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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.

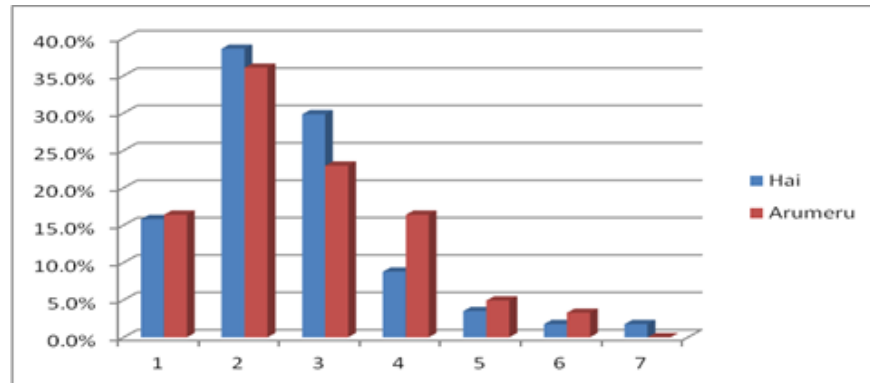


Figure 1: Percentage Distribution of Number of Dairy Cows Owned in Arumeru and Hai

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).

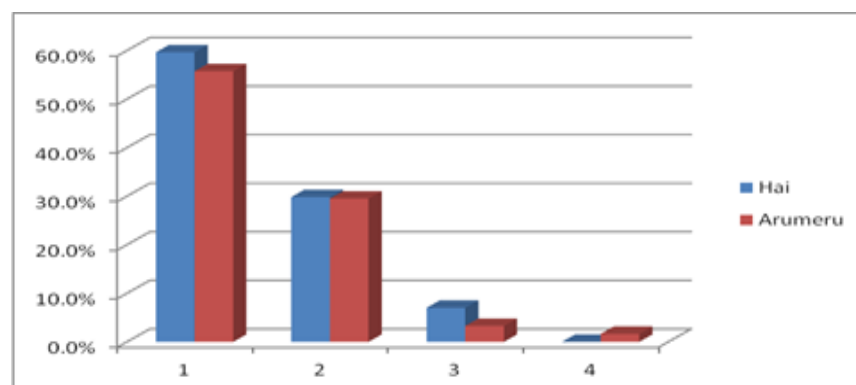


Figure 2: Proportion of Dairy Cows Currently Producing Milk in Arumeru and Hai

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

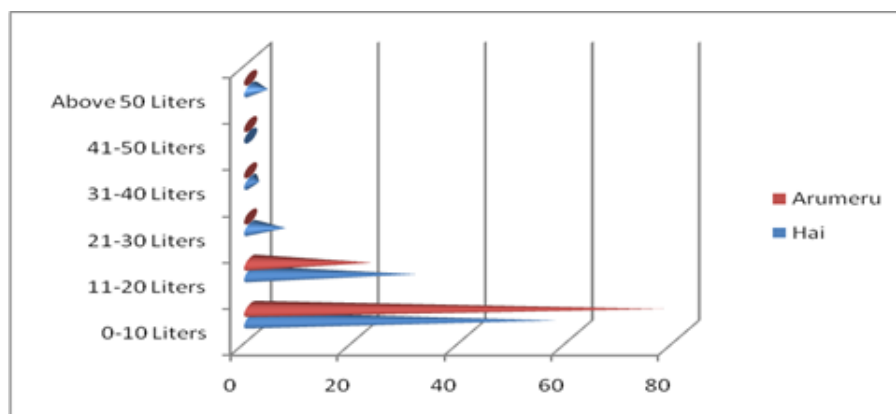


Figure 3: Amount of Milk Produced Per Day in Liters in Arumeru and Hai Districts

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.

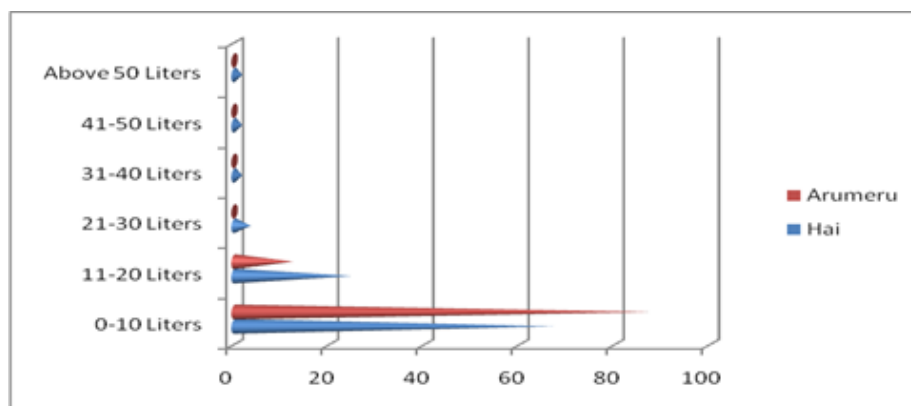


Figure 4: Amount of Milk Sold Per Day in Liters in Arumeru and Hai Districts

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):

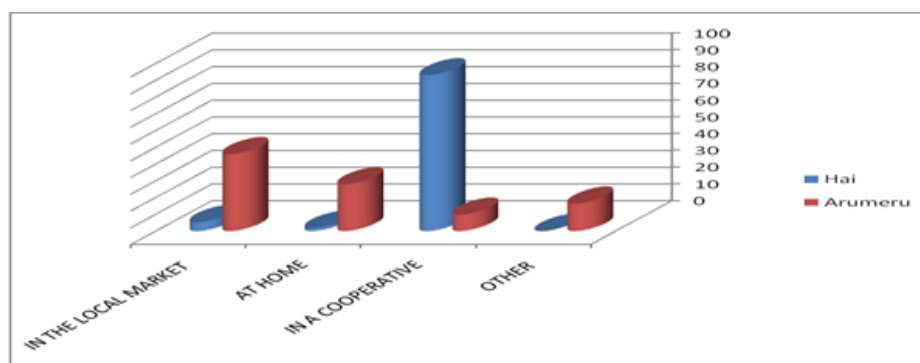


Figure 5: Percentage Distribution of Milk Selling Points

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:

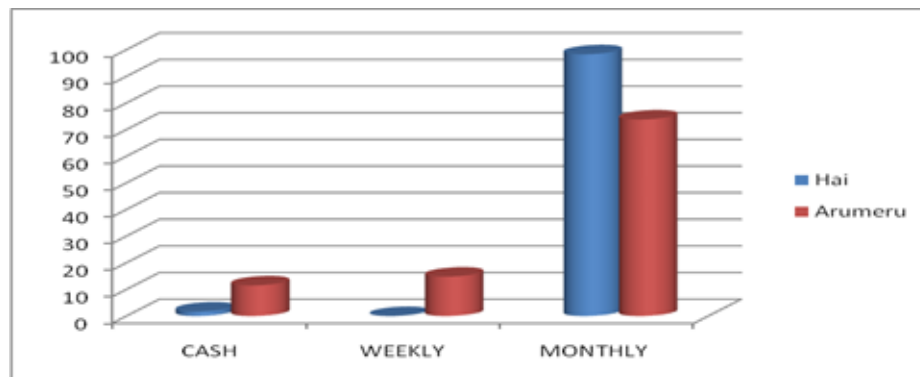


Figure 6: Percentage Distribution of Payment Methods

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.

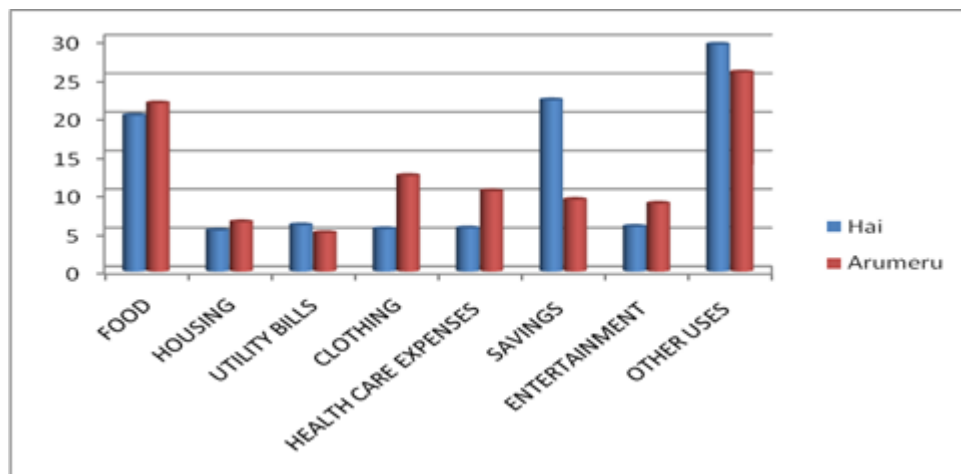


Figure 7: Percentage Distribution of Uses of Milk Revenue in Arumeru and Hai Districts

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."