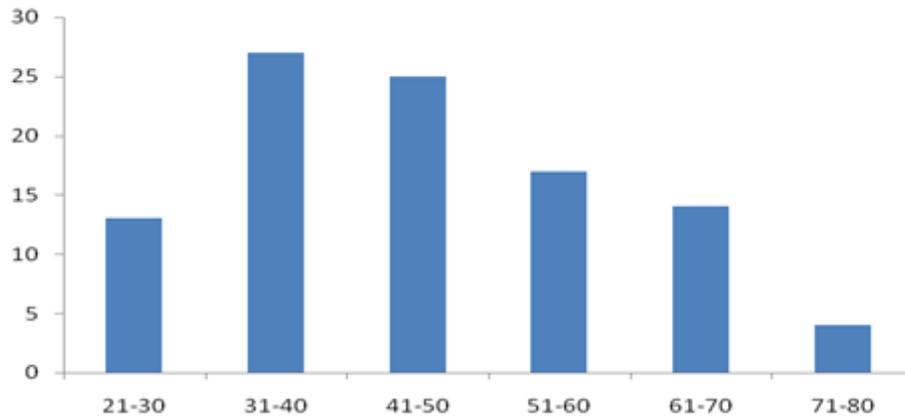


Figure 2: Distribution of Respondents According to Age

Table 5 reveals that the major economic activities among the respondents were crop farming (72 percent), followed by livestock keeping (24 percent), then business had the lowest share at 18 percent. In terms of main occupation, farming, which includes both crop and livestock keeping, had the highest share (82.4 percent), while skin and clothing production was the main secondary activity, scoring 80 percent. Other activities include tailoring, casual labor, building, nursing, and the making of crafts such as bracelets, Barabaig traditional blankets, traditional shawls (sarong wrap), etc.

Economic Activity	Frequency	Percent
Crop Farming	72	63.2
Livestock	24	21
Business	18	15.8
Main Occupation		
Skin and Cloth Making	6	6.6
Farming (Crop/Livestock)	75	82.4
Trader	10	11
Secondary Occupation		
Skin and Cloth Making	56	80
Farming (Crop/Livestock)	11	15.7
Trader	3	4.3

Table 5: Respondents by Economic Activities and Occupations

3.2.3 Data Analysis and Study Findings

Availability of Inputs

The leather manufacturing process is divided into 3 sub-processes: preparatory stage —removing unwanted raw skin components to prepare for tanning; tanning³ and crusting; and finishing — surface coating is applied. This basic traditional skin/hide tanning process is used to tan more than 90 percent of leather worldwide.

Traditional Leather Tanning Process in Barabaig Area

a). Soaking/Washing/Fleshing and Unhairing (Pre-tanning Operations)

Cleaning dried or fresh hides/skins is the first stage where all foreign bodies, such as blood, excess animal fat, and hair are removed from the hides. The dry hide/skin is soaked in salt water to soften it before cleaning. Then, cleaning is done for three to nine days.

The soaked hides are immersed in a mixture of lime (calcium carbonate) and water. Poor households use animal urine⁴ instead of lime as a source of protease. The liming process makes it easy to remove fat, flesh, and hair from hides.

The clean hide is further immersed in a mixture of boiled water and papaya fruits. Papaya fruits are rich in proteases, which are enzymes used for the de-hairing process. These are used instead of chemical de-hairing products, such as lime, which is environmentally unfriendly.

After cleaning, the de-liming process is undertaken by soaking hides in a mixture of water and ammonium sulphate (obtained from industrial fertilizers). This process removes lime from the hide. A successful de-liming process will lead to an absence of pink coloring in the hide, which is determined by applying the phenolphthalein test.

Tools and equipment for the above process are pits or vats/buckets, scrapers, knives, small axes, drying shed, hand gloves, rain boots, fire wood and chemical inputs including lime, papaya fruits, ammonium sulphate, and phenolphthalein.

b). Tanning Stage

The leather tanning process involves soaking clean hides and skins in a mixture of boiled water and mimosa—this will take up to twelve hours. Mimosa is a tanning extract made from the bark of a tree called wattle (*Acacia mearnsii*). Mimosa preserves the tan color that is the hide's natural color.

Ultimately, dyeing can be applied to give the leather color variations such as black, red, brown, etc. Some households find it cheaper to bleach the hides by using brown colored soil, locally called 'lokaria.'

c). Crusting Stage

This process involves oiling, softening, and drying the leather. The tanned leather is spread with a mixture of boiled oil (any type of seed oil) with soap on the inner side of the hide, while oil is applied only on the

outer side. Then, the tanned hides are stretched in the shed to dry. Lastly, the leather is pressed by using blunt glass before it is ready for use.

It is worth noting that the quality of leather depends on the quality of inputs used and undertaking the requisite tests of each process; however, in the Barabaig area, compliance to these prerequisites appears to be adhered to by few groups or individuals, especially those who produce for commercial purposes.

The Barabaig community still uses traditionally made inputs for tanning skins/hides because these inputs are affordable, but of poor quality, which also compromises the quality of locally produced leather. For example, use of animal urine instead of lime or colored soil during bleaching compromises the quality of leather. Also, tanning requires a lot of water, which is a problem in semi-arid Barabaig land and thus contributes to poor quality leather. Moreover, most households cannot afford to buy all of the necessary tanning tools, such as vats/buckets, scrapers, knives, small axes, hand gloves, etc. Awareness concerning the health impact of chemical inputs is low in the area. Very few producers use protective gear, such as hand gloves and boots, while creating the leather.

However, in improving the skin/hide processing technology, the district, through support from the public organization called Small Industries Development Organisation (SIDO), established a few tanning points, which were put under the custodian of producer groups. SIDO also offers training on tanning and using better chemical inputs, such as mimosa and lime, to group members. Unfortunately, the tanning points are underutilized due to expensive input. Better chemical inputs, such as mimosa, limestone, and oil, which can produce better leather, are available in the regional markets at higher prices that are prohibitive to small-scale producers, or to those who produce for domestic use. It was also observed that in order to improve the quality of leather products, some business women, including producer groups, prefer to procure better quality leather from large-scale tanneries outside the region, such as Himo Tannery and Moshi Leather Factory, rather than producing locally.

Other inputs and tools used to make leather products, such as beads, buttons, needles, sharp knives, scissors, etc., are procured from the local markets within the districts, but there are only two market days a month. As seen in Table 6, local and district markets are the biggest outlets for both chemical and non-chemical inputs, and very few inputs are procured outside the district. The data from the questionnaires shows that despite their poor quality, locally made chemical inputs and non-chemical inputs are widely used. Table 6 shows that 25 percent of respondents use traditionally made chemical inputs, while 52 percent use non-chemical inputs.

	Chemicals	Non-chemicals
Traditionally Made	25%	52%
Nearby Markets	27%	76%
Within the District	20%	60%
Outside the District	3%	20%
Through SIDO	0	7%
Imported	0	0

Table 6: Chemical and Non-chemical Input Sources

Other challenges include fake (counterfeit) inputs; poor husbandry practices leading to quality deterioration of hide/skin due to defects caused by diseases; inappropriately placed brand marks; and damage to skins by thorns, beatings, ripping during slaughter, and inappropriate curing methods caused by inadequate training. Poor storage facilities lead to a rapid rate of spoilage for unprocessed hides and skins, resulting from hot climate in the pastoral areas since most of the households in the area have no access to electricity. Moreover, tanning is considered to be women's work where men are not willing to participate, which overburdens the female members of the household.

The respondents suggested a couple of solutions to the challenges, namely, more training on livestock keeping and tanning; access to cheaper input markets, such as wholesale input markets/shops for chemical inputs like lime and mimosa; exposure to affordable sources of credit; and help in forming commercial groups and cooperative shops for women. Other solutions include construction of a leather factory in Manyara as a source of ready-made inputs, subsidizing the tanning inputs, increasing the market days from two to four each month and complementing local/traditional tanning processes with modern chemical and non-chemical inputs to improve the quality of leather and the leather products.

Production Level

During the interviews, it was noted that the peak production months were between June and November. This period falls after harvesting and thus less farming activities are done at this time. This is important to production since the work of creating leather gowns is considered to be a part-time undertaking for most of the respondents, and, therefore, farm activities are prioritized. However, business women and groups produce leather products throughout the year as long as there is a demand. Table 7 shows the production of Barabaig traditional gowns and skirts. Only 35 leather gowns, 38 skirts, and a jacket were produced a month before the survey, which took place in May 2015. The low production is explained by a number of factors such as: the data for the month of May, which is during the off-season; poor tools, such as traditional needles, slow down the production processes; and a lack of appropriate markets for higher production rates, etc. The interviews revealed the lack of markets, inability to produce quality gowns due

to poor tanning technology, and unaffordable inputs, are some of the reasons why the majority of the respondents produce traditional leather gowns/skirts for personal or domestic use, rather than commercial purposes. It is common for a grandmother to make a gown for her grandchild or a new bride in the family. It can take up to 4 months to finish 1 gown because this is a part-time job and producers use traditional needles instead of sewing machines.

Item	Units
Dresses/Gowns	35
Skirts	38
Jackets	1
Others	101

Table 7: Level of Production in the Last Month (May)

Barabaig business women and groups diversify production in order to increase their incomes. They not only produce leather gowns/dresses, skirts and jackets, but also other leather products, such as different types of decorations, tablemats, handbags, wallets, belts, earrings, necklaces, bracelets, neck and waist ornaments, and cloth/textile products, including Barabaig traditional blankets, traditional shawls (sarong wrap), scarves, and processed skins/hides for sale in the local markets (Table 7).

Producer groups or individuals hire few permanent workers, and most of the work is done on a part-time basis when there is demand or orders. One of the employers in this case is the Barabaig Tradition Cultural Heritage Group (BTCHG).⁵ This is a popular Catesh (Hanang)-based women's group that receives orders from different parts of the country including Kilimanjaro, Arusha, and Dar es Salaam. The group is also active in exhibitions, such as Saba Saba and Nane Nane.⁶ It was also noted that in cases of big orders and when there is not enough time to produce products themselves, the BTCHG procure the goods from small-scale individual producers or groups at an agreed price.

Respondents further revealed that in town centers, there is a growing demand for traditional Barabaig gowns and skirts made of cloth instead of skin/leather. The main consumers are women/girls who live in towns and cities. The traditional Barabaig dresses/skirts made of cloth materials are exactly the same in color and other decorations, but are lighter and good for the warm weather in most of the urban centers.

Production Challenges

Production challenges include expensive inputs (74 percent), followed by lack of markets (69 percent), as well as technology limiting factors (32 percent) and shortage of better chemical products/inputs by 9 percent (Table 8). Other factors that constrain diversification and production include lack of capital and

the inability to capitalize and make other leather products, such as shoes, bags, etc., due to lack of training. Also, poor equipment, low quality skins/hides, and lack of leather sewing machines were cited as inhibiting factors. Old age and poor eyesight due to age were also mentioned as factors by old women.

	Frequency	Percent
Shortage of Chemical Products	9	9%
Technology Limiting Factors	32	32%
Expensive Inputs	74	74%
Lack of Markets	69	69%

Table 8: Current Production Challenges

The major sources of capital were women's savings (52 percent) and loans from friends and relatives (9 percent). None of the respondents had accessed formal lending institutions for capital, mainly due to lack of collateral and a fear of debt; however, some respondents (16 percent) received cash support from NGOs. Only 8.3 percent of the respondents had attended training and received advice on leather processing and producing leather products.

Marketing

The main consumers of traditional Barabaig products are Tanzanians, although a few items are bought by the foreigners or tourists. The main purchasers of the products in the study were final consumers (76 percent), traders (25 percent), cooperatives (14 percent), and middlemen (12 percent). The major marketing channels for Barabaig traditional products were telephone calls and WhatsApp (35 percent), followed by trade fairs, such as Saba Saba and Nane Nane (13 percent). It was noted in the study that 93 percent (80 women) of respondents sold their own products; only 2 respondents were assisted by their husbands.

Major sales or marketing challenges (Table 9) were low prices on the market (52 percent) and distance from the markets (good market segments were not reachable) (52 percent). Other market limiting factors cited by the respondents include: competition from cheap/fake or counterfeit products; some customers not showing up after making orders; being very difficult and expensive to penetrate the trade fair markets due to limited number of slots at the district level; and some customers buying on credit and running away.

	Percent
Price Not Good Enough in the Market	52%
Cheating by Middlemen	9%
Distance from the Markets (Good Markets Segments Not Reachable)	52%
Communication is a Hindering Factor	29%
Low Quality Products	2%

Table 9: Current Marketing Challenges

Incomes

Summary statistics for the monthly average incomes from the sales of the traditional Barabaig products are shown in Table 10. The mean income and standard deviation of the Barabaig woman from sales of traditional gowns/skirts were Tanzania shillings (TZS) 143,232.4 (US \$65.30) and TZS 156,418.6 (US \$71.30), respectively.

	Percentiles	Smallest		
1%	8,000	8,000		
5%	20,000	16,000		
10%	30,000	18,000	Obs	71
25%	45,000	20,000		
50%	70,000		Mean	143,232.4
		Largest	Std. Dev.	156,418.6
75%	200,000	40,000		
90%	360,000	40,000	Variance	2.450110
95%	400,000	70,000	Skewness	2.036134
99%	800,000	80,000	Kurtosis	7.614298

Exchange rate ended June 2016 (TZS/US \$2,192.40)

Table 10: Descriptive Statistics of Monthly Average Incomes from Sales (TZS)

Given the mean income and standard deviation, most of the respondents had incomes between TZS 13,186.2 (US \$6.00) and TZS 299,651 (US \$136.70) — an indication of a wide income/earnings gap. Table 10 further shows different quartiles of participants. The first quartile of participants was grouped in income levels less than TZS 45,000 (US \$20.50) per month. The second quartile had income of TZS

70,000 (US \$31.90), while the third quartile registered income of TZS 200,000 (US \$91.20) and the 99th percentile recorded TZS 800,000 (US \$364.90). Income difference between the highest and lowest records is significant.

Employment and Empowerment

The small-scale nature of the activities/businesses, which are mostly family or group-owned, handicaps the employment generation in the sector. As a result, only 13 individuals (11 women and 2 men) are hired by 16 households, which is 16.3 percent of the respondents, and the rest (83.7 percent) do not need hired labor.

The question pertaining to whether participants had any savings indicates that 71 respondents (72.4 percent) had savings in different forms – savings in rural areas can be in cash or kept in a form of physical assets or animals such as goats, sheep, or hens. When it comes to decisions on how to spend the savings and for what purposes, about 85 percent of the respondents have a final say on their savings (Table 11).

	Frequency	Percent
Myself/Female	62	84.9%
My Husband/Male	4	5.5%
Jointly with my Husband	5	6.9%
Marketing	2	2.7%

Table 11: Who Decides When the Savings Will Be Spent and What For?

The responses to questions regarding membership in any organization(s) or group(s) indicate that 56 respondents (58.3 percent) are members in at least one group or organization. Some of the benefits from these memberships include: training (37 percent), sources of capital (31 percent), etc. (Table 12).

	Percent
Source of Capital	31%
Input Supply	9%
Training	37%
Marketing	23%

Table 12: Group/Organization Membership Benefits

Other benefits accrued to the respondents were: access to credit, which is used to solve other family problems like buying food, supporting sick family members, and paying school fees; and support in cases

of catastrophes such as fire, floods, deaths, etc. Responses regarding who is traditionally allowed to inherit land/property or other assets indicate that, just like in most African societies, men take almost everything while women inherit very little (Table 13).

	Frequency	Percent
All Family Members	8	8.2%
Male Family Members Only	73	74.5%
Female Family Members Only	3	3.1%
Children	14	14.3%

Table 13: Who is Traditionally Allowed to Inherit Land/Property or Other Assets

The responses to the questions regarding the contributions of rural women's use of IK for development are presented in Table 14. The highest contribution of income generated through selling leather products to development amongst the Barabaig community was in terms of voice in decision-making (women's empowerment) (54 percent); followed by provision of good health care for the family (43 percent); ability to educate their children (42 percent); and ability to buy food for the family (34 percent). Other benefits accrued from IK income to the respondents include access to clean water (connection charges), acquired solar power, and the ability to build modern houses.

	Frequency	Percent
Ability to Buy Food for Your Family	34	34%
Ability to Educate the Children	42	42%
Ability to Ensure Adequate Healthcare for Your Family	43	43%
Voice in Decision Making (Empowerment of Women)	54	54%

Table 14: The Extent to Which Generated Incomes Affected Their Lifestyle

Succession Plan and Replication

The respondents who have arrangements (succession plan) to preserve and pass on the knowledge to others within the community were 95 percent. The majority opined that it could be done through transferring knowledge to youths (98.6 percent); 29 percent were open to transfer the IK to relatives (29 percent) and interested neighbors, women groups, and disabled people. The respondents (62 percent) favored training, as a better means of imparting the knowledge, attachment to IK practicing households was also anonymous (42 percent) and suggested that girls who are in schools could be attached to IK practicing families or groups during holidays in order to acquire the IK.

In terms of constraints/challenges associated with succession plans, the respondents lamented that as much as they are willing to transfer the knowledge, there is very little support for doing so since the process is costly (64 percent of the respondents), and in the training processes, there is a need for better equipment that they do not have (33 percent). There are also time constraints because most of the girls were attending schools. They posed the following solutions to some of the constraints: introduce training at the primary school level, facilitate access to credit, establish centers for vocational training (including training on IK), support and encourage learning groups, and instill in young people a value for working hard.

The majority of respondents (69 percent) are willing to replicate all or parts of the knowledge to other places or other people. They — 49 respondents (51.6 percent) — further attested that there are no specific cultural traits that could impede the smooth transfer of the knowledge; however, they mentioned some challenges: language problems, girls being reluctant in undertaking handwork, and an inadequate number of trainers.

3.3 Opportunities and Challenges

- (i) Tanzania has sector specific policies on IK, that form a stepping stone for indigenous organizations and supporters to promote IK. Some indigenous organizations have already taken advantage of possibilities offered at the national policy level in terms of participatory consultations and representation in important taskforces. It is now the indigenous communities' turn to make use of the other possibilities, namely engaging and getting their views represented in the decision-making bodies at the village, district, and regional levels. A lot can potentially be gained from the current government move towards industrialization and efforts to revitalize the hides/skins and leather sector through the Tanzania Leather Sector Development Strategy 2016–2020.
- (ii) Ongoing national development efforts (sectoral policies) have one thing in common: the involvement and protection of indigenous knowledge; however, the efforts are quite disconnected. Strategies and approaches need to be defined, along with the rules of engagement, with emphasis on responsibilities of all parties, in implementing IK.
- (iii) The Barabaig women in Hanang can capitalize on the availability of large livestock base in the area to scale up production of leather and leather products. The growing national and international markets in Arusha and Dar es Salaam, as well as demand from tourists in the Northern circuit, if well-tapped, can help to boost production.
- (iv) Defects associated with poor animal husbandry, slaughtering, storage, and preservation methods result in poor quality hides and skins.

-
- (v) Unavailability of some chemical and non-chemical inputs in the local markets compromises production and quality of leather. Chemical inputs are mostly available in the regional markets at higher prices. Also, counterfeit inputs compromise quality not only in regards to tanning, but also in making leather products.
 - (vi) Inadequate tanning training limits the processing of hides and skins.
 - (vii) Poor roads and inadequate access to electricity and water hinder production of quality leather due to poor storage and costly transportation in search of inputs. Access to clean water is a serious problem in semi-arid Barabaig land, where one moves long distances in search of clean water.
 - (viii) Tanning is the women's job in the Barabaig tribe, which sets men free from tanning and compounds the problem of productivity and quality in hide and skin processing. Women are also occupied with other family tasks like searching for firewood and accessing health services—it is the responsibility of women in Barabaig tribe to send sick family members to the hospital.
 - (ix) Less sensitization on the impact of chemical inputs in the environment and health leaves people exposed to environmental pollution and toxic chemicals.
 - (x) Constraints in production of leather products, such as gowns and skirts, include expensive inputs. For example, the use of traditional needles (hand-stitch) instead of leather sewing machines along with the inability to produce quality gowns is due to poor tanning technology and lack of markets. Lack of training caused insufficient capital and the inability to diversify other leather products such as shoes and bags.

4.0 Conclusion and Policy Implications

4.1 Conclusion

The study focused on opportunities and challenges in harnessing IK for the creation of employment for rural Barabaig women in Hanang, Tanzania. Indigenous knowledge is a critical factor for sustainable development. IK, like any other knowledge, needs to be constantly used, challenged, and further adapted to the evolving local contexts. Thus, the value of indigenous knowledge presides on its ability to deliver social and economic goods. Certain traditional practices, if popularized and integrated with modern knowledge systems, can help reduce and alleviate poverty.

The study findings indicate that, due to lack of appropriate tanning training and expensive tanning inputs, Barabaig women are forced to use locally made, poor quality inputs and, therefore, produce low quality products. The use of some traditional tools in production compromises efficiency and quality, and thus creates market problems. Lack of markets forced most of Barabaig women to consider production of

traditional leather products a part-time undertaking. In diversifying, business women and groups are involved in making other traditional products such as Barabaig blankets, traditional shawls, bracelets, neck and waist ornaments, etc.

In bridging the gap, Barabaig women need training, especially on skin/hide tanning; access and availability of better inputs and equipment; better production technology; access to market production; and access to affordable credit. They should be encouraged to form groups that will be important links for inputs, production, and markets.

4.2 Policy Implications

In order to harness the IK potentials in Tanzania the following issues should be observed in the creation of policy:

- (i) Address all IK challenges, including adopting one comprehensive IK policy rather than relying on sector specific policies; define the roles of actors; and build human, technical, and physical capacity.
- (ii) Conduct crucial training on tanning technology to improve the quality of leather. Equally important is that training on the making of other leather products, such as shoes, bags, etc., will widen the scope of diversification and scale up rural incomes.
- (iii) Facilitate access to quality and affordable tanning inputs and production tools, such as tanning points and leather sewing machines, to reduce the per-unit production time.
- (iv) Working in groups should be encouraged. Only through groups women can access cheaper credit, cheap inputs through bulk procurement, and market outlets outside the district. Also, most of the NGOs and development partners prefer working with groups rather than with individuals.
- (v) The district authority pillars, such as Tanzania National Business Council, can be used as market outlets outside the district. District authority can reserve more slots for IK products in trade fairs, like Saba Saba and Nane Nane.
- (vi) Address other rural bottlenecks such as poor infrastructure, long distances in search of water, education, healthcare, and upgrading access to electricity.

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Endnotes

¹ Unemployment, according to international standards, is defined as the situation of a person who: (a) did not work in the reference period, (b) was available to take up a job had one been offered in the week prior to the reference period, and (c) actively sought work within the past 30 days (for example, by registering at an employment center or answering a job advertisement) (ILO 2013).

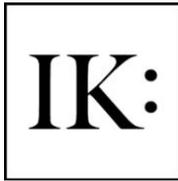
² There is a low likelihood for own-account workers and workers who contribute to family labor to have formal work arrangements and thus are likely to lack elements associated with decent employment, such as adequate social security and a voice at work, which is why the two statuses are classified as vulnerable employment.

³ Tanning is the process of treating skins and hides of animals to produce leather. Tanning hide into leather involves a process, which permanently alters the protein structure of skin, making it more durable and less susceptible to decomposition, and also possibly coloring it. Before tanning, the skins are unhaired, degreased, desalted, and soaked in water over a period of six hours to two days. Crusting is when the hide/skin is thinned, re-tanned, and lubricated.

⁴ The use of a mixture of animal dung and urine is unhygienic and produces a leather with a bad scent.

⁵ Barabaig Tradition Cultural Heritage Group is a women's group formed to promote Barabaig traditions and culture.

⁶ These are very popular annual trade fairs in Tanzania that provide marketing opportunities for producers, including small-scale producer groups and individuals.



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Stepping up Indigenous Knowledge and Technologies for Higher Incomes for Women in Rural Tanzania: A Case of Food Processing and Storage

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This study addresses various indigenous technology and knowledge-based food processing and storage methods used by rural women farming in Tanzania, focusing on the ways these can be improved for higher incomes. Primary data collected in June 2016 from 103 small-scale women farming in Dodoma, Iringa, and Mbeya were analyzed with secondary data in order to meet the study objectives. We found that the food processing activities of the women farming in these areas are largely primary—they are meant to facilitate transportation and/or storage and are accomplished using hands. The storage infrastructure is characterized by traditional methods, and sacks are the most widely used storage vessel. Farmers store the food crops for food security and to sell at a higher price later. The regression results revealed that poor storage facilities discourage increased farm production; therefore, efforts to achieve higher farm production should be accompanied by the improvement of indigenous farmers' storage facilities. Farmers themselves prefer hermetically sealed storage facilities such as drums and hermetic bags.

Keywords: Indigenous Knowledge, Food Processing, Food Storage, Production Volume and Income

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1.0 Introduction

Indigenous knowledge and technologies have proven to be of great importance to human livelihoods in many countries. Indigenous knowledge (IK) forms a basis for decision-making in various fields, affecting human wellbeing, including agriculture. In agriculture activities,

IK is particularly useful to poor women in rural areas whose livelihoods are based on agriculture (Nwokeabia 2006). Sustainability of agriculture in Tanzania is largely dependent on indigenous knowledge and technology. Rural households' food processing and storage represent an important segment of a series of post-harvest activities benefiting greatly from the use of IK. Since there is a substantial time lapse between harvest seasons (at least seven months for most crops), it is crucial for households to store harvested food to ensure a steady supply of produce in the market and in the household for security of both income and subsistence. There are various reasons part of a crop's yield may be stored (including future family consumption, future sale at higher prices, seed for sowing in the coming season, etc.), but there is no distinction made for storage facilities to suit different purposes. The success of food storage depends on the presence of effective storage facilities at the household level.

Table 1 shows food losses associated with household storage conditions that are favorable to pest infestation. This data also indicates that, aside from pests, poor quality of storage facilities is the leading cause of stored food losses in Tanzania.

Type of Loss	Type of Farm Scale	
	Small (<2 Hectare Farm Size)	Large (>25 Hectare Farm Size)
Lack of Storage	13	13
Pest Infestation	40	50
Poor Quality of Storage Facilities	23	25

Source: World Bank 2009

Table 1: Losses Related to Storage Conditions in Tanzania (in Percent of Total Maize Losses)

The absence of suitable storage facilities with sufficient capacity is among the factors that force most farmers to sell their crops shortly after harvest to avoid post-harvest losses (Abass et al. 2014). This, too, means they forgo an opportunity to sell the same product at higher prices in the future.

The food storage facilities available in rural Tanzania vary in terms of their storage effectiveness, with most of the commonly used methods having the capacity to store food for only short periods. In spite of this, there is a wide acceptance of the fact that traditional food storage facilities are better adapted to the local conditions than exotic facilities (Proctor 1994). Although

there are also modern storage facilities, they are limited, as their adoption depends on the economic status of the household. Poor rural farmers, in many cases, are not able to afford modern storage facilities.

The need to have improved storage facilities emerges from the fact that rural smallholder farmers depend on staple food sales to earn part of their annual incomes, and, therefore, poor food storage infrastructure, leading to post-harvest losses, is cited as one of the factors contributing to reduced disposable income (World Bank 2011). Low agricultural earnings increase the poverty among rural women who mainly carry the burden of farm labor. The possibility of postponing early sales until supply falls in the market could immensely contribute to reducing poverty among rural farmers, especially women (Abass et al. 2014).

Household food storage is normally accompanied by food processing, although some households may prefer to store their food crops unprocessed. Processing can be carried out mainly to facilitate storage (primary processing), or to transform the crops into various useful products (e.g., extracting oil from oilseed, getting cream from milk, etc.), which is known as secondary processing. Secondary processing entails value addition to the raw crops and, therefore, increases the market prospects of various food crops.

Most post-harvest food processing methods are carried out manually and are, to a large extent, performed by women, due to traditional practices found in many rural areas. Many of these methods are labor-intensive and time-consuming, but the incentive of earning an increased income has resulted in many women's persistence in embracing such methods (Abass et al. 2014). The lack of both efficiency in post-harvest food processing and of effective storage technologies not only leads to low income among farmers, but also acts as disincentive to increased farm production. Since a large number of rural women are engaged in indigenous food processing, upgrading the processing technologies by, for instance, introducing simple built-in machines that still retain society's traditional values, would improve women's status by enhancing their earnings (Aworh 2008).

1.0.1 Food Crop Preservation

Rural women have indigenous knowledge of storing food for value protection. Various traditional inputs, as well as local herbs, are used by women in different rural areas to treat food crops (seed/grain) to prevent post-harvest losses caused by rodents or pests. The protectants differ from one location to another depending on the cultural practices as well as the agro-ecological conditions of a place (Lwoga, Ngulube, and Stilwell 2010a). This means that indigenous knowledge is location-specific. Using protectants to store food reduces losses, maintains the quality of the food, and postpones early sales after harvest. Although

commercial/synthetic chemicals for this purpose do exist, their relatively high prices have been a stumbling block to successful adoption and use of such additives (Abass et al. 2014).

The IK regarding food preservation in rural areas includes the use of materials that are accessible locally, such as tree leaves, roots, bark and husks of particular plant species, chilli pepper, kitchen/wood ash, anthill soils, sand, goat/cattle dung ash, and tobacco. Some of these local herbs/inputs are common in many places, with others being more location-specific (Table 2).

Area	Crop(s) Preserved	Inputs/Local Herbs Used
Kilosa	Cassava	Salting
	Maize	Kitchen ash
		Burnt rice ash
Moshi Rural	Bean or Maize	Chili pepper
		Wild tobacco
		Concoction of chili pepper and <i>mabangi mwitu</i> leaves
		Concoction of <i>urutupa</i> and <i>mabangi mwitu</i> leaves
		Concoction of <i>urutupa</i> and chili pepper
		Kitchen ash
Kasulu	Bean or Maize	<i>Mshindwi</i> tree ash
		A mixture of chili pepper and <i>mshindwi</i> tree ash
		A mixture of chili pepper and <i>mtundu</i> tree ash
		A concoction of chili pepper and ash from any tree
		Kitchen ash
	Peas	Concoction of chili pepper and ash from any tree
Mpwapwa	Bean or Maize	<i>Msakasaka</i> plant leaves

		Ground neem leaves
		<i>Kajashi</i> tree ash
		<i>Mluku</i> tree leaves
		A mixture of <i>msonobali</i> and chili pepper
		Kitchen ash or goat dung ash or maize cobs ash
	Sorghum	Kitchen ash or goat dung ash or maize cobs ash
Karagwe	Maize	<i>Kajai</i> plant leaves
		<i>Kajashi</i> tree ash
		<i>Masaka</i> plant leaves
		A mixture of <i>kaswagala</i> and <i>kajai</i> tree leaves
		Kitchen ash or mud or dry cow dung or anthill soil
	Sorghum	<i>Kajai</i> plant leaves
		<i>Mluku</i> tree leaves
Songea Rural	Bean or Maize	Kitchen ash

Source: Adapted from Lwoga et al. (2010a)

Table 2: Food Crops Preservation Practices in Rural Areas

Some local herbs are believed to be insecticidal; these plant species are used because of their ability to prevent development and growth of destructive pests. These traditional methods are best suited to small quantities of stored food crops, suiting the needs of most rural farmers. They are also an economical option, compared to industrial chemicals, which have further sustained their usage among rural farmers. Moreover, the use of local herbs does not have significant health risks, unlike the industrially manufactured chemicals for which there are environmental and health concerns.

It is, however, important to note that application of IK in agriculture is not limited to crop processing, preservation, and storage only. Rural farmers, due to their limited access to weather forecast information, are able to use indigenous knowledge and skills in many other areas of agriculture, such as for the timing of land preparation and planting or sowing; selection of

planting materials and seed; and management of pests and diseases as well as coping strategies for climate change, including managing the environment for sustainable crop cultivation. This knowledge has enabled the majority of poor rural dwellers to sustain their agricultural livelihood. It is with this view that Mascarenhas (2003) emphasizes that had it not been for the use of IK in Tanzania, the agricultural sector would not have developed to the current level.

1.0.2 Women Employment in Agriculture

Gender-based employment disparities are prevalent in various sectors of Tanzania. Men tend to constitute the larger proportion of workers in the formal sector jobs, and women tend to work in low paid jobs with less security compared to their male counterparts (URT 2015).

The largest percentage of Tanzania's economically active population is employed in the agricultural sector. More women than men are employed in this sector (Table 3), although, generally men are considered to be the owners of farms and agricultural products, especially those related to cash crops.

Activity	% of Hours Spent per Day	
	Male	Female
Land Preparation and Planting	44.2	55.8
Weeding	45.0	55.0
Ridging, Fertilizing, and Other Non-harvest Activities	43.0	57.0
Harvesting	45.0	55.0
Aggregate Agriculture	44.6	55.4

Source: National Panel Survey (NPS) Data 2012-2013

Table 3: Gender Responsibilities in Agriculture

In the countries of sub-Saharan Africa (SSA), about 60 to 80 percent of the labor force in food crop farming is provided by women (Pidatala and Khan 2003). Practically, for the case of food crops, men and women participate rather equally in clearing the site, preparing land, sowing, and planting. Women, however, shoulder a bigger load in the rest of activities, including processing and storage. Post-harvest operations are considered to be the obligations of women (Leavens and Anderson 2011). Men are generally more involved in the cultivation of cash crops, whereas women are more involved in the cultivation of food crops. Revenue resulting from the sale of

surplus food crops is, therefore, accrued to women (Leavens and Anderson 2011). The employment gender gap in the agriculture industry is further established in the 2014 Integrated Labour Force Survey (ILFS), which shows women's employment in the sector exceeds that of men by about 6 percent (URT 2015). This is the largest gap (as far as analysis of employment by industry is concerned) out of all of the country's industries, including the food services industry, which is well-known for employing a significant number of women (Table 4).

Industry	Male	Female	Gender Gap (In Favor of Females)
Agriculture, Forestry, and Fishing	64	69.9	5.9
Accommodation and Food Service Activities	1.4	6.5	5.1
Transportation and Storage	5.0	0.2	-4.8
Construction	4.0	0.1	-3.9
Mining and Quarrying	1.7	0.4	-1.3
Manufacturing	3.6	2.6	-1.0
Administrative and Support Service Activities	1.0	0.3	-0.7
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	12.4	12.8	0.4
Human Health and Social Work Activities	0.7	1.0	0.3
Education	2.1	2.1	0.0
Others	4.1	4.1	0.0

Source: ILFS (2014)

Table 4: Percentage Distribution of Employed Individuals Aged 15+ Years by Selected Industry and Sex in Tanzania Mainland, 2014

The seasonal nature of agricultural activities, accompanied by low earnings from crop sales, have forced women to engage in other occupations. As vulnerable members of society, women tend to be involved in some other income-generating activities or practice garden cultivation through some kind of small-scale irrigation, mainly using a bucket. For example, Tengeru women in

Northern Tanzania tend to cultivate African indigenous vegetables, which they process for sale in various markets, including wholesale, supermarkets, institutions, hotels, and retailers; this activity has increased their incomes (Muhanji et al. 2011). Likewise, based on the gender roles among Maasai societies, women are responsible for milking, processing the milk, selling the surplus on the market, and keeping the proceeds.

Many rural women tend to work as housewives for their households, but do not earn any extra income (FAO 2014). In most cases, their roles in the family and society at large, especially during off-farming seasons, is not valued. This is partly due to the fact that women have lower access to formal education compared to men; however, women have rich farming IK. Improving women's access to agricultural employment opportunities through increased crop production would enhance their incomes. To change women's employment situations, especially when one considers rural employment, recognizing the role of IK can be a good starting point. Thus, this study is focused on examining ways to upgrade indigenous knowledge and technologies that are used by rural women in processing and storing food.

1.1 Statement of the Problem

Food processing and storage activities done by women in rural areas constitute crucial indigenous knowledge that is transmitted from one generation to another as it becomes part of the cultural norms. For a long time, such IK has been underutilized in many societies. As traditional bearers of IK, rural women are better positioned than most to use IK to add value to agricultural products they produce. There is still a lot about indigenous technologies that is unknown to researchers and policy makers; therefore, identifying and scaling up resources available to women utilizing such skills could motivate more production. The slow progress of improvements to the existing indigenous food processing and storage technologies makes women vulnerable to low earnings. The fact that these technologies are supported by social, cultural, and economic aspects acts as a bedrock for rural women to improve revenues for higher earnings through surplus production. Having adequate food processing and storage facilities will enhance farmers' confidence in increasing agricultural production; a view that is maintained by World Bank (2011) states that there is a direct relationship between crop production volume and the available storage technologies. To this end, encouraging farming operations for increased crop productivity will not convince farmers if no sustained and focused efforts are directed towards addressing the poor state of their available food processing and storage technologies.

1.2 Objectives of the Study

Generally, this study intends to take account of various IKs and technologies that are used by women for food processing and storage in rural areas, with a focus on ways to improve them for higher incomes and employment. Specifically, the study's aims are the following:

- i. To understand indigenous knowledge applied in food processing and storage in rural areas of Tanzania.
- ii. To determine the effect of indigenous food processing and storage technologies on the size of cultivated land and hence rural women's employment.
- iii. To analyze ways to improve indigenous food processing and storage technologies for sustainable storage and flexibility in marketing of food crops.

1.3 Significance of the Study

IK plays an important role in the lives of many rural dwellers. It forms a basis for decision-making in the lives of many people worldwide. Survival and subsistence of rural people can be attributed to the existence of various IKS in their communities. Tanzania is no exception, and women play a very important role in agriculture and related post-harvest activities. Most rural women have agricultural IK and rely on farm earnings to sustain their livelihoods.

Identification and documentation of IK in food processing and storage as it is used by Tanzanian rural women will enable its preservation for the next generations, especially as such IKS and technologies are losing their popularity in the country. Moreover, the study will play a vital role in revealing the necessary improvements in such technologies to encompass more employment opportunities for women to increase their incomes. The presence of effective food processing and storage technologies is crucial in enabling rural women who are farmers to safely store their produce over an extended period of time, thus giving wider flexibility in marketing food crops. An understanding of the local situations for most rural farmers will inform policy makers on the ways to harmonize the existing techniques with modern technologies. More specifically, in the wake of increasing damaging effects to stored crops caused by *prostephanus truncatus* or larger grain borer (LGB) (introduced in Tanzania in the late 1970s) and by *sitophilus*, there is a need for research in this area of food storage to take into account what is currently being used by rural farmers and propose more sustainable ways to resolve food losses. As Mascarenhas (2003) and Lwoga, Ngulube, and Stilwell (2010b) put it, it is not a matter of debate on the choice between indigenous or modern knowledge, but rather an appropriate blending of the two that will foster sustainable agriculture and facilitate value addition for most products. A similar argument is given by Lodhi and Mikulecky (2010), that in developing countries, communities at the grassroots level should maintain both indigenous and modern knowledge in order to attain maximum benefit.

2.0 Literature Review

2.1 Economics of Food Processing and Storage in Africa

Customarily, farmers make allocative decisions about harvested food in terms of sale, storage, and other uses like feeding cattle, etc. The decision for each allocation is, in the first place, determined by influencing factors and the individual farmer's primary motive to engage in agriculture. The decision to, for instance, store food is influenced by the farmer's possession of proper food storage technologies. Appropriate storage structures ensure that there is sufficient quantity and quality of food in the market at all times, and at more stable prices.

Most approaches to improving agricultural development so far have focused on substituting the indigenous knowledge and technologies with modern scientific methods; however, these interventions have attained little efficacy as they do not use a participatory approach involving local people who would be the potential beneficiaries (Pidatala and Khan 2003). On top of the aforementioned, the failure of such interventions could also partly be attributed to the fact that experts did not take into account the already existing traditional values in the design of modern technologies (Pidatala and Khan 2003).

Today there is increasing awareness of the need to plan and design storage structures and facilities that are not only capable of storing the food grains with minimum loss, but also with cost effectiveness. Willingness of farmers to invest in an improved storage facility arises only if the expected benefits exceed the cost. Although interventions in agriculture may advocate for the adoption of modern food storage structures amidst high stored food losses, the lack of farmers' incentive to attain lower losses may lead to lower adoption rates (Proctor 1994; World Bank 2011). This shows that it takes farmers a substantial period of time to evaluate results before adopting new storage technology; therefore, quite large losses in the stored food might be incurred before making remarkable changes to their storage systems. These facts are among the reasons for early sale of food grains and the low level of adoption of modern food storage technologies in many African rural societies.

There has normally been a conception that high post-harvest food loss is a justification for implementing new food processing and storage technologies; however, the assessment of the demand for some particular technology by its potential users is crucial before introducing the technology. Current efforts seem to aim at encouraging small-scale rural farmers to adopt modern technologies as a third party, rather than primarily the intended users, but such modern technologies are generally meant for large-scale commercial farmers (Hart and Aliber 2010). The fact that these new technologies are associated with a high cost of capital that does not outweigh the value reduction from losses, has made success to introduction of exotic technologies almost impossible, particularly in the developing world (Proctor 1994; Kadjo et al. 2013). This explains

rural farmers embracing the traditional food storage facilities. For such farmers, simple improvements to the existing traditional technologies matter more than the adoption of complex technologies. By the same token, one can mention that no success stories in Africa can be found from the intervention of metal silos. In countries such as Tanzania and Mozambique, for instance, the main constraint to fruitful adoption of metal silos is unavailability of galvanized iron sheets of required quality (World Bank 2011), rendering local fabrication impossible. For a particular technology to be successfully adopted, careful evaluation has to first be made of all technical, economic, social, and cultural aspects.

Inadequacy of safe storage facilities among rural farmers is one of the challenging issues for increased crop production. As Kadjo et al., (2013) put it, the sale of grains shortly after harvests, due to lack of effective storage facilities, has withheld many African countries' governments' campaigns to increase crop production at the household level. In the northwestern province of Cameroon, for instance, although potato cultivation is well-known to employ women, its production is limited only to the quantities that are needed during harvest periods because they cannot successfully store crops (FAO 1997). Under such circumstances, farmers are forced to live the puzzle "sell low and buy high," rendering them unsecured. Abass et al. (2014) observed a significant price difference during the harvest (low price) period and towards the end of the post-harvest (high price) period for oil seed (sesame and groundnut) and pulses (beans, green grams, pigeon pea, and cowpea) in semi-arid savanna regions of Tanzania. This shows that sale prices during harvest season are not in favor of farmers and therefore tend to reduce profits.

2.2 Food Processing and Storage Interventions in Africa

2.2.1 Ineffective Project Cases in Africa

Projects to promote farmers' adoption of improved food storage technologies have been in place in SSA since the mid-1970s. In Tanzania, such projects were introduced around the late 1980s in collaboration between the government and NGOs. In Kilosa, in the Morogoro region, the Village Go-Down project was introduced in 1989, targeting the establishment of go-downs made of burnt bricks/concrete blocks with corrugated iron sheet roofing (Makalle 2012). The Vihenge project was also introduced in the same area by the government in collaboration with Food and Agriculture Organization (FAO) for adoption of improved granaries, this time using locally available materials in terms of their construction. However, both of these projects faced low adoption rates of the technologies being disseminated. This is because the technologies could not be culturally accepted, and farmers could not afford the associated capital and operating costs. Most farmers made no use of such improved technologies, and even the early adopters eventually moved back to their traditional technologies (Kadjo et al. 2013).

According to World Bank (2011), the introduction of concrete-filled PVC pipes in Zimbabwe in place of timber posts (used to raise the mud-plastered granaries in the fight against rodents, termites and other insects) could not gain traction due to the fact that the intervention was associated with high costs, and also the PVC pipes and concrete could not be acquired locally.

The government and FAO project to promote metal silos in Malawi also faced low adoption rates among smallholder farmers because of their inability to afford the costs. Culturally, the intervention was not accepted because farmers used to store their produce in bags inside their houses, and therefore could not accept the risk of outdoor storage that was associated with the silos project (World Bank 2011). A similar case of a failed metal silos promotion project is found in Kapchorwa, a district of Uganda, due to cultural reasons, as farmers could not start using technology to store their produce that was superior to their own houses. Similar reasons for the nonperformance of the same project can also be drawn from Mozambique and Tanzania.

The programs to reduce food losses in developing countries, such as the Prevention of Food Losses Program that was initiated by FAO in 1977 and the Global Post Harvest Forum (PhAction), seem to be nonperforming due to farmers' low adoption rate of the storage technologies being advocated. Notwithstanding poor project performance, it is now commonly agreed among development partners and organizations that current efforts on revitalization should focus on nurturing innovation and assist in upgrading whatever best practices are already at the disposal of rural farmers (World Bank 2011).

Much like these cases of storage technologies, the design of improved food processing technologies also have to be socially and economically viable in order to get farmers' acceptance. Willingness to pay for a particular processing or storage technology is an important signal for its effective demand. As shown by Aworh (2008), promotion of low cost traditional food processing technologies is essential in facilitating rural development. The development emerges partly from increased revenue due to increased production coupled with reduced rural urban migration. It is important for the improved food processing technologies to be situated in rural areas where there is adequate supply of raw materials and where practice of these technologies can foster more employment opportunities.

The promotion of manually-driven maize shellers by an FAO project in Tanzania failed because of their processing slowness and not being cost effective; instead, farmers opted to shell by hand through hired labor (FAO 1997). In some places the introduction of improved processing technologies failed because of their consequences of reducing women's labor demand. The fact that labor supply is not a constraint in rural areas has made many farmers opt to use labor in processing because it is cheaper using labor than mechanical processors. Food processing activities in Africa, whether organized at the individual or group level, are a well-known source

of employment, as they involve a large number of women and act as a source of income to them. Alteration of perishable foods to sustain longer storage periods, such as *gari*¹ making in West Africa and fish smoking in Ghana, are also well-known sources of employment for women in those areas (FAO 1997). With this usual practice in place, the introduction of large-scale *gari* processing machinery in Nigeria failed because not only did it compromise women's incomes, but the product was also not accepted by consumers because it tasted different. Consequently, producers returned to using hand labor for peeling and grating cassava (FAO 1997).

Although IK is specific to certain cultures, it can be used to promote innovation and experimentation in other societies once exchanged. Sometimes the improvements of existing indigenous food processing and storage technologies can perform better, in terms of farmers' preferences, than a complete introduction of new technologies. As Nukenine (2010) argues in his study, rural farmers are likely to adopt the technology that is a result of an improvement from the prevailing ones. The point by Nukenine clearly underscores the need to nurture innovation in the design of food processing and storage technologies in the societies in which they will be promoted.

2.3 Traditional Additives for Food Storage

Food losses during the post-harvest period can occur at various times, including when the crop is still in the field, during harvesting, processing, and in storage. Abass et al. (2014) found a significant amount of food losses during processing and storage in the semi-arid savannah regions of Dodoma and Manyara in Tanzania. Based on their study, loss during processing is estimated to be between 13 and 20 percent, while during storage is between 15 and 25 percent. Such high loss rates discourage farmers from undertaking measures, leading to increased farm production.

Women farmers traditionally use additives such as extracts from local herbs or inputs in the fight against storage pests, insects, and rodent infestation. Abass et al. (2014) found about 23 percent and 20 percent of households surveyed in Dodoma and Manyara use herbs and wood ash, respectively, to store food crops.

Local herbs are also used in various areas to process and preserve milk. For example, some women in central parts of Tanzania (Dodoma and Singida) use woods from certain herbal plants (such as *Boscia angustifolia*, *Euphorbia candelabrium*, etc.) that are then burnt. The smoke is directed into the gourds containing milk, a practice that increases fresh milk's shelf life, which in turn increases its market opportunities (Komwihangilo, Goromela, and Bwire 1995). Moreover, cream is sometimes separated from milk locally to reduce its rate of deterioration. The cream can then be used for cooking at the household level, or sold to generate cash (Abass et al. 2014).

Local preservation means are used by farmers to facilitate longer storage of food crops with minimal storage loss. The length of storage of the food crops is influenced by, among other things, the storage and climatic conditions of a place. For example, the length of storage is higher in arid and semi-arid areas (Nukenine 2010). The study by Kadjo et al. (2013) found that when farmers are provided with storage protectants, they tend to increase the amount of produce that is allocated to storage.

Thus, it is important to understand and scale up this body of knowledge and skills among rural women who farm in order to foster local innovation at the grassroots level for more reliable crop storage and preservation methods.

2.4 Success Stories of Improved Adaptation

Despite the reported cases of failed project interventions, there are cases of farmers successfully acquisitioning (on their own) modified storage structures that have been improved based on adaptations from existing ones. In Zimbabwe, farmers were able to construct and use storage structures from burnt bricks walled with thatched roofing, an improved adaptation from the pole and mud granaries (World Bank 2011). This improved adaptation came about due to a scarcity in the supply of poles.

In Tanzania, the introduction of the Ram Press for extracting edible oil from oilseed has enabled small-scale farmers to obtain cooking oil at the household level. The Ram Press was initially introduced in Arusha in 1986 and later extended to other regions by Small Industries Development Organization (SIDO) in collaboration with donors. This oil processing technology is low-cost, therefore farmers could afford owning one at the household level. Apart from increasing the cultivation of oilseed, especially sunflower, farmers also reported an increase in income through selling value-added oil (instead of oilseed) and charging for oilseed pressing services extended to other small-scale farmers that could not afford to buy one (Hyman 1992). The promotion of sealed mud silos in some northern districts of Ghana has become more effective compared to their locally grass-woven baskets, such as *kambons* and *kunchuns*. In Namibia, hermetic plastic drums for food storage have been made available to farmers by manufacturers of water tanks. This drum's resemblance to the widely used traditional wood-made storage granaries (known as *mopane*), together with its effectiveness in improving grain quality and storage duration, have made it to be widely adopted by farmers (World Bank 2011).

The introduction of hammer mills and investments in dehulling equipment for processing sorghum flour in Botswana have proved to be extremely useful in saving time for women as it enables them to engage in other domestic and non-farming activities. However, in cases in which the promotion of such processing technologies entailed a loss or reduction in women's employment potentials, they faced a rejection. In Nigeria, the shift from large-scale gari

processing mechanization to small-scale gari processing factories was greatly successful because the latter was not only cost effective, but also retained some manual work that women still attended (Aworh 2008).

Understanding the existing IK in agriculture concerning various local conditions can provide useful insight to the stakeholders when planning agricultural interventions. Farmers' likelihood to adopt an improved technology increases when they perceive the new technology as an addition to the effectiveness of the already existing technologies. Proper understanding and utilization of indigenous knowledge promises to be a source of future success for interventions in the agricultural sector (Hart and Mouton 2005).

From reviewing the literature, it is clear that interventions to enable safe processing and storage of food can be sustainable if they reflect three main issues: economic, social, and cultural acceptability. The notion that agricultural technological developments in developing countries ought to be externally induced seems to be insupportable. Various authors have argued that the technology transfer approach, which has been advocated for previously, does not benefit poor farmers—most of them being women. Many technologies could not be adopted by farmers because of either association with high costs, or because their construction materials were not based on locally available means. Finding the best ways based on local innovation for farmers to manage their produce during post-harvest periods will facilitate reaching the food and income security objectives.

3.0 Methodology

3.1 Data Type and Sources

This study uses both primary and secondary data. Using a semi-structured questionnaire for primary data, a total of 103 small-scale women farmers were interviewed in the Dodoma, Iringa, and Mbeya regions in June 2016. In Dodoma and Iringa, 2 districts were surveyed, while 3 districts were surveyed in Mbeya (Table 5). Dodoma was chosen because of its agro-ecology as a semi-arid area with frequently reported cases of food shortages. On the other hand, Iringa and Mbeya are high-production zones, which, in combination with Ruvuma and Rukwa, constitute the southern highlands and are known to be the breadbasket of the country. The regions in the southern highlands receive unimodal reliable rainfall ranging between 800 and 1400 mm per year. The temperature goes as low as 10⁰C during the cold season and reaches 20⁰C during the hot season. Dodoma, by contrast, receives unimodal unreliable rainfall ranging between 500 - 800 mm per year. The secondary data used was from the 2007/08 national sample census of agriculture, National Panel Survey (2012/13), ILFS (2014), and reviewed literature and reports.

Region	District	Village	Number
Dodoma	Bahi	Bahi	3
		Bahi Sokoni	4
		Kigwe	8
	Kongwa	Kibaigwa	21
Iringa	Iringa Rural	Igula	3
		Ndiwili	6
		Tagamenda	8
	Kilolo	Luhindo	5
		Lulanzi	4
Mbeya	Kyela	Ikambi	20
	Mbarali	Itamboleo	14
	Mbeya Rural	Inyala	6
		Makwenje	1
Total			103

Table 5: Distribution of Sample Size According to Village

The analysis is largely facilitated by primary data collected from these villages. The data were collected using a semi-structured questionnaire.

The survey population of the study comprised women living in Dodoma, Iringa, and Mbeya. The sample frame includes entirely women living in 13 selected villages of these regions, as indicated in Table 4. These villages were selected because they are among the most famous places in these regions using indigenous food processing and storage methods. We targeted a sample size of 100 respondents, based on time and financial resources, and the actual number of respondents reached was 103. In Dodoma, 36 women were interviewed, while in Iringa and Mbeya there were 26 and 41 interviewees, respectively.

The sampling procedure involved a combination of both purposeful and random procedures to select the elements from enumeration areas. The three regions and districts of the study were purposefully chosen due to their recognized effective background of traditional applications of food processing and storage methods: they were deemed quite useful for this analysis in the case of Tanzania. Selection of enumeration villages was dictated by the scale of activity. The study focused on and captured data in places noted as areas with reasonable use of indigenous food crops processing and storage methods. The choice of interviewed women in the enumerated villages was done by a simple random sampling procedure.

3.2 Econometric Estimation Model

Most of the literature uses a qualitative approach to studying IK. According to Grenier (1998), a qualitative approach is mostly suited to studies pertaining to human behavior (action), which tends to be subjective and highly variable.

Building on the reviewed literature, this study utilizes both qualitative and quantitative approaches to analyze various indigenous food processing and storage technologies as used by the interviewed farmers. The qualitative approach aims to describe various rural food processing and storage technologies. The quantitative approach involves estimation of an employment model using survey linear regression rather than the Ordinary Least Squares (OLS) method. The employment model investigates the possibility of increase in amount of land cultivated (implying more employment), if farmers were provided with improved storage facilities. The model uses the farm size (i.e., household farms for food crop cultivation, of which women farmers are a major source of labor force) as the dependent variable, while demographic characteristics and storage factors, such as not being satisfied with storage facilities in place, are independent variables.

The farm employment model specification is as follows:

$$\logfarmsize_i = \beta_0 + \beta_{11}age_i + \beta_{12}accland_i + \beta_{13}mrtstatus_i + \beta_{14}edn_i + \beta_{15}nchild_i + \beta_{16}disstrgchoice_i + \mu_i \dots \dots \dots (1)$$

where $\beta_0, \beta_{11}, \dots, \beta_{16}$ are coefficients, μ is an error term and:

- logfarmsize* = Logarithm of Size of Farm
- age* = Age
- accland* = Access to Land
- mrtstatus* = Marital Status

<i>edn</i>	=	Education
<i>nchild</i>	=	Number of Children
<i>disstrgchoice</i>	=	Dissatisfaction with Storage Choice

The description of the variables as used in the model and the hypothesized sign of causality of each variable is explained in Table 6:

Variable	Description	Hypothesis
<i>logfarmsize</i>	Size of land (in acres) cultivated by the household (log)	<i>regressand</i>
<i>age</i>	Age of the respondent in years	+
<i>accland</i>	1 if respondent considers easy access to land, 0 otherwise	+
<i>mrtstatus</i>	1 if the respondent is married, 0 otherwise	+
<i>edn</i>	1 if respondent's highest education level is primary and above, 0 otherwise	+
<i>nchild</i>	1 if household has 4+ children, 0 if it has 0-3 children	+
<i>disstrgchoice</i>	Dissatisfaction with storage facilities in use (1 if dissatisfied, 0 otherwise)	-

Table 6: Description of Variables Used in Estimation

We are interested in the effect of each independent variable concerning farm size. The model is multiple regression for isolating the effects of each hypothesized explanatory variable after accounting for others. We will be looking at effects of variables while controlling for the effects of others to find out the extent to which the respective explanatory variables interact to determine the land size utilized and hence the degree of women's engagement. In practice, β_0 is an intercept, which is either estimated or suppressed, depending on the researcher's knowledge and theoretical modelling background. For example, if one knows that the intercept of the regression line is zero, he/she should avoid wasting the variance in the data by estimating what is already known, i.e., to deal with the values that must be estimated.

Note that the parameter β_0 is a constant or autonomous determinant. When estimating a linear regression, we should be able to know what happens if all explanatory variables were inoperative: would the dependent variable be still realizable – at least in part? If yes, it means there is an autonomous determinant, β_0 ; if no, then there is a reason to suppress the constant in the respective regression.

We adopted standardized software (STATA in this case) to do survey linear regressions as a method to avoid biased results. This appropriately accounts for the effect of the complexities involved in survey design. To understand the problem that results from standard linear regression when it comes to survey data, see the case of a simple (heteroscedastic) format of the general equation: $y_i = \alpha_0 + \alpha_1 x_i + \varepsilon_i$, with $\varepsilon_i | x_i \sim N(0, \sigma_i^2)$. Note that y_i is the dependent variable (farm size) and x_i represents a respective independent variable. The usual OLS estimator of β_1 , call it b_1 , where sums and products are weighted by the reciprocals of σ_i^2 , whose value is assumed to be known, would be an unbiased estimator of β_1 , if the model holds. The estimator of the variances of the OLS, $v(b)$, is model-unbiased under the appropriate specification (the homoscedastic model in the case of $v(b)$). This being the case for the usual OLS regressions, the validity of the OLS model can be questionable in estimation of survey data. For this reason, instead of estimating β_1 , it is appropriate to estimate the finite population counterpart of β_1 , which can be denoted as B . Although b (the OLS estimator) is a model-unbiased estimator for $\beta_1 \approx B$, it is not generally design-unbiased.

In respect to this possible problem of OLS estimation, the estimators in the linear survey regression model are modified to take care of the highlighted possible complexities. If a standard software, like STATA, is employed for survey data regression, it is capable of accounting for such complexities in estimation, and this is what is done in our study. Use of survey linear regression resolves the design and model bias problems smoothly. For further details on how this process works, one can refer to Nathan and Holt (1980).

4.0 Results and Discussion of Findings

4.1 Respondents Profile

Most of the interviewed women (29 percent) were between 40 and 49 years old, with an average age of 42 years (Table 7). Of all the interviewed women, 66 percent were married, and 37 percent were the heads of their household. In total, about 57 percent of the households were headed by women. The 2011/12 Household Budget Survey (HBS) indicates that at that time, about 25 percent of the interviewed households were headed by women. This implies that women are increasingly becoming responsible for household matters, including nurturing the family and the production and preparation of food. This increased responsibility of women is due

to accelerated urbanization, which has led to the migration of men to urban areas in search of work, while women remain in rural areas.

Age	20-29	30-39	40-49	50-59	60-69	70+	Total
Sample	19	28	30	13	7	6	103

Table 7: Distribution of Sample Size According to Age

The increasing responsibility rural women have regarding household matters is also reflected by the role they play in making decisions pertaining to various aspects of farming (Table 8). For most households, decisions on food crop selling — including decisions about when to sell and how the resulting revenue should be spent — are made jointly between husband and wife. Generally, women have an upper hand compared to men in making decisions pertaining to farming activities, reflecting the earlier finding that the largest percentage of interviewed households were headed by women.

	Husband/ Male	Wife/ Female	Husband & Wife	Children & Wife
Food Crops Selling	10.8	38.6	47.0	3.6
Time to Sell	15.0	36.3	45.0	3.8
Revenue Keeper from Sale of Food Crops	16.3	67.5	13.8	2.5
How Revenue Should be Spent	17.7	36.7	41.8	3.8

Table 8: Decision-Making on Various Aspects of Farming (Percent)

Most of the interviewed women attended primary education (about 57 percent), followed by those without formal education (about 38 percent). Only 4 respondents had attained a secondary level of education, and there was 1 respondent with tertiary education.

In the surveyed villages, the primary cultivated crops are maize, beans, paddy, millet, cassava, sunflower, groundnuts, and sweet potatoes. About 81 percent of all interviewed women who farm were engaged in the production and sale of food crops, while the rest farmed for household

subsistence only. Information collected from the 2007/08 national sample census of agriculture (as indicated in Table 9) shows decisions by farmers on the percentages of their harvested crops to store and sell. For most food crops, the amount allocated to storage is greater than the amount sold during harvest (with the exception of beans). The amount allocated to storage may not all end up being consumed by the household; some of it might find its way to the market, especially when there is a price surge.

Staple Food Crops	As Percentage of Produced Quantities	
	Stored	Sold
Maize	60.6	39.1
Beans	43.2	56.8
Paddy	55.0	45.0
Sorghum	72.7	27.3
Millet	67.5	32.5
Cassava	54.9	45.1
Sweet Potatoes	53.0	47.0

Source: National Sample Census of Agriculture, 2007/08 Data

Table 9: Households' Staple Food Allocation to Storage and Market

An examination of annual income per acre generated by women farmers from the sale of food crops indicates that farmers in Mbeya have the highest earnings, averaging TZS² 376,000 per year, followed by Iringa, where earnings average TZS 270,000 per year. Farmers in Dodoma earn only TZS 102,000 per year (Figure 1). This difference in earnings could be attributed to the fact that Mbeya and Iringa, on top of having fertile soils, receive reliable and sufficient rains throughout the year, so that farmers enjoy bumper harvest, unlike in Dodoma, which is a semi-arid area, where farmers get only meagre harvests.

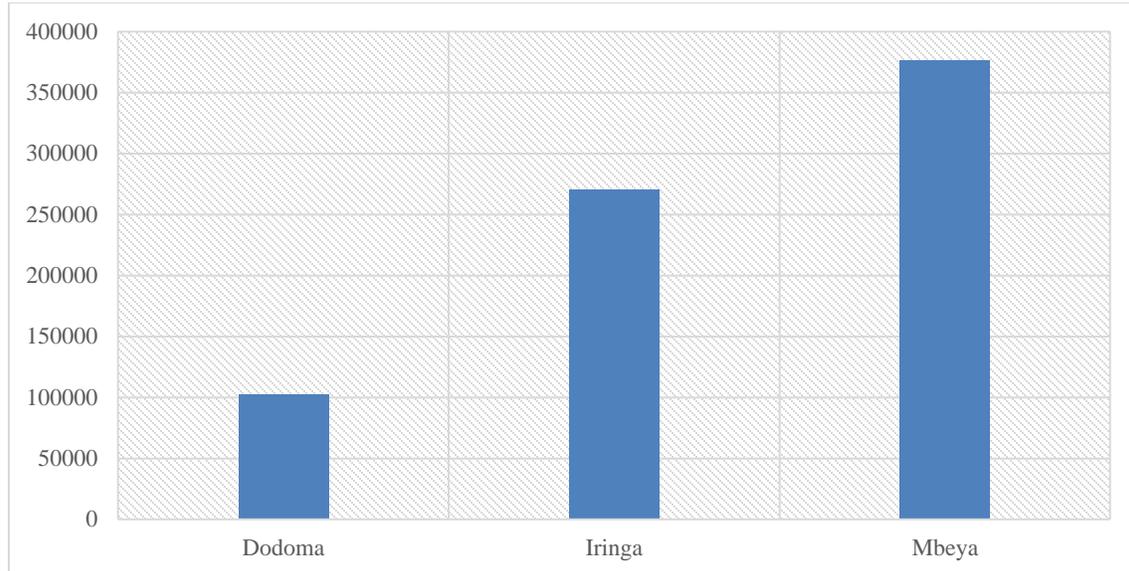


Figure 1: Regional Distribution of Household Average Annual Income from Food Crop Selling

Since farming in the country is seasonal, rural women engage in other activities during off-farming seasons. This study observed that, apart from crop farming, 9 percent of the respondents were engaged in petty business, while 19 percent were engaged in handcrafts' production as side activities. These activities enable women to earn extra income to supplement what is earned from the sale of food crops.

4.2 Farm Level Characteristics

On average, surveyed farmers cultivate farms of about 4 acres in total. Farmers can access land with relative ease in Iringa and Mbeya regions (Figure 2). About 65 percent of respondents from all regions indicated that it was easy to access land, but 56 percent of those who had difficulties accessing land were in Dodoma. Surveyed farmers' easy access to land is evidenced by the largest percentage of them (about 43 percent) claiming that they normally hire land for cultivation. Apart from hiring land, about 22 percent of women farmers cultivate the land that they are entitled to ownership, while 14 percent claimed to cultivate the land owned by their husbands. The remaining percentage involves cultivation of land that is jointly owned by husband and wife. This observed land ownership pattern emphasizes the earlier mentioned point that women have an upper hand in the cultivation of food crops, hence they are likely to have ownership of the land devoted to cultivating food crops. Generally, men have higher ownership of land in most parts of the country.

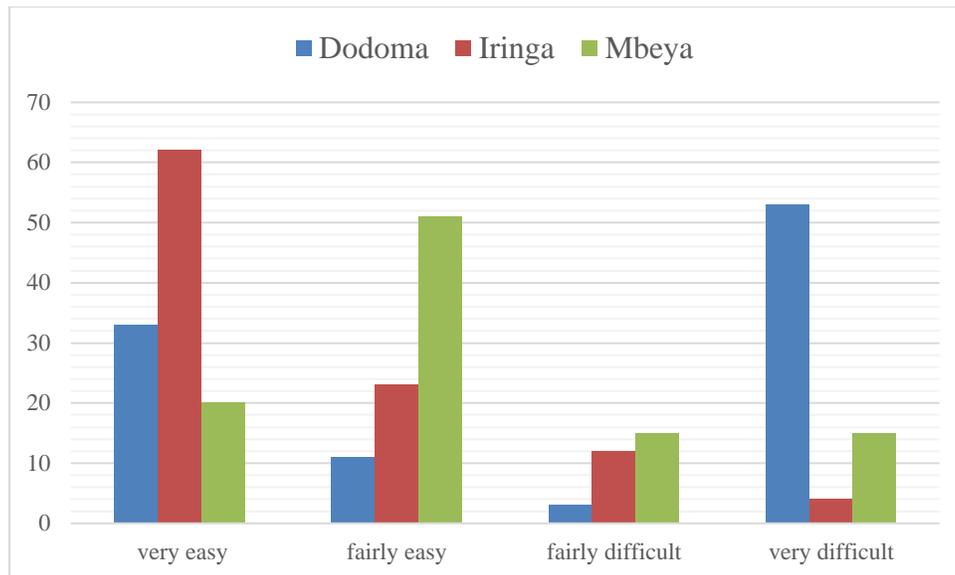


Figure 2: Percentage Distribution of Access to Land by Region

4.3 IK in Food Processing

Indigenous technologies for food processing are mainly primary, i.e., facilitate preparation of the food crops for storage and transportation. The methods used are mainly carried out manually (i.e., using hands) as outlined in Table 10. Secondary processing activities that add value to the crops to obtain a certain by-product are not utilized, despite the existence of indigenous processing knowledge for crops like sweet potatoes, cassava, vegetables, eggplant, etc. As a result, most farmers sell unprocessed crops depriving them of the opportunity to earn more.

Method	Sample Crops	Mechanism/Operationalization
Threshing	Groundnuts, Beans, Sorghum, Paddy, Sunflower, Millet	-Hitting with sticks
Winnowing	Beans, Sorghum, Paddy, Sunflower, Millet	-Throwing the grain into the air using a sieve/winnowing -Dropping the grains from the air using a basket
Shelling	Maize	-Manually using hands -Hitting with sticks

Peeling	Cassava, Sweet Potatoes, Peas	-Using hands and knife
Drying	Cassava, Groundnuts, Maize, Paddy, Sunflower, Vegetable, Eggplant	<p>-Exposure to sunlight by spreading in a thin layer or on the ground</p> <p>-Sweet potatoes and cassava, after being cut into small pieces and soaked, are then exposed to sun</p> <p>-Vegetables (such as <i>mchicha</i>) are partially boiled before being exposed to sun</p> <p>-Eggplant, after being peeled and cut into small pieces, is then rinsed with water and exposed to sun for drying</p>

Table 10: Primary Food Processing Methods

One respondent in Mbeya reported using a grinding stone (known as *Luwala*) to obtain flour from finger millet. There was also a reported case of grinding roasted groundnuts using a grinding stone.



Figure 3: A Research Assistant with a Woman who is Processing Cassava (Peeling) for Storage



Figure 4: Drying Vegetables before Storage for Durability



Figure 5: Sun Drying Maize and Beans by Spreading on the Ground

4.4 IK in Food Storage

The survey of rural women shows that sacks/bags are the most commonly used storage facilities for grains in rural areas (Table 11). This finding is in line with the 2007/08 agricultural census survey, which also found that the largest percentage of the interviewed households were using sacks for storing food crops. The significant adoption of sacks as a storage facility is the result of two benefits: the low cost of sacks, and saving space; sacks can easily be stored in-house when they are empty. The decline in the use of granaries (*vihenge*) as a storage facility by most rural farmers is attributed to (among other things) the persistence of rampant theft, as the granaries were constructed outside the houses. However, few farmers had granaries constructed inside their living houses, while some have upheld this technology without dismantling their granaries constructed outside houses even though they are no longer in use. Granaries allow the grain to dry well, and, therefore, cases of grain loss due to high moisture content are almost negligible. The continuous disappearance of granaries as storage technology results in a loss of granary construction skills. The survey revealed that about 70 percent of the respondents acquired IK regarding food processing and storage from their parents/elders, but at present, there has been little knowledge transfer due to the high level of motivation that is given to farmers to adopt modern methods and technologies. As such, the death of a parent/elder implies a loss of IK that this person was endowed with, including granary construction skills.

<i>Storage Facility</i>	<i>Adoption (Percent)</i>	<i>Duration of Possible Storage (Months)</i>
Granary (<i>Kihenge</i>)	4	7
Sack/Bag	95	9
Aerial/Ceiling: Hanging from Tight Lines above Fire Places	1	6
Underground Storage	3	7
Clay Pots/Baskets/Plastic Tins	3	8

Table 11: Commonly Used Food Storage Structures

Some other rural storage methods include underground storage for root tubers, such as cassava and sweet potatoes, which are harvested only when they are to be consumed or sold.

It is clear from Table 11 that sacks, which are the most widely used grain storage facilities, have the capacity to store grains up to a maximum of only 9 months. Since most grains are harvested once a year, while in other years farmers experience a total crop failure due to unfavorable climate change, there is a need for farmers to be provided with improved storage facilities that can foster longer storage periods to even the supply of food in the market and enhance assurance of food security and opportunity to earn higher incomes.



Figure 6: Maize Stored in a Granary

An examination of farmers' motives for food crop storage reveals multiple purposes. All farmers store food to make sure that their households have food security. Others store food to ensure availability of seed for planting in the coming sowing season; while others store crops to sell at higher prices later on and hedge against future cash needs to meet unforeseen contingencies (Table 12). Dodoma has the largest percentage of farmers who store to ensure availability of seed for planting in the coming season, while Mbeya has the largest percentage of those who store to sell at higher prices later. All these storage purposes require the presence of good storage facilities to guarantee that grain quality is maintained throughout the storage period. This acts as a starting point for the assessment of storage technology innovation.

Purpose of Storage	Dodoma	Iringa	Mbeya
Food for Household	100.0	100.0	100.0
Seed for Planting	84.9	34.8	59.3
To Sell at a Higher Price Later	39.4	43.5	55.6
To Meet Future Cash Needs	15.2	73.9	59.3
Others	9.1	0.0	0.0

Table 12: Household Food Storage Reasons

During storage, some farmers use various additives to protect food from damage. They range from industrial chemicals (considered to be modern), to traditional additives (listed in Table 13). Additives are often used for crops stored in sacks, but about 49 percent of the interviewed farmers stored their crops without any additives, especially when storing them in clay pots, baskets, and plastic tins. The fact that there is a high percentage of farmers who reported storing their food crops without any additives may be due to high prices and/or being aware of health effects (such as causing cancerous diseases) associated with modern storage chemicals.

<i>Storage facility</i>	<i>Storage Protectant</i>			
	Artificial/Industrial Chemicals (Spraying/Dusting)	Neem Leaves (mwarobaini)	Cowdung/Ashes/Magadi	Smoking
Granary (<i>Kihenge</i>)	✓	0	✓	0
Sack/Bag	✓	✓	✓	0
Aerial/Ceiling	0	0	0	✓
Underground Storage	0	0	0	0
Clay Pots/Baskets/ Plastic Tins	0	0	0	0

Table 13: Food Storage Protectants Used in Surveyed Areas

Farmers reported food loss in current storage facilities, despite the use of various protective additives. A significant number of farmers reported food losses caused mainly by rodents and pest/insect infestation (Figure 7). The common food pests causing the greatest loss in the country, according to Tefera and Abass (2012), are beetles: *prosthephanus truncatus* or LGB and weevil: *sitophilus*. Both LGB and *sitophilus* destruct crops by making holes or tunnels in the grains as they feed, turning them into flour, although the former is more destructive than the latter (Tefera, Mugo, and Likhayo 2011). These results also confirm similar findings by the World Bank survey (2009). Food losses during storage reduce earnings either due to sale of low volume or poor quality products post-storage, or due to farmers selling during harvest simply out of fear of food loss in storage. In general, this acts as a disincentive for farmers to increase farm production levels, thus immensely limiting engagement in agricultural employment.

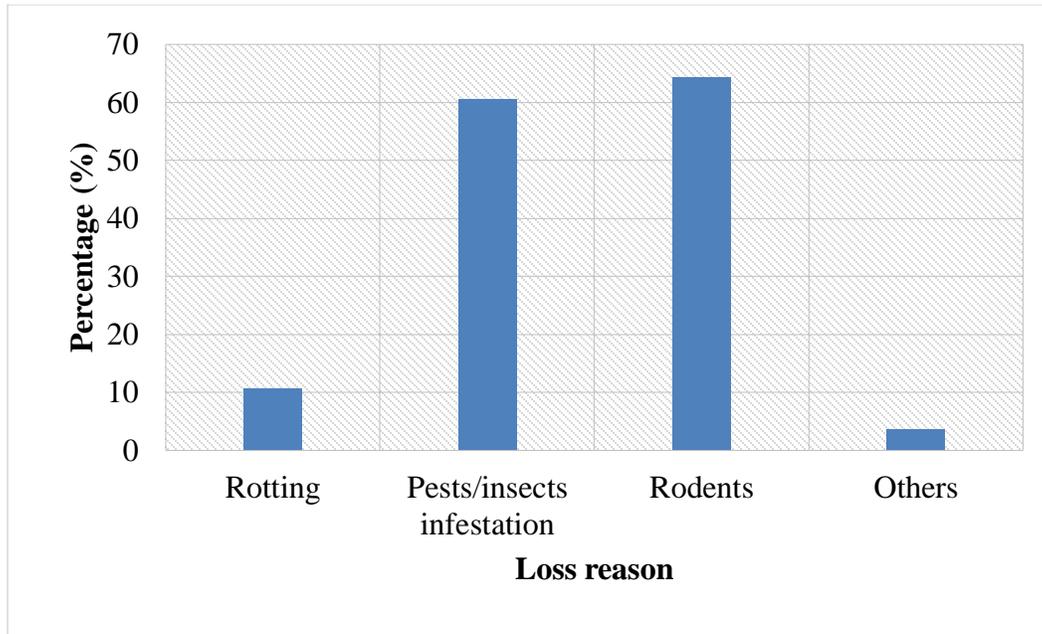


Figure 7: Farmers Reported Food Losses



Figure 8: Damaged Maize (by LGB) from Storage

Following the reported food losses by the households resulting from storage, a simple survey linear regression was performed to see if the existing storage facilities negatively impact farmers' farm production volumes. The approach used is underpinned by the assumption that if a particular farmer reported a food loss, then this is due to poor storage infrastructure. The dependent variable is the logarithm of the size of farm cultivated by the household.

The regression results indicate that three variables are statistically significant in influencing farm employment. These variables are marital status, number of children, and dissatisfaction with storage choice (Table 14). All variables had the expected signs, i.e., showing a positive or negative relationship with the dependent variable as hypothesized earlier, except variables on education (*edn*) and access to land (*accland*) that showed a negative relationship with farm employment whereas were hypothesized to have a positive relationship.

Marriage increases a woman's chance of employment by 32.7 percent, compared to unmarried women. This variable is statistically significant, at a 5 percent level. This is because living together as a couple increases the chance of cultivating larger farms since the labor is shared between husband and wife (although men participate mainly in preparing farming lands, sowing, and planting).

Bigger households cultivate even larger farm lands. The variable number of children per family is statistically significant, at a 5 percent level. This is because the food requirement for bigger households is higher, compared to the food requirements for households with only a few members. Moreover, a larger household also implies a larger labor force to be deployed in farming, hence an incentive to cultivate more farm land. It is common practice among African families for children to provide labor on farms, and, therefore, having many children is an incentive to engage in extensive cultivation.

Variable	Coefficient	Robust Std. Err.	P-Values
<i>age</i>	0.00026152	0.0052791	0.961
<i>mrtstatus</i>	0.32657193*	0.1345515	0.017
<i>edn</i>	-0.07750317	0.1625508	0.635
<i>nchild</i>	0.30182096*	0.1403690	0.034
<i>accland</i>	-0.04790627	0.1561152	0.760

<i>disstrgchoice</i>	-0.37221404*	0.1533397	0.017
<i>_cons</i>	0.87596429**	0.2968106	0.004

legend: * $p < 0.05$; ** $p < 0.01$

Table 14: Regression Results of Employment Model

The results also indicate that households' dissatisfaction with storage facilities reduces farm size by 37 percent, which decreases farm employment for women. The variable is significant at a 5 percent level. This means that the presence of poor storage facilities is a disincentive for increased farm production. This finding is consistent with the argument that quality storage facilities are incentives to increased farm production, which implies that longer storage is associated with higher profits that is realized for selling the crops later when demand is high.

The age of the respondent, although not statistically significant, showed a positive relationship with employment. Although both education and access to land were not statistically significant, they showed a negative relationship with women's employment. Education's negative relationship could be attributed to the fact that educated farmers use modern ways of farming, including the use of modern technologies for higher productivity thus considered as practicing intensive farming rather than extensive farming, as assumed in our model.

The suggested improvements by farmers for better storage showed that farmers want to be provided with safe and secure storage facilities (Table 15). Some of the suggested facilities include drums, hermetic storage bags, and granaries (*vihenge*), reflecting a desire for low-cost storage facilities. All these facilities are improvements to the existing storage facilities. Hermetic storage bags, for instance, would be an improvement from the jute bags that are currently in large-scale use. Demand for granaries arises as some of the farmers are now constructing them inside their houses, although they impose a challenge that they still occupy a place even when they are empty. One of the hurdles to successful adoption of modern storage facilities is the associated high capital cost (Proctor 1994; World Bank 2011; Kadjo et al. 2013), implying that modifications to improve storage facilities should take into consideration cost-effectiveness aspects. Moreover, the common feature of the farmers' suggested storage facilities is that they are all hermetic, meaning that they can safely store food crops without any protective additives. Drums and hermetic sacks can serve this purpose well. Hermetically sealed storage facilities hinder the development and growth of pests/insects due to oxygen deprivation. This suggestion could be a result of farmers' awareness of the harmful health effects (such as causing diseases) associated with the use of industrial storage chemicals.

Suggested Improvements	Suggested Storage facility		Percentage (%)
Provision of safe and secure storage facilities	Use of drums	19.1 %	55.8
	Hermetic storage bags	13.2 %	
	Use of <i>vihenge</i>	10.3 %	
	Others	13.2%	
Manufacture of effective storage protectants	-Nil-	-Nil-	32.4
A method that does not require to put/add artificial protectants	-Nil-	-Nil-	11.8

Table 15: Respondents Suggested Improvements for Better Food Storage

5.0 Conclusion and Policy Implications

This study surveyed a total of 103 rural women smallholder farmers in Iringa, Mbeya, and Dodoma. Apart from farming, rural women engage in other income-generating activities such as petty business, including handcrafts, to augment income earned from the sale of food crops. Generally, while women own some land for the cultivation of food crops, averaging 4 acres per person, men own larger parcels of land and specialize in the production of cash crops instead of food crops.

As is the case in most parts of Africa, women assume a larger role than men in nurturing the family and catering to household needs; therefore, they apply IK. We found that rural women have various food processing and storage indigenous knowledge and technologies in the studied areas. Most of them acquired food processing and storage IK and technologies from the elders, but according to the rural survey respondents, the rate of knowledge transfer has slowed. This highlights the need to document the know-how associated with such technologies before most of it is lost, so that we can take care of the warning of an old African proverb, which says, “when an elder dies, it is as if a library burned down to the ground.”

The primary food processing activities, such as threshing and shelling, are manually performed, suggesting that advancement to some simple machines like mechanical shellers and threshers could help reduce women's workload in processing and foster increased production. This too will permit women to engage in other income-generating activities. Moreover, the provision of training on food processing for certain crops such as sweet potatoes, cassava, and vegetables could facilitate scaling up to include marketing these products in supermarkets, wholesale institutions, hotels, retailers, etc.

Product quality is an important aspect for attracting good prices in the marketing of food crops. Sun drying through exposure on the ground does not guarantee product quality, and also increases the extent of post-harvest food losses, thereby affecting the amount to be earned upon selling. Provision of drying garments, canvas, or mechanical dryers guarantees product quality and can reduce post-harvest loss to some extent, allowing a modest increase in income from the sale of food crops.

All surveyed households engage in food crop production and storage for various reasons: food security; the assurance of seed availability; and keeping products for deferred sale since prices are usually low during harvest season. The largest proportion of the storage facilities used were traditional, with sacks being the most widely used. These are only able to store food for less than a year, suggesting that improvements that can keep food safely stored for longer periods are needed.

The regression results indicated that poor storage facilities are a disincentive to increased farm production. This implies that the success of the efforts to encourage increased farm production should be accompanied by an improvement of indigenous farmers' storage facilities to achieve increased income for rural women. The reason indigenous knowledge and technology are emphasized is because rural women cannot afford relatively expensive modern methods, whereas traditional storage facilities benefit from locally sourced construction materials as such requiring only low capital and operation cost for their existence and sustainability. By virtue of existence of some means, the critical matter is just to improve the technology. Using some durable inputs, safe storage locations, and coverage from sun and rain can be part of the requirements. The continued upholding of traditional food storage facilities, despite leading to high food losses, suggests that farmers want to maintain low cost storage facilities. Therefore, upgrading to safe and secure storage facilities, such as hermetic structures, as a means for improving existing technologies, would be quite effective.

To this end, establishment of the organized framework for various indigenous knowledge in the country, i.e., taking stock of the available methods and ways to scale them across the country, would be relevant to agricultural productions and welfare of not only women, but households in

general. Innovation in IK is important, rather than relying on modern storage facilities that are associated with high capital and operating costs, which may not be achievable for rural areas of developing countries.

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Endnotes

¹ Gari is a product of dried cassava after cassava tubers have been crushed to produce a mash and then fermented.

² TZS is Tanzania currency (USD 1=TZS 2,200)



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Indigenous Vegetable Production and the Economic Empowerment of Rural Women in Africa: Reality, Prospects, and Challenges in Rwanda

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In many parts of sub-Saharan Africa, indigenous vegetables have added important nutritional value to the diets of locals for hundreds of years. Women, cultivating or collecting indigenous vegetables. Studies on indigenous vegetables have pointed to the vegetables' higher levels of micronutrients.

These nutrients are greater than their modern or exotic counterparts, which are now more regularly consumed across the region. However, in more recent of indigenous vegetables across sub-Saharan Africa. In some communities, cultivation and consumption of indigenous vegetables have been relegated to the rural areas and have become the concern of older, rural women. This study explores the role of rural women in the production of indigenous vegetables in Rwanda, especially in view of the preponderance and consumer preference for modern vegetables in the country's recent history. Further, the study probes into the nutritional and economic importance of indigenous vegetables in Rwanda, with emphasis on how rural women stand to expand their earning power through scaling up their production capacity.

Keywords: Rwanda, Indigenous Knowledge, Indigenous Technology, Indigenous Agriculture, Indigenous Vegetables, Nutrition, Farming, Women Empowerment, Economic Development.

1.0 Introduction

Indigenous or traditional vegetables are vegetables that have been cultivated and collected within a locale for many generations. The environments in which these indigenous vegetables have traditionally thrived are suitable for their cultivation, and usually sustainable; in addition, through “natural selection and farmer-based breeding practices,” the genetic base of these vegetables has expanded over time (Mnzava et al. 1999, iii).

In many parts of sub-Saharan Africa, indigenous vegetables have constituted an important nutritional value-addition to the diets of local peoples for hundreds of years. Women, who are traditionally in charge of family nutrition, are also traditionally more involved in the cultivation or collection of indigenous vegetables.

In more recent times, a noticeable reduction in the cultivation and consumption of indigenous vegetables across sub-Saharan Africa has occurred. In some communities, cultivation and consumption of indigenous vegetables are relegated to only rural areas, and to the care of older, rural women. Studies concerning indigenous vegetables have pointed to these vegetables’ higher levels of micronutrients— much more than their modern or exotic counterparts, which are now more regularly consumed across the region (Flyman and Afolayan 2006; Ndlovu and Afolayan 2008; Odhav et al. 2007; Nesamvuni, Steyn, and Potgieter 2001). The result, in addition to other implications, is a rising deficiency in nutrition across sub-Saharan Africa with an estimated 265 million people undernourished (FAO 2010). Additionally, the viability of commercial production of indigenous vegetables for consumption has been established in previous studies (Lekgoa et al. 2016). In essence, the decrease in production and consumption of indigenous vegetables across sub-Saharan Africa is at great health (nutritional) and economic costs to the continent.

Some countries have realized that indigenous vegetables have become rare in places where they used to grow wild, owing to increase in population, coupled with environmental degradation. Also, there has been a decrease in terms of interest in the cultivation of indigenous vegetables by farmers who now prefer cash crops and other crops of interest to city dwellers, such as wheat, grains, and tubers. These countries, concerned about the decline of indigenous vegetables in the national diet, have embarked on deliberate efforts to increase the production and consumption of these vegetables. In Botswana, for example, the government has become involved in efforts to “identify the role of indigenous underutilized plants in national food dynamics and how they can be mainstreamed into the country’s agriculture” (Madisa and Tshamekang 2016, 1).

In Rwanda, the onset of the colonial era marked a steady decrease in the production and consumption of indigenous vegetables, in favor of less nutritious and more resource-intensive ones such as cabbage, cucumbers, and tomatoes. These exotic vegetables, in addition to requiring

more acreage for cultivation, require the use of many fertilizers and pesticides, and can be much more labor-intensive than their traditional counterparts. Therefore, women living in rural areas are less inclined, and lacking in the ability, to cultivate modern vegetables despite high consumer preferences.

This study explores the role of rural women in the production of indigenous vegetables in Rwanda, especially in view of the preponderance of, and the consumer preference for, modern exotic vegetables in the country's recent history. Furthermore, the study probes into the nutritional and economic importance of indigenous vegetables in Rwanda, with emphasis on how rural women stand to expand their earning power by upgrading their indigenous vegetable production capacity. Questions the research paper will seek to answer are: What historical role have indigenous vegetables played in the economic empowerment of women in Rwanda? What is the present production and consumption rate of indigenous vegetables in Rwanda? In present times, what role do indigenous vegetables play in the economic empowerment of women in rural Rwanda? What are the possibilities and challenges that exist when upgrading the production of indigenous vegetables for women in rural Rwanda? How can consumer interest in indigenous vegetables be increased to expand the market for rural women in Rwanda?

This study is necessary in the absence of any existing, notable academic work concerning indigenous vegetable production in Rwanda. Additionally, it is necessary to understand the opportunities and challenges faced during the cultivation of indigenous vegetables and the economic benefits the process stands to confer on rural women in Rwanda. This need is greater in the face of the overwhelming emphasis by the government and other stakeholders on the cultivation of exotic or modern vegetables in Rwanda. This study will be useful to the Rwanda research community, policy makers, NGOs, civil society, and all others interested in food security and the economic empowerment of women living in rural areas in Rwanda. Data were gathered qualitatively through semi-structured interviews and focus group discussions with females living and producing indigenous vegetables in rural areas, and with government officials concerned with the economic empowerment of women, rural development, and food cultivation. Interviews were conducted in June 2016 among 50 women in Musanze district in the northern province of Rwanda. Within the Musanze district, 2 sectors were selected due to the high number of women involved in cultivation of indigenous vegetables. These sectors are the Shingiro Sector and Nyange Sector. Within these 2 sectors, 10 villages were focused on, including Kadahenda, Cyimbazi, Byimana, Bikekeri, Rwinuma, Mutuzo, Budasubira, Terimbere, Rwebeya, and Ntamiziro.

The most common types of traditional vegetables identified in the two sectors were, in their local names: *inyabutongo*, *isogo*, *isogi*, *ibidodoke*, *urudega*, *inyinya*, *ibihaza* (pumpkins), and *isombe*.

All of these vegetables are found in both sectors; and the most produced vegetable, as well as the most liked vegetable, was found to be *inyabutongo*, also called “*Dodo*” (amaranthus).

Additional interviews were conducted among government officers from the Ministry of Agriculture at the national and district levels. Representatives of Rwanda Farmers Association were interviewed, in addition to consumers of indigenous vegetables and wholesale dealers.

2.0 The Economic Situation of Women in Rural Areas

Between 2000 and 2008, women living in rural areas fared lower than rural men as well as urban women and men for each Millennium Development Goal (MDG)¹ marker with accessible information (UN Women 2018). Several reasons account for this, including the fact that around 79 percent of women in developing nations consider farming their major enterprise, although just 15 percent of landholders are women. Essentially, rural women confront greater limitations than men in obtaining access to key productive assets, which include administrative support such as credit, income augmentation, and social welfare; these women face wage disparities in rural employment and regularly work without compensation on family plots, which restricts their ability to exploit new opportunities (FAO 2011a). For instance, in Malawi, women fetch wood and water 8 times more than their male counterparts, while in rural regions of Guinea, women spend more than twice the time men do on similar undertakings (Anderson 2012). Insights from the government of Kenya show a huge gap in poverty levels between female-headed and male-headed rural family units where 48.8 percent of male-headed families are named poor when contrasted with twice this figure for the female-headed families (Anderson 2012).

In Africa, 80 percent of agricultural work originates from smallholder farmers, and many smallholder farms are worked by women. Despite the important role they play in agriculture, women in rural sub-Saharan Africa control less land than men and have restricted access to information sources, seeds, credits, and expansion opportunities (UN 2012). According to UN Women (2016), the World Bank, and the Poverty and Environment Initiative, the gender gap in agricultural efficiency ranges from 4 to 40 percent and could cost up to USD 100 million in Malawi, USD 65 million in Uganda, and USD 106 million in the United Republic of Tanzania. At the national level, female staffing levels have remained especially low in Ethiopia, Togo, Niger, and Burkina Faso, while in Botswana, Mozambique, and South Africa over the past several decades, levels were high. Hussein and Nelson (2009) reveal that, in Africa, numerous women are occupied with the most minimal levels of small-scale undertaking, mostly family-unit-based wage-creating exercises.

2.1 The Economic Empowerment of Women in Rural Areas

A subject of deliberation among scholars in recent times has been what constitutes the economic empowerment of rural women. Kishor and Subaiya (2008) conceptualize empowerment in terms of agency, resources, and achievements. Agency is central to the concept of empowerment and is defined as the process by which a choice is made and transformed into effect. Resources are conceptualized as a medium through which agency is exercised, and achievements are conceptualized as outcomes of agency. Similarly, Samman and Santos (2009) highlight that agency and empowerment are interrelated concepts—that is, empowerment does not happen in a vacuum. Alsop and Heinsohn (2005) postulate that the level of empowerment for a given person is associated with his/her personal capacity to make meaningful and purposive choices (agency) and the institutional environment in which the choices are made (opportunity structure).

The economic empowerment of women living in rural areas entails exploring and entrenching avenues that will ensure a visible, sustained, and sustainable improvement in the overall economic situation of female dwellers in rural areas. Economic empowerment demands that women in rural areas are exposed to a variety of choices that hold the possibility of yielding economic rewards, are equipped to make wise choices, and are endowed with the ability to independently invest in their choices and nurture them over time through cycles of profit.

2.2 Economic Empowerment of Women Living in Rural Areas in Rwanda

The government of Rwanda is globally recognized for its commitment to the advancement of women across sectors. Gender equity is entrenched in the constitution, and Rwanda is the first nation in the world to possess a parliament composed of more than 50 percent female members. Women in Rwanda have rights to land titles and possess equal inheritance rights to their parents' property. Women living in rural Rwanda who are leaders in the village councils constitute 43.9 percent; women leaders in sector councils constitute 45 percent; and in district councils they constitute 43 percent (CLGF 2015). Notwithstanding Rwanda's extraordinary advancement in the economic empowerment of women, women in rural areas still experience challenges such as food insecurity and the lack of access to basic income (IFAD 2017). Their poor access to infrastructure in rural areas confines them from opportunity and limits access to certain support platforms and services that are available to their urban counterparts.

3.0 Indigenous Vegetable Production and Consumption in Africa

Africans have traditionally consumed indigenous vegetables made from the edible parts of species originating in Africa (Abukutsa 2010). The use of traditional vegetables is part and parcel of the cultural heritage playing a significant role in customs, traditions, and in maintaining

equity in the family. Studies conducted in different countries identify some widely consumed, traditional vegetables throughout Africa, including amaranthus species, spiderplants (*Cleome gynandra*), African nightshades (solanum species), cowpeas (*Vigna unguiculata*), African eggplant (*Solanum aethiopicum*), African kale (*Brassica carinata*), and jute mallow (*Corchorus olitorius*) (Abukutsa 2010).

In Rwanda, a study conducted by the country's Ministry of Agriculture (MINAGRI) indicates that indigenous vegetables, including *imbwija* (amaranthus), *isogi* (spiderplant), *inkoli* (cowpea), *isogo* (nightshade), and *ishunyafrica* (kale) (Gahakwa 2011), serve different roles, such as being high in nutritive value due to the abundance of vitamins, minerals, and moderate protein percentages (Aphane, Chadha, and Oluoch 2002). Rwanda's indigenous vegetables also have medicinal and health benefits; many have been known to cure ailments, such as upset stomachs (Kokwaro 2009). These indigenous vegetables are also known to grow to full maturity within a short period of time, produce seeds under tropical conditions, respond well to organic manures, and tolerate abiotic and biotic stresses (Abukutsa 2010).

Indigenous vegetables grown in Africa hold great potential for income generation across the region, especially in rural communities since they have led to the improvement of living standards among poor families in rural areas (Jacobs and Baiphethi 2009). Traditional vegetables, such as amaranth, and jute mallow, have market potential, and thus contribute towards enhancing income at the household level. In Kenya, it has been established that consumers prefer traditional vegetables because of their nutritional value, and would be willing to buy such vegetables, given that they are well produced and reach the market at peak quality (Ebert 2014).

3.1 Women in Production and Marketing of Indigenous Vegetables in Africa

In most African countries, indigenous vegetables are seen as crops that should be cultivated by women since they are mostly grown and sold by women, who make up a greater percentage of the agricultural workforce (Ayanwale and Amusan 2014). In Rwanda, for instance, the production and sale of indigenous vegetables were described, according to research conducted in the volcanic areas, as being a "business for women" (Taremwa, Mukakamali, and Butera 2016). Indigenous vegetables are a fundamental financial pillar for many rural women who depend on the production and sale of the vegetables to support their livelihood. These women cultivate, weed, harvest, pack, and transfer traditional vegetables to the nearest selling points and strategic wholesale urban markets. Women who produce and trade indigenous vegetables can generate up to a 74 percent profit margin, which is income that enhances food security; provides access to

improved health care, education, and housing; and allows women to exercise some degree of financial independence in the family budget (Aphane, Chadha, and Oluoch 2002).

3.2 Shift from Indigenous to Exotic Vegetables

Most non-traditional vegetables were introduced to Africa during early trade with foreigners, western missionary activities, and the colonial era; then they were integrated into the indigenous food systems. Globalization and the exchange between communities also introduced vegetables to the continent in more recent times (Maundu 1997). Through intercommunity exchanges, intermarriages, and domestic trade activities, imported vegetable species penetrated deep into the hinterland and spread widely across the region. In many instances, exotic vegetables have grown to dominate over indigenous vegetables, especially in urban areas, leading to the reduced consumption of the latter; however, rural dwellers, in many instances, still mostly consume traditional vegetables (Muhanji, Roothaert, Webo, and Mwangi 2011).

Many colonial powers did not support indigenous agriculture. Instead, they actively promoted imported crops and species. The introduction of exotic vegetables in Africa during colonial times was backed by state support and dealt a huge blow to indigenous vegetables. The net effect of such suppression flowed into the post-independent era, since many African governments continued with agricultural policies developed by the former colonialists; many depended on erstwhile colonial masters to provide funds and/or technical support for the development of the agricultural sector. The result has been a consistent decrease in the cultivation and consumption of indigenous vegetables, while the consumption of exotic vegetables increases. Among the younger generation, for instance, one who has cultivated a taste for exotic vegetables is usually considered modern, classy, and trendy (Onim and Mwaniki 2008). However, despite the observed decrease in consumption and production, indigenous vegetables still significantly contribute to the economic situation of rural women and can contribute even more if adequate investment is made in production and marketing (Chweya 1997).

3.3. Prevailing Trends in the Production and Consumption of Indigenous Vegetables

In general, investments in the production of indigenous vegetables are much less when compared to the production of exotic vegetables across sub-Saharan Africa. Despite their nutritional and medicinal benefits, indigenous vegetables are considered low standard and are not emphasized in research and development; as a result, they do not access markets beyond local consumption. In Tanzania, a study conducted in 2004 among local farmers established that of all the vegetables produced, 35 percent were indigenous vegetables that were mostly cultivated by small-scale farmers (Weinberger and Msuya 2004). Despite the low output of indigenous vegetables, literature shows that the production of indigenous vegetables is more advantageous compared to

exotic vegetables. According to Onim and Mwaniki (2008), indigenous vegetables are preferable due to their local adaptability and resistance to pests and diseases compared to exotic vegetables. In Tanzania, farmers said that a particular benefit from cultivating indigenous vegetables is that they can be repeatedly harvested with a lower maturity period (Weinberger and Msuya 2004). Research on indigenous vegetables conducted in Rwanda's volcanic area shows that women prefer the cultivation of indigenous vegetables to exotic vegetables for many reasons, including the multiple roles they play, such as medicinal and dietary, in addition to their resistance to adverse climatic conditions (Taremwa, Mukakamali, and Butera 2016). In Tanzania, indigenous vegetables make an important dietary component, especially during the rainy season; however, according to a study in Tanzania, "the share consumption in all vegetables consumed is much higher among poor households (40 percent) than among wealthiest households (11 percent)," and the consumption of exotic vegetables increases as one gets wealthier, while the consumption of indigenous vegetables decreases as a result (Weinberger and Msuya 2004). It has generally been noted across east Africa that indigenous vegetables are mostly consumed by those in the lower income bracket, especially in rural areas (Muhanji, Roothaert, Webo, and Mwangi 2011). It is important to note that the level of consumption of vegetables in sub-Saharan Africa is very low compared to other parts of the world, such as Latin America and Asia (Onim and Mwaniki 2008).

3.4 Challenges Facing Indigenous Vegetable Production

Challenges facing Africa's indigenous vegetables are significant and have diverse effects on their production and consumption. One of the challenges is the lack of information concerning indigenous vegetables, or a dearth of research and development on such indices as their nutritional value and uses (Afari-Sefa et al. 2011). Another challenge faced by growers of indigenous vegetables is the generation and safeguarding of seeds. The intentional and commercial production of indigenous vegetable seeds in sub-Saharan Africa is not common, making the availability of quality seeds difficult since farmers have to grow and maintain their own seeds (Afari-Sefa et al. 2011). This is an indication that growers of indigenous vegetables may not be prepared to respond to market demands if the preferences change from exotic to indigenous vegetables. A study conducted in Kenya in 2007 demonstrated that, as consumers became aware of the nutritive and medicinal value of indigenous vegetables, their relative demand increased, mainly in urban centers; however, the suppliers/farmers of indigenous vegetables were generally unable to meet increased demand (Ngugi, Gitau, and Nyoro 2007). In addition to this challenge, in sub-Saharan Africa, and mainly in East Africa, the percentage of women involved in agriculture is more than 50 percent, according to FAO (2011a), yet most of these women do not control the resources used in agriculture, including land. This indicates that

there is a high necessity for the empowerment of women in agriculture, and indigenous vegetables are to benefit from producers and consumers' attention.

4.0 Women and Indigenous Vegetable Production in Rwanda

Historically, indigenous vegetables grew as widely as any other natural herb in Rwanda. Older citizens in rural Rwanda recall a time when indigenous vegetables grew on the outskirts of the village, around where cows were reared; this was when cows were traditionally kept outside of homes and outside of human-dwelling places. Cows deposited dung that nourished the soil, thereby supporting the growth of indigenous vegetables. The land remained uncultivated and is called *ibiraraor ubugando* in Kinyarwanda, and citizens would source vegetables from these places. To date, vegetables such as *isogo*, which grows in forested areas, although now scarce, are considered of better quality. In Rwandan culture, these vegetables were eaten widely, especially with ground sorghum paste, *ugali* (thick paste made from cassava or maize flour), and potatoes. During harvest season, indigenous vegetables are specially prepared and consumed on *Umuganura*, the day of celebrating harvested crops.

Until the 1970s, indigenous vegetables grew wild across Rwanda; however, deforestation and overpopulation have led to the disappearance of much of the fertile, free grazing land and forested areas, where such vegetables thrived. Another reason for the disappearance of free-range indigenous vegetables in Rwanda is the villagization initiative that began in Rwanda after the genocide of 1994. Prior to 1994, Rwandans in rural communities lived in household farms in far flung places, but this ended when the government built villages and strongly encouraged Rwandans to live close to one another. Friesian cows were also introduced into the country. These cows produce more milk and require less grazing—in fact, the government of Rwanda mandates zero-grazing for a segment of its cattle rearing population. The result has been the scarcity of indigenous vegetables, such that some rural dwellers began to develop kitchen gardens to produce both indigenous and exotic vegetables. These kitchen gardens are constructed using sticks, old sacks, and stones, which all help to reduce soil erosion. Circular seedbeds are created in step-like ridges. Each ridge has a different type of vegetable planted. For instance, one ridge can hold *isogo*, another *isogi*, and another *inyabutongo*. As soon as the vegetables start germinating, the tasks of weeding, watering, and adding manure starts. After one month, harvesting can begin.

4.1 Women and Indigenous Vegetables in Rwanda: The Production Process

Production of indigenous vegetables in farms takes many forms and depends on the farmer and the farm. Usually, land is first ploughed, followed by the addition of organic fertilizers, such as cow dung and decayed leaves. Seeds are often self-generated from previous production by being

dried and stored in a small bottle. To be able to harvest seeds for storage, farmers usually allow the vegetables to grow old enough, or else they will not produce seeds. Seeds can also be borrowed from neighbors, and in rare instances, they can be purchased from the market. The actual process of planting indigenous vegetables can vary depending on the vegetable. For this study, we looked at the production processes of *inyabutongo*, *isogo*, *igihaza*, *urudega*, and *isosogi*.

Inyabutongo and Isogo: Once seeds are ready for cultivation, they are sown by being spread over a small patch of land, known as *umutabo*, to enable seedlings to germinate. This process of growing seedlings takes a period of two weeks, after which seedlings are transferred to a more permanent location. After transplantation, these vegetables need to be consistently monitored and cared for through daily weeding and watering, especially the latter during the dry season.

Isogo normally matures within one and a half months, and harvesting can begin right away once the plant has matured. After the initial harvesting, the stalk can grow other branches and leaves that can be harvested at a later date, and, normally, subsequent harvests can follow each other in a period of one week in between. An *isogo* planting usually lasts for five to seven months, depending on the climate, the fertility of the land, and coupled with the sort of manure utilized; afterwards, fresh seeds will need to be cultivated.

Igihaza: For *igihaza*, seeds are sown carefully to ensure sufficient space between two plants since this plant needs more space to grow. Seeds produce a plant after two to three weeks. *Igihaza* plants grow vertically at first, and later spread out horizontally, requiring much land space. *Igihaza* requires the input of manure and can produce in two to three months. One stalk can produce six or more *igihaza* branches at the same time. Harvesting is a continuous process since the lifetime of one *igihaza* plant is normally one year or more.

Urudega: *Urudega* has only one root and, therefore, is not given to transplantation. Weeding and adding manure is carefully coordinated due to the tenderness of the plant. Harvesting can commence after three months. Only the leaves are harvested while the stalk and branches are left intact. During the rainy season, the harvested *urudega* planting grows new branches and leaves within a period of one to two weeks to enable a second, and, eventually, more rounds of harvesting.

Ibidodoki: The seeds of *ibidodoki* are planted near a fence or tree to allow the climbing and spreading of leaves across a wider area since it is a climbing plant.

4.2. Motivation and Benefits from the Production of Indigenous Vegetables

Rural women dwellers in Rwanda noted several reasons for the decision to go into production of traditional vegetables that are explained below.

4.2.1 Health Reasons

There is a general belief that people who eat traditional vegetables did not fall sick often. Rural dwellers are motivated by this belief, and many were advised by healthcare practitioners to increase their consumption of indigenous vegetables when they or their children presented symptoms of malnutrition. Rural clinics would prescribe increased consumption of indigenous vegetables to people experiencing kwashiorkor, anemia, and ulcers.

Having heard of their benefits from family and community members, some rural women began to cultivate indigenous vegetables to forestall malnutrition among their wards. According to a respondent, “My grandmother used to tell me much about the benefits of these vegetables and, more especially, their benefits for children. So, when I got married, I thought of producing these vegetables since I had to nourish my children. The benefits were later emphasized by nurses at the hospital, and as a result, I decided to permanently have these vegetables at my home.”

Furthermore, rural dwellers believe indigenous vegetables act as a remedy as follows:

Isogo and *isogi* are used to prevent hepatitis A, malnutrition, different parasitic worms; loss of appetite, nausea from bingeing alcohol, ulcers, kwashiorkor, anemia, oral candidiasis skin infections, wasting disease or being underweight, and for the treatment of abdominal pain. It can also serve as prenatal multivitamin, help reduce pregnancy nausea, increase breast milk production, and facilitate food digestion. *Isogo* also helps to strengthen sperm production in men (*igihaza*), and a drunk person who has lost appetite due to excessive drinking is usually advised to eat the plant to gain an appetite.

Urudega is used by locals to treat diarrhea and to strengthen the joints. Locals also attest to the plant’s ability to heal backaches and cure worms if it is cooked without water; its own water heals worms. Rural dwellers attest to the ability of *urudega* to treat symptoms of autoimmune diseases. According to a respondent, “I used to have a problem in my veins. I could not walk well and, so, was advised by doctors to plant and eat *urudega*. I took the advice and was cured after some weeks.”

Inyabutongo is known to contribute to having a balanced diet since it is abundant in vitamins and irons.

4.2.2 Economic Reasons

Some rural women went into the cultivation of indigenous vegetables for economic reasons. Many learned from family members that cultivation and trading in indigenous vegetables can be a profitable enterprise. According to a respondent, “I started producing vegetables after seeing the income my mother was getting from it. I also wanted to get money by selling them in the market.”

For another, “I started producing this vegetable because their demand is high. They are liked by many people.”

Another said, “My number one reason for producing vegetables was household consumption and children protection against kwashiorkor; however, I also realized later that I can make money from these vegetables, and I started to produce more for the market.” Other economic uses include using a vegetable like *urudega* to mend holes in leaking sauce pans, thereby saving families money.

4.2.3 Food Security Reasons

Some women in rural Rwanda began to grow indigenous vegetables to add bulk to family staples. This is more so after observing that the vegetables had become scarce and expensive in the market and, therefore, quite unaffordable. According to one respondent, “The vegetables serve in increasing food security. If you have a large household, you prepare them mixed with other foods, and you are able to feed many kids. In 1998, I realized that these vegetables were becoming too expensive in the market, and yet, they were very important to my family, so I had to start growing them.”

4.2.4 Sustainability Reasons

It became apparent that some indigenous vegetables were becoming rare species, so older rural women began to grow them out of concern for the next generation. According to one respondent, “I decided to start growing indigenous vegetables to make sure that they don’t disappear.”

Others grow the vegetables out of fondness, nostalgia, or habit. According to a respondent, “My mother used to grow indigenous vegetables, so I learnt from her, and today, I am doing the same.”

4.2.5 Financial Benefits

According to all respondents, indigenous vegetables are profitable, even much more than modern vegetables, such as cucumbers, cabbages, carrots, and bell peppers. The market is also more available, and indigenous vegetables, such as *igihaza*, sell out quickly once harvested. According to a respondent, “If I take my indigenous vegetables to the market, they will be bought before cabbages. Although I grow both cabbages and *inyabutongo*, I am only able to sell cabbages after *inyabutongo* is exhausted.” In many instances, rural women note that they sometimes do not even need to get to the market before they sell off their indigenous vegetables because customers come to harvest them from the garden. Income reported by the women varies depending on available land for cultivation; however, on average, respondents earn between 1,000 and 15,000 RWF per month. Income is mostly used to purchase health insurance (*mutuelle*) and other household needs.

4.2.6 Food of Choice

As far as rural dwellers in Rwanda are concerned, indigenous vegetables are the food of choice for several reasons. First, these vegetables are cost-effective and do not require as many ingredients to cook as modern exotic vegetables (which require a lot of oil and other ingredients). Furthermore, indigenous vegetables are quick and easy to prepare. Indigenous vegetables can be prepared without being fried, and still taste sweet. Modern vegetables often require frying, which sometimes results in feelings of discomfort, and even indigestion, especially when eating at night. Also, many prefer the taste of indigenous vegetables; according to a respondent, “Myself, I don’t take modern vegetables because they are sugary. I eat only traditional vegetables.”

4.2.7 Community Living

In regards to communal life experienced in rural areas, indigenous vegetables are easier to share with neighbors compared to nontraditional vegetables, which producers grow mostly for profit. According to a respondent, “I cultivate much more indigenous vegetables than I need because I get to share with my landless neighbors. It strengthens our relationships.”

4.2.8 Production Time

Finally, traditional vegetables can be harvested in a shorter period of time compared to modern vegetables. For example, cabbages require a period of three months from the time of planting to mature and be ready for the market, whereas a farmer needs only one month for traditional vegetables like *inyabutongo* “dodo,” the amaranthus vegetable. Thus, female producers in rural

areas prefer traditional vegetables because, as noted by a respondent, they “need to produce very fast and take them to the market to get money.”

4.3 Challenges Faced by Women Living in Rural Rwanda When Cultivating Indigenous Vegetables

4.3.1 Limited Knowledge

Many women living in rural areas who produce indigenous vegetables note that very little training is given to them in cultivation, tending the vegetable garden, and harvesting and post-harvesting techniques. According to one respondent, “Currently we use only the knowledge from our elders.” Some women, however, acknowledged that they received some form of training from NGOs and the Rwanda Ministry of Agriculture, and some even received seeds of *inyabutongo* from their respective sectors (referred to as *Umurenge*: administrative unit in the local government). A few rural women received training from ActionAid under the Akalima Kigikoni program, but the training focused on the cultivation of modern vegetables since international organizations are more interested in exotic vegetables.

4.3.2 Limited Land

In rural areas, female vegetable producers have limited land and are only able to produce a limited amount of indigenous vegetables. Rwanda is a country where land is one of the scarcest commodities. This is especially so because rural dwellers now live in villages and no longer have access to large swathes of land as they once did. People cultivate only the land close to them since these vegetables can be stolen when growing them far from home. Furthermore, it remains a challenge for rural women to forego other traditional cash crops, such as potatoes, to produce indigenous vegetables.

4.3.3 Manure

Lack of sufficient organic manure is a major challenge among female producers of indigenous vegetables in rural areas. According to a respondent, “Sometimes I need to beg from my neighbors to get manure.”

Another respondent said, “Availability of manure depends on livestock, which I don’t have.” Some women who own livestock are able to generate organic manure to cultivate their fields.

4.3.4 Effects of Climate Change

Climate change leads to unfertile land, which then leads to the reduction of harvested crops. As dry seasons become longer, it becomes difficult to grow indigenous vegetables because of the need to irrigate crops. During this season, water is expensive, and irrigation may not be possible or otherwise affordable. According to one respondent, “It is quite difficult to irrigate indigenous vegetables in the dry season. We first have to build a shade for them so that they do not dry up. Also, drought comes with pests and diseases, which reduce the production of local vegetables. Production is really low in the dry season.” On the other hand, heavy rains can destroy seeds and make it impossible for vegetables to germinate and completely mature.

4.3.5 Diseases

There are many diseases that attack indigenous vegetables. One of them is *urusimba* disease, which is prevalent during the dry season. It occurs in the form of small black insects that destroy vegetables. A whole planting of vegetables can be lost to *urusimba*, therefore, there is a need to invest in research and development to find a solution to this disease.

4.3.6 Market Access

Limited markets in rural areas and lack of access roads to urban centers mean that rural dwellers produce a limited amount of vegetables, otherwise they will incur severe post-harvest losses. According to a respondent, “When grown in much quantity and by many people, we do not get the market for them because of too much supply, and, therefore, we sell them at lower prices or even waste them. Also, there is no road; however, if I grow them extensively and have access to the market, I can be able to supply to more people since their demand is also high in urban areas.”

4.3.7 Post-harvest Losses and Storage Challenges

Rural female producers of indigenous vegetables note that sometimes, they may harvest more vegetables than they can readily consume and sell, but because of lack of transport to cities where these vegetables are in high demand, they are left with the vegetables, which often spoil. There is need for transport and provision of some sort of storage facility that can extend the freshness of these indigenous vegetables.

4.3.8 Pests

Rural women producing indigenous vegetables say that birds and various insects, which eat up the seeds of *ibidodoki*, pose a concern to them because they are unable to afford preventatives such as traps and pesticides to contain the pests' activities.

4.3.9 Seeds

Some indigenous vegetable producers note that a lack of seeds is a major challenge. According to one respondent, "We lack the seeds of these vegetables, such as *urudega*, *isogo*, and *isogi*. If I can get more seeds and more land, the production would increase, and this would increase my income."

4.3.10 Consumer Perception

Most traditional vegetables are popular in Rwanda's rural areas. In the urban areas, only *inyabutongo* (dodo) is widely consumed, and younger Rwandans in urban areas prefer modern vegetables. In rural communities, some vegetables such as the bitter *isogol*, which grows wild, are eaten by the older generation partly because they constituted part of their diet from childhood. They are also linked with the consumption of sorghum bread, which has an important significance in their culture. In rural areas, vegetables like *inyabutongo* are consumed more than nontraditional vegetables like cabbages while in the urban areas, its consumption is limited only by unavailability and high prices. According to one respondent, "The problem is that they [indigenous vegetables] are grown by few people. For *igihaza*, Rwandans like it too much, but people have not yet started to produce them too much, and, as result, they reach the market when they are expensive."

Furthermore, the way in which the younger generation regards the consumption of traditional vegetables is a matter of concern. The younger generation, who prefers modern vegetables rather than traditional vegetables, believes that indigenous vegetables are for old and uncivilized village folks. One respondent noted, "We are putting serious measures to push young people to eat traditional vegetables by explaining their benefits to them often. When I prepare foods like potatoes or bananas, I mix them with traditional vegetables and make sure my kids cannot separate them, thus pushing them to eat traditional vegetables."

4.4 Expansion Possibilities for Female Indigenous Vegetable Producers in Rural Areas

4.4.1 Improved Technology

Over and above the traditional technology currently in use, rural female producers of indigenous vegetables need more modern technology for enhanced operation. According to respondents, “It is more difficult to water the vegetables during the dry season. It is very tiresome.”

4.4.2 Disease Control

Female producers of indigenous vegetables in rural areas are interested in learning disease control mechanisms against threats such as *urusimba*.

4.4.3 Establishment of Cooperatives

Rural women producing indigenous vegetables recognize the need to form cooperatives whose members can share ideas that can lead to increasing production through innovation.

4.4.4 Land Use Matters

Access to enough land for cultivation is a major issue identified by most rural women producing indigenous vegetables. Women producers believe the government of Rwanda should include indigenous vegetables as part of the crops required for cultivation under the government land consolidation program.

4.4.5 Citizen Sensitization

Women producing indigenous vegetables think there is a need to sensitize Rwandans on the benefits of indigenous vegetables. This can be done through various community engagements, such as the once-a-month mandatory community service (Umuganda, where citizens come together to work on common areas and address challenging issues). NGOs involved in health and nutrition can also assist the government in spreading knowledge of the benefits of local vegetables.

4.4.6 Improved Manure Availability

The government of Rwanda’s Girinka project, which gifts cows to the poorest households in communities, can be used to increase the availability of manure across communities. One way of doing this is by insisting that beneficiaries of Girinka should also cultivate indigenous vegetables and be open to sharing excess manure with other cultivators of indigenous vegetables.

4.4.7 Financial Support

Women producing indigenous vegetables note that they need financial support in order to increase production. This support can come in the form of materials to use for irrigation, additional lands, and acquisition of different equipment.

4.4.8 Sustainable Seeds

Women producing indigenous vegetables note their need for support to procure industrially produced seeds that can last for long time and can be purchased whenever they are needed. Although these women consider industrially produced seed, which has been pretreated with pesticides and even sometimes is genetically modified, as progressive, there might be need for more education regarding the benefits of organic farming and its health and sustainability benefits.

4.4.9 Training

Support for indigenous vegetable production and harvesting techniques is needed. Field visits with agricultural extension workers could be arranged at the district level with indigenous women producers who can then be trained to educate others at the village level.

4.4.10 Networking

Indigenous vegetable producers desire to network with their colleagues around the country to share knowledge and good practices. According to a respondent, “In some places in the southern part of the country, we hear they successfully produce vegetables, so if we could be facilitated to visit them and get knowledge through trainings, it can also contribute towards improving our production.”

4.4.11 Market Access

Assurance of market for their produce may lead female indigenous vegetable producers to put in more effort and increase their crop output. Many women note that the absence of market for much of what is cultivated often leads to reduced investments. According to a respondent, “We are discouraged from producing more quantities because of market. I think that by getting enough market, we can increase production and be able to sell in large quantity. We only have market for *inyabutongo* and modern vegetables in different hotels.” There are many ways that market access can be improved for women producers of indigenous vegetables, including:

- Exhibitions, such as trade fairs, expos, etc.

- Media formats, such as radio, television, documentary, etc.
- Training healthcare workers on nutritional knowledge concerning indigenous vegetables
- Training teachers who can disseminate information during parent-teacher meetings

There are also several platforms of interaction at the local level that can be used to disperse information on the benefits of indigenous vegetable production. One platform is Umuganda, which is a once-a-month event in Rwanda for communities to gather together, conduct community work, and for community leaders to inform citizens about important news and announcements. Umuganda is a traditional or indigenous knowledge-based concept that was reintroduced to Rwanda in 1998 as part of the post-genocide nation rebuilding efforts. Umuganda has proven quite a successful platform for the government to disseminate necessary information to citizens at the shortest possible time and to pass along critical information and necessary trainings to citizens. Another platform that can be used to inform citizens on the importance of indigenous vegetables is the Umugoroba Wababyeyi, or evening of parents, where all parents gather to discuss household issues and community development challenges.

In addition, researchers can be encouraged to conduct studies on indigenous vegetables and work with advocacy groups to attract the attention of stakeholders in order to gain policy support towards the improvement of indigenous vegetable cultivation and consumption.

5.0 Conclusion

Indigenous vegetables hold huge potential for strengthening the economic situation of women in rural Africa. Focusing on Rwanda, this paper presented a study on the place of indigenous vegetables in the livelihood of rural women and the opportunities for advancement in this field. Although most indigenous vegetables are quickly being replaced by exotic vegetables in urban Rwanda, rural dwellers, especially the older generation, still consume many indigenous vegetables. Rural women producing indigenous vegetables face many challenges, most of which are rooted in the absence of strong support by either government agencies or development partners involved in rural development. While the Rwandan government is heavily involved in rural development, with an emphasis on agriculture, recognition of the indigenous vegetables sector in government policies and decision has yet to be seen. Several development partners are also active in rural Rwanda, but most have shown a proclivity for training women on the production of exotic vegetables. On another hand, rural women producing indigenous vegetables are not organized and are unable to present a strong platform that is capable of influencing policy and project decisions. Formation of cooperatives and building of inter-community networks will go a long way in carving out a voice for rural women producing indigenous vegetables within the circles of government agencies and development partners. Government agencies and

development partners who desire to strengthen production capacities and become involved with these vegetables will do so through training; provision of improved technology; disease and pest control; sensitization of potential consumers; addressing land-use matters; infrastructural development; and many more. In all, strengthening the capacity of rural women producing indigenous vegetables, in addition to taking measures to expand the market, will be strategic to the advancement of rural Rwanda and Africa in the coming decades.

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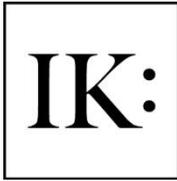
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Endnote

¹ The Millennium Development Goals (MDGs) “are eight goals with measurable targets and clear deadlines for improving the lives of the world’s poorest people. To meet these goals and eradicate poverty, leaders of 189 countries signed the historic millennium declaration at the United Nations Millennium Summit in 2000. At that time, eight goals that range from providing universal primary education to avoiding child and maternal mortality were set with a target achievement date of 2015” (MDGF 2018).



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Knowing of Indigenous Ways: Fieldwork Dispatches from Atitlán, Guatemala

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*Correction issued January 8, 2019. Original published version listed an incorrect author affiliation.

Coupled with the aesthetic beauty of its highland volcanic landscape, the modern indigenous culture of ancient Mayan descendants is a primary factor in bringing over 300,000 international and domestic visitors to the Lake Atitlán, Guatemala region each year. In this field report, I share the evolution of my ethnographic research process within one of these indigenous groups, the Tz'utujil residents of Santiago Atitlán, as they navigate the development and ongoing production of tourism in their town. I provide a vignette of a tourist's typical morning in Atitlán, convey the methods by which my ethnographic insights were derived, and reflect on these fundamental field experiences as they influence my research ethic as a burgeoning scientist.

Keywords: *Guatemala, Lake Atitlán, Ethnography, Tourism, Identity, Socio-cultural Change*

1.0 Morning in Atitlán

The majority of tourists arrive in Santiago Atitlán (simply Atitlán to locals) via *lancha* (water taxi), disembarking on a large floating dock at the *Playa Pública Chi Nim Ya'*. Stepping off the boat, passengers are greeted by adorable girls as young as 5 years old, dressed beautifully in handmade clothing, who pause their laughter-filled play to sell trinkets to the new arrivals. Following the dock's boardwalk, the passengers are routed through a small gazebo with a thatched roof, where they will find at least 2 of the benches occupied by young guides in their 20s or 30s – decked out in outdoorsy clothes with INGUAT (the Guatemalan Tourism Institute) authorization badges hanging around their necks – offering local sightseeing tours. The dock area is home to several cafes and mini-markets, public restrooms, and an “artisan walk” filled with upwards of 70 vendor stalls. These stalls are small one-story shacks with open fronts, bursting with blankets, bags, shoes, headbands, notebooks, and every other item that one could possibly imagine. The products are made with brightly-colored and intricately-patterned woven and embroidered fabric that is referred to simply as *típica* (typical).

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At 9:45 a.m. on a sunny Thursday morning in mid-July 2017, about half of the stalls are open for business, while the other half are just slowly coming to life or remain shuttered. After all, at this hour, only 1 public water taxi has arrived so far, bringing those who got an early start from Panajachel, the tourist hub across the lake. Heading downhill to the dock from the center of town, I pass several young women in colorful *traje* (the traditional clothing worn by the Tz’utujil people), toting baskets of shiny beaded keychains and bracelets, each with one arm hung heavy with necklaces and headbands. From inside the open stalls, seated women call out to me as I pass by: “¡Hola! ¡Hola!” (Hello!) and “¡Pase adelante!” (Come inside!). An older man in jeans, reflective sunglasses, and a cowboy hat stands in his usual spot at the bottom of the hill, yelling out destinations across the lake and directing potential passengers to the boats waiting to be filled. He asks me where I am headed – “San Pedro? Panajachel?” – but upon hearing that I do not plan to leave town this morning, he offers me a trip to visit *Maximón*, a local attraction, instead. Even 9 weeks into my stay in Atitlán, he still repeats this routine with me every time we cross paths, hoping that one day I will take him up on it.

I take a seat on a bench in a small open plaza area near the dock. When I arrive, a neighboring group of tourists is in the company of two *vendedoras ambulantes* (directly translated as “traveling saleswomen,” but used here to refer to the peddlers who operate on foot) carrying goods with them and moving around to approach tourists in various locations. The *ambulantes* are indigenous women dressed in traditional *traje*, and they each have one shoulder draped with a pile of patterned tablecloths and table runners. They keep their hands free for unfolding and displaying the various textiles, but some carry even more items in baskets artfully balanced on their heads. Within several minutes, the *ambulantes* outnumber the tourists, and they are persistent in their attempts to sell their beautiful products, displaying many different options and listing off prices in English. When the tourists begin to walk away, the women trail them to their departing boat, repeating their offers.

Another boat has now docked, and two visitors with large backpacks are heading uphill toward me, followed by one of the young guides, who is displaying a paper map with English descriptions and pointing to the different destinations he can take them. As I watch the interaction, one of the older *ambulantes* approaches me, offering to sell me a beaded quetzal keychain for my backpack, but quickly loses interest when she sees that a group of six middle-aged women have paused in front of her stall at the very top of the hill. She takes off, running up the steep street (at an impressive pace) to greet them.

I leave my vantage point on the bench and pursue a group of eleven tourists as they continue their way slowly uphill away from the dock toward the center of town. Several members of the group pause to browse at stores selling *recuerdos típicos* (typical souvenirs), while others stop to order a cup of locally grown and roasted coffee at the first of the six coffee shops that they will eventually encounter on this block. Two of the group members enter one of the mini-market style *tiendas* (stores), selling snacks and daily sundries, to purchase sodas, and yet a few more wander into one of the several art galleries to peruse the brightly-colored paintings covering the walls. This is the heart of *Calle Real*, referred to by some locals as *Calle Gringo* and others as *Calle Principal*.

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I continue to follow the group through this primary vein of town, which serves as the introduction to Atitlán for the majority of tourists that arrive by boat. Soon they reach the indoor market building and the main square of town. In the middle of the square is Central Park, a mostly concrete open area with benches, several statues, and a relief map showing the surrounding towns in the Lake Atitlán area. Facing the near side of the park is a large building that contains the municipal meeting room and a secondary school, while on the far side a combination basketball/soccer court is filled with teenagers kicking around a plastic ball. The opposite 2 sides of the park contain the municipality building on 1 side, and a set of stairs leading up to the plaza of the town's 470-year-old Catholic Church on the other. Though it is not 1 of the bi-weekly market days, the blocks around Central Park are lined with vendors selling fresh fruits and vegetables, used clothing, shoes, household goods, and more. Many of the women are dressed in striped blouses adorned in embroidered flowers and birds, *hüipiles* tucked into ankle-length skirts made of colorful patterned fabric, *cortes* that are held up with wide belts, or *fajas*; collectively these items make up the local indigenous *traje*. Fewer indigenous men than women dress in *traje*, but those who do are wearing wide-legged culottes that hang below the knee, white with vertical purple stripes and adorned with intricately-detailed embroidered birds. A scarf-like length of woven fabric tied around the waist serves as a belt and storage pouch; the men pair this with collared work shirts and cowboy-style hats.

Each morning, *Calle Gringo* comes to life as described, shopkeepers filling their allotted two meters of sidewalk space with colorful goods hanging from floor to ceiling and crammed onto every surface. Coffee shops and restaurants open their large sliding doors, setting up outdoor seating and displaying menus to catch the eye of people passing by. Tourists come and go by the boatful – small numbers arriving on the public water taxis also used by local commuters, and many arriving on privately-chartered boats in groups ranging from just a few to up to 50 people. As the arriving visitors slowly ascend the steep hill into town, and the departing ones mill about waiting for their boats to leave, the local vendors and guides vie for their piece of the market. By midafternoon – or earlier if it's raining – the reverse metamorphosis begins. Displays are shifted inside, corrugated metal garage doors pulled down, and then, by nightfall, the town is completely transformed. Food carts fill the streets, throngs of locals pour out of cafes and congregate in Central Park, and the powerful sound systems blasting from the Evangelical churches compete over one another. Each evening, the townspeople of Santiago Atitlán live their after-work lives largely devoid of the sounds, sites, and demands of the tourists that pulse from clubs, restaurants, and hotels in other lakeside towns like Panajachel and San Pedro La Laguna. Yet, asking around, one will find that those residents involved in the tourism industry do not consider the current situation in Santiago Atitlán ideal.

2.0 Background and Research Setting

In the central highlands of Guatemala, about 100 miles west of the capital city, several rivers converge at the base of 3 towering volcanoes to fill an ancient collapsed caldera with the 92 square miles of Lake Atitlán – referred to by Aldous Huxley as the most beautiful lake in the world (Huxley 1934). The shore of the lake has long been dotted with communities of varying size and social makeup, all of which have a majority indigenous population. In the 17 governmental municipalities making up the Lake Atitlán basin, tourism has grown dramatically right alongside its growth at the global scale (World Tourism

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Organization 2017). Tourism is one of the major driving forces for the phenomenon of globalization, which ushers in a tide of political, ecological, and socio-cultural change. I set out to study these issues in Santiago Atitlán.

Coupled with the highly aesthetic landscape, the modern indigenous culture of descendants of the ancient Maya is a primary pull factor, bringing over 300,000 international and domestic visitors to the Lake Atitlán region each year (INGUAT 2015). Santiago Atitlán is pueblo-rich with this living culture – the town is alight with its vibrant colors, patterns, sounds, and smells. This culture is reflected in the language, clothing, traditions, customs, and artisanship of the local Tz’utujil people. In addition to the highly visual cues of culturally based tourism, Santiago Atitlán holds a wide variety of lesser-known attractions of the type that tourists travel the world to seek, yet few know they can be found here. The town offers religious tourism in the form of the afore-mentioned *Maximón*, a mysterious deity of blended Maya and Christian origins that is celebrated by local spiritualists. The Catholic Church is not only impressive for its architecture and age of nearly 500 years, but also infamous as the site of the martyr of a revered Roman Catholic priest from Oklahoma during the country’s violent civil war. The town is also home to the Central American headquarters of Evangelical mega-church Palabra Miel, which brings thousands of visitors, during its various retreats, several times each year. The town’s nature-based attractions are also numerous, including a wide range of floral and faunal biodiversity, access to the 3 volcanoes that punctuate the iconic views throughout the region, virgin forests, archeological sites, beaches and lakefront parks, a wealth of bird species, viewpoints, trails, and more. Yet, despite abundant potential, many of the tourists who venture to Santiago Atitlán stay for only a few hours’ visit. Those residents who work in the tourism sector express concern about the town’s status and future as a destination.

Santiago Atitlán sits in the mouth of a narrow bay that extends from the southern side of Lake Atitlán in the central highland department of Sololá, Guatemala. Nestled in the crux of 3 volcanos – protected by the lake on its front and the steep forested slopes at its back – the municipality encompasses 136 square kilometers (Municipalidad de Santiago Atitlán 2012). This land is comprised of a small urban center and expansive rural surroundings that are a mix of forest and agricultural production. On the highways leading into town, billboards welcome visitors to the “Capital of the Tz’utujil Reign.” The modern name of the pueblo, Santiago Atitlán, dates back to the Spanish conquest, when the first Christian church – named for Saint James the Apostle, or *Apóstol Santiago* in the Spanish language – was established in the town; however, the majority of local indigenous residents refer to the town simply as Atitlán, a name of Tz’utujil origin that roughly translates to “by the water” (Municipalidad de Santiago Atitlán 2012).

In the twenty-first century, there has been a lot of concern with protecting the lake – aesthetically for its beauty, for reasons concerning human health, and more broadly for conservation and biodiversity protection. But, in addition to environmental threats, there are social ones; Lake Basin heritage is being threatened by new technology, rapid changes, growth, and the encouragement (and desire) to modernize. In characterizing the current situation, one informant – an expert on lake biology who has done a lot of

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natural sciences work in the Lake Atitlán region – said, “The human environment is deteriorating much faster than the lake environment” (J. Skinner, personal communication, June 9, 2017).

The town is growing at a notable rate, close to 3 percent annually, and projections put the 2018 population just over 53,000 (Instituto Nacional de Estadística [INE] 2008; Centro de Salud Santiago Atitlán 2011). According to 2011 data, 98 percent of *Atitecos* (the name used for residents of the town) identify as members of the indigenous Tz’utujil race (Centro de Salud Santiago Atitlán). The Atitecos base much of their economy on farming and the production of artisan goods. Coffee, avocados, corn, beans, and other produce is grown on the volcanic slopes for subsistence use, sale in the local market, and widespread distribution through large corporations. The town is known for its quality woven fabrics, clothing, and glass beads, which are sold to locals, national and international tourists, and indigenous peoples from other regions of Guatemala. However, the Tz’utujil ethnic population, which is heavily concentrated in Santiago Atitlán, ranks among the lowest in the department of Sololá in the Index of Human Development (IDH) rating – a demographic measure based on the 3 dimensions of health, education, and income level (Programa de las Naciones Unidas para el Desarrollo 2011). Likewise, in the last Guatemalan national census, Santiago Atitlán, as a municipality, ranked below both the national and departmental averages of IDH (INE 2002).

3.0 Ethnographic Fieldwork

During 10 weeks of fieldwork in Atitlán in summer 2017, I built a large body of ethnographic evidence for socio-cultural change while documenting local stakeholders’ efforts to engage in the global tourism market. Realizing that what I set out to study was broad, my work took me in several exciting, new directions as I narrowed my focus. While future publication efforts will focus on elaborating the many themes within these data into additional findings, the purpose of the current field report is to convey a detailed account of the evolution of my research process, from which my ethnographic insights were derived.

My data collection began during a summer field school program, wherein I learned ethnographic research methods through a combination of traditional classroom instruction and in situ practice. During my first few weeks in Atitlán, I spent as much time as possible establishing connections within the community and building rapport with my host family, as well as creating concept maps of institutions, the physical community, and social networks. After field school, I remained in Atitlán to continue my work, resulting in a total of ten weeks at the field site. I collected two broad forms of data. I sought and compiled existing archival data in the form of local government planning documents, social media posts, external reports, and relevant scientific and academic research. I also collected original ethnographic data in the form of participant observation (DeWalt and DeWalt 2011), structured survey interviews (Babbie 2013), and in-depth, semi-structured, key informant interviews (Bernard 2011).

I recorded observations of tourism interactions and exchanges, conversations, meetings, transportation systems, personal informal interviews, photographs, and detailed notes jotted down at the scene. I

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converted jot notes into full field notes as soon as possible, resulting in about 200 pages of observation data. I utilized a typical case sampling strategy in my structured interviews (n=34) to build an emic understanding of local business stakeholder opinions on the tourism market (Creswell 2007; Guest, Namey, and Mitchell 2013). As such, I conducted these interviews with employees and owners of souvenir shops, art galleries, coffee shops, cafés, restaurants, and convenience stores along the main drag of *Calle Real*, described above. I employed several purposive sampling strategies in my semi-structured key informant interviews, including intensity sampling for cultural expertise, stratified sampling to capture key tourism industry sectors, and chain referral (Creswell 2007; Guest et al. 2013). This resulted in 14 hours of recorded interviews from 15 sources. All interviews except 1 were conducted in Spanish, a second language for myself as well as all but 2 of the informants. The majority of the informants spoke Tz’utujil as their mother tongue. Only 1 interview was conducted in English, the first language of both the informant and me.

I combined my archival data, detailed field notes, and interview transcriptions into a single corpus of text using MAXQDA qualitative data analysis software. I am currently in the process of open coding the data to iteratively develop a rigorous codebook for subsequent text analysis. This codebook will incorporate both structural coding to organize the data and inductive thematic coding (Bernard 2011; Saldaña 2015).

4.0 Preliminary Analysis

I interviewed and observed Atitlán’s Tz’utujil residents and their institutions across the tourism sectors. I asked them about their cultural identity – both how it is incorporated into their work in tourism, and, conversely, how their contact with tourists affects their identity. I witnessed immense pride in the language, clothing, art, and customs of the Tz’utujil people. Despite the history of persecution and racism that indigenous peoples of Guatemala have faced, the Tz’utujiles I spoke with expressed nothing but pride to me when discussing their cultural identity and the opportunity to share it with visitors. When asked how he learned the job skills he needed to be a guide, one respondent replied simply, “It’s my life. I lived it.” I also asked them about their community – current tourism trends, strengths and challenges, the future they would like to see for Santiago Atitlán, and their ideas on how the town can reach those goals. As I start the coding and analysis process, I have recognized patterns and thematic areas. I have triangulated these themes from within multiple sources, supported by anecdotes and evidence from the greater body of evidence from my ethnographic field research.

The power of globalization has reached even the furthest, sheltered corner of Lake Atitlán in the Guatemalan highlands. Despite Atitecos’ widespread and immense pride in their heritage, socio-cultural changes – due in part to globalization – have nonetheless driven shifts in Tz’utujil cultural institutions. In Atitlán, I saw socio-cultural change exemplified in concepts of indigenous identity, issues of ownership of knowledge, and new forms of constructed reality and authenticity. These changes have contributed to various cultural changes, including widened gaps between groups and generations, increased competition and rivalry, reduced social bonds and norm adherence, and an eroded ability to work together.

In ongoing and future analyses, I will continue to iteratively work with my data through coding and thematic analysis. This analysis will draw upon priori themes present in existing literature and theory (e.g., indigenous culture research, social capital and community capitals theory, collective action), yet also allow for emergent themes grounded in the data that may offer alternative explanations for the ways that indigenous peoples in Atitlán manage their shared cultural heritage and institutions in the context of tourism.

5.0 Reflections on Knowing Indigenous Ways

As my first field work experience, this project was a roller coaster ride of emotions, challenges, and excitement. Knowing that many foreigners had come and gone before me, and that many more would follow, I felt uneasy about my place as an outsider in the community. I thought often about my ethical responsibility as a researcher. I believed I would find a community that was wary of outsiders studying and using its people for their own benefit and professional gain, without investing in the town in return. Instead, even though I tried to express that I was a student and still learning how to conduct research, I was regarded as someone with the power, knowledge, and potential to help change lives. Perhaps this was due to differences in schooling systems, access to education, and a misunderstanding of what it means to be a graduate student in the United States. I wanted to convey my care and respect for the Atiteco people and my desire to contribute my knowledge to them in any way possible, but also felt a need to be clear in communicating the exploratory nature of my research and limited financial means. At times, I also felt conflicted about my presence as a tourist. It felt frivolous to want to go kayaking on the lake for fun – and pay money to do so – when many residents (my host father included) paddle wooden canoes across the bay each day as the means to an end (to fish or to access their farmland).

Guatemala, in general, and the tight-knit community of Santiago Atitlán, in particular, are characterized by obstacles to trust and safety. I received a slightly different version of the same story from every person asked, and sleuthing out the “truth” felt, at times, to be an insurmountable challenge. The entire data collection period had the uncomfortable feeling of toeing the line of danger in order to get anywhere. Though I am aware of differences in culture and worldview in this area, I was subject to what I consider to constitute as sexual harassment on a daily basis. Being a woman opened many doors, yet closed others. A research partner of the opposite sex would have been helpful, and more time in the field could have enabled both a greater opportunity to build rapport and the ability to devise alternate ways of attaining data when safety concerns prevented initial attempts. I made a lot of quick decisions about the lengths to which I was willing to go in the name of research, and I would be lying if I said that I had no regrets; however, the outcome was an incredible experience that resulted in both personal and professional growth and insights.

As one informant articulated, “All cultures change, but they aren’t always forced to change this fast.” Scholars acknowledge that “in the rapid global environmental change experienced in the twenty-first century, indigenous and other rural communities face the challenge, perhaps more than before, of integrating the wisdom of past generations with the reality of the present” (Berkes 2012, 27). This

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resonates deeply with my time in Atitlán, and I am greatly appreciative of the opportunity afforded to me by ICIK, whose recognition of the importance of this field of inquiry allowed me to apply my interest in community-level work to an indigenous population. This experience has no doubt influenced my long-term research trajectory. As I develop my ethic as a scientist, I will continue to reflect on these fundamental experiences.

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When the Earth Shakes: A Status Report on Dissertation Research Regarding Mexican Volcanoes

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Situated above multiple tectonic plates, central Mexico and highland Guatemala often experience strong earthquakes and volcanic activity. During the sixteenth to eighteenth centuries, this unpredictable topography shaped the human interactions with the natural environment. While indigenous populations in these regions were familiar with this terrain, Spanish colonists struggled to make sense of this volcanic topography upon their arrival. This field report provides an overview of 4 months of dissertation research completed during fall 2017 in Mexico City, Puebla, and Tetela del Volcán. This research occurred in the aftermath of a 7.1 earthquake, measured on the Moment Magnitude scale, that struck central Mexico 2 weeks after my arrival. This essay discusses the realities of living in post-earthquake Mexico and the archival research undertaken in each city. Preliminary findings reveal that knowledge concerning the volcanic topography influenced the outcome of property conflicts in favor of indigenous litigants. Research for this project will continue throughout 2018 in Spain and Guatemala.

Keywords: *Central Mexico, Earthquake, Popocatépetl, Volcano, Archives, Methodology*



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1.0 Introduction

On September 19, 2017, I was sitting at one of the long tables in *Galería 4* at the *Archivo General de la Nación* in Mexico City, engrossed in reading an archival document about a property conflict from 1732 over volcanic lands. A deep rumbling abruptly disrupted the reading room's sleepy silence, forcing me back into the present, when I realized that small tremors were shaking the floor beneath my feet. Suddenly, screeching wails reverberated around the halls, causing my stomach to drop. It was the seismic siren, signifying that an earthquake was seconds away. As I attempted to reach the exit, the tremors became massive waves, causing me to stumble into the wall. "*Corre!*" (Run!), one of the archivists shouted, her voice barely audible above the cacophony. When I reached the courtyard door,

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the ceiling began to crack. With a horrendous roar, large pieces of brick and plaster crashed down in the doorway, accompanied by enormous clouds of dust. Trapped, unable to see, and with a mouthful of brick powder, I huddled with a group of archivists, hoping that the violent shaking would not topple the dome ceiling.

Everyone emerged safely from the archive that day, but the earthquake of September 19, 2017, took the lives of hundreds and collapsed buildings in Mexico City, Puebla, and Morelos. This earthquake eerily occurred on the 32nd anniversary of the 1985 earthquake that killed thousands and demolished large areas of the city. An overwhelming force of local residents, emergency workers, medical students, doctors, and hundreds of others responded to this most recent deadly disaster by rescuing individuals trapped in the ruins, clearing the rubble, and providing shelter and supplies. As the threat of an aftershock remained, concern also shifted towards the Popocatepetl volcano. Looming about 45 miles southeast of Mexico City, the volcano had been spouting ash and lava since the earthquake, stirring fears of a massive eruption. One did not occur, but Popocatepetl's outbursts and tiny tremors, along with the ruined cities in its vicinity, caused a state of increased anxiety during the following months.

For most of those months, I was living in Mexico City, supported by a Whiting Indigenous Knowledge Research Award to conduct archival research for my dissertation. My project coincidentally focuses on the effects of volcanoes and seismic activity in Mexico and Guatemala, but during the early modern period. The September earthquake occurred just two weeks into my research trip, shutting down the city for days. Afterwards, many people suggested that I might now have a better understanding of the experiences of the historical subjects in my project, albeit at a high cost. Nothing can compare to the surreal experience of the earth trembling beneath your feet and the lives an earthquake can take in an instant. It serves as a reminder of the potency of the earth and human resilience to rebuild each time the earth shakes or a mountain erupts. Historians are often trained to direct their focus on the archive, yet, especially on this trip, the current realities were as important, if not more so, than the archival record.

2.0 Project Overview and Significance

My dissertation project investigates the human-environmental interactions in Mesoamerica in the sixteenth through eighteenth centuries. More specifically, it focuses on the ways that volcanoes served as sites of cultural and intellectual exchange among Nahuas in central Mexico, Kaqchikel Mayans in highland Guatemala, and Spanish priests, colonists, and naturalists who settled in this topography. For varying historical actors, volcanoes offered places for rituals, provided fertile soil and water sources, and became the loci of empirical expeditions aimed at expanding knowledge of the natural and subterranean worlds. Looming over moments of Spanish colonial interactions, volcanoes offer a lens through which to illuminate the role of indigenous knowledge in early modern interpretations of geological phenomena.

This project brings together insights from ethnohistory and the history of science. Using native language sources and ethnographic methods, ethnohistorians have profoundly expanded our understanding of the lives of Nahuas and Kaqchikel Maya. Building from these insights, I use ethnographic information about

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indigenous relations with volcanoes to underline their cultural persistence and knowledge concerning this topography. This methodology resonates in scientific history debates on indigenous knowledge, the importance of locality in scientific development, and Spain's role in the Scientific Revolution. While recent scholarship on Spain's involvement in European intellectual developments asserts that key scientific information came from Spain, my project evaluates volcanoes to suggest developments also came from indigenous peoples in the Americas. Volcanoes were familiar to Kaqchikel Maya and Nahuas, and gave them privileged knowledge about the topography that Spaniards lacked. This project expands the traditional geographic boundaries in the Scientific Revolution and stresses the role of indigenous knowledge in natural histories and understandings of volcanic landscapes.

3.0 Research Sites and Archives

Situated above the subduction of the Rivera and Cocos plates under the North American Plate, Mexico has a long history of seismic activity. This region contains the Trans-Mexican Volcanic Belt, which stretches from the Pacific Ocean to the Gulf of Mexico and contains several active volcanoes. Despite careful monitoring and alert systems, seismic outbursts have shaped, and continue to shape, the lives of millions who inhabit this area. Similarly, Guatemala is located above the subduction of the Cocos plate under the Caribbean Plate, which also has created an earthquake-prone region and several active volcanoes. In central Mexico, my investigation focuses on Nahua towns located around four volcanoes: Popocatépetl, Iztaccihuatl, Matlalcueye, and the Nevado de Toluca. In Guatemala, I focus on the volcanoes surrounding present day Lake Atitlán and Antigua.



Figure 1: Research areas in Central Mexico

From left to right: Volcanoes Nevado de Toluca (1); Iztaccihuatl (2); Popocatépetl (3); Matlalcueye (4)

I selected these areas because Nahuas and Kaqchikel Maya maintained economic, cultural, and socio-religious connections to their volcanic homelands after the Spanish arrival. They considered these often-volatile landscapes to be animate members of their communities, believing that volcanoes housed their deities and ancestors, and that rivers originated from within them. During the conquest, Spaniards relied on Nahua allies to guide them through this unfamiliar volcanic terrain towards highland Guatemala. Many of these Nahua then resettled in the Kaqchikel Maya highlands, bringing their own understandings of volcanoes into a familiar topography. Both highland regions contain especially active, as well as dormant,

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volcanoes. Since these volcanoes could impact the lives of anyone, no matter their position in the colonial hierarchy, documents concerning the volcanoes are located in numerous archives in Mexico, Guatemala, and Spain. In my larger project, I rely on over fifteen different archives and libraries, but for this report, I am only addressing the research completed in Mexican archives last fall.

4.0 Mexico City

My research in Mexico City focused on the ethnohistorical components of my project that address the ways indigenous populations, as well as Spaniards, lived among volcanoes. This section of my research focuses on periods of light volcanic activity and/or dormancy to understand the effects of the topography on colonial interactions. To do this, I worked in two different archives, the Archivo General de la Nación (AGN), and the Archives and Manuscripts Division of the Fondo Reservado at the National Library of Mexico. Although I had originally planned to spend most of my time in the AGN, it closed after the earthquake, so I went to the Fondo Reservado instead. During several weeks there, I surveyed the Franciscan Collection, as well as the *Tenencias de Tierras de Puebla*, or documents pertaining to land ownership in Puebla.



Figure 2: Inside the Biblioteca Nacional in Mexico, facing the entrance to the Fondo Reservado

The Fondo Reservado houses one of the largest collections of Franciscan documents in Mexico, along with the Biblioteca Franciscana in Puebla. Both contain the materials once held in small archives and libraries in the Franciscan convents located throughout central Mexico. These sixteenth to eighteenth

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century records include general information about the daily functioning of the convents, inventories of their libraries, information on indigenous evangelization, and some natural history materials. I searched for documents from, or pertaining to, the Franciscan, Dominican, or Augustinian convents located on the slopes of Popocatepetl. These fourteen convents provided spaces to evangelize the Nahua populations in the region southeast of Mexico City. Now UNESCO World Heritage Sites, the convents reflect the earliest evangelization efforts in the region, while their presence on or near the volcano's slopes highlights the tensions between the built and natural environments. After assessing the Franciscan documents, I spent a week examining the Puebla land materials, which were primarily from the eighteenth century. I looked for records produced in towns close to Popocatepetl and Iztaccihuatl to find information regarding how individuals described the topography or used the terrain.

When the AGN reopened, I returned to consult documents from the collection about land and water conflicts. Similar to the process in the Fondo Reservado, I searched for conflicts located around Popocatépetl, Iztaccihuatl, and the Nevado de Toluca to understand how Spanish and Nahua individuals clashed over control of the volcanic topography and debated over resources such as fertile land and water. Many of the land cases I consulted also contained valuable hand-drawn maps produced by the courts. Not only did many of the maps contain depictions of an erupting volcano, but they also drew upon both indigenous and Spanish cartographic techniques. Additionally, I consulted records from the General Indian Court that provided additional information about the topography.

5.0 Puebla

After spending two months in Mexico City, I went to Puebla for a few weeks to consult the Archivo Histórico Municipal de Puebla and the Biblioteca la Fragua, as well as to visit some of the towns in my project. Although I arrived a month after the earthquake, many buildings were still damaged or in ruins. Wooden beams supported the corners and doorways of countless buildings, while giant cracks disturbed the otherwise smooth surfaces of stone walls. The fallen cupolas, the broken stones and saint statues from the façades of churches created an uneasy reminder of the disaster: it was strange to see such ornate and well-kept structures as asymmetrical and damaged. Ropes blocked the doors of numerous buildings deemed unsafe to enter, and the earthquake still dominated daily conversations. One of the archives I planned to consult remained closed during my entire stay in Puebla due to damage.

I was able to consult the Municipal Archive, where I surveyed the *cabildo*, or city council records, for information on volcanic or seismic activity. The *cabildo* records of Puebla are some of the most comprehensive records we have of this genre, as they begin in the 1530s with the founding of the city, and continue through the nineteenth century. These records contain accounts of the proceedings and descriptions of local conflicts that appeared before the council. Although this did not yield much information on the volcanoes, I did obtain some records that referenced the landscape and small property conflicts. In the La Fragua library, I searched the Jesuit records for information from missionaries and geographical surveys. In addition to their manuscript collection, the La Fragua library also contains valuable printed primary materials, such as the nineteenth century scientific journal *Memorias de la*

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Sociedad Científica Antonio Alzate. Several editions contained documentation of the historical activity of Popocatepetl since the sixteenth century, as well as information on seismic activity in Mexico.



Figure 3: Valley of Atlixco in Puebla, Mexico

While in Puebla, I visited some of the towns in my project, including Atlixco and Huaquechula. Located in the fertile Valley of Atlixco, these towns often appear in my documents regarding conflicts over this land. Although the landscape descriptions in my documents are from hundreds of years prior, visiting these towns provided me with a better visualization and perspective of the terrain. At the same time, the damage from the earthquake was more visible here than anywhere else. While wooden beams provided support to some structures, other streets contained nothing more than piles of bricks and stones.



Figure 4: Earthquake damage in Atlixco, Puebla

6.0 Tetela del Volcán

In December, I spent several days in the small town of Tetela del Volcán, located in Morelos at the foot of the Popocatepetl volcano. After taking a bus and small van, I arrived in Tetela to attend the Seventh Annual Symposium on the Popocatepetl and Iztaccihuatl volcanoes. The conference was held outside the sixteenth century San Juan Bautista convent (due to the earthquake damage we were not able to enter the building). Over the course of three days, I listened to presentations by top volcanologists, archaeologists, sociologists, and anthropologists, and attended poster presentations by biologists and earth scientists. I was able to meet numerous scholars, including archaeologist and anthropologist Arturo Montero, who later invited me to consult his library.

During the last day of the symposium, I traveled with a group of ten other researchers on a *vista del campo*, or field visit, to several small towns on the slopes of Popocatepetl. Throughout the day, we visited different farms where we saw the economic activities of this region and viewed the different types of construction methods used to withstand the seismic activities. We also witnessed other structures that had been ravaged by the earthquake and heard countless stories about when the disaster struck: fallen houses; families separated; and the rebuilding process.

7.0 Conclusion

During the 4 months I spent in Mexico, I developed important perspectives for my research and collected valuable archival materials. While my research will continue in Spain and Guatemala throughout 2018, I have begun to construct a narrative about the interactions with the volcanic landscape and its human inhabitants, which will become part of several chapters. I found that Nahuas and Spaniards had distinct understandings of this region's ecology, which often worked in favor of Nahua litigants. Although Spaniards slowly developed an understanding of this region's topography, they often overlooked the various ways that Nahuas engaged with this terrain, which cost them their claims to the land.

Both in the sixteenth century and now, this topography exists in a precarious balance between creation and destruction. The threat of another disaster constantly simmers beneath the earth, yet the surface provides valuable water sources and fertile fields. I plan to spend the next year consulting additional archives to better understand how indigenous and Spanish inhabitants lived with and constructed knowledge concerning these unpredictable topographies.

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A Review of *Incorporating Cultures' Role in the Food and Agricultural Sciences*

Book Review by Jennifer Sumner

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Incorporating Cultures' Role in the Food and Agricultural Sciences. By Dunkel, Florence V. 2018. Elsevier Academic Press. 320 pp. Paperback ISBN: 9780128039557

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This book is a must-read for anyone interested in teaching about food and agriculture in the classroom or working in the field with communities – both locally and around the world – because, regardless of our geographical location, political persuasion, or ancestral heritage, culture matters.

Culture is the medium in which we swim as humans – our complex sets of beliefs, practices, material manifestations, arts, architectures, fashions, food habits, ideas about gender and hierarchy, the way in which we socially construct memories and memorials, our ethical and aesthetic systems, even our views about what constitutes “nature” ... which in turn influence or determine our views of ecology, how we treat non-human animals, our dietary practices and our landscape painting (Clammer 2016, 16).

Florence V. Dunkel has seized this concept and made it the centerpiece of her work in the food and agricultural sciences. Along with a group of dedicated academics, administrators, and practitioners, she has developed a series of chapters that are full of new ideas, stories, case studies, personal reflections, images, and information.

She begins her inquiry with a seemingly simple question: where did you come from? She herself was asked this question when she attended a meeting of Native American elders of the Apsaalooke tribe in 2013, about three hours away from her university. At this meeting, she witnessed the Apsaalooke students using the skills they had learned in her class. When she replied that she was an Associate Professor of Entomology at Montana State University in Bozeman, her two Apsaalooke students intervened, emphasizing that the elders wanted to know *where* she was from – about her people and her ancestral land. Feeling herself on unfamiliar territory, she told the story of her family’s history. This resulted in Dunkel learning an important life lesson: “How can you know where you are going if you don’t know from where you came?” (6).

Dunkel has taken this lesson and made it her first “tool” in her toolkit for incorporating culture into the food and agricultural sciences. She describes this tool as “know and understand from where you come,

your own culture(s).” In other words, recognize your own culture(s) and people regardless of who you are or what you do.

This first tool takes Dunkel into a discussion of culture itself, which she defines as:

the integrated pattern of human behavior that includes thought, speech, action, and artifacts, and depends upon the human capacity for learning and transmitting knowledge to succeeding generations, particularly as it is intertwined with the culture of, or production of, food (9).

For Dunkel, recognizing one’s culture is the beginning of the development of intercultural competency, a process that starts with realizing that there are people with worldviews other than our own. She proposes, “Inclusivity begins with recognizing where you are coming from and where your colleagues and students and administrators are from” (14). If we either do not recognize or subconsciously deny that there are other cultures, we will not ‘see’ them, which results in dragging others into our own culture. Recognition of other cultures, she warns, is only a first step, and still encompassed in an ethnocentric worldview. What Dunkel is aiming for is ethno-relativity, in which people recognize subtle, subsurface differences between cultures and accept these profound differences as okay, just different. This, she argues, is the next step in intercultural competency. In advanced levels of ethno-relativity, she adds, people learn to move seamlessly between different culture systems.

This brings us to what Dunkel refers to as the urgency of this book – the “attempt to decolonize the language of the food and agricultural sciences by providing examples of the importance of raising awareness and the tools to decolonize language and learning structures” (17). For Dunkel, knowing the nature of our own cultural filter and how we both consciously and unconsciously respond in an intercultural situation will end up creating a broader, wider field in which to teach and learn. She develops this approach by first addressing what she calls the gap that faces all of us. This gap is “a hiatus, a chasm that exists between two groups who wish to communicate with each other” (23). Overcoming this gap means engaging in bilateral communication in which both groups are enabled or at least willing to really hear what the other is saying. Dunkel illustrates the gap through diagrams and case studies, such as crop scientists pushing Kenyan farmers to switch from traditional grains to a corn-based diet in an effort to alleviate hunger, not realizing that corn is deficient in two essential amino acids. At the same time, she declares war on grasshoppers and locusts, which eliminated these nutritionally dense snacks children used to depend on, resulting in physical and cognitive stunting. She then uses the rest of the book to teach people how to build the skills and bridge the gap, beginning with the idea of deep, contemplative listening before moving on to the process of decolonizing one’s words and actions, and using a holistic process to ensure being in tune with the desired outcomes as well as focusing on the qualities of life for the people of the community. For Dunkel, a decolonized worldview is an ethno-relative worldview, one that moves from the ethno-centric position of denial of other cultures, defense of one’s own culture, and minimization of cultural differences to the ethno-relative worldview of accepting cultural differences, adapting to cultural differences, and integrating into a variety of cultures. It involves decolonizing our interactions

with the community of focus. To put it otherwise, it means refraining from imposing our own values on the community, which involves two steps: identifying colonizing actions and words, and then decolonizing our actions and words. Subsequent levels include identifying communication languages, recognizing cooperation-based groups (and eschewing competition-based groups), achieving participation of everyone, and establishing ownership of original data or products. Such immersion in another culture can help us move toward a transformative experience that can lead us from an ethnocentric worldview to an ethno-relative one.

This brings us to Dunkel's discussion of Reductionist (Western) Science and Traditional Ecological Knowledge (TEK). She explains how, during the nineteenth and twentieth centuries, Western scientific discoveries became compartmentalized, resulting in the loss of interconnections within the whole biosphere or simply an ecosystem. TEK, on the other hand, involves doing Native Science – a process of learning through direct experience that requires “a connection with heart and mind, interrelationships, and a participatory approach” (58). For Dunkel, TEK accumulates within those cultures that live in a particular place as the cultures adapt and adopt while learning how to provide for their means of life, from generation to generation. Colonization suppresses or devalues TEK, but it becomes easier to see after decolonization, when worldviews become ethno-relative. She argues that in spite of the difference between Native Science and Western Science, “both scientific processes are needed to solve complex issues such as food insecurity and to reduce the ecological footprint of food and agricultural production” (59). Both are also equally valued in what she refers to as ‘the holistic process,’ which she describes as an informal, nonlinear process with the following categories of action, which are not sequential but spontaneous:

- Describing the ‘whole to be managed’ and creation of the holistic goal
- Identifying tools and testing questions
- Establishing the feedback loop
- Creating focus groups
- Convening stakeholder meetings (59).

Students engage in the holistic process through directed readings and content modules, reflective writing, small and whole group discussions, whole class group case study, an individual Holistic Management Plan, guest speakers, and field trips.

At the heart of the book are examples of how the holistic process and decolonizing methodologies can take place in practice. Under the topic of listening in and between communities, these examples include subsistence farmers in Mali, two Native American tribes and a bioregion in Mongolia, along with building ‘power line’ connections between students and policy leaders, and listening to students themselves.

The book concludes with a call to action to bridge the gap between food and agricultural sciences and the humanities and social sciences, emphasizing that both Native Science and Western Science contribute

essential understandings to the whole of place-based and culture-based knowledge. Overall, Dunkel sees this book as a new teaching process at the interface of teaching, scholarship, and engagement and as a response to students who wanted to connect the dots between their technical education in the classroom and people in the real world. For her, the way forward is enabled by eleven basic tools:

- Recognize and understand one's own culture
- Be open to failure and how to learn from it
- Decolonize (use language of those with whom you work and live)
- Strive to have an ethno-relative worldview
- Use the holistic process in one's own life and facilitate its use in learning and sharing in a community
- Value immersion experiences
- Listen to indigenous peoples
- Listen across "power lines"
- Instructors listen to students and students listen to each other
- Listen across campus
- Include Traditional Ecological Knowledge and the doing of Native Science as an important basis and ongoing process (299).

For Dunkel, this new teaching process represents a 'Quiet Revolution,' a way to create systemic change in every aspect of higher education. Such a change is needed because "poverty and the whole area of health and food security is one of our global grand challenges" (305). I couldn't agree more, and Dunkel et al. have created the roadmap for achieving this.

The book is clearly written and coherently organized. It can also be used as a toolkit for engendering this transformation. I would have liked to see a more refined concept of ethno-relativism. Under this worldview, "differences are noted and accepted not as 'good, bad, or disgusting,' but 'just different, and that is okay'" (101). This relativistic outlook does not take into account that some cultures engage in genocide, ethnic cleansing, female genital mutilation, or slavery. These cultural practices would not be considered "just different," but criminal by most standards and need to be denounced, not tolerated. One other small issue occurs in the preface of the book, written by the President of Montana State University. She writes that "the commitment to freeing the world of hunger and malnutrition still weighs on our nation's conscience" (xxiii). This is a startling sentence, considering that for many years the United States was complicit in dumping surplus farm products into developing countries in the name of food aid, thus benefitting their own producers while harming those in targeted countries (Friedmann [2012] 2017). Organizations like Via Campesina aim to be free of such impositions by powerful players in the global food system and to exercise food sovereignty – that is, the right to determine their own agriculture systems, food markets, environments, and modes of production. This would constitute an excellent exercise in ethno-relativism.

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A Review of *The Indigenous Peoples of Mesoamerica and Central America: Their Societies, Cultures, and Histories*

Book Review by Néstor I. Quiroa
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The Indigenous Peoples of Mesoamerica and Central America: Their Societies, Cultures, and Histories. By Carmack, Robert M. 2017. Lanham, Maryland: Lexington Books. 124 pp. Hardcover \$85.00. ISBN 978-1498558969

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*Correction issued January 22, 2019. Original published version listed an incorrect author affiliation.

No other Mesoamerican scholar has contributed more to the study of Mayan society, culture, language, and history than Robert M. Carmack. With a prolific contribution of seminal works - including *Quichean Civilization: The Ethnohistoric, Ethnographic, and Archaeological Sources* (1973), *The Quiché Mayas of Uatatlán: The Evolution of a Highland Guatemala Kingdom* (1981), *El Título de Totonicapán: texto, traducción y comentario* (1983), *Harvest of Violence: The Maya Indians and the Guatemalan Crisis* (1992), and *The Legacy of Mesoamerica: History and Culture of Native American Civilization* (1996), among others—Robert Carmack has left his own legacy on Mesoamerican studies through continuous ethnographic, historical, linguistic, archeological, and archival research since 1933 to present. His work could best be described as meticulous and groundbreaking with a clear commitment to disseminate the greatness of Mesoamerica-Central America indigenous peoples from precolonial to modern times. His book, *The Indigenous Peoples of Mesoamerica and Central America: Their Societies, Cultures, and Histories*, is no exception.

The premise of the book is to present a comprehensive analysis of the native peoples populations that inhabit the territories known as Mesoamerica and Central America, conclusively demonstrating the close interconnections between these geographic areas often seen as unrelated and outside the influence of the Mexican world to the north. Selectively using features of Immanuel Wallerstein's (1976) "world-system" theory, Carmack focuses on histories, societies, and cultures of these regions from pre-colonial to colonial and modern times. The first chapter opens with the 1502 Columbus encounter with a variety of highly sophisticated and advanced native groups in the Central American Atlantic coast, including a canoe of native merchants that demonstrated the existence of a complex commercial system with the Mexican region to the north. The chapter includes a description of the shared geographical and ecological characteristics of the region that simultaneously accounts for its diverse social history.

Chapter two subdivides the zone into the northern region (present-day Highland Guatemala and the northern lowlands of Yucatán), the middle region (roughly present-day El Salvador, Honduras, and Nicaragua), and the southern region (present day Costa Rica and Panamá). Each region's degree of

political development (states, chiefdoms, tribes), and cultural development (writing, architecture) depended on its geographic proximity to the powerful Aztec empire to the north. It is argued that, despite close interrelationships through complex exchange systems, the Central American region did not achieve economic, political, or cultural unity during its pre-colonial period.

Chapter three is a discussion of the type of native societies the Spanish conqueror encountered in the sixteenth century, and that ultimately determined their colonization and colonial experience. It invites readers to see such an encounter in terms of two different world-systems, where a large part of Central America was never fully integrated to the Mesoamerican advanced social economic system, although each zone participated, to some degree, in an active exchange system dependent on its level of socio-political development. The chapter concludes that at the time of the Spanish invasion, Central America was fractured and undergoing a “Mexicanization” due to the presence of Aztec and Maya merchant-soldiers.

Chapter four describes the complexities and diversity of the Mexican-dominated Mesoamerican imperial states, like the Mexican Aztec and Maya-K’iche’ in the northern region of Central America who both engaged in military conquests of less powerful states and chiefdoms. Furthermore, this chapter demonstrates that, at the time of the Spanish conquest, Mesoamerica and Central America were a vigorous “world-system,” or “intersocietal network,” stratified into core, semi-peripheral, and peripheral zones whose natural evolution-transformation was interrupted by the Spanish invasion.

Chapters five, six, and seven present ethnohistorical case studies of the Mesoamerican influenced Maya-K’iche’ of Guatemala, the Masaya and other native peoples of Nicaragua, and the native peoples of Buenos Aires and Costa Rica, respectively, from pre-colonial to modern times. Chapter six describes the K’iche’ social, cultural, and religious structures in order to identify change and continuities as K’iche’ communities faced Ladinization by the modern state. The case of the Masaya and other native people of present-day Nicaragua in chapter seven demonstrates the manner in which native peoples have actively participated in the historical process, first resisting European subjugation, as in the case of pre-colonial Chorotegas. Likewise, native peoples, such as the Masaya and the Monimbó natives, participated in the Sandinista Revolution of the 1970s. The chapter suggests that their success was due in part to their ability to maintain ancient ties. Chapter seven discusses how the native peoples of Buenos Aires and Costa Rica took a different path and resisted early European colonization through strong community relationships and by appealing to legal venues (National Indian Law) to defuse the threats posed by modernization to the environment, and thus to their ancient cultures and overall existence.

Finally, chapter eight summarizes the overarching arguments of the book, including the seldom recognized native legacy left on the historical development of Mesoamerica and Central America. It serves as a reminder that native groups were not pawns, but rather active participants in the historical process, with a legacy of survival that allowed them to resist and shape every historical development that has threatened their existence.

In a total of 124 pages, Carmack offers a coherent and persuasive argument demonstrating the importance of analyzing Mesoamerica and Central America as an integrated region. The book is clearly written, following a logical sequence of chapters, and the argument is equally accessible to a range of audiences, from non-experts to scholars of this topic. However, given that geography is central to the argument, additional maps would have better allowed the reader to conceptualize the different regions analyzed. Finally, a claim in chapter two that Friar Francisco Ximénez, transcriber and Spanish translator of the Popol Wuj, a sixteenth-century Maya-K'iche' creation narrative, was a creole historian is inaccurate given that he was born in the town of Ecija in the province of Seville, Spain, in 1666. Overall, this book is another important contribution to the field of indigenous studies, and a remarkable endeavor to place the native peoples of Mesoamerica and Central America as equals on the stage of world history. Carmack's research presented in this text will continue to influence future generations of students and scholars alike regarding the complex histories, societies, and cultures that developed in Mesoamerica and Central America, and that have undeniably outlived the test of historical time.

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New Resources on Indigenous Knowledge

This section lists recent publications related to indigenous knowledge. It is not intended to be comprehensive, but covers a wide range of disciplines and provides a snapshot of the depth and breadth of research on indigenous issues.

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Indigenous Leaders from Central America and Mexico Aim to Start Their Own Climate Fund

With their regional organization, the Mesoamerican Alliance of People and Forests, indigenous leaders from Central America and Mexico, are assembling a “Mesoamerican Territorial Fund,” which they hope could receive international funding. As reported by the Thomson Reuters Foundation, this initiative aims to give rapid and easy financing to indigenous communities so they can implement climate change adaptation and mitigation projects.

One of the key aspects of the fund is that it will be managed by indigenous people and benefit their own communities, with little input from outsiders – though the Central American Bank for Economic Integration would hold the money.

Leví Sucre, an indigenous leader from the Bribri community in Costa Rica, said that the Mesoamerican Territorial Fund will aim to finance adaptation projects that protect the food security of indigenous territories, in part using traditional knowledge they have acquired through the years. “We’re not dismissing the use of technology because we know that it must be complementary. But we want to incentivize the use of technologies that don’t erase our culture,” Sucre said.

In a 2008 research report, U.N. states that “indigenous peoples are among the first to face the direct consequences of climate change, owing to their dependence upon, and close relationship with the environment and its resources.”

New Institute Seeks to Empower Native American Communities

The Native American Budget and Policy Institute (NABPI) was launched in New Mexico, in February 2018. It aims to empower Native American communities to improve their health, education, and economic wellbeing. The NABPI will conduct research, budget and policy analysis, social justice advocacy, litigation, and community lawyering to encourage Native American communities to create self-determined and systematic change.

Cheryl Fairbanks, Esq., Institute Interim Executive Director (Tlingit/Tsimpshian), said, “We have the opportunity at this institute to develop indigenous policies which will have a positive effect to justify and access the much needed funding for our tribes. This institute is solution-oriented and will provide the basis for bringing constructive change to our children, families, and communities here in New Mexico.”

The institute is a project of the Robert Wood Johnson Foundation (RWJF) Center for Health Policy of the University of New Mexico, and the New Mexico Center on Law and Poverty. It is funded, in part, by the W.K. Kellogg Foundation (WKKF). The institute is an outgrowth of the work and ideas of the Leadership Institute at the Santa Fe Indian School.

More information can be found on the University of New Mexico University website.

Arctic Indigenous Film Fund Launches with Five Partners

International partners from across the Arctic – in Greenland, Sapmi (also known as Lapland), Canada, and Russia – established the Arctic Indigenous Film Fund, which was officially launched at the Indigenous Film Conference in Kautokeino, northern Norway, on March 8, 2018. The fund will support the development and production of indigenous film projects in the Arctic, encourage co-productions, and strengthen collaboration between film institutions, companies, producers, and universities.

The fund was established under the International Sami Film Institute in Norway. The four other partners are Greenland Film Makers, Canada Media Fund, Nunavut Film Development Corporation in Canada, and Archy Film Association based in Yakutia, Russia. The ISFI hopes to also add a partner in Alaska later this year.

The aim of the fund is to support film projects that “enhance indigenous peoples’ culture, languages and societies.” Activities will focus on capacity building, climate, environment, indigenous land rights, and indigenous knowledge.

Indigenous Peoples and Local Communities Vital to the Global Environment

In January 2017, LandMark – the first global platform to provide maps of land held by indigenous peoples and local communities – released new carbon storage, tree cover loss, natural resource concessions, dam locations, and other data layers that shed light on the environment in which these lands exist.

Now anyone, anywhere can view and analyze indigenous and local communities' environmental contributions and identify threats to specific lands.

Ethiopia: Bill Underway to Patent Indigenous Crops

The Ethiopian Intellectual Property Office (EIPO) is drafting a bill to upgrade patent inscription, protection, and promotion of social knowledge and biodiversity through a database management system.

The proclamation will prevent patent fraud and protect a patent right at an individual, organizational, and national level, as well as from international looters, according to Biruk Workineh, the communications affair acting director at EIPO. The stakeholders include traditional medicine and biodiversity researchers and indigenous knowledge protectors. The proclamation should become effective within a year.

University of Hawai‘i West O‘ahu Hosting Sustainable Agriculture Conference

Between July 27 and 29, 2018, about 400 educators, administrators, graduate and undergraduate students, and others involved in farmer training in North America are expected to attend the 2018 National Sustainable Agriculture Education Association (SAEA) Conference at the University of Hawai‘i–West O‘ahu.

The 2018 conference will be organized around the themes of indigenous knowledge, decolonization, and socio-ecological resiliency in agroecology and sustainable food systems education.

The conference will explore how the University of Hawai‘i, and other indigenous serving institutions in North America, are working to integrate traditional ecological knowledge, practice, and culture into post-secondary food systems education.

Join the L-ICIK Listserv

Readers of *IK: Other Ways of Knowing* are invited to join the free listserv managed by the Interinstitutional Center for Indigenous Knowledge, which is open to anyone interested in indigenous knowledge.

The nearly one thousand subscribers to ICIK's listserv receive postings that include informative articles from reliable sources.

The listserv will provide you with advance notice of ICIK seminars that can be viewed in real time via Mediasite or viewed at your leisure as an archived video on the ICIK website. The listserv will also inform you of upcoming conferences and current articles about indigenous peoples and their cultures as well as calls for submission of proposals issued by government and non-governmental programs.

To join the ICIK listserv, go to the ICIK website, then click "Join the ICIK Listserv" on the home page and provide your name and e-mail address.