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# A STUDY ON LACTOSE INTOLERANCE AND MILK INTAKE AMONG PEOPLE IN MGETA AND NJOMBE AREAS, TANZANIA

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**A STUDY ON LACTOSE INTOLERANCE AND MILK INTAKE AMONG PEOPLE IN  
MGETA AND NJOMBE AREAS, TANZANIA**

**BY**

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*–To God is the glory*

Ås, 2014

Prosper M. Mushi

## **ABSTRACT**

This study was done in August, 2012 in Mgeta and Njombe rural areas of Tanzania for the purpose of assessing the prevalence of lactose intolerance and its severity in relation to milk intake so as to create awareness on how people can cope with the problem without rejecting dairy foods completely. The small-holder farmers in Mgeta have been dealing with dairy-goat keeping based on the Norwegian breeds while the farmers in Njombe have been keeping dairy cows for more than 20 years now. The study was based on the cross-sectional survey whereby the household milk intake was assessed among the dairy-goat / cow keepers and the non-keepers. The status of lactose intolerance in the study areas was evaluated by assessing the typical symptoms following milk intake, and the quantity and form of milk that was associated with the intolerance. Pearson-Correlation test was used to determine whether the quantity of ingested milk influenced the severity of the symptoms among the lactose intolerant subjects. The severity of lactose intolerance was defined as the time taken for the symptoms to subside following milk intake among the lactose intolerant subjects. A linear relationship was assumed to exist between the quantity of ingested milk (an independent variable) and duration of the symptoms severity (a dependent variable).

Both in Mgeta and Njombe lactose intolerance manifested symptomatically following milk intake by the intolerant people; the typical symptoms experienced were nausea, vomiting, abdominal cramps, bloating and diarrhea. In Mgeta, only 1 person (10%) of the lactose intolerant subjects had the intolerance with fermented goat's milk while 9 (90%) experienced the intolerance with fresh or boiled-hot goat's milk. Generally, the lactose intolerant subjects in Njombe experienced the intolerance symptoms whenever they took cow's milk as fresh, boiled-hot, fermented, and as a cooking aid or mixed with tea / coffee. According to the Pearson's correlation test, the severity of lactose intolerance was found to be correlating positively with the quantity of ingested milk both in Mgeta and Njombe with ( $P \leq 0.005$ ;  $R = 0.807$ ) and ( $P \leq 0.000$ ;  $R = 0.860$ ) respectively at 99% CI. Cow's milk related to the severity of lactose intolerance more than goat's milk. This is due to the observation that, a larger volume of ingested goat's milk (586 MLs) was found to associate with the symptoms persistence for a shorter time (233 minutes) as compared to ingested cow's milk where a smaller volume (467 MLs) produced the symptoms that persisted for a longer time (237 minutes).



The prevalence of lactose intolerance in Mgeta and Njombe were 2% and 3% respectively. Based on the observed prevalence both in Mgeta and Njombe, lactose intolerance seems to pose no serious threat that may compromise milk intake now and in future. Putting these findings in perspective, the keeping of dairy animals (goats and cows) remain a potential contributor in fighting hunger and malnutrition in the country through increasing consumption of animal based protein sources (milk and meat) and income generation by selling off the surplus production which subsequently can entitle people to access balanced diet adequately.

Among the dairy-goat keepers in Mgeta, the household milk intake was approximately 6 litres per week – equivalent to 200 MLs per person per day. The non dairy-keeper households in Mgeta were consuming about 4 litres per week – equivalent to 100 MLs per person per day. A T-test showed a significant difference in weekly milk intake (MLs) between the dairy-goat keepers and the non-keepers in Mgeta ( $P \leq 0.004$ ; 1480 (MD)  $\pm$  498 (SE)) at 95% CI. On the other hand, milk intake in Njombe was quiet low; approximately 1 litre and 0.4 litre per household per week for the dairy-cow keepers and the non-keepers respectively. This was equivalent to the daily intake of 29 MLs and 11 MLs per person among the dairy-cow keepers and the non-keepers respectively. Also, there was no significant difference in weekly milk intake between the dairy-cow keepers and the non-keepers in Njombe.

Conclusively; the positive correlation between the quantity of ingested milk (with lactose therein) and the severity of lactose intolerance means, the more the lactose dose to be ingested, the more severe lactose intolerance is likely to manifest among the lactose intolerant people. This relationship provides a potential coping mechanism whereby reducing a volume of milk (lactose dose) to be ingested by the lactose intolerant people mitigates or eliminates the problem. Taking milk with other foods as part of a daily meal and preference to fermented milk can be added advantage in coping with lactose intolerance. Owing to the observed small number of lactose intolerant individuals which were 10 and 17 for Mgeta and Njombe respectively, there is a possibility the findings regarding lactose intolerance might have occurred by chance; thus further studies are recommended. People in the study areas seemed to have good perception on milk and the intake depended on dairy-keeping, household income and decision making in the families. Milk intake in Mgeta was found to be influenced by dairy-goat keeping and probably household power distribution from which women were postulated to play a significant role on a better use

of milk. On the other hand, milk intake in Njombe was very low because the households were selling most of the milk to the dairy company in the town; this priority could have possibly been attributed by poverty (increased need for cash) and somewhat low involvement of women in decision making. What is required in stabilizing milk supply and consumption in the country is to encourage keeping of dairy animals (mainly cows and goats) and educating the citizens on the health / nutritional benefits of milk. This should go together with poverty eradication strategies and provision of knowledge among the lactose intolerant people or the maldigesters on how they can cope with the problem without ruining their recommended intake of milk and dairy products.

***Key words: Goat milk, cow milk, lactose intolerance, Tanzania***

## LIST OF ACRONYMS AND ABBREVIATIONS

- BOS: Bacterial Overgrowth Syndrome
- CMF: Cow's milk formula
- D – IBS: In patients with diarrhea – predominant
- DASP: Department of Animal Science and Production (SUA)
- EFSA: European Food Safety Authority
- EPINAV: Enhancing pro-poor innovation and value chain participation by the poor
- GMF: Goat's milk formula
- HBT: Hydrogen Breathe Test
- HIT: Heifer in Trust
- IDA: Iron Deficiency Anaemia
- IDD: Iodine Deficiency Disorder
- IHA: Institutt for Husdyr- og Akvakulturvitenskap (Department of animal and aquacultural sciences)
- LBT: Lactose Breathe Test
- LI: Lactose Intolerance
- LIQT: Lactose Intolerance Quick Test
- LP: Lactase Persistence
- Min: Minutes
- MLs: Millilitres
- Mm: Millimetre
- MS excel – 2007: Microsoft Excel for Windows 2007
- NMBU: Norges Miljø- og Biovitenskapelige Universitet (Norwegian University of Life Sciences)
- N<sub>0</sub>: A goat's breed based on the Norwegian blood
- NORAGRIC: Department of International Environment and Development Studies (NMBU)
- PANTIL: Programme for Agricultural and Natural resources Transformation for Improved Livelihood
- PIBS: Primary Irritable Bowel Syndrome

- Ppm: Parts per million
- SLD: Secondary Lactase Deficiency
- SPSS – 19: Statistical Package for Social Sciences, version 19
- SUA: Sokoine University of Agriculture
- TCIPU: Tabora City Investment Promotion Unit
- TDHS: Tanzania Demographic and Health Survey
- VADD: Vitamin A Deficiency Disorder

#### **LIST OF STATISTICAL NOTATIONS**

- \*\*: Correlation is significant at the 0.01 level (2-tailed)
- \*\*: Correlation is significant at the 0.01 level (2-tailed)
- CI: Confidence interval
- MD: Mean difference
- N: Number of observations
- P: Probability
- SE: Standard error
- Std: Standard

#### **LIST OF CHEMICAL FORMULAS AND SYMBOLS**

- $\text{Ca}^{2+}$ : Calcium ions
- $\text{Cl}^-$ : Chloride ions
- $\text{HCO}_3^-$ : Hydrogen-carbonate ions
- $\text{HPO}_4^{2-}$ : Hydrogen-phosphate ions
- $\text{K}^+$ : Potassium ions
- $\text{Mg}^{2+}$ : Magnesium ions
- $\text{Na}^+$ : Sodium ions
- $\text{SO}_4^{2-}$ : Sulfate ions

## CHAPTER ONE

### 1.0. INTRODUCTION

Milk is the chief source of calcium and other crucial dietary components that are needed by the human body for good health (Smolin and Grosvenor, 2013). The major components of milk are water, fat, proteins, lactose, ash (sum of dissolved minerals and, calcium and phosphate which are bound to milk protein) (Table 1). Other components are vitamins and trace elements. Milk contains several ions whose concentrations are greater than 1 mmol / litre, namely; monovalent ions ( $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Cl}^-$ ,  $\text{HCO}_3^-$ ), divalent ions ( $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{HPO}_4^{2-}$ ,  $\text{SO}_4^{2-}$ ) and organic ions (citrate). Lactose is a milk sugar (disaccharide) which requires an enzyme, lactase to be hydrolyzed into its simple absorbable components: glucose and galactose (Sjaastad *et al.*, 2003).

**Table 1: Mean values for the major components of various mammals' milk**

	<b>Water (g/l)</b>	<b>Fat (g/l)</b>	<b>Protein (g/l)</b>	<b>Lactose (g/l)</b>	<b>Ash (g/l)</b>	<b>Energy (MJ/l)</b>
Goat	872	33	35	45	8	3.1
Cow	872	38	33	50	7	3.07
Human	874	45	9	70	2	3.14

Source: Sjaastad *et al.*, (2003)

People with insufficient lactase secretion are likely to experience lactose malabsorption. Ethnicity has a strong influence at which age the adult population starts to experience hypolactasia during which lactase secretion declines. Hypolactasia is lowest among North Europeans and the white population in the United States (2 – 22%) while Asians, African – Americans and Native Americans population have the highest prevalence (60 – 100%). Lactose malabsorption leads to lactose intolerance when symptoms manifest (Jellemaet *al.*, 2010). Lactose intolerance is a symptomatic disorder which occurs due to inadequate secretion or lack of lactase enzyme by an individual to digest milk / lactose. Typical symptoms of lactose intolerance which occur 1 – 3 hours after lactose ingestion are abdominal cramps, bloating,

diarrhea, nausea and vomiting (EFSA, 2011). A natural decline of lactase secretion from childhood (after weaning) refers to primary lactase deficiency. Secondary lactase deficiency is a loss of lactase activity by individuals who are actually not lactose – deficient. This may occur due to inflammation of the small intestine brush border which can result from gastroenteritis, giardiasis and celiac disease. Congenital lactase deficiency which is very seldom occurs from birth where an infant is born with inability to secrete lactase. There is a possibility that availability and consumption of milk leads to genetic evolution which brings about persistence of lactase secretion in later life, hence ability to digest lactose. For instance, the northern European societies who have had a long history of dairy farming are among the most lactase – persistent people in the world (Attel and Carter, 2013). Hydrogen breathe test (HBT) (Labuschagne *et al.*, 2012) is considered the best clinical test for diagnosing lactose intolerance.

Milk and its products are of great value in human diet due to their excellent protein quality, calcium, and numerous bioactive components such as whey peptides, conjugated linoleic acid (CLA), sphingolipids, oligosaccharides and immunoglobulins which are health promoters. Consumption of dairy products is associated with reduced risk of obesity and blood hypertension (Rideout *et al.*, 2013). Regular milk intake is potentially important in reversing or reducing the problem of lactose maldigestion. For the developing countries like Tanzania, it suits to focus on the keeping of dairy animals, particularly goats and cows as a means of ensuring adequate milk supply and intake. Covarrubias *et al.* (2009) reported that about 22% of income among the rural households in Tanzania is derived from livestock keeping from which three of five households engage in animal husbandry. Kiango (1996) reported that the majority of farmers in Tanzania practice subsistence production which focuses in producing just adequate food for household consumption. There is a growing interest in dairy goat keeping among small-holder farmers in Tanzania. This is due to increased requirement for food, particularly animal based protein sources (milk and meat). Small holder farmers have found that dairy goats are suitable in increasing food supply (milk and meat) and generating income because a dairy goat project requires low cost for investment, the project can be accommodated in locations where land is marginalized and it is easy to manage the project. The small-holder farmers are motivated to keep dairy goats because it is cost effective to produce milk from the goats. For instance; feeding goats with cheap stuffs such as roughages and crop remains is an economic way to produce milk.

Also, manure from goats is useful for fertilizing the crops. In this way, small-holder farmers create a cost-effective zone by integrating dairy-goat keeping with crop cultivation.

In 1980's pure breeds of the Norwegian dairy goats and their crosses with the indigenous Tanzanian breeds were introduced in Mgeta highlands (some 1600 meters above sea level) to enhance milk supply and consumption in the area where there is no dairy cows (Kifaro and Mtenga, 1992). Dairy goat is a substitute of dairy cow for poor people due to the fact that the goats can be kept even in marginalized farms like in urban areas and input requirements are relatively low. According to Isaksen (2009), the Norwegian dairy goats produce more milk than the indigenous goats in Tanzania. Introduction of dairy goats and cows projects in Tanzania contributes to the efforts of combating malnutrition and poverty.

Farmers in Southern highlands of Tanzania, including Njombe and Mbeya participate in "Heifer in Trust" (HIT) project. The project provides a number of dairy heifers to small groups of farmers who share the benefit among themselves at the same time perpetuate the project by paying back two heifers per each received heifer (Bayer and Kapunda, 2006). However, it seems to take some time for the benefit to be recognizable. Improving milk supply in Tanzania requires empowerment of the dairy-keeping sector. Land entitlement and easy access to agricultural inputs are major aspects to be considered by the Tanzanian Government in motivating the small-holder farmers to keep dairy animals.

### **1.1. PROBLEM STATEMENT AND JUSTIFICATION**

Malnutrition is still a big challenge in Tanzania starting from childhood. Mosha *et al.* (2000) reported protein-energy malnutrition to be as high as 50% among the young children in Tanzania. Kilama and Leach (2009), reported that around 40% of the children who are under the age of five years experience chronic malnutrition, making them stunted – which means they are too short for their age. The prevalence of wasting (low weight for height) is approximately 3% among the under – five years children while about 22% of the children have low weight for age (underweight). Iron deficiency anemia (IDA), vitamin A deficiency disorder (VADD) and iodine deficiency disorder (IDD) are the most common forms of micronutrient disorders. The 2004/05 report by Tanzania Demographic and Health Survey (TDHS) indicated that about 50% of children of age 6 to 59 months and around 16% of women of age 15 to 49 years were anemic. As it is for most of the developing countries, Tanzania is still facing challenges of malnutrition and

poverty. Poverty is well tied to malnutrition as people of low income are limited to produce or to buy enough food. Benson *et al.* (2006) indicated that poverty is a prominent challenge in most parts of Tanzania. The Household Budget Survey of 2000/2001 reported the poverty rate to be 37% which implied inability to access basic needs (food, shelter and clothing) by one third of the Tanzanian population. Approximately 11% were reported to have food poverty – inability to access elementary food needs (energy, protein, vitamins, minerals and clean water). Agriculture (animal husbandry and crop cultivation) should be empowered as the major means to eradicate poverty since above 70% of Tanzanians depend on agriculture.

Tanzania produces about 1150 million litres of milk per annum – equivalent to 39 litres per person per year which is too low for the FAO recommendation of 200 litres per person per year. Regular intake of milk is an excellent approach to improve human health due to the fact that milk contains most of the dietary components needed by the human body (TCIUPU, 2013). Heaney (2013) contended that lactose (milk) intolerance is one of the problems which can discourage people from meeting the recommended intake of milk or not to take milk at all. About 65 – 85% of African people are unable to digest lactose properly due to their insufficient lactase secretion. However, low level of understanding and fear of lactose intolerance have guided people to self-proclamation that they have lactose intolerance and hence unnecessary rejection of dairy foods, consequently they are exposed to chronic diseases such as hypertension and osteoporosis due to compromised calcium intake. Excluding dairy products entirely can potentially lead to nutritional deficiencies which in turn, worsens the situation of lactose maldigestion. There have been seldom cases of confusing the symptoms of lactose intolerance with cow's milk allergy which is the response of the body's immune system against the milk proteins. Correct diagnosis of lactose intolerance can be improved by supplementing the clinical investigation with individual perception on the symptoms and the quantity of milk / lactose taken. Self-perception on the symptoms which is connected to beliefs can increase or decrease the extent of the problem (McBean and Miller, 1998). Interestingly, the black Africans such as Maasai and Ariaal people from East Africa (where the prevalence of lactase non – persistence is as high as that of African Americans) consume about 5 – 6 litres per day but they manage to maintain good health by tolerating milk. However, nowadays it has been a common behaviour for people to overstate the



severity of lactose intolerance whereby all the symptoms – related problems are narrowed down towards lactose intolerance from which the claim may be unrealistic (Moore, 2003).

Dairy goats' and cows' projects in Mgeta and Njombe are potential contributors for improving human diet in Tanzania; therefore it is very important that people accept milk. The tendency of overstating the symptoms of lactose intolerance may discourage people completely from taking milk and its products. In turn, this will undermine the potential contribution of dairy-keeping in combating hunger and malnutrition in the country. This is the motivation behind conducting this study; to study the status of lactose intolerance and to find out how do people in the targeted areas respond towards milk consumption. It was also interesting to get information why some people do not take milk and whether lactose intolerance is a potential threat against milk intake. The information obtained from this study will help to address the possible ways of managing lactose intolerance / malabsorption without rejecting dairy foods.

## **1.2. OBJECTIVES**

### **1.2.1. THE MAIN OBJECTIVE**

- (a) To assess the prevalence of lactose intolerance and its severity in relation to milk intake so as to create awareness on how people can cope with the problem without rejecting dairy foods completely.

#### **Hypothesis**

- Null hypothesis ( $H_0$ ): There is no significant association between the severity of the symptoms and the quantity of milk taken.
- Alternative hypothesis ( $H_1$ ): There is a significant association between the severity of the symptoms and the quantity of milk taken.

### **1.2.2. SPECIFIC OBJECTIVES**

- (a) To assess the symptomatic occurrence and prevalence of lactose intolerance
- (b) To assess milk intake in the households and how it can be influenced by the keeping of dairy goats / cows.
- (b) To assess the coping mechanisms practiced by people who are lactose intolerant.

## CHAPTER TWO

### 2.0. LITERATURE REVIEW

Both goat's milk and cow's milk serve as a valuable product for human diet. A randomized controlled trial conducted by Grant *et al.* (2005) in Auckland, New-Zealand to compare growth rates of infants fed with goat's milk formula (GMF) or cow's milk formula (CMF) indicated that there was no difference in the rate of growth between the infants who were fed GMF and those who were fed CMF. In a randomized double-blind trial by Razafindrakoto *et al.* (1994), 30 malnourished children aged 1 – 5 years were randomly rehabilitated with goat's milk and cow's milk. In the end of the intervention, the results showed that mean weight gain for those who received goat's milk was slightly higher than that of cow's milk takers;  $8.5 \pm 1.37$  grams per kilogram of body weight per day and  $7.8 \pm 1.9$  grams per kilogram of body weight per day for goat's milk takers and cow's milk takers respectively. Biochemically, goat's milk has favourable nutritional value relevant to cow's milk and human milk which is very effective for nutritional rehabilitation. Thus, dairy goats are mostly needed in the developing countries in order to improve nutritional status (Pellerin, 2001).

However, goat's milk is considered to suit human health better than cow's milk. Superiority of goat milk over cow milk in human nutrition is demonstrated in three dimensions; firstly, it has more nutritional value to feed starving and malnourished people in the developing countries than cow milk. Secondly it has potential to eliminate problems associated with cow milk allergy and gastrointestinal illnesses which are common in the developing countries and thirdly, it is suitable to fulfill the gastronomic needs of connoisseur consumers – which have huge impact on market share in the developing world. Lack of information is probably the main reason for too little exploitation of the physiological and biochemical properties of goat milk such as high levels of short and medium chain fatty acids which have medicinal values against health disorders and diseases. There is a need to introduce innovation in making goat milk to better fit human health and nutritional benefits, for instance; enrichment of short and medium chain fatty acids in goat butter, plus their higher concentration than in cow butter can add a significant value to the product. Despite the worldwide appreciation of yoghurt, cheeses and milk powder derived from goat, goat butter is not that popular. Goats are considered the chief suppliers of animal based-dietary proteins (dairy foods and meat) in rural areas. The importance of goats in food production

is demonstrated by the tremendous increase in the number of goats with subsequent increase in goat milk production worldwide (Table 2) (Haenlein, 2004). Dairy goat-keeping is getting more popular, especially in the developing countries where rural communities benefits from milk / dairy products consumption. In 2009, goat milk production in the world was around 5,128 thousand metric tons with about 868 million goats. In the long run, the worldwide goat milk production is expected to increase up to 2% (Popescu, 2010). Owing to unreported household consumption, intake of goat milk is expected to be even higher than what is accounted for by official statistics.

**Table 2: Worldwide number of farmed mammalian (millions) since 1980 and annual milk production (1000 MT)**

	<b>1980</b>	<b>1999</b>	<b>Change (%)</b>
Animal numbers			
Goats	458	710	+55
Buffaloes	122	159	+30
Pigs	796	913	+15
Cattle	1216	1338	+10
Sheep	1096	1069	-3
Milk production			
Goats	7720	12161	+58
Buffaloes	44296	60334	+36
Cattle	423034	480659	+14
Sheep	7887	8026	+2

Source: FAO, 2001

Major differences between cow's milk and goat's milk are based on; homogenization, allergic reaction, digestibility and lactose content. Unlike cow's milk, goat's milk has smaller fat globules and it does not contain *agglutinin* (a compound responsible for separation of milk into cream and skim). This makes cow's milk much more a subject to industrial homogenization than goat's milk. The process of industrial homogenization requires a very high pressure that destroys the cell walls of fat globules in cow's milk so as to create a homogenized mixture of cream and skim. However, destruction of the fat globule releases free radicals called xanthine oxidase which can be a necessary factor for carcinogenesis – cancer development. Thus, goat's milk can be taken in a more natural form than cow's milk. Also, the likelihood of goat's milk to cause

allergy to the consumers is much less than that of cow's milk. This is due to the fact that, the milk protein, (*alpha S<sub>1</sub> casein*), responsible for allergic reaction is more predominant in cow's milk than in goat's milk. Cow's milk has 89% more level of *alpha S<sub>1</sub> casein* than goat's milk. Therefore, the association of cow's milk with allergy is very far beyond that of goat's milk. The level of lactose is another difference between the two milk types where the level of lactose in cow's milk is 10% more than in goat's milk (Table 1). Hence, people who are lactose mal-absorbers are likely to tolerate goat's milk more than cow's milk. Moreover, presence of small fat globules and medium chain fatty acids in goat's milk makes it easier to digest than cow's milk. This is because the medium fatty acid chains can easily be broken down and small fat globules impact on increased surface area to volume ratio during digestion (Cookie, 2010).

Recently, the number of studies telling about goat's and cow's milk is limited (Restani, 2004). A study by Freund (1996) at Creteil (France) revealed that 93% of the children with cow's milk allergy did not experience allergic reaction upon taking goat's milk in a period of 8 days to 1 year. Park (1994) reported that, goat's milk suits people who are allergic to cow's milk. About 40 – 100% of people who are allergic to cow's milk proteins can handle goat's milk. Physicochemical properties of goat's milk including numerous short and medium chain fatty acids, presence of small fat globules and soft curd formation based on its proteins provide better digestibility and more efficient lipid metabolism as compared to cow's milk.

## CHAPTER THREE

### 3.0. MATERIALS AND METHODS

#### 3.1. DESCRIPTION OF THE STUDY SITES

Mgeta is a division in Mvomero District of Morogoro Region in Tanzania which is situated in the Uluguru Mountains at about 1550 – 1750 metres above sea level. It is about 60 kilometres away from Morogoro municipality. The temperature varies from 16 to 20 ° C per annum and the area experiences about 1400 mm of rainfall per annum. Apart from keeping dairy goats, the farmers keep pig and grow plentiful of food crops such as beans, maize, cabbage, cauliflower, peaches and pears (Kifaro and Mtenga, 1992). In the present study, two nearest villages of Mgeta (Ndugutu and Nyandira) were included due to time and budgetary constraints. The landscape of Mgeta and the Norwegian dairy goats are presented in Picture 1.



*Picture 1: Mgeta landscape and the Norwegian dairy goats (Photo by Mushi, P.M. in September, 2012)*

Njombe is a region in the southern highlands of Tanzania (Figure 1). The major economic activity in Njombe is agriculture. Crops grown are maize, beans and Irish potatoes. Ibumila and Magoda villages were selected as the study areas in Njombe region because they were the first villages to benefit from dairy cows. Also, the villages were the easiest to reach, hence suitable for budgetary and time constraints.



Figure 1: Map of Njombe region in Tanzania

Source: Wikipedia, (2014); [http://en.wikipedia.org/wiki/File:Iringa\\_Regionen.png](http://en.wikipedia.org/wiki/File:Iringa_Regionen.png)

### 3.2. STUDY DESIGN

This study deployed the cross sectional design method. In this study, the respondents (farmers) were visited and interviewed at their households. Enumerators walked from one village to another, covering the major parts of the area. After interviewing one farmer, a respective household was marked by “X” so as to avoid repetition. The respondents were selected by simple random method. Information was collected through interviewing and observation.

### 3.3. SAMPLING PROCEDURES

Cochran’s equation was used to obtain the required sample size.

$$N_0 = (Z^2 \times P \times Q) / E^2$$

Where:

$N_0$  = is the prerequisite sample size for the entire study area,

Z = is the abscissa of the normal curve with respect to the confidence interval of 95%

P = is the proportion of an attribute in a given area (In this case, prevalence of lactose intolerance) and  $Q = 1 - P$ .

The prevalence of lactose intolerance (P) was taken as 80% which is the estimated prevalence in Africa (Itan *et al.*, 2010). At 95% confidence interval;  $E=0.05$  and  $Z=1.96$ . Substituting these values in the equation above,  $N_0$  was calculated as follows:

$$N_0 = (1.96^2 \times 0.8 \times 0.2) / 0.05^2$$

$$N_0 = 245.9 \approx 246$$

To account for response-deficit and the farmers that would not be contacted, the sample size ( $N_0$ ) was increased by 10% to yield the new sample size ( $N_n$ ).

$$N_n = N_0 + (10\% \times N_0)$$

$$N_n = 246 + (10\% \times 246) = 270.6 \approx 271.$$

Thus, the required sample size was 271 farmers (Israel, 1992).

According to the records provided by the respective village councils, the number of farmers in Nyandira, Ndugutu, Ibumila and Magoda were found to be 671, 408, 613 and 600 respectively. The total number of farmers ( $T_H$ ) was calculated as  $T_H = 671 + 408 + 613 + 600 = 2292$ . Finally, the required number of farmers to be contacted from each village was determined proportionally as follows:

$$N = \frac{671}{2292} \times 271 = 79.3 \approx 79$$

$$N = \frac{408}{2292} \times 271 = 48.2 \approx 48$$

$$N = \frac{613}{2292} \times 271 = 72.5 \approx 73$$

$$N = \frac{600}{2292} \times 271 = 70.9 \approx 71$$

Simple random sampling method was applied to decide from which household a farmer had to be interviewed out of the required sample size in a given village (Bourguet and Logue, 2011; Kalton, 1983). Simple random sampling is the one in which each of the subject in a study area stands an equal chance of being selected. During surveying, as enumerators approached each of the next household, a coin was tossed so as to guide on whether the household had to be visited. If the tossed coin registered a “head”, the house was visited and the house had to be skipped in case the coin registered a “tail”. The process continued until the required number of sample was attained. This sampling method was preferred due to its simplicity which saved time and money.

### **3.4. DATA COLLECTION**

The materials used for data collection were questionnaires, pencils, notebooks, coins, camera and measuring cups / cylinders. The methods deployed in the information gathering were interviewing and observing (Picture 2). Self-observation was important because there was a chance that some respondents would provide unrealistic information or they would answer automatically. The main challenges in collecting data were the use of language and possibility of obtaining inaccurate information. Some terminologies such as “lactose intolerance” could not be translated directly into Kiswahili which is the national language, understandable to all Tanzanians. To counter these challenges, the researcher trained his assistants on how to handle the interview with the farmers, particularly those who seemed to be too far from literacy. It was crucial for the interviewers to use simple language and to provide thorough explanations whenever it was necessary. Information accuracy was assured to some extent by re-questioning. Moreover, special aid was also provided to minimize errors, instead of asking the respondent to mention the amount of milk consumed by each person in the family, he / she was given a measuring cup / cylinder and asked to indicate the volume of milk consumed. The following information were gathered and recorded in the questionnaires (Appendix 1).





*Picture 2: Interviewing the farmers (Photo by Mushi, P.M. in September, 2012)*

### **3.4.1. DEMOGRAPHIC INFORMATION**

This included age distribution in a family, sex (male or female), household's head and the education level of the head of the family. This data would provide additional information in interpreting the results of the final report.

### **3.4.2. INFORMATION ON DAIRY KEEPING**

Some farmers had dairy goats / cows while others were non-keepers. The surveying required to gather this information so as to compare the per week milk intake between the two groups of farmers. The comparison was valuable in determining whether the households with dairy animals had higher accesses to milk than those who had not been keeping dairy animals.

### **3.4.3. MILK INTAKE PER WEEK**

The household's milk intake per week was assessed by recording the amount of milk taken by each person per serving, the number of serving per day and number of days per week in which milk was served.

#### **3.4.4. SYMPTOMATIC OCCURRENCE OF LACTOSE INTOLERANCE**

This assessment involved recording the subjects who claimed to get sick from taking milk due to occurrence of lactose intolerance-related symptoms. This information was useful to determine whether they could be having lactose intolerance. To be sure that the symptoms were not referred to milk intake by mistake, the respondents were required to state how often they had experienced the symptoms after taking milk. It was assumed that the symptoms could relate to lactose intolerance only if the occurrence was in not later than two hours following milk intake. However, infants and pregnant women were excluded in this assessment because they could be experiencing the symptoms related to lactose intolerance independently from milk intake.

#### **3.4.5. SYMPTOMATIC PREVALENCE OF LACTOSE INTOLERANCE**

The prevalence of lactose intolerance in the study areas was obtained by taking the number of people experiencing the symptoms of lactose intolerance and divide by the total number of people in all the studied households.

#### **3.4.6. SEVERITY OF LACTOSE INTOLERANCE**

The individuals who reported to have lactose intolerance-related symptoms provided information on how a certain quantity of milk could make the symptoms persist. The severity of the symptoms was measured by the time taken for the symptoms to subside. A linear relationship was assumed to exist between the quantity of ingested milk (an independent variable) and duration of the symptoms severity (a dependent variable); the longer the time taken for the symptoms to disappear, the higher the severity. Nevertheless, it was not obvious that the stated volume of milk was the minimum amount necessary to initiate the symptoms.

### **3.5. DATA ANALYSIS**

The data were analyzed using “Statistical Package for Social Sciences, version 19” (SPSS – 19) and “Microsoft Excel for Windows 2007” (MS – Excel 2007) software. Pearson correlation from the SPSS – 19 was used to determine how the quantity of ingested milk associated with the severity of the lactose intolerance symptoms. The comparison of the average milk intake per week among the dairy-keeping households and the non-dairy keeping households was analyzed by the “Independent Sample T – test” in the SPSS – 19. Percentiles from the SPSS – 19 and charts from MS – Excel 2007 were applied to analyze the prevalence of lactose intolerance according to age and sex, and the demographic information.

## CHAPTER FOUR

### 4.0. RESULTS AND DISCUSSION

#### 4.1. DEMOGRAPHIC INFORMATION

The average household size was found to be about 5 people per family in both Mgeta and Njombe. The distribution of age in relation to sex for the two places is shown in Table 3.

**Table 3: Information on age and sex in Mgeta and Njombe**

<b>(a) Mgeta</b>				
	<b>Sex</b>		<b>Total</b>	
	Females	Males		
	<1 year (infants)	10	4	14
	1-3 years (toddlers)	32	25	57
	4-6 years (pre-schoolers)	32	35	67
	7-13 years (school-children)	68	51	119
<b>Age</b>	14-17 years (puberty)	29	31	60
	18-59 years (adults)	149	105	254
	60+ years (elders)	27	21	48
<b>Total</b>		347	272	619

<b>(b) Njombe</b>				
	<b>Sex</b>		<b>Total</b>	
	Females	Males		
	<1 year (infants)	5	5	10
	1-3 years (toddlers)	18	19	37
	4-6 years (pre-schoolers)	24	19	43
	7-13 years (school-children)	76	58	134
<b>Age</b>	14-17 years (puberty)	37	41	78
	18-59 years (adults)	170	130	300
	60+ years (elders)	37	36	73
<b>Total</b>		367	308	675

The household power distribution in Mgeta and Njombe are presented in Figure 2. Female headed households in Mgeta were 31% while male headed households were 41% and 28% of the households were headed by both a man and a woman. About 69% of the households in Njombe were headed by men while women headed 25% and only 6% of the households were being headed by both a man and a woman.

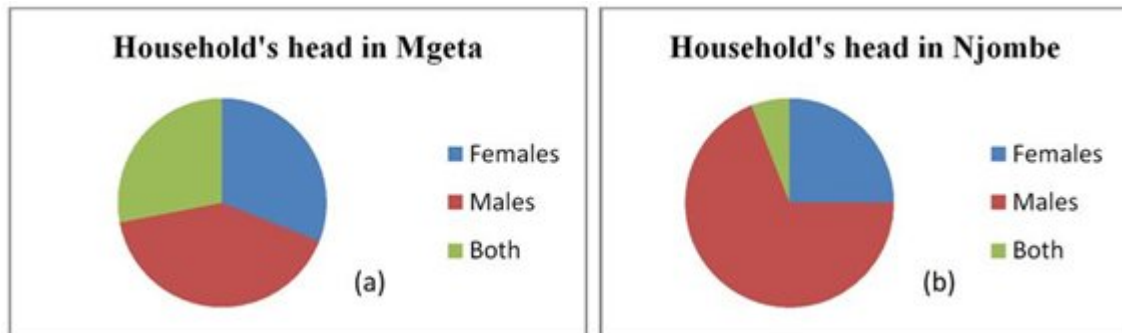


Figure 2: Household's heads in Mgeta and Njombe

About 81% and 73% of the household heads in Mgeta and Njombe respectively had attained the level of primary school education. About 9% of the household heads in Mgeta and 19% in Njombe were uneducated while the proportion of secondary education in Mgeta and Njombe were 8% and 4% respectively.

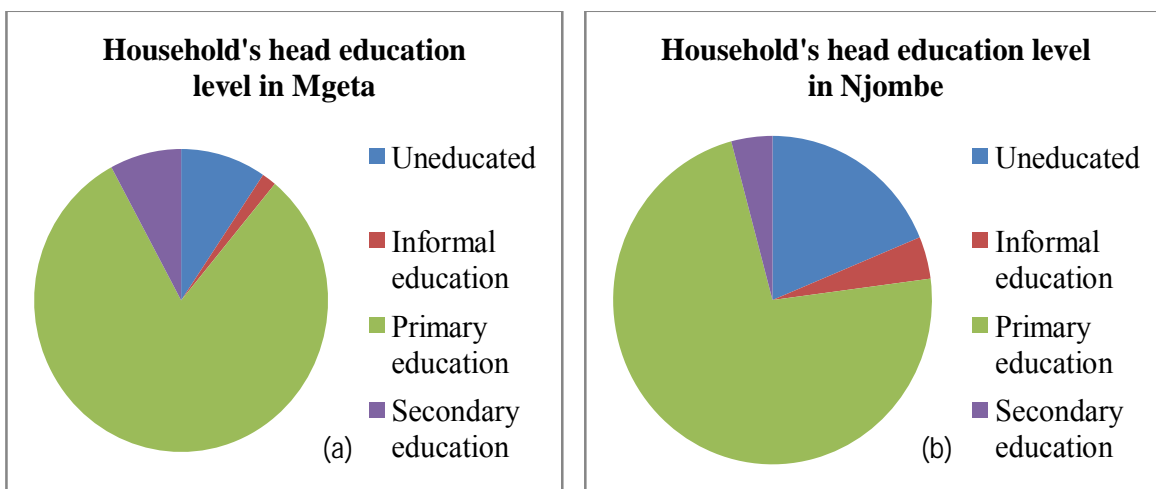


Figure 3: The education level of the heads of the households in Mgeta and Njombe

#### 4.2. MANIFESTATION OF LACTOSE INTOLERANCE

Both in Mgeta and Njombe, lactose intolerance was found to manifest symptomatically after milk intake; the common symptoms experienced were nausea, vomiting, abdominal cramps, bloating and diarrhea. As presented in Table 4, the lactose intolerant individuals reported to be experiencing the symptoms whenever they ingested goat's milk as fresh, boiled-hot or fermented. Moreover, 2 (20%) of the intolerant individuals in Mgeta were reported to have ulcers while the remaining 8 (80%) of the intolerants did not have any clue as to why milk intake gave them the symptoms. Possibly, goat's milk had narrow chances for causing lactose intolerance since 9 (90%) of the intolerant persons experienced the symptoms only due to ingestion of fresh or boiled-hot goat's milk while only 1 person (10%) reported the symptoms when ingested fermented and fresh or boiled-hot goat's milk. Unfortunately, all the lactose intolerant people in Mgeta had never tried taking goat's milk as a mixture with other foods / nutrients, and only 1 person had tried the fermented milk which did not work. Taking yogurt, using goat's milk as a cooking aid (mixed with other foods / nutrients) and as part of the meal (taking milk with food, not just plain) is something that has to be tried out by the lactose intolerant people in Mgeta.

**Table 4: Form of goat's milk taken in relation to the symptoms of lactose intolerance in Mgeta**

<b>Form of milk</b>	<b>Symptoms</b>	<b>Respondent's view on the cause</b>	<b>n</b>	<b>%</b>
Fresh, boiled-hot	Flatulence and diarrhoea	unknown	2	20
Fresh, boiled-hot and fermented	Flatulence, abdominal cramps and diarrhoea	Ulcers	1	10
Fresh, boiled-hot	Nausea	unknown	2	20
Fresh, boiled-hot	Nausea and flatulence	ulcers	1	10
Fresh, boiled-hot	Nausea and vomiting	unknown	2	20
Fresh, boiled-hot	Nausea and vomiting, flatulence, abdominal cramps and diarrhea	unknown	1	10
Fresh, boiled-hot	Stomach rumbling and flatulence	unknown	1	10

Integrating the use of fermented milk and the combination of milk with other foods / nutrients seems to be promising towards reducing or eliminating the symptoms of lactose intolerance because fermented milk has lower lactose content than fresh milk and it can easily be hydrolyzed (Rosado *et al*, 1992; Adolfsson *et al*, 2004). Also, Martin and Savaiano (1988) reported that ingesting lactose as a mixture with other nutrients in food is beneficial as it slows down the rate of stomach emptying which improves lactose digestibility.

The lactose intolerant subjects in Njombe reported to be experiencing the symptoms whenever they took cow's milk as fresh, boiled-hot, fermented, and as a cooking aid or mixed with tea / coffee (Table 5). Only 1 (approximately 6%) of the intolerant subjects were suffering from ulcers, the rest being without any clue as to why they were experiencing the symptoms after taking cow's milk. Cow's milk seemed to have a considerable wide chance for causing lactose intolerance because all the assessed forms of milk (fresh, boiled-hot, boiled-chilled, fermented, powdered and mixed with food / other nutrients) were associated with the symptoms.

**Table 5: Form of cow's milk taken in relation to the symptoms of lactose intolerance in Njombe**

<b>Form of milk</b>	<b>Symptoms</b>	<b>Responder's view on the cause</b>	<b>n</b>	<b>%</b>
Fresh, boiled-hot, boiled-chilled, fermented, as cooking aid and powdered	Abdominal cramps	Unknown	2	12
Fresh, boiled-hot, boiled-chilled, fermented, as cooking aid and powdered	Flatulence and diarrhea	Unknown	4	24
Fresh, boiled-hot and boiled chilled	Flatulence, abdominal cramps and diarrhea	Ulcers	1	6
Fresh, boiled-hot	Nausea	Unknown	1	6
Fresh, boiled-hot,boiled-chilled and fermented	Nausea and vomiting	Unknown	2	12
Fresh, boiled-hot, boiled-chilled, fermented and as cooking aid	Nausea, vomiting and stomach rumbling	Unknown	1	6
Fresh, boiled-hot, boiled-chilled, fermented and as cooking aid	Flatulence and abdominal cramps	Unknown	1	6
Fresh, boiled-hot and fermented	Nausea, vomiting, abdominal cramps and diarrhea	Unknown	1	6
Fresh, boiled-hot, boiled-chilled and fermented	Vomiting and stomach rumbling	Unknown	2	12
Fresh, boiled-hot and fermented	Vomiting, abdominal cramps and diarrhea	Unknown	1	6
Fresh, boiled-hot, boiled-chilled, fermented and as cooking aid	Vomiting, flatulence, abdominal cramps and diarrhea	Unknown	1	6

The same suggested approaches (fermenting milk and / or taking milk with other foods) for limiting lactose intolerance in Mgeta can be applied in Njombe. Owing to the differences between cow's milk and goat's milk, the latter seems to be more responsive. Gastrointestinal

health could be another factor that impacted on lactose intolerance in Mgeta and Njombe. According to Novillo *et al.* (2010), the digestive symptoms are highly influenced by small bowel bacterial overgrowth or an increased fermentative intestinal profile which in turn can lead to milk intolerance. Ruchkina *et al.* (2013) observed that, 59.4% of the patients with primary irritable bowel syndrome (PIBS) had secondary lactase deficiency (SLD) which was associated with bacterial overgrowth syndrome (BOS) in the small bowel lumen; as tested by HBT ( $101 \pm 37$  ppm (a normal value of  $< 20$  ppm)). Upon the therapeutic intervention with probiotic bifiform in 14 days, there was restoration of the eubiosis of the small bowel lumen by 70.8% of the patients. Alteration of the small bowel intraluminal microflora as a result of intestinal infection is a potential problem leading to SLD. Thus, gastrointestinal health is an important aspect in maintaining lactase persistence. By assuming the influence of ulcers on the development of lactose intolerance; and the ulcer cases being higher in Mgeta (20%) than in Njombe (6%) among the intolerant people, the number of people with lactose intolerance in Mgeta could be slightly less than the observed one.

As mentioned previously in this study, the severity of lactose intolerance was based on how long it would take for the symptoms to disappear after taking a certain quantity of milk. Figure 4 and 5 present scattered plot-diagrams for the duration of symptoms severity (a dependent variable) against quantity of ingested milk (an independent variable) in Mgeta and Njombe, respectively. The patterns exhibited by both figures depict the existence of positive correlation between the two variables in both places.



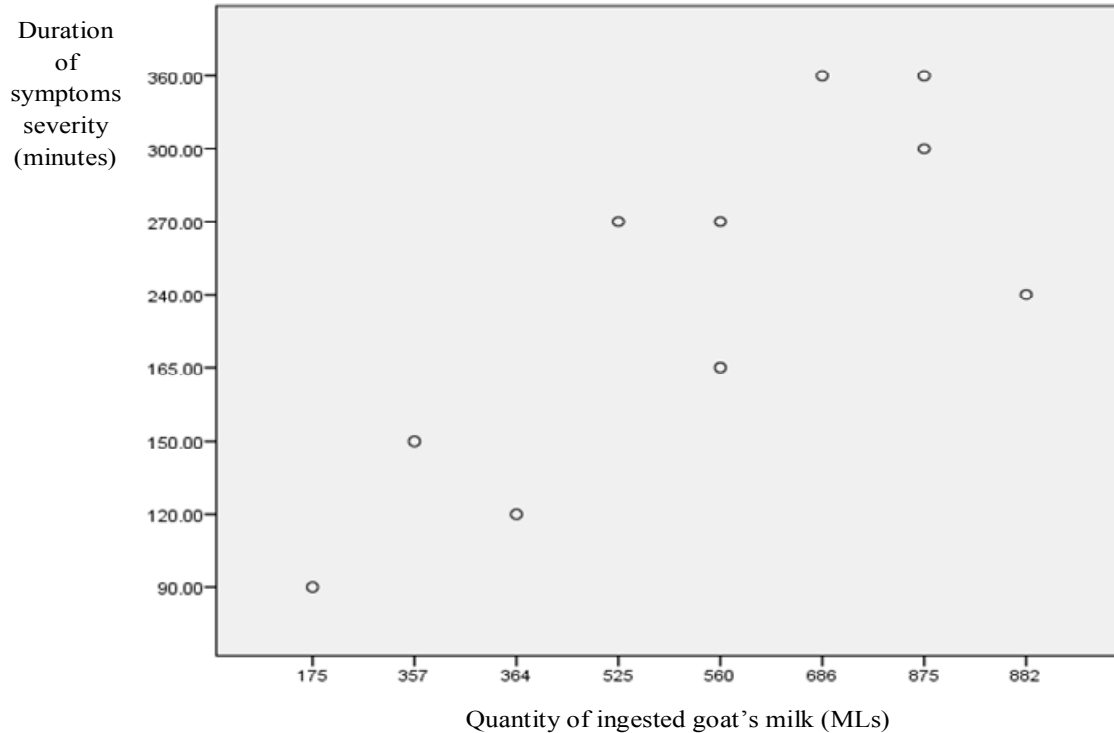


Figure 4: A scatter plot for symptoms severity against quantity of ingested goat's milk in Mgeta

As per output in Table 6, there was a significant association ( $P \leq 0.005$ ;  $R = 0.807$ ) between the quantity of ingested goat's milk and severity of the symptoms of lactose intolerance in Mgeta at 99% CI.

**Table 6: Correlations output for quantity of ingested goat's milk against the severity of the symptoms in Mgeta**

		Quantity of ingested goat's milk (MLs)	Duration of symptoms severity (Minutes)
Quantity of ingested goat's milk (MLs)	Pearson Correlation	1	.807**
	Sig. (2-tailed)		.005
	N	10	10
Duration of symptoms severity (Minutes)	Pearson Correlation	.807**	1
	Sig. (2-tailed)	.005	
	N	10	10

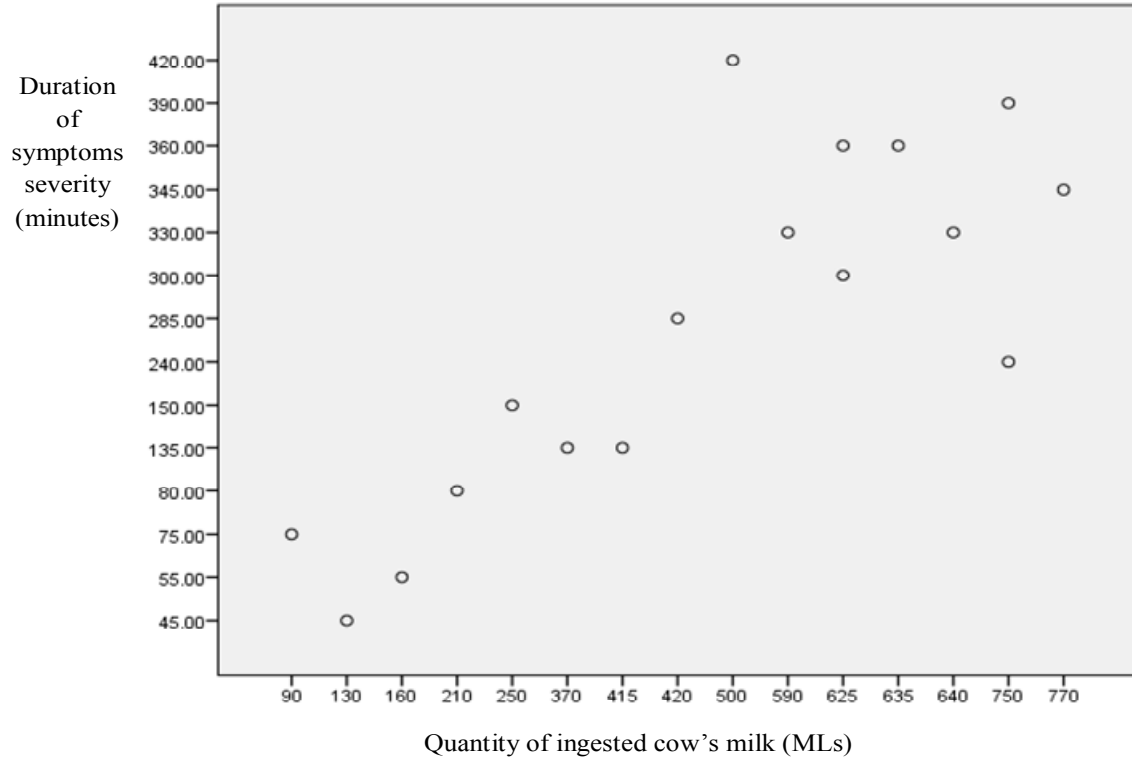


Figure 5: A scatter plot for symptoms severity against quantity of ingested cow's milk in Njombe

As depicted in Table 7, there was a significant association ( $P \leq 0.000$ ;  $R = 0.860$ ) between the quantity of ingested cow's milk and severity of the symptoms of lactose intolerance in Njombe at 99% CI.

**Table 7: Correlations output for quantity of ingested cow's milk against the severity of the symptoms in Njombe**

		Quantity of ingested cow's milk (MLs)	Duration of symptoms severity (Minutes)
Quantity of ingested cow's milk (MLs)	Pearson Correlation	1	.860**
	Sig. (2-tailed)		.000
	N	17	17
Duration of symptoms severity (Minutes)	Pearson Correlation	.860**	1
	Sig. (2-tailed)	.000	
	N	17	17

The positive correlation between the quantity of ingested milk and the severity of lactose intolerance (for both Mgeta and Njombe) is an indication that the level of lactose malabsorption was being exacerbated by higher doses of lactose which in turn manifested symptomatically as lactose intolerance among the lactase-deficient subjects in the study areas. This is in line with a study to investigate the relationship between lactose intolerance and milk intake among the Chinese adults where Qiao *et al.* (2011) observed that the amount of milk taken was positively correlated with the severity of the lactose intolerance ( $R = 0.637$ ;  $P < 0.05$ ). The implication was that, most Chinese adults with lactose intolerance could tolerate moderate milk intake below 160 milliliters. Similarly, in a randomized controlled trial, Yang *et al.* (2013) observed that, the risk of lactose intolerance (LI) was directly related to the quantity of ingested lactose dose and bowel gas production which was higher in patients with diarrhea – predominant IBS (D – IBS). However, self-reported LI (but not HBT results) was associated with milk rejection among the subjects.

People who consider themselves severely lactose-intolerant, they probably overstate the situation due to confusion of lactose intolerance with other abdominal symptoms. Limiting 240 millilitres of milk per day, it is very unlikely that the symptoms should manifest (Suarez and Savaiano, 1995). Based on the ingested volume of milk in relation to persistence of lactose intolerance symptoms among the lactose intolerant subjects, the severity of lactose intolerance seemed to be slightly less in goat's milk than in cow's milk. This is because a larger volume of goat's milk was associated with the symptoms persistence for a shorter time as compared to cow's milk where a smaller volume produced symptoms that persisted for a longer time. As depicted in Table 8, the average time taken for the symptoms to subside was about 233 minutes after ingesting an approximate of 586 MLs of goat's milk in Mgeta while Table 9 presents that an average of 467 MLs of cow's milk was associated with the persistence of the symptoms for about 237 minutes in Njombe. Thus, the observed results provide a reflection that, a given volume of goat's milk is likely to associate less with lactose intolerance than the same volume of cow's milk.

**Table 8: Descriptive Statistics for quantity of ingested goat's milk in relation to the symptoms severity in Mgeta**

	<b>Mean</b>	<b>Std. Deviation</b>	<b>N</b>
Quantity of ingested goat's milk (MLs)	586	245	10
Duration of symptoms severity (Minutes)	233	97	10

**Table 9: Descriptive Statistics for quantity of ingested cow's milk in relation to the symptoms severity in Njombe**

	<b>Mean</b>	<b>Std. Deviation</b>	<b>N</b>
Quantity of ingested cow's milk (MLs)	467	231	17
Duration of symptoms severity (Minutes)	237	130	17

Severity of lactose intolerance is increased by an increase in the volume of milk (lactose dose) to be ingested by a lactose intolerant person / maldigester. However, lactose intolerant individuals can take a reasonable quantity of milk (with lactose therein) which is nutritionally significant for health promotion without developing severe symptoms (Stephenson and Latham, 1974). Despite the increased severity of lactose intolerance due to ingestion of high doses of lactose, the tolerability can be improved when lactose is ingested with other nutrients. Shaukat *et al.* (2010) observed that, ingestion of 12 grams of lactose (240 MLs of milk) at once by a person with lactose malabsorption caused no symptoms when milk was taken without other foods. Interestingly, 15 – 18 grams of lactose could be tolerated by lactose malabsorber subjects when the equivalent amount of milk was taken with other foods. Ingestion of 24 grams of lactose produced only considerable symptoms while ingestion of 50 grams of lactose (1 litre of milk) led to symptoms in most of the subjects. In another study based on nutrient balance, Brown *et al.* (1980) investigated the nutritional consequences of supplementary milk intake by lactose-malabsorbing children. The study involved feeding 12 subjects with sufficient rice and vegetable as baseline diets alone and with milk supplement containing either glucose or lactose in three different periods. Both diets were well accepted and tolerated. For both diets, the children

marked significant body-weight increments and they exhibited improvement in apparent nitrogen absorption and retention on the diet supplemented with milk ( $P < 0.001$ ) without difference between the effects of glucose-based milk and lactose-based milk. It is therefore convincing that supplements with low dose of milk can safely be consumed by lactose malabsorbers when mixed with other foods. For population where lactose malabsorption is a big problem, suitable intervention should consider promoting milk intake in small / moderate doses under clinical surveillance rather than rejecting milk completely.

Possible implication from the results of this study is that, lactase-deficient individuals do not necessarily suffer lactose intolerance if they ingest reasonable low doses of milk. Thus, people who were abandoning milk for the allegation that they were lactose intolerant can take lower quantities of milk. Milk can be taken in small portions with other food items as part of a daily meal. Vesa *et al.* (1996) observed that, lactose maldigesters do not usually experience the symptoms of lactose intolerance under lactose dose of 0.5 – 7 grams (10 – 140 MLs of milk). In a meta-analysis study to compare the lactose intolerance symptoms among the lactose maldigesters after ingesting lactose or placebo, Savaiano *et al.* (2006) observed high incidence of diarrhoea among subjects who were at least 4 years of age and free from gastrointestinal disorders but its effect was almost negligible – implying that, lactose maldigesters do not necessarily develop the symptoms under moderate milk intake which is 1 cup per day. Similarly, Suarez and Savaiano, (2007) reported that, the maldigester individuals need not to worry about the symptoms when daily milk intake is limited to 1 cup (240 MLs). Hertzler *et al.* (1996) conducted a double-blind randomized study that included 13 healthy adults who were lactose malabsorbers so as to test whether it is necessary for lactose maldigesters to abandon milk completely. HBT was used as a measure of maldigestion and symptoms response to each dose of lactose challenge. The treatment involved feeding of 0, 2, 6, 12 and 20 grams of lactose dose to the subjects after a 2 hours fasting period. Results marked no significant difference in hydrogen production after consuming 0 – 2 grams of lactose but the 6 grams dose was associated with increased hydrogen production. Also, severity of abdominal pain increased with a lactose dose of 12 grams but flatulence did not occur until the dose of 20 grams was attained.

In this study, it is useful to account for the possible reasons that make some people lactose intolerant while others retain the ability to digest milk. In addition to good gastrointestinal health

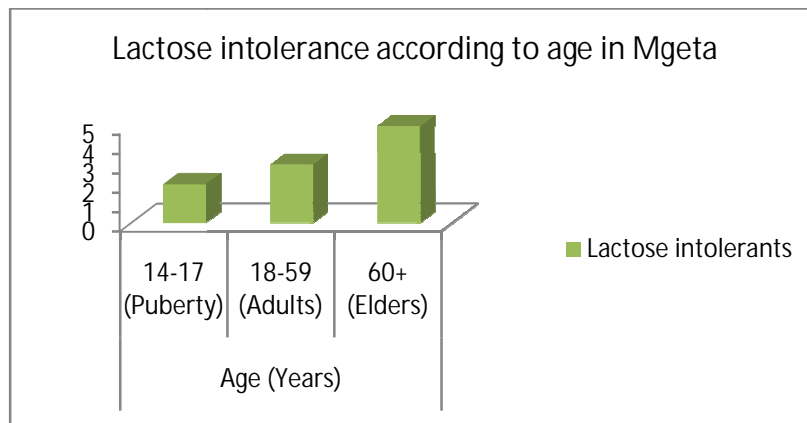
(Yakoob *et al.*, 2011; Ruchkina *et al.*, 2013), studies based on the historical importance of keeping the dairy animals (continuous milk accessibility) and the influence of genetic evolution towards persistent lactase-secretion can postulate why some people become lactose intolerant / maldigesters while others retain the ability to digest milk properly. Evidence based on genetic studies (Gerbault *et al.*, 2013), hypothesized that lactase persistence is a current human adaptation which is associated with milk intake. The geographical distribution of lactase persistence is correlated with dairy-keeping history among different population groups. Thus, dairying and regular milk intake can potentially lead to improvement in lactase persistence – hence milk / lactose tolerance. Sverrisdóttir *et al.* (2014) reported that lactase persistence (LP) which is usually down-regulated after the weaning period in humans may have evolved independently over the last 10,000 years in various parts of the world – this is related to natural selection theory among the dairying population groups, for instance North Europeans. O’Neil (2013) documented that, the ability to retain lactase activity in adulthood among the European societies is possibly a recent evolutionary progression. Nine thousand years ago, when the domestication of goats, cattle, sheep and horses had not yet started, milk was only consumed by babies breast-feeding their mothers. Pastoralism led to accessibility of non-human milk which enhanced genetic variation and enabled some adults to continue digesting lactose after childhood. Natural selection worked slightly to favour lactose intolerant people in Europe and eventually led to genetic evolution towards persistent lactase secretion. Torniaainen *et al.* (2009) reported that, while Europeans share the trait for genetic evolution on lactose tolerance (C/T.<sub>13910</sub>), Africans have several alleles (G/C.<sub>14010</sub>, T/G.<sub>13915</sub>, C/G.<sub>13907</sub> and T/C.<sub>13913</sub>) responsible for perpetuation of lactase secretion trait and they can be expressed differently in various ethnic groups. The genetic study on lactase persistence / non-persistence in populations from South Africa and Ghana by Torniaainen *et al.* (2009) confirmed the genetic relatedness of the Xhosa population to other nomadic societies (Bantu groups) in Tanzania and Kenya due to their common possession of G/C.<sub>14010</sub> allele variant for perpetuation of lactase persistence trait. The modern Xhosa in nowadays South Africa which originated from Eastern-Cape Province have been having access to milk due to their involvement in cattle keeping. Cattle keeping and continuous milk access which is generally valid among the Bantu people indicates the adaptability to digest lactose.

By assuming the validity of the above exploratory studies on the possible-historical cause for the occurrence of lactose intolerance in Mgeta and Njombe (or anywhere else in the world), it follows that; dairy-keeping ensures milk supply and regular consumption which in turn leads to genetic evolution towards persistent lactase activity – the trait necessary for milk / lactose tolerance. However, concrete information on the mechanism behind this genetic evolution is currently lacking. Johnson *et al.* (1993) suggested that, the mechanism of adapting to lactose tolerance among maldigesters is due to regular milk intake which induces colonic-lactose fermentation. In their study to evaluate the influence of consistent milk intake on lactose tolerance among African Americans who were lactose maldigesters, they observed that 77% of the subjects who completed continued milk therapy at a given period tolerated more than 12 grams of lactose while 23% of the subjects tolerated less than 12 grams of lactose. Additionally, they noticed that upon the maximum dose of lactose tolerated; only 18% of the subject had a breath-hydrogen concentration of less than 5 ppm above fasting concentration. Majority of the African Americans who are said to be lactose intolerant can tolerate up to 12 grams of lactose – equivalent to 227 MLs of milk. Gilat *et al.* (1972) observed that, taking small portions of milk by slight increase of up to 1 litre per day for about a year eliminate the problem of lactose intolerance. Regular milk intake for a long time may not necessarily boost lactase activity but it improves the wellbeing of bacteria in the colon which are necessary for colonic fermentation that breaks down lactose molecules into other products which are gaseous mixture of hydrogen, carbon dioxide and methane and short chain fatty acids; acetic, propionic and butyric acids (Valeur and Berstad, 2010). The process limits the occurrence of lactose intolerance among the intolerant people (Arrigoni *et al.*, 1992). However, it is useful to question whether this adaptation is not associated with diarrhea as the products of colonic fermentation and probably some of unbroken lactose can potentially raise the osmotic pressure in the colon which drains water from the body and lead to diarrhea (Read, 1982). He *et al.* (2006) reported that, colonic fermentation of lactose by the microbiota is important in limiting lactose intolerance but when lactose is hydrolyzed, the symptoms may be attributed to a high rate at which the microbial intermediate and end metabolites are produced. Further studies are needed to elaborate a mechanism behind the fermentative processes leading to symptoms occurrence after lactose hydrolysis. Szilagy (1999) suggested that colonic bacterial adaptation and hence reduced lactose intolerance can effectively be promoted by the use of prebiotics and probiotics.

Convincingly, adaptation to lactose digestion (tolerance) among the maldigesters is due to good health of the digestive system, regular milk intake, colonic fermentation and the influence of gut bacteria. Despite the fact that genetic makeup of an individual is a crucial source of information on whether a person can digest lactose properly or not, more studies should be conducted to establish a clear connection between regular milk intake and genetic evolution towards adaptability to digest milk / lactose properly.

### 4.3. PREVALENCE OF LACTOSE INTOLERANCE

Out of 127 studied households in Mgeta with a total of 619 people (Table 3), only 10 people were found to be lactose intolerant – equivalent to the prevalence of 2%. As presented in Figure 6, older age could be one of the risk factors for developing lactose intolerance in Mgeta. This is because the number of lactose intolerant people was found to be increasing with age. Among the 10 intolerant individuals; 2 (20%), 3 (30%) and 5 (50%) belonged to the following age group: 14 – 17 (puberty), 18 – 59 (adults) and 60+ (elders), respectively.



*Figure 6: Prevalence of lactose intolerance with respect to age in Mgeta*

On the other hand, the prevalence of lactose intolerance in Njombe was found to be around 3%, that is, 17 out of 675 people in 144 studied households were affected. Similarly, older age was a possible contributor to lactose maldigestion / malabsorption, leading to the intolerance in Njombe. Almost like in Mgeta, lactose intolerance was noticed to be more prevalent to people with older age as compared to young ones. As presented in Figure 7, out of the 17 intolerant



people; 1(6%), 9 (53%) and 7 (41%) belonged to the age groups 14 – 17 (puberty), 18 – 59 (adults) and 60+ (elders), respectively.

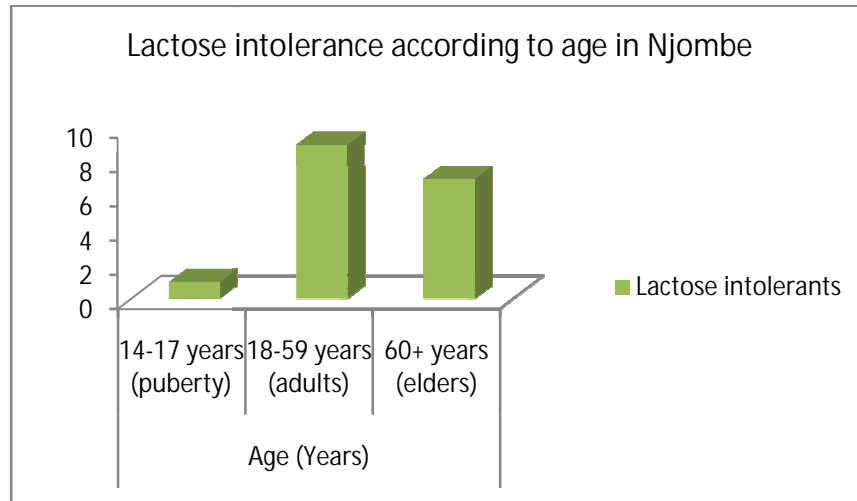


Figure 7: Prevalence of lactose intolerance with respect to age in Njombe

According to Casellas *et al.* (2013), lactose intolerance exists among people of different age groups but there is scarcity of information among the elderly people. Usually primary hypolactasia manifests under the age of 20 years. The age at which primary hypolactasia manifests, varies among different ethnic groups. Despite the fact that people usually start to experience the symptoms of lactose intolerance in adulthood, in seldom cases, the decline in lactase activity may proceed beyond the age of 20 years (Seppo *et al.*, 2008). It is possible that older age influences the occurrence of lactose intolerance in both Mgeta and Njombe. Since lactase activity declines with age (Mattar and Mazo, 2010), the observed results in Mgeta and Njombe are possibly in line with this fact. More studies need to be conducted in the areas to validate these findings.

Generally it seemed that lactose intolerance was more prevalent among female subjects than in male subjects. As presented in Figure 8, out of 10 lactose intolerant individuals in Mgeta, 7 (70%) were females while males were only 3 (30%). Similarly, in Njombe, 12 (71%) were females while males were only five (29%) (Figure 9).

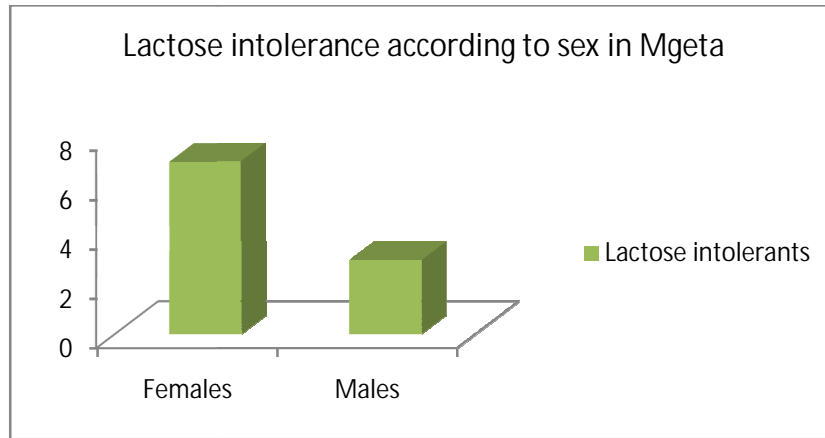


Figure 8: Prevalence of lactose intolerance with respect to sex in Mgeta

There is no concrete information on the influence of the biological difference between men and women on the likelihood of acquiring lactose intolerance. A few studies on lactose tolerance between males and females suggest that women are more exposed to the risk of getting lactose intolerance than men while some other studies show that there is no difference. Jussila (1969) and Krause *et al.* (1996) observed the likelihood of being exposed to the risk of lactose intolerance was more in women than in men. On the contrary, studies by (Saltzberg *et al.*, 1988; Rao *et al.*, 1994) suggested that, there is no difference in the risk of acquiring lactose intolerance between men and women after milk intake. Since the number of lactose intolerant individuals in Mgeta and Njombe was relatively low, it is not certain whether the observed relationship truly exists.



Figure 9: Prevalence of lactose intolerance with respect to sex in Njombe

The observed prevalence of lactose intolerance in Mgeta (2%) and Njombe (3%) are by far very low as compared to the anticipation of the extent of the problem if one reflects the reported (Itan *et al.*, 2010) prevalence of lactose intolerance in Africa (80%). Scrimshaw and Murray (1998) reported that the prevalence of lactose maldigestion in Africa varies from 15 – 100% depending on the ethnic groups. However, lactose maldigestion does not necessarily mean that a person is completely unable to digest a certain quantity of lactose unless the disorder manifests symptomatically. Hence the true prevalence of lactose intolerance may be less than what different studies report in various ethnic groups (Keith *et al.*, 2011). It is still difficult to pinpoint the prevalence of lactose intolerance in various population groups worldwide because of variation in diagnostic techniques which are also based on inconsistent definition of lactose intolerance among different researchers (Suchy *et al.*, 2010). Lactose intolerance being a small problem in both Mgeta and Njombe, this seems to pose no serious threat that may compromise milk intake now and in future. The main aspects required in stabilizing milk supply and consumption in the country are to empower the keeping of dairy animals (mainly cows and goats) and educating the citizens on the health / nutritional benefits of milk. This should go together with poverty eradication strategies and provision of knowledge among the lactose intolerant people or the maldigesters on how they can cope with the problem without compromising their recommended intake of milk and dairy products.

Probably, there has been a tendency of overstating the severity of lactose intolerance against milk intake due to self-perception on the problem. For instance, the study conducted by Robert *et al.* (1979) in Kilosa District of Morogoro Region in Tanzania indicated that 62% of the Maasai children within 5 – 14 years of age were lactose malabsorbers but all of them could tolerate milk well enough. The study indicated that all the children could consume at least 750 MLs (about 3 glasses) of fresh and or fermented milk per day without adversity from any lactose intolerance-related symptoms such as diarrhea. Therefore, it is important to inform lactose malabsorbers that milk and milk products can still be consumed in appropriate amounts. Moreover, the diagnosis techniques can be helpful in obtaining correct or misleading information about the nature of the problem depending on the setup and practicality of the techniques. Proper diagnosis technique is crucial for provision of guidance on appropriate measures to be taken against lactose intolerance with regards to the absolute nature of the problem, hence avoidance of unnecessary milk

rejection. In addition to patients' views on the nature of the problem, Perets *et al.* (2013) reported that, effective diagnostic approach of lactose malabsorption among the suspected patients should integrate lactose breath test (LBT) which is the standard method and lactose intolerance quick test (LIQT) which measures lactase activity in duodenal biopsies. The combined technique would have LBT as a primary tool for screening the presence of lactose malabsorption while LBT should be applied as a secondary test for the suspected patients with negative LBT test.

#### 4.4. HOUSEHOLD MILK INTAKE AND DAIRY GOATS / COWS KEEPING

The comparison of the household milk intake between the dairy-keepers and the non-keepers in Mgeta and Njombe were explained by t-test results. Among 68 dairy-goat keepers in Mgeta, the average milk intake per week was 6 litres while a total of 59 farmers' households who had no dairy goats were consuming approximately 4 litres of goats' milk per week (Table 10).

**Table 10: Differences in average milk intake among dairy goat farmers and other families in Mgeta**

	<b>Dairy goat-keepers</b>	<b>N</b>	<b>Mean</b>	<b>Std. Deviation</b>	<b>Std. Error Mean</b>
Goats' milk intake per week (MLs)	keeper	68	5620.74	2508.312	304.178
	non keeper	59	4140.51	3029.223	394.371

As depicted by the T-test output in Table 11, the average milk intake per week among the dairy goat keepers and the non-keepers in Mgeta differed significantly at 95% CI ( $P \leq 0.004$ ; 1480 (MD)  $\pm$  498 (SE)). Thus, the keeping of the Norwegian dairy goats in Mgeta was found to have a reasonable impact on milk supply and consumption in the households. The farmers alleged that, when the goats are well fed and treated, the daily milk intake per family is as much as 2 litres per day among the dairy-keepers. The intake of 6 litres per week among the dairy goat-keepers in Mgeta is approximately 1 litre per day which is equivalent to the intake of 200 MLs per person per day (the average family members being 5). This intake is almost a half of the recommended

intake by FAO (TCIUPU, 2013) (73 litres out of 200 litres per person per year). Kiango (1996) reported that, the genetic traits of the goats have significant impact on milk yield. In her study in Tchenzema (a village in Mgeta) and Dareda Wards of Tanzania, she found that goats with 100% blood based on Norwegian breed (N<sub>O</sub>) gave the highest milk volume (1.07 litres) per day while goats with 75 – 94% N<sub>O</sub> had milk yield of 0.83 litres, and those with 50% N<sub>O</sub> had the lowest milk yield (0.74 litre). In the same study, average milk intake in Tchenzema and Dareda were found to be 1.8 and 1.7 litres per day respectively.

The non dairy-keeper households in Mgeta were consuming about 4 litres per week – equivalent to 100 MLs per person per day. Despite the observed difference, it is convincing that a good number non dairy goat-keepers were concerned about buying as much milk as they could from the dairy goat-keepers in Mgeta because the per person daily intake of 100 MLs is not too small for 200 MLs as one could have anticipated a huge intake-difference to exist among the milk producers and those who depend solely on purchasing. The positive attitude of buying and consuming milk in Mgeta is probably due to anecdotal-oriented evidences on the health benefits of goat's milk.

**Table 11: Independent Sample T-test output for milk intake among dairy goat-keepers and the non-keepers in Mgeta**

		Levene's Test for Equality of Variances				T-test for Equality of Means				
		F	Sig.	t	df	Sig. (2- tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper	
Goats' milk intake per week (MLs)	Equal variances assumed	5.923	.016	3.012	125	.003	1480.227	491.457	507.572	2452.881
	Equal variances not assumed			2.972	112.935	.004	1480.227	498.049	493.496	2466.958

People seemed ready to spend some cash on goat's milk because they are well informed of the health and nutrition facts related to goat's milk. Few of these facts are; it is more tolerable than cow's milk due to its lower lactose content, it boosts the body's immune due to its richness in immunoglobulin molecules and it is less associated with allergy than cow's milk. Some of the farmers in Mgeta reported that, apart from food, they also have been regarding goat's milk as a natural medicine – providing relief against ulcers and improving the immune system to the patients of chronic diseases, particularly HIV / AIDS. The status of milk consumption in Mgeta is very promising due to the dairy goat-keeping programmes which are likely to increase milk supply and intake in the future. If the farmers consider improving the husbandry situation, for instance, supplementation of feed-pellets concentrated with protein, energy and minerals during lactation, there will be potentiality of increasing milk production and hence the intake. Good feeding practices improve the capability of a goat to produce milk. A goat which is well fed is likely to increase body weight reasonably which is an important aspect in producing high volumes of milk. Season of conception in relation to adequate feed availability has impact on

volume of milk to be produced by the goat. Feeding practices influence hormonal balance which necessitates ovulation (1996).

On other hand, among 78 farmers' households with dairy cows in Njombe, the average milk intake per week was about 738 MLs (approximately 1 litre) while the number of non-dairy keepers was 66 with even less per week milk intake which was about 410 milliliters, approximately 0.4 MLs (Table 12).

**Table 12: Differences in average milk intake among dairy cow farmers and other families in Njombe**

	<b>Dairy cow-keepers</b>	<b>N</b>	<b>Mean</b>	<b>Std. Deviation</b>	<b>Std. Error Mean</b>
Cows' milk intake per week (MLs)	keeper	78	737.82	1702.809	192.805
	non keeper	66	409.70	1128.439	138.901

Despite the dairy cow-keeping in Njombe, the household milk intake was very low. The farmers reported to be collecting an average of 10 litres of milk per day but they were selling most of the milk to the dairy factory (Picture 3) in Njombe town for their interests lied much on income generation rather than household milk consumption. The cash obtained was being used to improve the living standard such as making a new house, taking children to school and provision of essential needs to the family such as food. With milk missing in the diet to a great extent, people in the area are facing a risk of negative health impacts such as osteoporosis and hypertension. Low milk intake can also lead to lactase inactivity which will probably create even more discouragement on milk consumption, hence exacerbating the situation.



Picture 3: Dairy factory in Njombe town (Photo by Mushi, P.M. in September, 2012)

The T-test output in Table 13 indicates that, there was no significant difference between the average milk intake per week among the dairy cow keepers and the non-keepers at 95% CI in Njombe.

**Table 13: Independent Sample T-test output for milk intake among dairy goat-keepers and the non-keepers in Njombe**

		Levene's Test for Equality of Variances				T-test for Equality of Means				
		F	Sig.	t	df	Sig. (2- tailed )	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper	
Cows' milk intake per week (MLs)	Equal variances assumed	6.371	.013	1.336	142	.184	328.124	245.529	-157.242	813.489
	Equal variances not assumed			1.381	134.689	.170	328.124	237.629	-141.843	798.090



Generally, both the dairy keepers and the non-keepers in Mgeta and Njombe could access milk depending on how household headers were setting priorities for their family potentials. It seemed that the dairying families had more possibilities for consuming milk than the non-keepers. However, the non-keepers could buy milk from the keepers while some of the keepers were selling all the milk for they absolutely needed cash. Strictly speaking, it seemed that people were consuming or not consuming milk depending on what the disposable income allowed them to do; meaning that the dairy-keepers could afford to keep some of the produced milk for household consumption, while the non-keepers could only buy milk if they had cash available. The household power distribution (between males and females) could be another factor contributing to the family's milk intake. In Mgeta where the household power was considerably balanced for both males and females, the intake was by far higher than in Njombe where most of the families were headed by men. In Africa, it is customary for a woman to take the lead in preparing the family's meal. Hence, women involvement in the household decision-making is likely to impact on a better use of milk because they are known to be good caretakers.

#### **4.5. COPING WITH LACTOSE INTOLERANCE**

Self-perceived or true lactose intolerance can be one of the reason making people to restrict milk intake (Bailey *et al.*, 2013). In both Mgeta and Njombe, all the lactose intolerant individuals were not taking milk or any other dairy product at all so as to avoid getting sick from milk. Savaiano (2003), self-reported lactose intolerant persons have a tendency to limit milk intake, hence subjecting themselves at higher risks of acquiring chronic diseases that are caused by calcium deficiency such as osteoporosis. The symptoms of lactose intolerance are unlikely to manifest under normal dietary conditions due to the fact that the diagnosis based on lactose challenge of 50 grams dose – equivalent to 1litre of milk is not usually ingested in meals at one instance. Regular milk intake (lactose ingestion) induces colonic fermentation by the gut bacteria which mitigate lactose maldigestion among the lactose intolerant people. Almon *et al.* (2010) reported that regular consumption of milk and its products can potentially influence lactase persistence, particularly in adolescence and childhood. Thus, proper management of milk intake is a sound strategy to help the patients not to compromise their recommended milk intake.

As mentioned previously, regular milk intake impacts the adaptation on colonic fermentation which improves lactose tolerance among the maldigesters. Upon the controlled crossover studies

conducted by Hertzler and Savaiano (1996) in determining the effect of daily lactose intake on colonic adaptation and intolerance symptoms, the observation indicated that, there is colonic adaptation to regular lactose intake which reduces the symptoms of lactose intolerance. Aribila *et al.* (2000) reported that, lactose intolerance is not a limiting factor on calcium intake. Thus, lactose intolerant people can alternatively take dairy foods at moderate amounts (about 1 cup of milk, yogurt or cheese) with meals everyday so as to maintain their adequate calcium intake without experiencing the symptoms of lactose intolerance.

The approach of taking fermented milk is a good way of ensuring intake of dairy products with less chances of experiencing digestive disorders. Fermented milk favours lactose digestion due to presence of lactase activity induced by the bacteria. Lactose in yoghurt can be digested and tolerated better than the same amount of lactose in fresh milk (Rosado *et al.*, 1992; Adolfsson *et al.*, 2004). Apart from the induction of lactase activity by bacteria, fermentation enhances lactose tolerance as it reduces lactose content by about 25 – 50 % (Gorbach, 1990) which is a significant impact on the tolerability among lactose maldigesters. Usually, milk is fermented when incubated with lactic acid bacteria such as *L. bulgaricus* and *S. thermophilus*.  $\beta$ -galactosidase (whose lactose is one of its substrates) is made available from the cell membrane of lactic acid bacteria and hydrolyze lactose in milk. The osmotic pressure that would be increased by lactose load is greatly limited because of the optimized action of  $\beta$ -galactosidase in the small intestine as a result of slow entrance of lactose in the intestine caused by delayed gastric emptying when fermented milk is ingested (Labayen *et al.*, 2001). Improved lactose digestion in yoghurt is essentially due to the bacterial-lactase activity when added as culture to ferment milk (McDonough, 1987). Since enzymes work best at optimal temperatures, lactase activity is prone to destruction at high and low temperatures. Savaiano *et al.* (1984) suggested that, owing to destruction of lactase activity by pasteurization, there is a need to add live bacterial culture in yogurt so as to attain the purpose of improving lactose digestion by the maldigesters. Martini *et al.* (1987) documented that; frozen yogurt may not improve lactose digestion sufficiently due to reduced lactase activity at very low temperature.

Stomach emptying time can also impact on elimination or reduction of lactose intolerance severity. The lower the level of lactose leaving the stomach and the small bowel, the easier the active lactase in the duodenum can digest the milk sugar. When lactose is mixed with other

nutrients / food materials, it takes longer time to be transited from the stomach to the duodenum; thus offers extra time for the residues of active lactase in the small bowel to digest lactose without being overwhelmed. The implication is, when milk is taken as part of the meal with other food materials, it is likely to prevent the occurrence of the symptoms of lactose intolerance (Martin and Savaiano, 1988). The same fact applies on the higher tolerability of lactose in whole milk as compared to skimmed / low-fat milk. Lee and Hardy (1989) reported that, since whole milk has higher fat content than low-fat milk, it is emptied from the stomach more slowly than its counterpart, thus reducing lactose load in the small bowel of a lactose intolerant person – thereby facilitates the tolerance by allowing sufficient time for the active lactase to digest lactose.

## CHAPTER FIVE

### 5.0. SUMMARY

#### 5.1. CONCLUSION

The prevalence of lactose intolerance in Mgeta (where they take goat's milk) was found to be less (about 2%) than that of Njombe (about 3%) where the predominant source of milk is dairy cows. Since the observed prevalence in the study areas are well below what can be reflected from the published scientific reports, lactose intolerance does not seem to be a serious problem that can restrict people from taking milk now and in the future. Since this study was just a cross-sectional survey based on interviewing and personal observation, the observed results in Mgeta and Njombe merely reflect the extent of lactose intolerance in the areas but may not account for a clear distinction between the people who were just lactose malabsorbers from those who were truly lactose intolerant. There is a possibility that some of the subjects who claimed to be lactose intolerant were just lactose malabsorbers to some extent. Fear of getting sick from milk and lack of information might have influenced people into a coincidental judgment that would confuse the problem with ordinary gastrointestinal symptoms which have nothing to do with milk / lactose ingestion. Lactose maldigestion / malabsorption is not synonymous with lactose intolerance. Probably, the lactose maldigesters / malabsorbers can tolerate a certain quantity of lactose. Usually a person is termed to be lactose intolerant when the extent of maldigestion and absorption of lactose is so high that the symptoms manifest following milk intake / lactose ingestion. Since the quantity of ingested milk / lactose correlated positively with the severity of lactose intolerance both in Mgeta and in Njombe, lower milk volumes are likely to reduce or to eliminate the symptoms completely among the patients.

Except for those who were abandoning milk for the fear of getting sick (lactose intolerance), people in the study areas seemed to have positive perception on milk but income and adequate supply are two of the potential challenges. Milk intake in Mgeta was found to be influenced by the keeping of the Norwegian dairy goats and knowledge (anecdotal evidences) on health benefits of goat's milk. Moreover, women involvement in the household decision making may have been contributing to a better use of the home-produced milk whereby family's consumption is highly regarded. Milk intake in Njombe was very low due to the fact that most of the milk was being sold to the dairy factory in town because the households had higher priority for cash than

home consumption. This may have been influenced by high requirements for income and low involvement of women in family's decision making.

## **5.2. RECOMMENDATIONS**

It is highly important to educate people in the study areas (and elsewhere) on the importance of consumption of dairy products for a balanced and healthy diet. People who experience allergic symptoms (whether they are just lactose malabsorbers or truly lactose intolerant) should take milk even in small portions as part of daily meals, thereby training their digestive systems to digest milk 'little by little'. As accounted in the discussion, this may lead to adaptation to the ability of digesting milk properly, hence mitigating or reducing the problem. Though a good number of researchers have observed different lactose quantities that suggestively may not temper with the consumers' tolerability, it is wise that the decision of lactose content to be ingested remains on the consumers themselves because they are the one who can give firsthand information on how severe they experience the symptoms. This should be in line with good diagnostic procedures, that is; the diagnosis should also regard the patients' own views because their experiences may necessarily not tally the technical diagnostic procedures.

Dairy-keeping is the sole source of milk supply in rural areas. The ongoing dairy-farming in Mgeta and Njombe are potential contributors in reducing hunger / malnutrition and poverty in Tanzania. To ensure that some of home-produced milk is saved for household consumption, it is important to encourage household milk consumption (especially in Njombe where it is very low) through provision of education on health benefits of milk and knowledge on alternative income sources rather than total dependence on the produced milk. Dairy keeping is essential for increasing milk supply that in turn helps to improve human diet in the country by encouraging dairy consumption and generating more income (obtained from selling milk and meat) with subsequent entitlement to adequate and healthy food. Putting aside the nutritional / health benefits of goat's milk over cow's milk, keeping of the dairy goats is much cheaper and thus convenient for people of low income than cows. Empowering dairy goat projects in Tanzania means to improve consumption of animal-based proteins (milk and meat) which are greatly needed to contribute in combating hunger and malnutrition. It should however be noted that, encouraging the keeping of dairy goats does not mean to compromise the keeping of dairy cows but to supplement the latter so as to increase efficacy in food production and poverty eradication

which are prerequisites in ensuring nutrition and food security in the country. It suits to emphasize dairy goat keeping since a large number of small-holder farmers can easily benefit because the initial costs are relatively low, turnover rates are high, milk / meat production can easily be sustained under low running costs, and a small piece of land can accommodate the project.

Additionally, gender can virtually affect milk intake in rural households where milk is produced. Being good caretakers in the families, women involvement in decision making is likely to encourage consumption of home-produced milk.

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## APPENDICES

### Appendix 1: The questionnaire for the assessment

#### A STUDY ON LACTOSE INTOLERANCE AND MILK INTAKE AMONG PEOPLE IN MGETA AND NJOMBE AREAS, TANZANIA

Age of respondent..... (Years)

Sex..... (Male/Female)

Marital status..... (Single/Married/Divorced/Widowed)

Education attained..... (None/Formal/Primary/Secondary/College and above)

Occupation..... (Peasant/Employed/Business)

Location.....Responder's number.....

#### **Family's general information**

##### 1. Family type

Family Type	Mark
Nuclear family	
Cohabiting family	
Single parent family	
Extended family	
Other family type (.....)	

##### 2. Head of the household (the main decision maker)

- (a) Father
- (b) Mother
- (c) Both father and mother
- (d) Any other relative (.....)

##### 3. Distribution of family members by age and sex:

Please fill in the table below

Age group	Female	Male
>1 (Infants)		
1-3 (Toddlers)		
4-6 (Pre-schoolers)		

7-13 (School-children)		
14-17 (Puberty)		
18-59 (Adults)		
60+ (Elders)		

**Assessment of type and quantity of milk consumption in the households**

4. Do your household members take milk?

- (a) Yes, all of them
- (b) Yes but not all
- (c) No one takes milk in my family

5. If no one takes milk in your family, what are the reasons?

- (a) Milk is not available
- (b) Milk is too expensive
- (c) Milk is not our traditional food
- (d) Other (.....)

6. In which form is milk consumed?

- (a) Fresh, boiled-hot, boiled-chilled
- (b) Fermented
- (c) Mixed with tea/coffee
- (d) As cooking aid (for instance, vegetable ingredients)
- (e) Powdered

7. Please fill the table below by indicating the quantity and frequency of milk intake by different age groups in your household with respect to one week ago:

Age	Quantity (Litres)	Days	Frequency (number of times per day)				
			Never	Once	Twice	Thrice	More than thrice
Age group							
>1 (Infant)							
1-3 (Toddler)							
4-6 (Pre-schooler)							
7-13 (School-child)							
14-17 (Puberty)							
18-59 (Adult)							
60+ (Elder)							

**Assessment of symptomatic prevalence of milk (lactose) intolerance experienced among individuals of different age and sex in the households**

8. Does any of your family members experience symptomatic sickness when they take milk?.....Yes/No.

Please fill in the table below by indicating age and sex of your family members who are troubled with milk intake:

Age group	Female	Male
>1 (Infants)		
1-3 (Toddlers)		
4-6 (Pre-schoolers)		
7-13 (School-children)		
14-17 (Puberty)		
18-59 (Adults)		
60+ (Elders)		

9. What symptoms does the patient experience after consuming milk?

- (a) Nausea
- (b) Vomiting
- (c) Stomach rumbling
- (d) Flatulence
- (e) Abdominal cramps
- (f) Diarrhoea

10. What do you think are the reasons for the occurrence of such symptoms after milk intake?

- (a).....
- (b).....
- (c).....

11. When did the individual start to experience such symptoms?

- (a) A few days ago
- (b) A few months ago
- (c) At least one year ago

(c) Whenever he/she takes milk

(d) Milk products

12. Severity of the symptoms:

Please complete the table below

Quantity of milk causing symptoms (ML)	Severity measured by symptoms persistence		Average time (min)
	Minimum time (min)	Maximum time (min)	

**Assessment on the coping strategies of lactose intolerance in the households**

13. Has the patient ever tried an alternative type of diet?.....Yes/No?

14. If “YES”, what alternative diets does the patient take?

(a).....

(b).....

(c).....

15. What are the impacts of the diet?

(a) Symptoms disappear

(b) Symptoms persist

16. Who advised on the diet usage?

.....