FACTORS AFFECTING ADOPTION OF ARTIFICIAL INSEMINATION TECHNOLOGY BY DAIRY FARMERS IN KINONDONI DISTRICT

BY

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ABSTRACT

A study was carried out in Kinondoni district in Dar es Salaam region with the aim of establishing factors affecting adoption of AI technology by dairy farmers. Data were collected using formal and informal interviews where structured questionnaires were administered to 90 randomly selected dairy farmers from three wards. The data were analysed quantitatively using descriptive analysis and Tobit regression. Results from descriptive analysis indicated that dairy farmers who used AI technology were significantly older ($P < 0.05$) by 4.8 years and women had higher adoption proportion (51.5%) than men (31.5%) and 65.7% of adopters had high knowledge level about AI versus 10.9% of non adopters. Cattle belonging to adopters had significantly higher ($P < 0.05$) average milk yield by 2.3 litres. Among the total respondents, 61.1% used natural mating, 28.9% used natural mating + AI and only 10% used AI alone to breed their animals. Average cost of using AI service was higher than using natural service by Tshs 14 290/=. Majority of respondents (62.2%) indicated difficulty in getting AI services, 75.6% had their contact with extension agent made on request, 57.8% indicated inadequate extension services and only 21.1% of respondents joined dairy farmers' groups. Results from analysis of extent of adoption indicated that the rate of adoption of AI technology was 38.9% implying that the uptake is low. Based on Tobit results, factors positively associated with adoption and use intensity included education level, difficulty in getting AI service, extent of extension visits and being a member of dairy farmers' group or not. On the other hand factors negatively associated with adoption and use intensity included sex and breed of dairy cattle. These results suggest the need to train more inseminators and government to regulate AI service providers to ensure high standard of AI service, strengthen extension services, promote formation of dairy farmers' groups and conduct training to new and less educated dairy farmers to stimulate more adoption of AI in the study area.

DECLARATION

I, Abdallah Emil Mlemba Temba, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work and that to the best of my knowledge it has neither been submitted, nor being concurrently submitted for a degree award in any other Institution.

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The above declaration is confirmed

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Prof. Kifaro G. C. Date
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DEDICATION

This work is dedicated to my wife **Alice** and children: **Neema, Janet, Edwin, Nature** and **Exaver** for their love and patience.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIX

ABBREVIATIONS

AI	Artificial Insemination
ARI	Agricultural Research Institute
FAO	Food and Agriculture Organisation of the United Nations
FGD	Focus Group Discussions
GDP	Gross Domestic Product
ILRI	International Livestock Research Institute
IPM	Integrated Pest Management
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MLD	Ministry of Livestock Development
MLDF	Ministry of Livestock Development and Fisheries
NAIC	National Artificial Insemination Centre
NGO	Non Governmental Organisations
SACCAR	Southern Africa Centre for Cooperation in Agricultural Research
SNAL	Sokoine National Agricultural Library
TSHS	Tanzania Shilling
TSZ	Tanzania Short Horn Zebu
URT	United Republic of Tanzania
USA	United States of America

CHAPTER ONE

1.0 INTRODUCTION

1.1 The Tanzanian Livestock Industry

Tanzania is endowed with abundant natural resources, which include land, forage and a large livestock resource base. Out of the total 94 million hectares of land resource, 60 million hectares are rangelands utilised for grazing 19.2 million cattle of which 680 000 are dairy cattle; 13.7 million goats and 3.6 million sheep (MLDF, 2010). Currently, only 17 million Livestock Units are kept but the rangelands have a capacity to carry a total of 20 million livestock units (MLD, 2006a). The country ranks third in livestock population in Africa after Ethiopia and Sudan (FAO, 2003). However, like many other developing counties, it has large and growing deficit in milk and milk products to the extent that it imports substantial amounts of dairy products (Doto, 1999). The growth rate of livestock industry was 2.3% in 2009 (URT, 2009) and it provides about 30% of the agricultural GDP which was 24.1 % in 2010 (URT 2011).

Annual meat production during the last 10 years (1995 – 2005) has increased from 244 000 tons to 378 500 tones (55% increase), mostly from the traditional sector. Similarly, milk production increased from 555 million in 1995 to 1.65 billion litres in 2010, of which the traditional sector contributed 997 million litres and 653 million litres came from exotic breeds (MLDF, 2010). Regardless of this increase in production trends, the performance of the livestock industry is still low. This is mainly due to low genetic potential of the indigenous livestock coupled with limited supply of improved livestock and declining breeding services leading to poor production and productivity, high mortality rates, low reproductive rates and poor quality of the products (MLD, 2006b).

The livestock industry can be categorized into two major production systems namely extensive and intensive. The extensive system, which is mostly agro-pastoralism and pastoralism, is a production system based on seasonal availability of forage and water. For survival, farmers tend to cope with the extremes of climate (Hella and Mkunda, 2006) thus resulting into uncontrolled mobility and are dominated by the Tanzania Short Horn Zebu (TSZ) which is about 90% of the national cattle herd (MLD, 2006b). Its production coefficients are low e.g. slow growth rates and late maturity, long calving intervals, high neonatal and post weaning mortality and low milk yield (Doto, 1999). The intensive system, though limited in size, has been receiving more emphasis in investment and improvement because of its contribution to the market oriented economy and dominated by government ranches, livestock multiplication units, dairy farms, and individual smallholder dairy farms where improved dairy breeds are kept (Teendwa, 2005). Livestock production in Tanzania is mainly for the domestic market with little or no export of live animals or livestock products (MLD 2006a) and almost all livestock products (milk and meat) come from the traditional sector.

1.2 Dairy Sub sector

Tanzania is estimated to produce 1.65 billion litres/year in 2009/10 (MLDF, 2010) which is only 3.55% of total milk produced in Africa and only 0.14% of milk produced worldwide (FAO, 2003). The produced milk comes from traditional herd (TSZ) which constitutes about 70% of the total milk produced in the country while improved dairy cattle are of *Bos taurus* types such as Friesian, Ayrshire, Jersey and their crosses resulting from local types (*Bos indicus*) such as TSZ, Ankole and Boran (Teendwa, 2005). Milk is mainly (60%) produced from indigenous cattle which in 2009/10 amounted to 997 million litres while 40% or 653 million litres is from improved cattle (MLDF, 2010). Milk marketed comes mainly from small-scale livestock farmers who supply on average about

70% and large-scale farmers supply about 30%. Average milk production per lactation from traditional herd is estimated at 500 litres compared to 2000 litres from improved dairy cattle (MLD, 2006b). Biwi *et al.* (1993) indicated that average milk yield in the zero-grazing system was 8 kg/cow per day, with a maximum of 22 kg/cow per day. In the semi intensive system, average milk yield is 6 kg/cow per day with a maximum of 15 kg/cow per day. In both situations income is adequate to sustain a farm family.

While Tanzania possesses Africa's third-largest cattle herd, and nearly two-thirds of the rural poor already own livestock, most farmers are unable to enjoy the incomes and improved food security that the dairy industry provides in neighboring countries such as Kenya (Land O'Lakes, 2011). In fact dairy farming has generally never been a commercial activity in Tanzania except in pockets of rural and urban areas (Limbu 1999). Some of the bottlenecks include: non- availability of exotic crosses with potential to produce high milk yield, seasonality in availability of cheap animal feed, poor veterinary services, lack of milk processing and storage technologies. Most people do not value milk more than they value other drinks such as beer, and availability of cheap imported milk products. While these bottlenecks are well known, some apparently profitable technologies sit underutilized which farmers can use to increase productivity. Artificial insemination is among the technologies which are underutilized and the current study intended to uncover the reasons for its underutilization.

1.3 Artificial Insemination

Artificial insemination (AI) is the most significant scientific invention for improving animal genetic make-up and hence increased animal productivity in the 20^{th} century. This is still the only tool available to mankind for moving massive genetic payloads into populations and for rapidly re-engineering the desired changes in their genetic architecture

(Kurup, 2000). AI is widely used in developed and developing countries for cattle, mainly dairy cattle, and to a lesser but increasing extent in other species such as sheep, goats and pigs. Although the immediate result is the impregnation of the female, the real benefit of using AI is that it gives all farmers the possibility of gaining from genetic improvements created elsewhere, privately or collectively (Chupin and Schuh, 1993).

Globally, the AI industry seems to be very active; large numbers of doses are being processed (2.5 times more than inseminated); intense international exchanges are observed; and approximately a fifth of the breedable female dairy cattle population in the world is now bred by AI (Thibier and Wagner, 2002). In Asia - excluding some smaller countries, such as Hong Kong, the Republic of Korea and Singapore - where almost 100% of breedable females are inseminated - AI coverage stands between 1 and 5%, except in China (12.6%), Afghanistan (20.2%) and Indonesia (23.1%) (Chupin and Schuh, 1993).

In Africa AI was introduced in the 1950s and 1960s, mainly on large scale private or institutional farms. Many governments later set up national AI programs in the 1970s and 1980s. While more than 70 percent of animals are bred using AI in the developed world, the technology is almost practically not available in 25 developing countries 16 of which are found in Africa. The coverage remains low, with less than 2 percent of breedable females being inseminated. Kenya recorded AI coverage of 12.9 percent and Zimbabwe 3.25 percent. In Uganda only a small proportion (2-15 percent) of farmers used AI services in the mid 1990s (MAAIF/ILRI, 1996). The low use of AI in Uganda was attributed to low availability of services, high cost, uncertain reliability and the wide spread misconception that AI produces disproportionately more bull calves.

The government of Tanzania has been putting a lot of emphasis on dairy development in the country since the mid 1970s. The combined efforts of government and development partners have resulted in expansion of the improved dairy herd from 143 000 in 1984 to 680 000 in 2009/2010 (MLDF, 2010). According to Kyomo *et al*. (2006), the dairy industry is facing a critical shortage of high producing dairy cows therefore; there is a need for expanding the national dairy herd through efficient and cost effective breeding strategies. However, AI which is a cheaper and faster tool to use than live male animals has been used in some cases in Tanzania to speed up crossbreeding (Kyomo and Kifaro, 2005). The government has been committing resources through establishment of National Artificial Insemination Centre (NAIC), including facilities for the production, storage and distribution of semen and training of inseminators for efficient maintenance of field AI services. Despite indication by Msanga *et al.* (2009) of potential national demand of about 800 000 doses of semen per annum, NAIC in 2008 distributed a total of 42 200 doses of semen which was only 5.2% of expected national annual demand. This is an indication of low uptake of AI by dairy farmers.

Kinondoni district experiences the same situation regardless of being amidst all service provisions like readily availability of semen, liquid nitrogen and adequate number of inseminators, easy access to farmers, and other services. The majority of dairy farmers in the district are complaining of low profits or losses and even some quitting the industry. This is so due to the fact that economic viability of a livestock enterprise depends on, among other factors, the genetic potential of that given germplasm to respond to improved husbandry (good feeding, housing and health care). The germplasm, and particularly its genetic potential when considered as a resource can impede increases in productivity (Oluoch-Kosura *et al*., 1999). In the district land is limited and labour is constraining, keeping a cow that has low genetic potential for milk production would be uneconomical and therefore the well being of the dairy farmers is not guaranteed. In such instances, development and wide adoption of germplasm that have higher genetic potential for milk production need to be undertaken with the aim of achieving higher productivity and consequently alleviating poverty among the dairy farmers in the district.

1.4 Problem Statement

In spite of a number of advantages of AI over natural service, the adoption rate of AI technology in Kinondoni district has been at a slower pace. This can be attributed to the nature of AI service provision being a complicated process entangled in socio-economic, cultural, political, technical and service related factors. Even if the social and political debates were resolved, there remain many reasons for poor utilization of services, method failure is not uncommon and refusal based on undisclosed reasons remain salient. Therefore, there is a need to identify factors that affect the uptake of technology by dairy farmers and provide intervention strategies to the problem. Innovation studies have been conducted in Tanzania in order to establish their impact on modernization of the agricultural sector (Lyatuu, 1994; Machumu, 1995). However, no studies on adoption of AI technology have been done in Kinondoni district to find out why people of the same social – economic status adopt AI and others do not.

1.5 Justification for the study

Temperate dairy cattle perform better than the indigenous Zebu cattle in the tropics (Oluoch-Kosura *et al.*, 1999). As the human population increases in Kinondoni district, land size decreases and it becomes prudent to adopt technologies that would enable efficient utilization of the scarce resources. The concurrent use of highly selected dairy cattle through AI is the technological package of choice to largely give stride to the development of dairy farmers in the district. Since the adoption of AI technology is not in high order, it is imperative to conduct a study which is going to generate information on factors that affect dairy farmers' attitude on adoption of AI in the district. This study is potential for government, policy makers, stakeholders and other development agencies such as Non Governmental Organisations and Community Based Organisations to provide appropriate intervention strategies that will ensure increased adoption and uptake of AI technology. This will increase the productivity coupled with increase in dairy cattle population resulting in a notable increase in milk production. In this case the study is in line with objectives of the National Livestock Policy (2006) and the Millennium Development Goals. In addition, the study is going to benefit different levels of academicians as reference materials for adoption studies.

1.6 Objectives of the Study

1.6.1 Main objective

The main objective of this study was to establish factors that affect the adoption of AI technology in Kinondoni district and establish the relationship that exists among them.

1.6.2 Specific objectives

i) To identify and describe dairy farmers' economic, AI technology, institutional and socio-psychological factors associated with the variance in AI practice.

ii) To determine the rate of adoption of AI technology by dairy farmers.

iii) To determine the level of relationship each factor has on the adoption and use intensity of AI technology by dairy farmers.

1.6.3 Research hypotheses

i) The farmers, institutional, AI technology, economic and socio-psychological related characteristics are not associated with variance in AI technology adoption.

ii) The dairy farmers direct acceptance on the use of AI technology is not associated with the probability of adoption.

iii) The continued utilisation of AI technology after adoption is not associated with farmers, technology, institutional, economic and socio-psychological related characteristics.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Livestock Policy

The 2006 National Livestock Policy was the third policy document of the livestock industry. The first policy was launched in 1983 with the aim of stimulating livestock development in the centralized economy. Emphasis was on large-scale parastatal institutions for production, processing and marketing of milk. The Agricultural and Livestock Policy of 1997, which was the second policy to be formulated was in line with the ongoing reforms and redefined roles of public and private sectors. However, during implementation of this Policy other reforms emerged thus demanding for a review and formulation of a new policy. The new policy seeks to address specific key issues including animal identification, registration and traceability, animal welfare, indigenous technical knowledge, biotechnology and bio-safety, organic livestock farming, food safety, emerging diseases, livestock products regulatory institutions, professional regulatory institutions, animal genetic resource conservation, livestock stocking, veterinary laboratory system, livestock related disasters and pet animals (MLD, 2006b).

2.2 Contribution of Livestock Sector to National Economy

The meat and dairy sub sectors in Tanzania are among the important sectors of the economy that have great potential to contribute towards economic development of this country. Of the 4.6 % contribution of the livestock sector to the National GDP, beef contributes 40 % and dairy 30% (Msanga *et al.*, 2009). The small contribution of cattle to the economy despite the large population is mainly attributed to the low productivity of the cattle. The genetic potential for milk and meat production of the indigenous cattle of the Tanzania Shorthorn Zebu (TSZ) type is low coupled with limited supply of improved livestock. Kurwijila and Kifaro (2001) argue that low genetic potential for milk production characterized by poor milk yields, short lactation lengths, long calving intervals and high age at first calving contribute to low contribution of livestock sector to the country's GDP. Gautam *et al.* (2005) stressed that AI is the only tool available to the scientists to carry massive genetic inputs into animal populations and to rapidly engineer the desired changes in genetic architecture of milch population. AI which is a cheaper and faster tool to use than live male animals has been used in some cases in Tanzania to spread up crossbreeding (Kyomo and Kifaro, 2005). However, efforts of modernization in livestock sector starts with technological improvement of the rural areas and therefore producers of this sector must be oriented to use new technologies and adopt innovations in order to increase the sector's contribution to the economy (Hasan *et al*., 2008). Teendwa (2005) argued that the dairy sub-sector plays a crucial role in sustaining smallholder crop and dairy system through nutrient recycling, sustaining high human population densities even in semi arid areas, and it is an important tool in reducing poverty in rural, urban and peri urban areas.

2.3 Constraints to Performance of Livestock Sector

According to MLD (2006b) the constraints to livestock development in Tanzania were land tenure system, water and pasture resources mainly due to lack of proper arrangement to allocate land and give ownership of grazing areas according to traditional or legal procedures. It also includes frequent changes of livestock grazing areas into crop cultivation, game reserves and the migration of livestock farmers that limit them to develop their areas. According to Kyomo *et al*. (2006), the dairy industry is facing a critical shortage of highly producing dairy cows; therefore there is a need for expanding the national dairy herd through efficient and cost effective breeding strategies. Low genetic potential of the indigenous livestock coupled with limited supply of improved livestock has led to poor production and productivity of the livestock industry. This has also been exacerbated by the existing production systems practiced by the livestock farmers. However, indigenous livestock are well adapted to marginal areas.

Other constraints include livestock diseases and parasites; inadequate infrastructure for processing and marketing of livestock and livestock products; unavailability of credit facilities to large, medium and small-scale livestock entrepreneurs and low capital investment limiting the expansion and commercialization of the industry; inadequate livestock farmers' knowledge and skills which is important for quick adoption of appropriate technology (MLD, 2006b). Despite the presence of extension system, for a long time farmers knowledge and skills have remained low. Deteme (1999) when studying agricultural technology, economic viability and poverty alleviation in Ethiopia pointed out that since extension agents are the only public employees deployed very close to farmers, they have become indispensable in executing policies and administrating affairs pertaining to rural areas.

2.4 What is Artificial Insemination?

Use of AI in animals is a human invention where the development and usage has come a long way since it was first done successfully in 1784 when an inseminated dog whelped three pups 62 days later (Foote, 2002). AI technology involves the identification of the very top genetic potential bulls. These are kept in central stations and semen continually collected, assessed, diluted, packed in straws and preserved in liquid nitrogen at low temperatures. When needed, each straw of semen can be used to artificially inseminate a cow that is on heat. One superior bull once identified can potentially sire thousands of offspring in different herds each year. The genetic superiority of one individual is therefore quickly spread to become beneficial to many farmers than would otherwise be possible with natural mating. When a cow is on heat and needs a bull, the farmer through training is able to detect this by observing the cow's behaviour as well as physical changes in external reproductive tract. The farmers then notify the inseminators who within preferably 18 hours of onset of heat artificially inseminate the cows using the semen from a superior bull (Oluoch-Kosura *et al*., 1999; Boa-Amponsem and Minozzi, 2006).

2.5 Advantages and Challenges of AI

The greatest advantage of AI is that it makes possible maximum extension of the use of males of proven genetic merit in desired traits over a vast number of females, which would be unachievable through natural service (Foote, 2002). Natural service would probably limit the use of one bull to less than 100 matings per year. Other advantages include accelerated introduction of new genetic material by import of semen rather than live animals and thus, reducing the international transport costs, enabling the use of frozen semen even after the donor is dead, enhancing progeny testing under different environment and managerial conditions to improve the rate and efficiency of genetic selection, exposure of sires to infectious genital diseases is prevented which reduces the danger of spreading such diseases, early detection of infertile bulls, use of old or crippled bulls and elimination of danger from handling unruly bulls (Boa-Amponsem and Minozzi, 2006).

However, there are challenges of AI. First, it can be more laborious. Male animals instinctively detect the females that are in the correct status for conception. With AI the detection work falls on the responsibility of the dairy farmer. Poor detection results in decreased rates of fertility (Foote, 2002; Boa-Amponsem and Minozzi, 2006). Success or failure of AI depends on how well this task is performed. AI requires more labour, facilities and managerial skill than natural service. Proper implementation of AI requires special training, skill and practice. Also, increasing the number of offspring per male has selective advantages only if the best males can be accurately determined. Otherwise, this process only decreases the genetic variability in a population. Increasing the number of offspring per male always reduces the gene pool. The benefits of more intense selection must be balanced against the negative effects of decreased variation and in some cases increased in-breeding (Webb, 2003).

2.6 Importance of AI to the Dairy Industry

On average the Zebu cow produces only 900 litres of milk per year, half of which is consumed by the calf while the half bred produces 1,500 litres per year. AI technology gives such farmers opportunity to almost double their milk production per cow per year in less than three years. Given that the extra overhead costs of maintaining a crossbred cow is less than 10% above that of the Zebu and that the improvement in milk production potential is permanent, and can be further built on in the subsequent generations, this technology offers cheaper avenue for poverty alleviation to aspiring dairy farmers who otherwise can not afford to purchase a purebred dairy cow (Oluoch-Kosura *et al.,* 1999).

2.7 Artificial Insemination Services

Provision of AI services requires active participation and cooperation between the stakeholders in dairy production (Galloway and Perera, 2003). This includes farmers, inseminators, AI centres and organizations involved in milk recording, milk collection and dairy product marketing. Governments need to be proactive in supporting and organizing the administration and infrastructure for AI. Mpofu (2002) when studying the importance of breeding infrastructure and support services indicated that livestock identification, performance recording and evaluation programs, research, training and extension programs, farmers' associations, and supply of replacement animals were important for the successes of AI.

Israelsson and Oscarsson (1994) as cited by Oluochi Kosura *et al.* (1999) indicated that the most low cost model of providing AI service to the farmer was “the daily run model”, as long as such inseminations are made per day by one inseminator, covering between 100 to 120 km along a prescribed route. An alternative model which also characterizes the Tanzanian smallholder dairy farmers would be where the inseminator waits for information from farmers on when to provide the service. In large scale farms it is practiced on a ‘do-it-yourself’ basis and farmers send their workers to attend AI courses. Smallholder farmers have not been able to use AI through this method due to costs of equipment, liquid nitrogen and semen.

2.7.1 Field practices

Getting cows in-calf requires good semen, good heat detection and good insemination technique (Galloway and Perera, 2003). Also communication between the farmers and the inseminators is an important factor in successful AI service (Karawita, 2008). An adequate infrastructure needs to be in place and maintained. Telephone services or transport systems for messages from the farmer must be reliable. Inseminators should have reliable and fast means of transport. Motor vehicles or light motor bikes are recommended (Schutte and Perera, 2004). Galloway and Perera (2003) stated that in each country, the policies and practices for delivery of improved genetics and related services to farmers should be formulated in relation to: country situation (animal population and production of milk); environmental conditions and availability of resources for livestock production; and social and economic situation of farmers and people.

Although AI can be a very useful technique in disseminating genetic material, it will only affect improvement if the semen is derived from genetically superior bulls. The use of below-average bulls will exert a detrimental effect on the genetic value of herds in which they are used (Mpofu, 2002). It is important that AI schemes are linked with performance or progeny testing programmes in order that they are correctly designated as parts of an overall genetic improvement policy. It is only when AI programmes employ demonstrably better sires, which produce outstandingly better offspring, that the costs and administrative complications are justified (Schutte and Perera, 2004).

2.7.1.1 Heat detection in dairy cattle

Heat detection plays an important role in the AI service (Karawita, 2008). Ideally, if a cow is first seen in heat in the morning, she should be inseminated in the afternoon of the same day and if she is first seen in heat in the afternoon or evening, she should be inseminated the next morning (Tnau, 2008). This well documented rule has recently been questioned. Good conception rates are being obtained with a once per day service. Galloway and Perera (2003) indicated that Australian In-calf programme has demonstrated an average first service conception rate of 48% in 69 herds with once per day insemination. In 99 herds inseminating twice daily the average first service conception rate was 50%. If the inseminator visits a particular location only once a day, the cow should be inseminated at the first visit after the farmer has observed standing heat.

Theoretically, the best time to inseminate is between 6 to 18 hours after detection of heat. Education of farmers is needed on heat detection methods, adequate feeding, and observation of cows for heat signs, identification of cows truly on heat and recording the time of heat observation and if possible informing the inseminator the time of first heat detection. One or more of the following signs should be observed as indicators of the different stages of oestrus: First, pre-heat signs: restlessness, separates from herd, ear movements, attempts to mount others, clear mucus, reduced milk production, bellowing; Standing heat: stands still when mounted; other signs include clear and copious mucus, vulva enlarged, rests head on back of other cows, tail head roughened (the last sign could also be seen post-heat); Post-heat (2–3 days after start of heat): moves away when mounted, tired and lying while others graze, clear or bloody mucus on tail or legs. Cows/heifers observed with these signs should be recorded for future management of heat/reproduction to reduce the economic loss due to missed heat (Schutte and Perera, 2004: Mpofu 2002). Karawita (2008) when studying AI a case in Anuradhapura district Sir Lanka pointed out that heat detection, timing of insemination, nutrition state of the cow, body condition score at insemination, handling of semen and also the donor bull, transport of semen were the main contributory factors to low success in AI. Therefore, farmers should be encouraged to keep proper fertility records of individual cows in their herds for efficient reproductive management. Inseminators can play a key role in encouraging this to be done or do themselves for some clients.

2.7.1.2 The inseminator

The AI technician or inseminator is a key person in the industry. They are currently employed in a variety of ways, e.g. government, co-operatives, AI organizations, non-governmental organisations or self-employed. Training of AI technicians should be conducted through residential courses, containing theoretical and practical components, followed by evaluation. In most countries newly qualified AI technicians must initially work under the supervision of a senior technician for a period of time after which they can be registered. Refresher courses and continuing education activities are important for maintaining a high level of performance, and should be instituted in all countries (Schutte and Perera, 2004). The AI technician must make sure that the cow is genuinely in oestrus and that she is not pregnant. If there is any suspicion that the cow may be pregnant, the insemination should be done only half-way into the cervix. If an inseminator is not available in a certain locality there will be no AI service (Karawita, 2008). Furthermore lack of mobility and large area of operation is the main constraint for the inseminators.

Non availability of the technicians may influence the mistrust building among the farmers about the AI service. According to the Bane and Hultnas (1977) quoted by Karawita (2008) once AI service is introduced it should be available at all times.

2.7.1.3 Body condition of dairy cow at calving and at insemination

Body condition of the cow at calving and at the subsequent insemination influences the interval from calving to first oestrus and also conception rate, and is therefore important. Farmers should aim to have cows in a condition score between 2.5 and 3.5 (based on a scale of 1-5) and to minimize loss of score between calving and insemination. Cows that are too fat at calving are likely to have calving difficulties and are more prone to early foetal death. Cows which are too thin, especially if they are losing condition, will have delayed oestrus and poor conception rates (Schutte and Perera, 2004).

2.8 Concept of Adoption

Adoption of technology is defined as a decision to apply an innovation and continue to use it (Van De Ban and Howkings, 1996). A simplistic definition of adoption is basically the use of a technology. This is further elaborated as the incidence/pattern and intensity of adoption. The incidence indicates whether a farmer has used a technology or not and the latter explains the degree of use of a technology (Langyituo and Mekuria, 2005). Adoption of technology is a process which involves changes that take place within an individual. These changes start from the moment a farmer first becomes aware of the technology to the final decision to use it or not (Rogers, 1983). An adopter passes through five stages before adopting an innovation. The stages include awareness, interest, evaluation, trial and adoption (Adesina and Baidu-Forson, 1995). The development of appropriate technology is necessary, but still it can be an insufficient condition for ensuring its use by the recipient (Byerlee and Heisey, 1992). It is important therefore to design the means of providing farmers with information they need to enhance the adoption, but more importantly is the involvement of farmers in the whole process of technology transfer (Feder *et al.,* 1985). Adoption at farmer's level shows the farmer's decision to use or reject a new technology in the production process. The decision is influenced by a number of factors which social scientists have been struggling over the years to explain (Langyituo and Mekuria, 2005).

2.9 Technology or Innovation

Various authors define the term "technology" or "innovation" in a variety of ways. Rogers (1983) defined technology as an idea, practice or object that is perceived as new by an individual. In short, technology can be defined as a set of 'new ideas'. New ideas are associated with some degree of uncertainty and hence lack of predictability on their outcome. For a technology to impact on the economic system, blending into the normal routine of the intended economic system without upsetting the system's state of affairs is required. This entails overcoming the uncertainty associated with the new technologies (Bonabana-Wabbi, 2002). Therefore researchers enigma is to establish factors associated with these uncertainty, and how they can be eliminated (if constraints) or promoted (if enhancers) to achieve technology adoption.

2.10 Agricultural Technology Adoption

Technology is a major factor in combating economic backwardness or poverty. It is broadly defined as a mix of knowledge, organizations, procedures, machinery, equipment and human skills to produce desirable appropriate products. Ogunsumi (2011) indicated that agricultural technologies developed and disseminated should meet farmers' socio-cultural, economic and changing environmental situations. Adoption of technological innovations in agriculture has attracted the attention of development economists and policy makers since it is commonly believed that introduction of new technology increases productivity (Feder *et al.*, 1985). The decision of whether or not to adopt a new technology hinges upon a careful evaluation of a large number of technical, institutional and socio-economic factors. Adoption analysis, in general, presupposes that innovations exist and the study of the adoption process evaluates the reasons or determinants of whether and when adoption takes place.

2.11 Adoption of Artificial Insemination Technology

A study by Gautam *et al.* (2005) on the knowledge level of dairy farmers regarding AI in India showed that poor people with poor education, land holding, occupation and mass media exposure were the ones who needed immediate attention. Large scale successful implementation of livestock up-gradation is not possible without motivating and increasing awareness of such farmers. In another study carried out in India by Sigh and Kaul (2002) on the effect of communication on attitudes of farmers towards AI, the result showed that the message was effective in changing the attitudes of the livestock owners towards AI in the favourable direction. Sinniah and Pollott (2006) conducted a study on breeding activities and adoption of AI amongst dairy herds in the dry zone of Sri Lanka and found out that the percentage of farmers adopting natural service and AI differed significantly within districts and over all the districts. Except for farms with no land, an increase in land holding size was associated with a decrease in the adoption rate of AI. Other findings included: family size had an impact on the adoption of AI; when the distance from the farm to veterinary office increased the adoption rate decreased; education level did affect the use of AI; availability of own bull and neighbour's bull affected the use of AI and with an increase in the number of inseminations required per conception, the adoption rate of AI decreased. A study on the status of adoption of AI in dairy animals in different agro-climatic regions of Punjab by Navjeet *et al.* (2006), found out that 41.67% of the respondents adopted AI in dairy cattle. Cramb (2003) pointed out that factors affecting adoption of innovation differ across countries and are location specific. Moreover, there may be a widespread adoption in one area but not in others in the same location or one project may lead to apparently successful adoption, but another project, following the same procedures to promote the same technologies, result in failure. Wetengere (2009) noted that if, for instance, factors influencing adoption of coarse grain or stall-feeding of dairy cattle or improved cassava technologies were to be employed in the adoption process of fish farming, there is no guarantee that it would work with the same degree of success because the technologies are different. Considering that there are many factors which affect farmer's decision to adopt or reject innovations, and that the factors differ across countries and being location specific, this study classifies the influencing factors into four main categories: Farmer, technology, economic and institutional characteristics to include farmer's subjective socio-psychological characteristics like knowledge level and attitude towards intended technology.

2.12 Factors Influencing Adoption of Innovations

2.12.1 Farmers characteristics

2.12.1.1 Age

The role of a framer's age in explaining technology adoption is somewhat controversial in the literature. Older people are sometimes thought to be less amenable to change and hence reluctant to change their old ways of doing things or young and energetic farmers have proved to be active and ready to try innovations (Nanai, 1993). In this case, age will have a negative impact on adoption. On the other hand, older people may have higher accumulated capital, more contacts with extension, better preferred by credit institutions, larger family sizes, all of which may make them more prepared to adopt a technology than younger ones (Langyituo and Mekuria, 2005).

2.12.1.2 Sex

Barry (2005) observed that women are more likely to be livestock adopters than men especially in urban and peri urban areas although most technologies were promoted to men. Matata *et al.* (2010) reported that the bias against women was manifested in the delivery of the extension message itself. The message was generally provided by male extension agents to men with the implicit assumption that it would “trickle down” to women. Furthermore, it was noted that extension messages tend to focus on activities of male farmers while ignoring the wide range of agricultural activities, responsibilities and constraints facing women farmers. This is so because in most parts of the developing world most extension workers are men and are usually biased towards men in their extension activities. Most technologies were considered to be gender neutral but often become gender biased during their introduction and use by societies. Lubwama (1999) noted that the productivity of labour will be altered depending on accessibility of the technology between men and women. Most of household heads are males which normally dominate capital business on most of social services. But female are highly potential adopters as they suffered more on poverty than male.

2.12.1.3 Education level

It is often assumed that educated farmers are better able to process information and search for appropriate technologies to alleviate their production constraints. The belief is that education gives farmers the ability to perceive, interpret and respond to new information much faster than their counterparts without education (Matata *et al.,* 2010). Wetengere (2009) observed that a farmer having higher formal education is more likely to adopt fish farming than the one with less formal education. Thus, the more complex the technology is, the more likely that education would play a major role in its adoption. Also several cases can be revealed in local government projects such as improved farming technologies, social technologies (health, biased culture, water and environment). Large proportion of rural projects adopters, posses' primary/secondary education level.

2.12.1.4 Marital status

Marital status provides information valuable for sociological explanation of family and the role of men and women in farming. Married couples were likely to be more productive due to labour reinforcement; they can use the funds and other resources they owned effectively and shared managerial skills properly. The association between marriage and adoption of improved technologies could be attributed to the desire to meet increased household needs as a result of marriage by increasing production (Namwata *et al.*, 2010). Matata *et al.* (2010) found out that a high percentage of married headed families were observed in his study which suggested that participation of farmers in improved fallow depended on the perception of the technology by the male members of the community because most of the women did not own land. Singles lacked ownership of assets and other agricultural resources, therefore turned to marginal labourers.

2.12.1.5 Family size

Family size refers to the total number of people living in the same compound, having their meals together, and being under the responsibility of the head of the household. The idea that large families will have greater labour resources and be more likely to invest in keeping dairy cattle in urban and peri urban areas is not always correct, as children go to school and it is usual for large urban families to rely on other sources of income, such as commerce (Barry, 2005). The effect of family size on adoption can be ambiguous. It can hinder the adoption of technologies in areas where farmers are very poor and the financial resources are used for other family commitments with little left for purchase of inputs. On the other hand, it can also be an incentive for adoption of new technologies as more agricultural output is required to meet the family food consumption needs or as more family labour is required for adoption of labour intensive technologies (Fufa and Hassan, 2006).

2.12.1.6 Occupation

The main occupation of the producers is of great importance in terms of economic improvement and specialization in production. Hasan *et al.* (2008) reported that in Turkey specialization in livestock sector was rare and that affected economic improvement negatively. Moreover Fernandez-Cornejo *et al*. (2002) showed that when off-farm income was lowered through reduction of other activities than farming, the more was the adoption of managerially intensive technologies such as precision farming. The effect of other occupations was also shown by Barry (2005) who indicated that employment outside the home is another important element in the practice of animal husbandry in the cities and if the dairy farmer works outside the household, time constraints might affect livestock activities. In this case if the main occupation is farming it is likely that would influence AI adoption positively.

2.12.1.7 Income

Household income is considered an important factor in the decision to adopt livestock technologies (Barry, 2005). Income enables a farmer to meet costs of adopting new technologies. Wealthier farmers may be the first to try a new technology especially if it involves purchasing the inputs. Furthermore, availability of capital acts as security in case of failure due to adopting new technology. Wambura (1988) found out that young, richer and better educated farmers had higher extension contacts than poor, older and less educated farmers. In this case extension system tends to favour dairy farmers with high income and neglecting those with low income. In some cases the higher the income the more unlikely the technology will be adopted. Wetengere (2009) revealed that income was inversely related to the probability to adopt fish farming implying that as income increased, the probability to adopt fish farming decreased.

2.12.1.8 Years in dairying

With increased farming experience, farmers are generally better able to assess the relevance of new technologies. Namwata *et al.* (2010) noted that experience enrich the farmer on the major production aspects such as a sound knowledge of involved practices. This often comes from their interactions with their neighbours and the outside world. Because of their experience, they also tend to be better placed to acquire the needed skills to use the technologies compared with younger ones (Langyituo and Mekuria, 2005). The effect is thought to stem from accumulated knowledge and experience of farming systems obtained from years of observation and experimenting with various technologies. In addition, since adoption pay-offs occur over a long period of time, while costs occur in the earlier phases, years (time) of farming of the farmer can have a profound effect on technology adoption (Bonabana-Wabbi, 2002; Hasan *et al.,* 2008).

2.12.2 Economic factors

2.12.2.1 Herd size

Much empirical adoption literature focuses on herd size as the first and probably the most important determinant. The size is frequently analyzed in many adoption studies (Adesina and Baidu-Forson, 1995; Baidu-Forson, 1999). This is perhaps because size can affect and in turn be affected by the other factors influencing adoption. In fact, some technologies are termed 'scale-dependant' because of the great importance of size in their adoption (Bonabana-Wabbi, 2002). Herd size affects adoption costs, risk perceptions, human capital, credit constraints, labour requirements, and more.

2.12.2.2 Motivation on future herd quality or level of expected benefits

Farmers must see an advantage or expect to obtain greater utility in adopting a technology. In addition, farmers must perceive that there is a problem that warrants an alternative action to be taken (Bonabana-Wabbi, 2002). Wetengere (2010b) noted that if a technology is perceived to be profitable, it is likely to be adopted. If, on the other hand, a recommended package of a technology is perceived to be unprofitable, it is unlikely to be adopted. Namwata *et al.* (2010) observed that increased income was a strong drive for adoption of improved agricultural technologies. Without a significant difference in outcomes between two options, and in the returns from alternative and conventional practices, it is less likely that farmers, especially small-scale farmers will adopt the new practice. If dairy farmers expect to build a better herd quality in terms of milk production and receive more long-term benefits from AI adoption, it would positively influence adoption. Fernandez-Cornejo (1996) showed a higher percentage of total household income coming from the farm through increased yield tends to correlate positively with adoption of new technologies.

2.12.3 Technological characteristics

Technologies have properties that affect their rates of adoption. Rogers (1983) identified five major technological characteristics associated with high rate of adoption. These included the relative perceived advantage, compatibility with the local culture, low technical complexity, trainability and observability. With regard to this study two factors were selected to be studied i.e. relative advantage and technical complexity.

2.12.3.1 Relative advantage

Prior to adoption, farmers do their individual analysis and finally adopt technologies with characteristics of their preference. Wetengere (2009) noted that adoption of a new technology is not only a choice between two alternatives the traditional and modern technology; it is also a choice of one technology against other technologies, particularly if they serve the same purpose or compete for the same resources. Simon (2006) perceived that farmer's subjective preference for characteristics of a technology is influenced by incremental production as a result of adopting a new technology. In addition to incremental production, the selected technology must also have a high risk reducing effect relative to the other technology. Generally farmers are risk averse as they tend to avoid adoption of technologies that give room to uncertainty in realizing the benefits. Kisusu (2003) reported rejection of AI technology in Dodoma, where farmers preferred natural mating due to risk associated with AI.

2.12.3.2 Complexity

Complexity is the degree to which a technology is perceived relatively difficult to understand and utilize. Wetengere (2010a) noted that complexity involve the number of activities that have to be performed to adopt and use the technology relative to other technologies. Technologies that are simpler to understand and use, can be adopted more rapidly than technologies that require the adopter to develop new skills and understanding (Langituo and Mekuria, 2005). A considerable time may be needed before the farmer develops the required technical knowhow and in addition there may be some tedious operations that need to be performed. Schutte and Perera (2004) when explaining AI field practices pointed out that under herd conditions farmers should observe cows for heat signs at least three times in a day (20 minutes of visual observation each time: morning, afternoon and late evening). This schedule seems to be tedious when compared to one who uses natural mating.

2.12.4 Institutional factors

Weak and inefficient agricultural institutions have been blamed to be the main reasons for poor performance of agricultural sector. Machumu (1995) identified research, credit facilities and extension services as the main institutions responsible for stagnation of agricultural sector. For the case of this study three institutions have been identified i.e. service availability, extension services and access to agricultural credit.

2.12.4.1 Extension service

Good extension programs and contacts with producers are a key aspect in technology dissemination and adoption. Extension can be defined as assistance to farmers to enable them identify and analyze their production problems and become aware of opportunities for improvement by changing their outlook towards their difficulties (Msuya, 1998). Regular contact with extension agents make farmers being aware of new technologies and how they can be applied (Namwata *et al.,* 2010). Exposure to information reduces subjective uncertainty and therefore increases the likelihood of adoption of new technologies (Langyituo and Mekuria, 2005). Fufa and Hassan (2006) argued that the introduction of new agricultural technologies creates demand for information useful in making decisions. Extension organizations supply useful information about new agricultural technologies and access to such sources of information can be crucial in adoption of new technology. Most studies analyzing this variable in the context of agricultural technology show its strong positive influence on adoption. In fact Bonabana-Wabbi (2002) showed that its influence can counter balance the negative effect of lack of years of formal education in the overall decision to adopt some technologies.

2.12.4.2 Service availability

This comprises all efforts made by the government in terms of ensuring the AI service is available to dairy farmers. It includes semen and liquid nitrogen production, distribution of semen and liquid nitrogen, field insemination services and training of inseminators. Gamba (2006) noted that the rapid development of private AI service in Kenya was highly dependent on the existence of a high density of exotic dairy cattle breeds, stable milk markets, low spatial distances, veterinary clinical services, functional co-operatives and rural infrastructure.

2.11.4.3 Credit facilities

Credit service is an important element in modernizing agriculture because it allows the use of other factors of production. In the literature it has been argued that the lack of credit is a constraint to adoption. Namwata *et al.* (2010) indicated that access to credits enables farmers to buy inputs required by improved technologies. Farmers can invest in new technologies either from past accumulated capital or through borrowing from capital markets. The lack of sufficient accumulated savings by smallholder farmers prevents them from having the necessary capital for investing in new technologies. Kaliba *et al.* (1998) reported some farmers received credit from the informal sector. The capital may be needed initially to procure good quality dairy animals or might be needed to procure complimentary inputs like concentrates, feeds, drugs, acaricides, and construction of good dairy housing and processing of milk to access market. Langituo and Mekuria (2008) argued that with limited sources of external credit, farmers rely on earnings from agriculture (crop and their household incomes).

The cash shortages faced by dairy farmers are partly due to deteriorating output prices and increasing external inputs prices makes availability of credit to be an important determinant of farmers’ adoption decisions. If a household accesses credit it means its capital base has improved and the household can now afford investment in enterprises with higher returns (Mujeyi, 2009). In this case differential access to capital is often cited as a factor in differential rates of adoption (Feder *et al.,* 1995). Teendwa, (2005) argued that advancing credit to small holder dairy farmers for encouraging technology adoption is a complex policy issue and among the related issues are amount and form of credit, the interest charged, targeting specific farmer groups and specific activities and payment scheme.

In most farming communities farmers form or join associations or cooperatives that offer farmers the opportunity to have better access to information, which is an important condition for adopting an improved technology (Langituo and Mekuria, 2005; Gamba, 2006). Furthermore in some cases some financial institutions are prepared to lend credit to farmers only when they are in an association or cooperative (Baltenweck and Staal, 2000). Where co-operatives are not functioning, the formation of other organizations such as “Service Committees” should be encouraged. These must include all stakeholders. Their tasks would be to determine how best the farmers can be served and to assist with the resolution of problems related to AI. With time, these committees should be gradually replaced by farmers’ organizations. Therefore, belonging to an association or cooperative can influence farmer’s decision to adopt an improved technology.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 The Study Area

The study was confined to Dar es Salaam region, specifically in Kinondoni district. Kinondoni District is the Northernmost of three districts in Dar es Salaam, the others being Temeke (to the far southeast) and Ilala (downtown Dar es Salaam). To the east is the Indian Ocean, to the north and west is Pwani Region (Fig. 1). The 2002 Tanzanian National Census showed that the human population of Kinondoni was 1 083 913. The area of Kinondoni is 531 km². The original inhabitants of Kinondoni are the Zaramo and Ndengereko, but due to urbanization the district has become multi-ethnic. Administratively, Kinondoni District is broken into 4 divisions, 27 different wards, and 113 sub-wards. The district has about 2,280 households keeping a total of 22 380 dairy cattle. The number of households raising dairy cattle keeps changing due to the fact that while some new households join the dairy industry, others quit.

3.2 Historical Background of AI in Kinondoni District

AI in Kinondoni district can be traced back to 1972 when a European guy by the name of Helvic started to work on AI through his clinic centered at Shaban Robert aiming at catering for dairy cattle keepers of Dar es Salaam. However the only places where one could find dairy cattle in those days were Oysterbay, Kimara and Kinondoni. In 1980 three inseminators trained by NAIC – Usa River were brought by regional authority and centred at City Hall for the purpose of providing AI services to the fore mentioned areas. Later, the AI service centre was shifted to Ilala Boma and the operations were taken by the Ministry responsible for livestock development. The period from early to late 1980’s, AI was successfully operated associated with good record keeping by farmers and inseminators and prices were heavily subsidized by the government. After the government had ceased to support the field AI services in 1990's, the role was left for the private sector to take over.

3.3 Current Situation of AI in Kinondoni District

Currently, the district has a total of 10 certified inseminators operating in five AI service provision centres namely Madunga and Mema centred in Ubungo ward, Mbezi in Kimara ward, Tegeta Kibaoni in Bunju ward and Municipality centre in Magomeni ward. The AI service is basically provided to farmers through private inseminators and to some extent by government inseminators through AI project established by Municipal Authority. All inseminators including the private inseminators are not full time inseminators. Government inseminators are also engaged in other activities like animal health activities such as vaccination campaigns etc. The normal practice was for inseminators to respond to calls from dairy farmers done through mobile phones or by sending a person. However, the services are not always available to a dairy farmer as inseminators do not have reliable transport to visit farmers. Some farms were too far from AI centres and therefore requiring much time and resources to reach them and therefore compromising inseminator's decision to respond to calls.

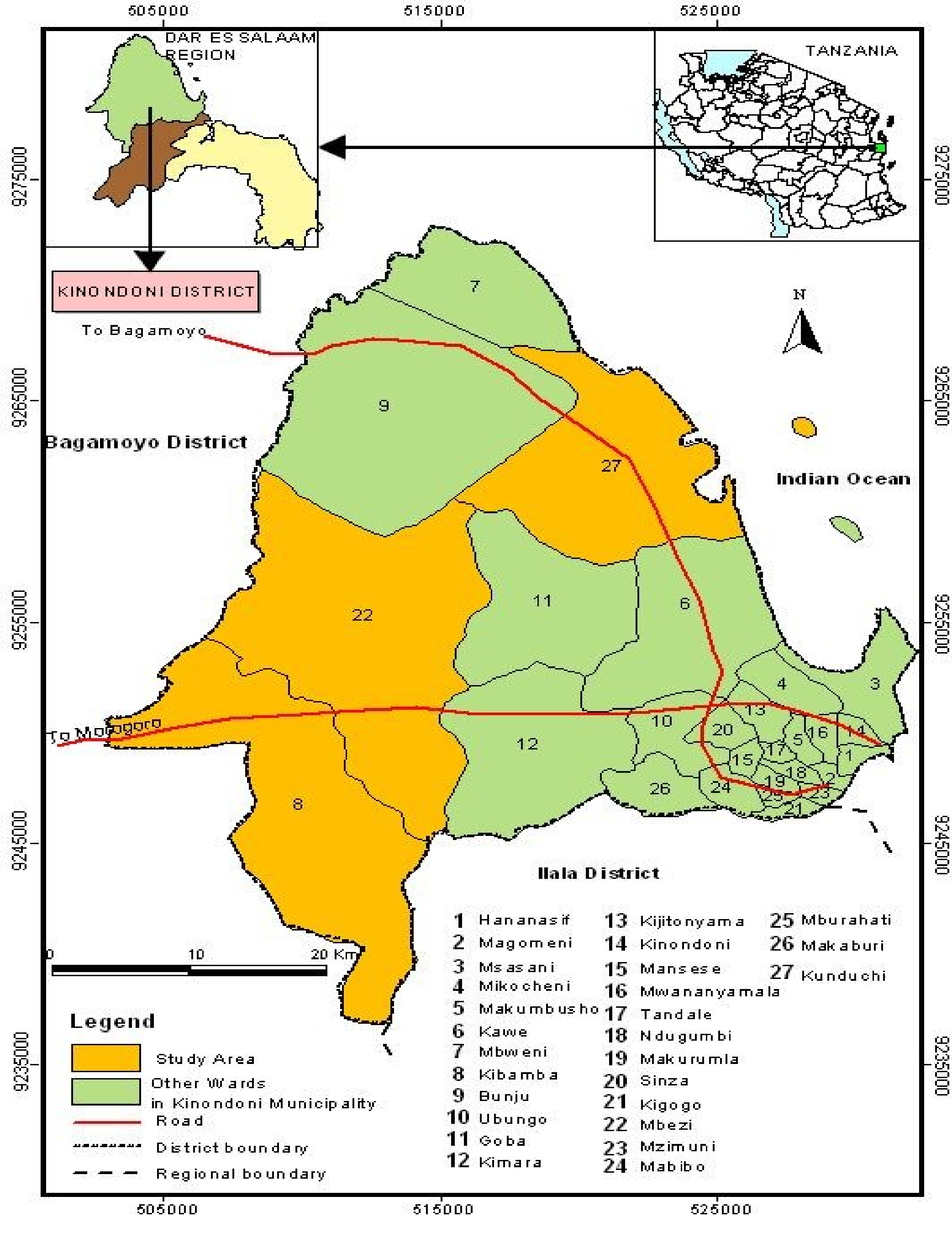

Figure 1: Map of Kinondoni district showing wards involved in the study

Source: Tanzania Administrative Boundaries, Ministry of Land and Natural Resources (2002)

3.4 Conceptual Framework

The conceptual framework consisting of factors affecting the adoption of AI in Kinondoni district is shown in Fig. 2. For a technology to be adopted, potential adopters should also perceive the problem which the technology intends to solve as a major constraint to their development efforts. An intended technology should not be complex, and its potential benefits should be easily visible. In this study, a combined effect of farmers, institutional, economic and technological characteristics towards enhancing the rise in farmers' knowledge level and thereby influencing change in farmers' attitude to adopt or not to adopt AI technology was examined.

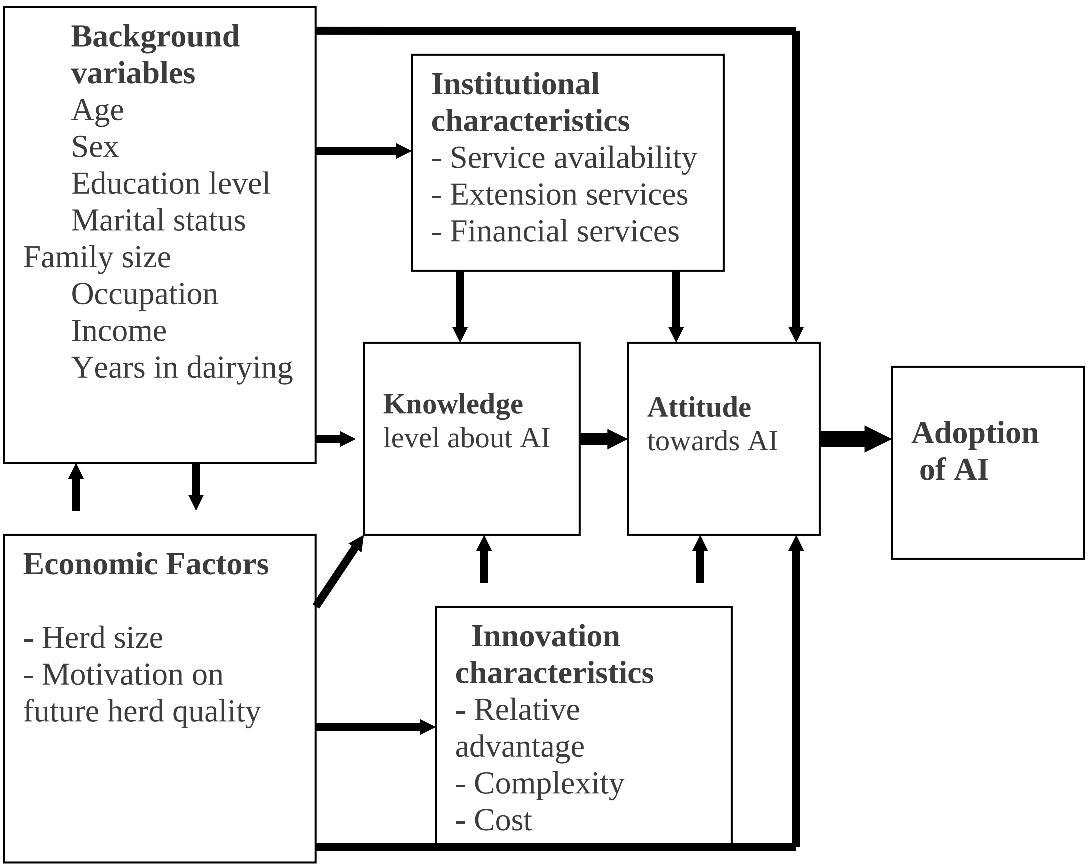

Figure 2: Conceptual framework for analyzing factors affecting adoption of AI technology

3.5 Sampling Procedure

The population of study was dairy cattle farmers in selected areas of Kinondoni district. The sampling units were composed of heads of households in the selected villages. By using multistage purposive method, three wards in Kinondoni district were selected and from each ward three villages were involved in the research. The sample size was determined by using the following formula (Israel, 2009):

$$n = \frac{N}{1 + N (e^2)} \quad \text{(1)}$$

Where;

N = Population size (total number of households keeping dairy cattle in Kinondoni district).

e = Acceptable error of estimation

n = Sample size

$$n = \frac{2280}{1 + 2280 (0.01)} = 81.43 \approx 81$$

A table of random numbers was used to select 10 respondents from each village making 30 respondents from each ward and a total of 90 respondents to represent the population.

3.6 Research Design

Data for this study were collected by using a cross-sectional design. This research design allows data to be collected at a single point in time and is used for descriptive study as well as for determination of relationships between and among variables (Byerlee and Heisey, 1992). The design has greater degree of accuracy and precision in social science studies than other designs (Casley and Kumar, 1998). In addition the design was considered favourable for this study because of the time limitation and resource constraints.

3.7 Instrumentation

A structured questionnaires and checklist for focus group discussions (FGD) were used in data collection. The questionnaires comprised of closed and open ended questions and were used to collect data from dairy cattle farmers to obtain the background variables such as age, sex, education level, income, as well as the dependent and independent variables. A checklist for focus group discussion was used to collect data from dairy farmers as well as extension agents. Before data collection pre-testing of the questionnaire was conducted to check its validity.

3.7.1 Primary data

Primary data was collected from respondents employing formal and informal interviews together with focus grouped discussions. Collection of primary data was done by the researcher assisted by three enumerators. The enumerators were trained for two days on how to administer the questionnaires. Data collection involved visiting individual farmers in their homes and farms. In addition, focus group discussions were conducted with a group of at least 10 dairy producers to get a common position and gain clear understanding of socio-economic issues in the AI system. A total of six FGD were conducted soon after the household questionnaire administration was completed to ensure that individual farmer's responses were not influenced by discussion outcomes.

3.7.2 Secondary data

Secondary data was obtained from livestock offices in Kinondoni district, National Artificial Insemination Centre, Ministry of Livestock Development and Fisheries offices and SNAL – SUA, Morogoro. The data included the number of dairy cattle in the district, the list of households keeping dairy cattle, the number of dairy cattle kept by each household and country wide semen distribution.

3.8 Data Analysis

Data collected from the primary sources were coded and analyzed using the STATA computer programme. Descriptive statistics such as distribution, percentages, comparison of means, standard deviations, minimum and maximum values of different variables were calculated. The Chi square test was used to determine the statistical differences in proportion of adopters and non adopters by sex (males and females), educational levels, age, marital status, occupation, income, family size, years in dairying as well as economic, technology related and institutional characteristics. A t-test was also employed in comparing adopters and non adopters when the variable was a continuous one.

Different models have been used in describing the factors affecting adoption of technologies. These include probit, Tobit and logit models that have been used in literature to gauge the probability of choosing one option over another (Senkondo *et al*., 1998; Langyintuo and Mekuria., 2005; Lemchi *et al.*, 2006; Mujeyi, 2009). In this study, the Tobit multiple linear regression model was used.

3.8.1 Description of conceptual model (Tobit Model)

In this study it was not only intended to know the probability that a farmer has adopted AI technology, but also the extent of use of the technology after adoption. To simultaneously explain probability of adoption, and intensity of use of the AI technology, the use of a Tobit model was appropriate (Baidu-Forson, 1999; Langituo and Mekuria, 2005; Mujeyi, 2009). Direct application of the Tobit estimation sufficiently provides the needed information on adoption probability and the intensity of use of AI. The Tobit model can be specified as:

$t\ i = X\ i\ \beta$ if $i^* = X\ i\ \beta + \varepsilon i > T$ (Adoption)

$= O$ if $i^* = X\ i\ \beta + \varepsilon i \leq T$ (Non-Adoption)……………………………………………(2)

Where:

ti = probability of adoption (and intensity of use) of the improved technology

Xi = represents the vector of independent variables.

εi: = is the disturbance or error term

i* = non-observed latent variable

T = non-observed threshold level

i =1,2,....n

In this case, a change in the level of any given characteristic (which is assumed to be directly linked to adoption) consists of two effects: (a) the change in the use intensities of AI technology, for those dairy farmers that are already adopters; and (b) the change in the probability of being an adopter. Finding these two effects requires examining the formula for the first-order partial derivative of Tobit model equation, such that:

$$\frac{Et}{\delta Xk} = F(z) \times \frac{\delta Et^{*}}{\delta Xk} + Et^{*} \times \frac{\delta F(Z)}{\delta Xk} \qquad \text{...(3)}$$

Where;

Et^{*} = is the expected value of t for cases above the limit (adopters)

$\frac{\delta Et^{*}}{\delta Xk}$ = tells how the intensity of adoption will change due to a change in a specific independent variable

$\frac{\delta F(Z)}{\delta Xk}$ = tells the effect of a particular independent variable on the probability of adoption.

3.8.2 Empirical model specification

Dairy farmers' decision to adopt or not to adopt AI technology was assumed to be the outcome of a complex set of factors related to the dairy farmers' objectives and constraints. In other words, there were certain factors – including farmers' characteristics, economic, AI technology related characteristics, institutional and social psychological factors that affect the likelihood that a farmer adopts AI technology. Thus, if each farmer and AI technology can be classified based on a core set of variables, then it is possible that the probability of a farmer adopting that technology could be estimated. Farmers with positive reactions towards adoption were classified as AI technology adopters and those with negative reactions were classified as non adopters. The observations were coded as "1" for adopters and "0" for non adopters (dummy variable) and were used as dependent variable.

The empirical model was specified as follows;

$$Adoption = \beta_0 + \beta_1\, Edulevel + \beta_2\, Sex + \beta_3\, Marstat + \beta_4\, Ocupatn + \beta_5\, Yrsdairy + \beta_6\, Bredairy + \beta_7\, Owndairy + \beta_8\, Incothrs + \beta_9\, Credt\ \beta_{10}\, Dstaisev + \beta_{11}\, Visitext + \beta_{12}\, Grpmeb \quad (4)$$

Where;

β_0 = Intercept

β_1 - β_{14} = Parameter to be estimated

ADOPTION = Adoption of AI technology (*if adopted =1, otherwise =0)

EDULVEL = Household head's educational level (*if Non = 0, Educated =1)

SEX = Sex of household head (*if male = 1, otherwise = 0)

MARSTAT = Marital status (*If Not married = 0, married = 1)

OCUPATN = Occupation of household (*If Agriculture = 1, otherwise = 0)

YRSDAIRY = Years in dairying

BREDAIRY = Breed of dairy cattle (*if, Cross = 1 otherwise = 0)

COSTINS = Cost of insemination (*If High = 1, Low = 0)

DIFGETAI = Difficulty getting AI service (*If Yes = 1, No = 0)

INCOTHRS = Amount of income from other sources

CREDT = Access to agricultural credit (*if having access = 1, otherwise = 0)

DSTAISEV = Distance to AI centre

VISITEXT = Frequency of extension contact (*if non = 0, sometimes =1)

GRPMEB = Being a member of dairy group (*if member =1, otherwise = 0

NB: * Dummy

Adoption of AI technology was hypothesized to be a function of education level, sex, marital status, occupation, years in dairying, breed of dairy animals and owner of dairy animals. Others were amount of income from other sources, access to agricultural credit, distance to AI centre, frequency of extension contact and being a member of dairy farmer group. High **education level** (EDULVEL) was hypothesized to have positive influence on adoption of AI technology because education level is associated with greater information on dairy husbandry and AI technology as a whole. Education enhances capacity for creativity and educated dairy farmers were expected to be more aware and more knowledgeble regarding the benefits of AI technology.

Sex is often considered an important variable in livestock ownership and management in Africa. The daily care and management of the stock are considered activities best left to women, children and hired people.

Marital status; Married couples are hypothesized to have a positive influence on adoption of AI technology because the couples were likely to be more productive due to labour reinforcement; they can use and compliment the funds and other resources they own effectively and share managerial skills.

Occupation; Urban dairy cattle owners are diverse in their occupations and motivations. However, those who rely on livestock for their livelihood are more likely to be farmers. As a result, it is expected that having farming as a primary occupation will positively influence the adoption of AI technology.

Years in dairying or number of years of experience in dairy farming might also have a positive effect on adoption of AI technology. However, in the study area, experienced farmers did not necessarily use AI technology. So the influence of years in dairying on AI adoption can be either positive or negative. The primary intension of using AI technology is to acquire a good breed in terms of high milk production. It is likely that AI technology would be adopted by farmers having cattle with poor genetic potential in terms of milk production. Therefore, a negative relationship was hypothesized between **breed** and adoption of AI technology.

Cost of insemination service (COSTINS). The cost of AI service at farm level is considered to be an important variable. When the price of semen tends to be high, it can limit the adoption.

Difficulty in getting AI services (DIFGETAI). Availability of AI service without difficulty is very important for adoption and continued utilization. When a dairy farmer is motivated and ready to use AI, if the service is not available or can be obtained with difficulty, the dairy farmer will decline its use.

Household **income from other sources** than dairy is also considered an important factor in the decision to adopt AI technology. However, sometimes in the cities, only wealthy people can afford to invest in several enterprises but, as they have other sources of income, they might not invest in dairy cattle. Therefore, income from other sources was hypothesized to have a negative influence on adoption of AI technology.

Access to agricultural credit may affect adoption decisions in many ways. Usually credit can increase the dairy farmers' capacity to have incentives for profitable and innovative activities including adoption of AI technology. In general, access to credit was hypothesized to have a positive effect on investment.

Distance to AI centre was hypothesized to have negative relation with adoption of AI technology. Increasing distance to the AI centre leads to increased cost and time to acquire the AI service and it may also lead to inseminators avoiding to respond to dairy farmers' calls.

Frequency of extension contact; Extension is a source of information about better farming practices. The more the farmer is being visited by an extension agent in a given time; there would be more exposure to information about technology. Therefore, frequent extension contacts are expected to positively impact adoption of AI technology.

Being a member of dairy farmers group; Dairy farmers group sometimes afford farmers the opportunity to have better access to information, which is an important condition for adopting an improved technology. Farmers' group can also afford farmers to have various inputs at reduced prices. Therefore, being a member of dairy farmers group is expected to positively influence adoption of AI technology.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

This chapter presents the findings from the study and respective discussions. The chapter is divided into six sections as follows; section one represents the dairy farmers' background characteristics. The second section oversees the economic factors, section three discusses innovation characteristics, section four highlights institutional characteristics, section five gives incite of socio psychological attributes and lastly section six discusses findings on factors affecting adoption of AI technology from tobit analysis.

4.1 Farmers' Characteristics

The farmers' characteristics which were identified as important for this study included age of respondent, sex, education level, marital status, family size, main occupation, source of income and years of dairying.

4.1.1 Age

Table 1 shows the influence of age on adoption of AI technology. About half (51.1%) of the respondents were between 46 – 60 years of age in which 28% were non adopters and 23% were adopters. This is the active age group having enough resources and experience to make appropriate decisions regarding the uptake of a particular technology. Other respondents had 30 – 45 (21.1%) years and above 60 (27.8%) years. The absence of youths in this study was among others, due to the fact that youngsters do not have enough time to accumulate substantial resources to enable them to own properties. The property ownership in urban and peri-urban areas is a prerequisite for establishment of dairy cattle business. The average age of respondents for AI technology adopters was significantly higher ($P < 0.05$) than that of non adopters by 4.8 years, implying adoption of AI technology was related to the age of respondents. These results support the findings by Simon (2006) who demonstrated relationship between age and adoption of rotational woodland technology in semi arid areas of Tanzania. Also Kaaya *et al*. (2005) revealed relationship between age and AI adoption in Uganda.

Table 1: Average age (years) and distribution of heads of households by age group

Statistics	Adopters		Non adopters		Overall	
Average age	56.4		51.6		53.5	
Std deviation	9.89		10.59		10.54	
Maximum	76		71		76	
Minimum	35		30		30	
Age group (years)	Adopters		Non adopters		Overall	
	n_1	**%**	**n_2**	**%**	**n**	**%**
30 – 45	4	4.5	15	16.7	19	21.1
46 – 60	21	23.3	25	27.8	46	51.1
> 61	10	11.1	15	16.7	25	27.8
Total	35	38.9	55	64.4	90	100.0

t=2.162 DF=88. The two-tailed P value equals 0.033

4.1.2 Sex

The study revealed that men were the majority of respondents interviewed representing 63.3% while women representing only 36.7% (Table 2). In this case, men show much greater representation in dairy farming than women. The low representation by women in dairy farming could be attributed to cultural barriers in the study area where women are considered household heads only when they are widowed, divorced or separated. Another probable reason could be that, involvement of women in farming is normally constrained by their intra-house division of labour, responsibilities and the control and use of income which have widespread implications in agricultural production. The relative proportion of women adopters was higher compared to men. Out of 33 women interviewed, 51.5% adopted AI versus 31.5% out of 57 men interviewed. The difference between adopters and non adopters with respect to sex of respondent was found to be statistically significant

(P < 0.05). In this case women dominated in adoption of AI contradicting findings by Makauki (2000) and Teendwa (2005) who reported dominance of men over women in access to different resources and services.

Table 2: Proportion of respondents by sex

Sex	Adopters		Non adopters		Overall	
	n1	**%**	**n2**	**%**	**n**	**%**
Male	18	20.0	39	43.3	57	63.3
Female	17	18.9	16	17.8	33	36.7
Total	35	38.9	55	61.1	90	100.0

χ^2 =6.400 DF=1. P value equals 0.0114

4.1.3 Education level

The educational level of a farmer does not only raise productivity and increase ability to appreciate the essence of credit but also to understand and evaluate the information on new techniques and processes disseminated through extension agents. Table 3 reveals that of the 90 respondents, 3(3.3%) had no formal education, 26(28.9%) had attained primary school education, 21(23.3%) had received secondary education and lastly 40 (44.5%) were the more educated group who had attained college education and above. Out of 35 adopters 57% had college and above education compared to 36% of respondents with college and above education out of 55 non adopters interviewed. In this case adopters were highly educated implying the higher the education level of a respondent the more likely he/she would be an adopter. There were no adopters with no formal education. Similar findings have been reported by previous researchers such as Fernandez-Cornejo *et al.* (2001) and Wetengere (2009) who reported that farmers with more education were also more likely to adopt new technologies. Statistically there was high significant difference (P<0.001) between the number of adopters and non adopters with respect to education level.

Table 3: Proportion of respondents by education levels

Education level	Adopters		Non adopters		Overall	
	n1	**%**	**n2**	**%**	**n**	**%**
No formal education	0	0.0	3	3.3	3	3.3
Primary school	8	8.9	18	20.0	26	28.9
Secondary school	7	7.8	14	15.6	21	23.3
College and above	20	22.2	20	22.2	40	44.5
Total	35	38.9	55	61.1	90	100.0

χ^2 =31.156 DF=3 P value is less than 0.0001

4.1.4 Marital status

The majority (75.6%) of respondents were married (Table 4) as observed in other studies (Teendwa, 2005; Namwata *et al*., 2010). Moreover, of the 68 married respondents, 40 were non adopters and 28 were adopters. However, there were very few not yet married, divorced, separated, and widowed farmers representing 7.8%, 4.4%, 11.1% and 1.1% respectively. The probable reason here was that married households had more advantages over the other categories on effective use of owned resources, sharing ideas and managerial skills within the family and provision of labour force. The deference between the number of adopters and non adopters with respect to marital status was highly significant (P<0.001).

Table 4: Distribution of respondents according to their marital status

Marital status	Adopters		Non adopters		Overall	
	n1	**%**	**n2**	**%**	**n**	**%**
Not yet married	1	1.1	6	6.7	7	7.8
Married	28	31.1	40	44.5	68	75.6
Divorced	0	0.0	4	4.4	4	4.4
Separated	6	6.7	4	4.4	10	11.1
Widowed	0	0.0	1	1.1	1	1.1
Total	35	38.9	55	61.1	90	100.0

χ^2 =125.556 DF=4 P value is less than 0.0001

4.1.5 Family size

Table 5 shows the distribution of respondents with respect to family size. About half (51.1%) of dairy farmers interviewed had a family size of 6 – 8 people. AI adopters with a family size below five and above nine were 7.8% and 8.9% respectively. Statistically there was no significant difference (P>0.05) between family size groups and between adopters and non adopters. These findings suggest that adoption of AI technology was not necessarily associated with family size. The large family sizes indicated by both adopters and non adopters may be a result of dairy cattle keeping being a labour intensive enterprise. These findings are in line with those obtained by Kandoro (2008). The probable reason is that AI technology is not a labour intensive technology as indicated by Semgalawe (1998) who found out that household size influenced adoption of labour intensive technologies in Northern Pare and Western Usambara mountains.

Table 5: Distribution of respondents according to their family sizes

Family size	Adopters		Non adopters		Overall	
	n_1	**%**	**n_2**	**%**	**n**	**%**
2 - 5	7	7.8	19	21.1	26	28.9
6 - 8	20	22.2	26	28.9	46	51.1
> 9	8	8.9	10	11.1	18	20.0
Total	35	38.9	55	61.1	90	100.0

t =1.912 DF=88. The two-tailed P value equals 0.0591

4.1.6 Main occupation

Table 6 shows that 42.2% of all respondents had their main occupation as farming and 33.3% were employed by government/NGO. There were very few dairy farmers who had other main occupations. This finding is similar to those reported by Mlozi (2001) who found out that people in urban and peri urban areas especially civil workers are engaged in dairy farming to supplement their low incomes and that after their retirement dairying became their main economic activity. Chi-square test indicated that statistically there was high significant difference (P<0.001) between the number of adopters and non adopters with respect to main occupation.

Table 6: Proportion of respondents according to their main occupation

Main occupation	Adopters		Non adopters		Overall	
	n1	**%**	**n2**	**%**	**n**	**%**
Employed	14	15.6	16	17.8	30	33.3
Not employed	2	2.2	3	3.3	5	5.6
Petty business	1	1.1	10	11.1	11	12.2
Tailor	1	1.1	1	1.1	2	2.2
Farming	14	15.6	20	22.2	34	37.8
Carpentry	0	0.0	1	1.1	1	1.1
Other	3	3.3	4	4.4	7	7.8
Total	35	38.9	55	61.1	90	100.0

χ^2=106.000 DF=6 P value is less than 0.0001

4.1.7 Income from the dairy enterprise

Table 7 shows the distribution of respondents with respect to income they get from dairy activities. The majority of respondents (66.7%) had income level from dairy activities lie between Tshs 101 000 and 500 000 which accounted for 26.7% of adopters and 40% of non adopters. Respondents with income level of less than 100 000/= were 24.4% and very few with income levels above 500 000/=. The deference between adopters and non adopters with respect to income levels was highly significant (P<0.001).

Table 7: Distribution of respondents according to amount of income obtained per month from dairy activities

Income level	Adopters		Non adopters		Overall	
	n1	**%**	**n2**	**%**	**n**	**%**
Less than 100,000	8	8.9	18	20.0	26	28.9
101,000 – 500,000	24	26.7	32	35.6	56	62.3
501,000 – 1,000,000	1	1.1	3	3.3	4	4.4
1,001,000 and above	2	2.2	2	2.2	4	4.4
Total	35	38.9	55	61.1	90	100.0

χ^2=92.933 DF=3 P value is less than 0.0001

4.1.8 Years in dairying

It was assumed that years in dairying might influence adoption of AI technology. This is because experienced farmers tend to be more knowledgeable of techniques and technologies needed to be employed for advancement of their dairy enterprises. Table 8 shows the respondents' overall average years in dairying to be 14.8. The AI adopters had significantly higher (by 6.4 years) average years in dairying (18.7) than non adopters (12.3) ($P<0.05$). This implies that adoption of AI technology is associated with number of years in dairying. Experience enriches the farmer on the major production aspects such as a sound knowledge of major practices (Namwata *et al.* 2010). In another study conflicting results were reported by Kaaya *et al.* (2005) who found out that more experienced farmers were less inclined to breed their cattle using AI technology.

Table 8: Average number of years in dairying and distribution of respondents according to years in dairying

Statistics	Adopters		Non adopters		Overall	
Average years	18.7		12.3		14.8	
Std deviation	11.72		8.49		10.30	
Minimum	2		2		2	
Maximum	45		40		45	
Groups (Years)	Adopters		Non adopters		Overall	
	n1	**%**	**n2**	**%**	**n**	**%**
2 – 10	9	10.0	30	33.3	39	43.4
11 – 20	14	15.5	16	17.8	30	33.3
21 - 30	6	6.7	6	6.7	12	13.3
> 31	6	6.7	3	3.3	9	10.0
Total	35	38.9	55	61.1	90	100.0

t=2.999 DF=88, The two-tailed P value equals 0.0035

4.2 Economic Factors

4.2.1 Number of dairy animals owned by respondents

Table 9 shows the average herd size and distribution of respondents according to number of animals. The majority of respondents (57.8%) had a small number of dairy cattle ranging from 1 – 5. Under such circumstances, A.I. can be several times cheaper than keeping a bull year-round for such small herds. When charging service to neighbours is considered, the price paid per service is between 5,000/= to 10,000/= and since the dairy farmers are scattered there will be a limited number of services to offset the cost of keeping a bull. The proportion of respondents with 6 – 10 heads of cattle represented 30% of all dairy farmers while those with 11 -16 and 17 - 21 heads of cattle were very few (4% and 7% respectively). A t-test revealed that the difference between the adopters and non adopters with respect to average number of dairy cattle was not significant (P>0.05). This is an indication that adoption of AI technology in Kinondoni district was not necessarily associated with the number of dairy cattle being raised. These findings contradict findings by Karawita (2008) and Khode *et al.* (2009) who reported significant difference between the number of dairy cattle in the herds of AI adopters and non adopters. Yet in another study by Kaaya *et al.* (2005) they found out that farmers who used AI had smaller herd sizes than non users. Large herd size is uneconomical due to the fact that the use of AI requires a high level of management in terms of input like feeding, routine herd observation and communication with inseminator; therefore as herd size increases the farmers' ability to manage and pay for AI services is constrained.

Table 9: Average number of dairy animals (Herd size) and distribution of respondents according to number of animals

Statistics	Adopters		Non adopters		Overall	
Mean	6.37		6.00		6.14	
Std deviation	5.01		4.62		4.75	
Minimum	1		1		1	
Maximum	20		21		21	
Groups (Number)	Adopters		Non adopters		Overall	
	n1	**%**	**n2**	**%**	**n**	**%**
1 – 5	19	21.2	33	36.7	52	57.8
6 - 10	11	12.2	16	17.8	27	30.0
11 – 16	2	2.2	2	2.2	4	4.4
17 – 21	3	3.3	4	4.4	7	7.8
Total	35	38.9	55	61.1	90	100.0

t=.360 DF=88, The two-tailed P value equals 0.720

4.2.2 Daily milk production levels

The average milk production and distribution of respondents according to milk production is provided in Table 10. Milk yield ranged from a minimum of 3 litres to a maximum of 20 litres. Cattle belonging to adopters had significantly higher (P <0.05) average milk yield (11.2) than cattle belonging to non adopters (8.9) by 2.3 litres. Likewise out of 35 adopters 57% had their dairy cattle producing from 6 and 10 litres per day compared to 45.5% out of 55 non adopters. The interpretation is that adoption of AI was related to milk production levels. Similar findings were reported by Khode *et al.* (2009). The quantity of milk produced and sold every day result into more income which in turn enables the farmer to be more likely to afford the costs of AI involved. It also means these dairy farmers are keener in their management and would like to improve genetic merit of their herds. Machumu (1995) argued that adoption of money oriented technologies depends on the availability of market since farmers have to sell some of their produce to get money to buy inputs.

Table 10: Average milk production levels and distribution of respondents according to milk production levels

Statistics	Adopters		Non adopters		Overall	
Mean	11.2		8.9		9.8	
Std deviation	4.44		3.97		4.29	
Minimum	4		3		3	
Maximum	20		20		20	
Groups (Number)	Adopters		Non adopters		Overall	
	n_1	**%**	**n_2**	**%**	**n**	**%**
1 - 5	2	2.2	21	23.3	23	25.6
6 – 10	20	22.2	25	27.8	45	50.0
11 – 15	7	7.8	4	4.4	11	12.2
16 - 20	6	6.7	5	5.6	11	12.2
Total	35	38.9	55	61.1	90	100.0

t =2.620 DF=88. The two-tailed P value equals 0.01

4.2.3 Farmers' satisfaction on milk production level

The dream of any dairy farmer is to have a good quality herd that produces optimum amount of milk for prosperous undertaking. But this is not always the case due to the fact that some factors contribute to variations in herd quality and milk production. Table 11 shows there was a statistically significant difference (P<0.001) between the numbers of dairy farmers who were not satisfied (76.7%) and those who were satisfied (23.3%) with their herd milk production levels. These findings indicate there is high motivation among the dairy farmers interviewed to change their future herd quality regardless whether they had adopted AI technology or not.

Table 11: Distribution of respondents with respect to farmer's satisfaction on average milk production potential

Farmers satisfaction on milk production	Adopters		Non adopters		Overall	
	n1	**%**	**n2**	**%**	**n**	**%**
Satisfied	10	11.1	11	12.2	21	23.3
Not satisfied	25	27.8	44	48.9	69	76.7
Total	35	38.9	55	61.1	90	100.0

χ^2 =23.511 DF=1. P value is less than 0.0001

4.3 Innovation Characteristics

4.3.1 Relative advantage of AI technology compared to natural service

4.3.1.1 Reasons for selecting AI technology

Table12 shows the major reasons given by respondents for adoption of AI. Among the reasons high milk yield represented the highest proportion 29.3%. Other reasons with higher proportions were cheap (18.7%), easily done ((16%) and avoid problems of keeping a bull (14.7%). Other reasons had low representations. When dairy farmers rely on AI technology proper record keeping would ensure breeding on time. In contrast if they rely on natural mating, most of the time they rely on a neighbour's bull. If the bull is not available on time, it would prolong the calving interval. Under these circumstances farmers prefer AI over natural service.

Table 12: Reasons given by respondents for selecting AI technology

Reason	n	%
Good breeds	9	12.0
High milk yield	22	29.3
Easily done	12	16.0
Cheap	14	18.7
Avoid natural bull problems	11	14.7
Healthy calf	5	6.7
Reduced calving interval	2	2.6
Total	75	100.0

Respondents had more than one response therefore the total exceeds the number of adopters. The percentages have been calculated out of 75 responses.

4.3.1.2 Reasons for continued use of natural mating

Table 13 shows reasons given by farmers for the selection of natural mating. The most prominent reasons given for preferring natural mating or non-adoption of AI were owning a bull (26.7% this included neighbour's bull as well) which result in having calves every year, no knowledge about AI (18.9%), and no persuasion and advice regarding AI (25.5%).

Table 13: Reasons given by respondents for continued use of natural mating

Factor	n	%
No heat detection trouble	9	10.0
Own bull - calves every year	24	26.7
No knowledge about AI	17	18.9
Failure of AI	7	7.8
No persuasion and advice	23	25.5
Small sized animals	4	4.4
Low mating cost	6	6.7
Total	90	100.0

Respondents had more than one response therefore the total exceeds the number of non adopters.

4.3.1.3 Sources of bulls for natural mating

The easy availability of bulls makes farmers depend mostly on natural service rather than on AI. The drawback of depending on natural service was that the bulls available were not necessarily genetically superior ones. This was revealed by some bull users’ responses that they did not mind the quality of bulls they use. The findings from this study (Table 13) show that dairy farmers relying on a neighbour's bull to service their animals represented 68.9% while those depending on their own bulls were only 21.1%. This study supports the finding by Sinniah and Pollott (2006) that the percentage of farmers relying on neighbours' bulls were higher than those who depended on their own bulls and that availability of own and neighbours' bulls negatively affected the use of AI.

4.3.2 Complexity of AI technology

4.3.2.1 Mating technique

Farmers make subjective inter-mating technique comparisons of the attributes of AI and natural mating and they would adopt AI only when they have perceived as having better characteristics than the natural mating. This study paid special attention to farmers' perceptions of AI technology characteristics such as requirement for heat detection, number of inseminations per conception, whether there is difficulty in getting AI services and advantages involved in using natural mating. Fig. 3 shows that among the total respondents, 61.1% used natural mating, 28.9% used natural mating + AI and only 10% used AI alone to breed their animals. The proportion of respondents who used natural mating was considered to be significantly higher than those using natural mating + AI and AI alone. Dairy farmers tend to buy and keep cross bred animals even non adopters also liked to keep high producing dairy cattle herds. It is an indication that farmers need more cross-bred animals irrespective of their breeding method.

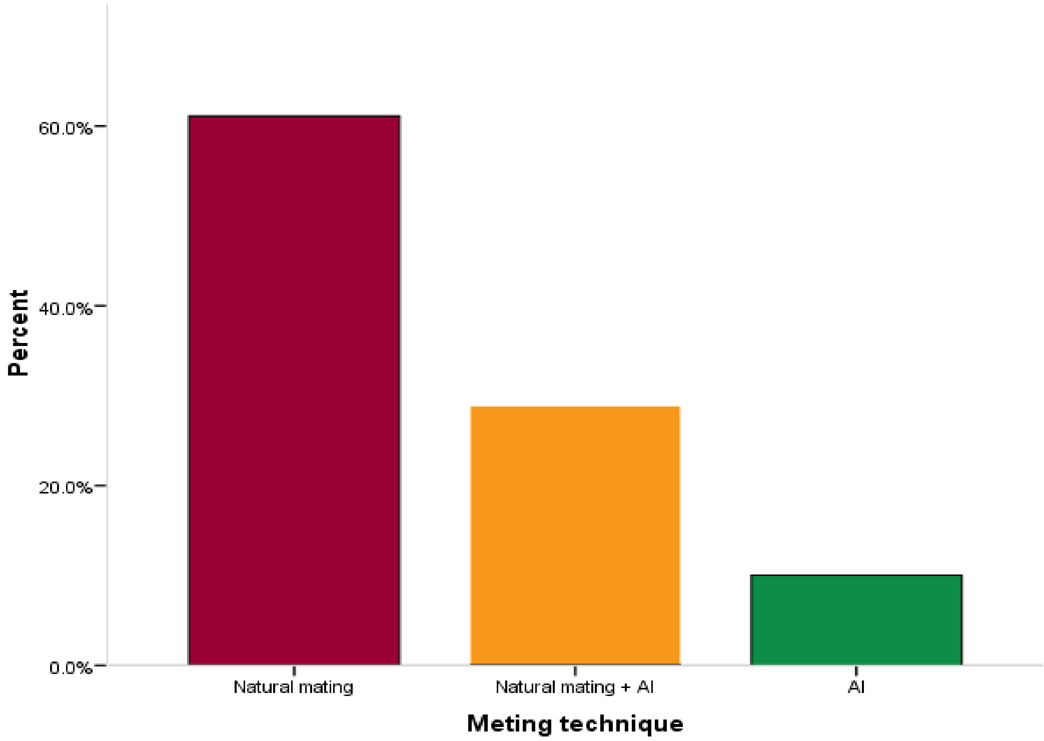

Figure 3: Percentage of respondents according to the mating technique used

4.3.2.2 Signs used for heat detection by dairy farmers

Heat detection plays a very important role in the AI service. Farmers' ability to detect the heat signs of cows and time of heat detection is important in this respect. Farmers' awareness and how they detect heat is given in Table 14. The most prominent signs used were bellowing (31.1%), mucous discharge (36.7%) and mounting other animals or being mounted by others (35.6%). Moderately used signs were restlessness and swelling of vulva. Other signs were least used. Adopters keep records of heat periods of their animals and they had an idea when the cows would come on heat. Non adopters had more inclination towards not observing the heat; it means they rely more on the bulls available in their area. Sinniah and Pollott (2006) when studying breeding activities and adoption of AI amongst dairy herds in dry zone of Sri Lanka reported similar findings.

Table 14: Signs used to detect heat by respondents for insemination

Heat sign	n	%
Bellowing	28	31.1
Mucous discharge	33	36.7
Restlessness	10	11.1
Reduction in feed consumption	8	8.9
Raising tail	4	4.4
Swelling of vulva	16	17.8
Mount others or being mounted	32	35.6
Drop in milk yield	6	6.7
Total	137	152.3

Respondents had more than one response therefore the totals add up to more than 100%.

4.3.2.3 Number of inseminations per conception

Farmers practicing AI were requested to state how many inseminations were required per conception. Their responses ranged from one to three inseminations. Adopters who indicated to inseminate their cows three times per conception represented 47.2% of all adopters. Other adopter farmers represented 36.1% and 16.7% had their cows inseminated twice and once respectively (Fig. 4). The number of inseminations per conception indicates the quality of AI service provided coupled with farmers' ability to detect the heat signs of their cows and time of insemination. Kaaya *et al.* (2005) reported that farmers ability to detect heat and time of insemination were crucial because when an animal does not conceive at first insemination there was a loss in terms of delayed conception, calving, loss of milk production and cost of repeated insemination. Therefore, the number of inseminations per conception is very important in influencing the dairy farmer on whether to adopt AI technology or not. Reynolds *et al.* (1996) when studying smallholder dairy production in Kenya reported that in addition to poor heat detection, unreliable AI service constrained the efficiency of AI on zero grazing farms.

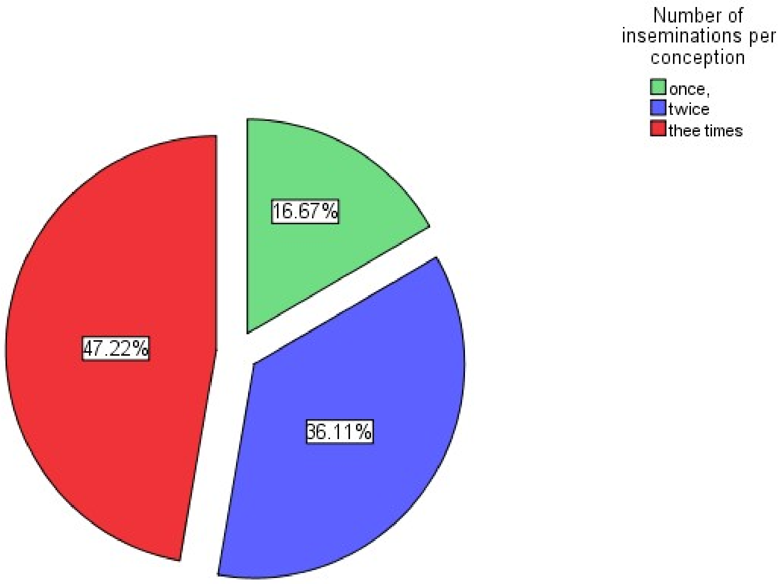

Figure 4: Percentage of adopters according to the number of inseminations per conception

4.3.2.4 Difficulties in getting AI services

Continuous supply of AI service is essential to get the farmers convinced and to have their confidence on AI service. Fig. 5 shows that the majority of respondents (62.2%) indicated difficulty in getting AI services. About 25.6% and 12.2% of respondents indicated no problem in getting AI or were undecided respectively. Some farmers interviewed indicated their calls being turned down by inseminators particularly those in areas far from the AI centres. Some times the inseminators respond to the calls but they used to come late after the standing heat had passed. Karawita (2008) reported reasons for not to attend to all AI calls by technicians to be lack of mobility and large area of operation.

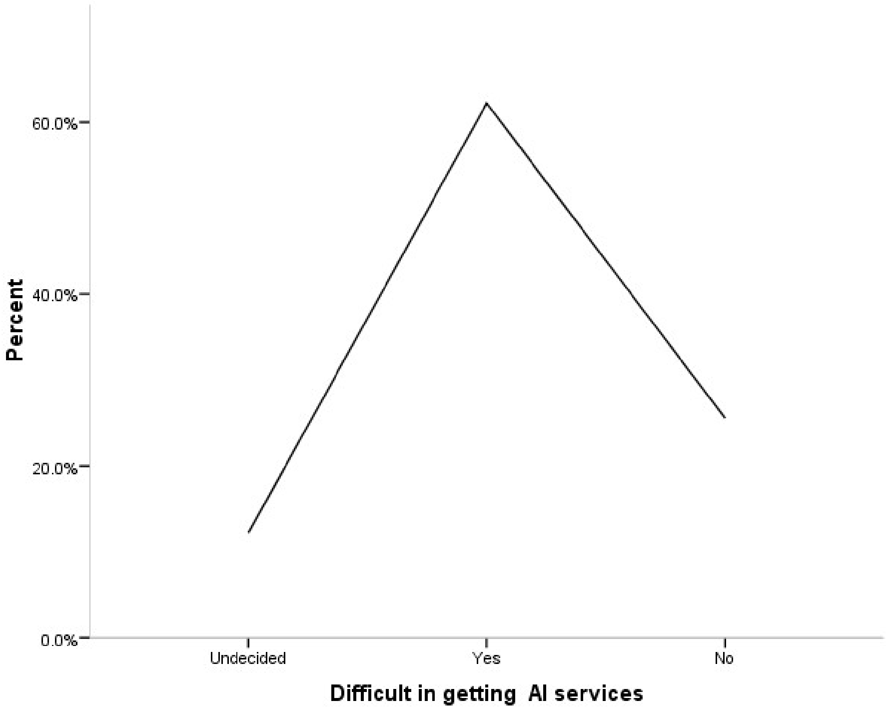

Figure 5: Proportion of respondents according to their responses on whether it was difficult to get AI service

4.3.2.5 Cost of keeping a bull

All interviewees were asked to respond to the question on the cost of keeping a bull whether it was high, medium or low. Fig. 6 shows two equal groups (38.9% each) of respondents indicated cost of keeping a bull to be high and medium. Respondents who felt the cost of keeping a bull to be low represented 22.2%. Some respondents among non adopters indicated that it was cheap to keep a bull especially when you have a large herd size and even much cheaper for those who graze their animals.

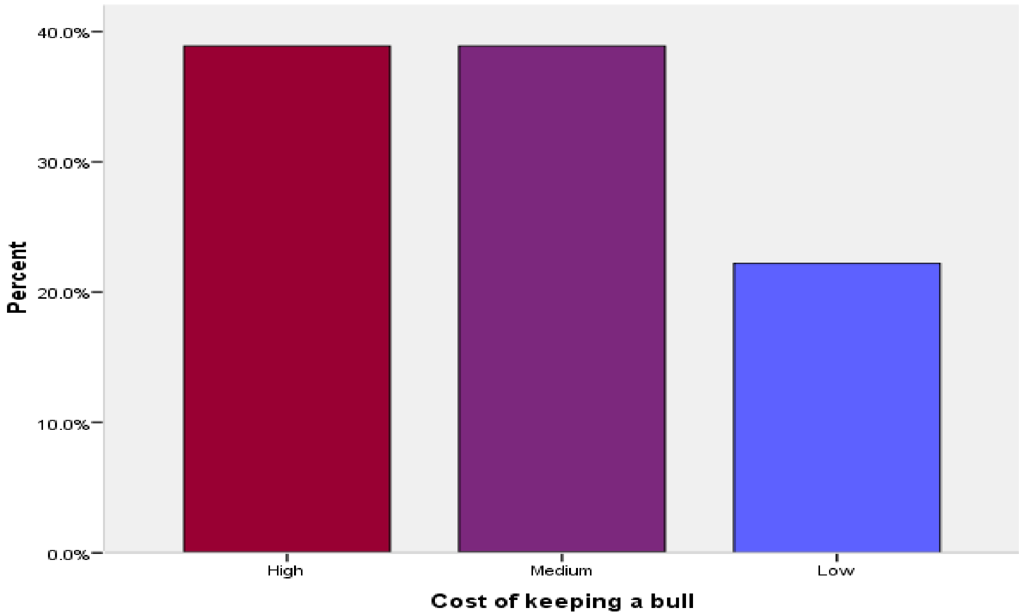

Figure 6: Percentage of respondents with respect to their responses on the costs of keeping a bull

4.3.2.6 Cost of using a bull, distance to a bull and cost of insemination

Table 15 shows the average cost of using a neighbours' bull was Tshs 8680/= and the average price of using AI service was Tshs 22 970/= being higher than natural service by Tshs 14 290/=. Although the average cost of using AI service was considered to be significantly higher than the cost of using a bull, the dairy farmers who use neighbours' bulls had to incur extra costs of sending a cow to a bull at an average distance of 1.013 km.

Table 15: Average cost of using a bull, distance to a bull and cost of insemination

Statistics	Cost of using a bull (Tshs)	Distance to a bull (km)	Cost of insemination (Tshs)
Mean	8 680	1. 013	22 970
Std. Deviation	3.110	0.9526	10 406
Minimum	5 000	0.0	10 000
Maximum	20 000	5.0	40 000

4.3.2.7 Cost of insemination

Adopters were requested to indicate the price they pay per each AI service. The prices paid ranged from 10 000/= to 40 000/= and amount paid in each category and percentage in brackets were 10 000/= (5.7%), 12 000/= (11.2%), 15 000/=(25.7%), 20 000/=(20%), 30 000/=(20%) and 40 000/=(17.1%) (Fig. 7). In some countries AI service is highly subsidized (Chupin and Schuh, 1993). Even in Tanzania semen from the National Artificial Insemination Centre (NAIC) is sold as low as Tshs 2,000/= per straw and a litre of liquid nitrogen for Tshs 2 500/=. It means the two items are subsidized but inseminators recover their expenses including transport cost from the farmer. During the study it was found that inseminators in some areas were getting higher payment compared to other areas. This was associated with the high demand for AI in some areas of the district. According to inseminators, farmers who paid more than 20 000/= per service preferred to use imported semen which was coming from USA, Netherlands and Italy. Some farmers tended to like imported semen than that of NAIC on the assumption that calves born have higher birth weights. Both government and private inseminators were available for service in the district but farmers would prefer to get AI service through government inseminators though they were few. Dairy farmers were more convinced to use government inseminators who were charging less for AI service compared to private ones.

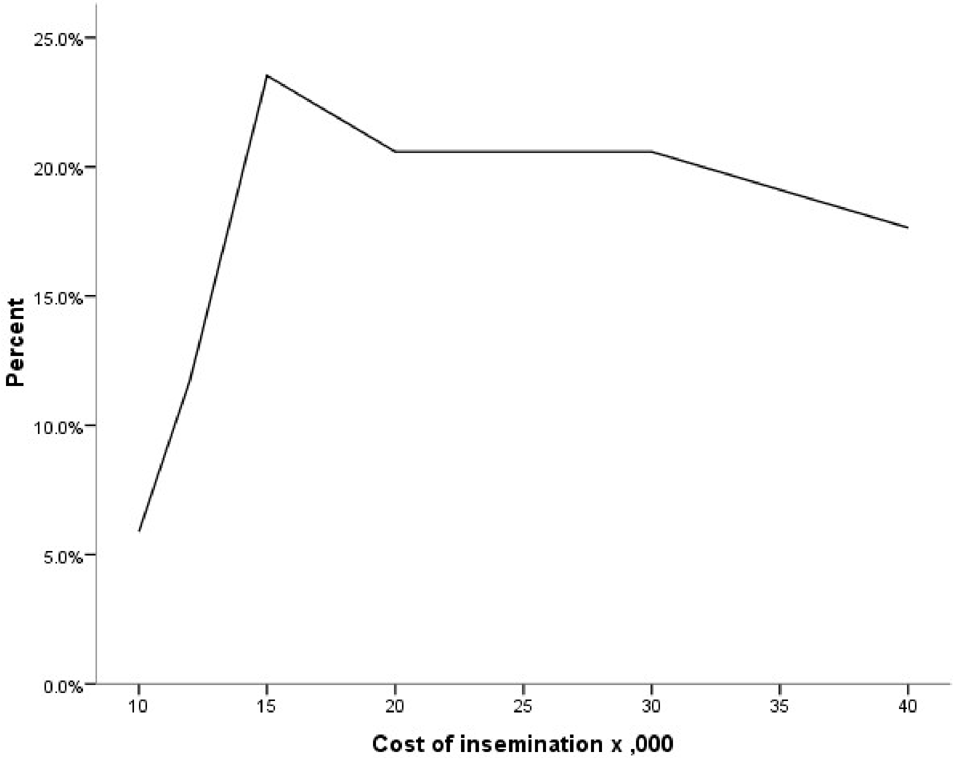

Figure 7: Distribution of AI adopters according to the price they pay per AI service

4.4 Institutional Characteristics

4.4.1 Service availability

4.4.1.1 Distance to the nearest AI centre

The distance to the AI centre was one of the major factors determining the efficiency of service provision to farmers. Table 16 shows the average distance to nearest AI service centre and distribution of respondents according to distance groups. Although the trend indicated as distance increased the number of adopters went down, there was no significant impact of distance from AI centre with regard to adoption of AI. This might be explained by the fact that adopters tended to reduce the cost by calling the inseminators using mobile phones instead of sending someone to inform the inseminator. However, as the distance increases the inseminators tend to charge more for the AI service to offset the distance barrier. Similar results were presented by Kaaya *et al.* (2005). Karawita (2008) found out that large area of operation and lack of mobility was the main reason for inseminators not attending to dairy farmers’ calls for AI services.

Table 16: Average distance to nearest AI service centre and distribution of respondents according to distance groups

Statistics	Adopters		Non adopters		Overall	
Mean	9.0		9.6		9.4	
Std deviation	6.52		8.36		7.67	
Minimum	1		2		1	
Maximum	30		30		30	
Distance groups(km)	Adopters		Non adopters		Overall	
	n1	**%**	**n2**	**%**	**n**	**%**
1 - 7	15	4.4	26	28.9	41	45.6
8 – 15	16	17.8	20	22.2	36	40.0
16 and above	4	16.7	9	10.0	13	14.4
Total	35	38.9	55	61.1	90	100.0

t=-.377 DF=88. The two-tailed P value equals 0.7071

4.4.1.2 Promotion of AI technology by government leaders

Sensitisation on the advantages of AI by government leaders and politicians is one of the policy related intervention to promote utilization of AI technology. Table 17 shows (92%) of respondents indicated that government leaders did not address AI technology and only (7.8%) said government leaders did address AI. This finding imply leaders need to change.

Table 17: Percentage of respondents according to whether government leaders addressed AI in their area or not

Response	Adopters		Non adopters		Overall	
	n1	**%**	**n2**	**%**	**n**	**%**
Yes	5	5.6	2	2.2	7	7.8
No	30	33.3	53	58.9	83	92.2
Total	35	38.9	55	61.1	90	100.0

χ^2 =64.178 DF=1 P value is less than 0.0001

4.4.2 Extension services

4.4.2.1 Contact with extension agents

Exposure to information reduces subjective uncertainty and therefore increases the likelihood of adoption of new technologies. Table 18 shows the effect of extension contacts on adoption of AI technology as also indicated by Akinola *et al.* (2007) and Langituo and Mekuria (2008). The majority (82.2%) of dairy farmers had extension contact and only a small proportion (17.8%) had no contact. Furthermore, out of 35 adopters 80% had extension contacts versus 63.6% of non adopters out of 55 interviewed established extension contacts. Statistically there was high significant (P<0.001) difference between the number of adopters and non adopters responses regarding contact with extension agent.

Table 18: Proportion of respondents who had contact with the extension agent

Response	Adopters		Non adopters		Overall	
	n1	**%**	**n2**	**%**	**n**	**%**
Yes	28	31.1	35	38.9	74	82.2
No	7	7.8	9	10.0	16	17.8
Total	35	38.9	55	61.1	90	100.0

χ^2 =37.378 DF=1 P value is less than 0.0001

4.4.2.2 Extent of visit by extension agent

Table 19 shows the distribution of respondents by extent of contact with extension agents. The majority of respondents (75.6%) had their contact with extension agents made on request in which 77% out of 35 adopters and 74.5% out of 55 non adopters had a felt need for extension agents. Once a week and once in a month contacts accounted for 14.4% and 10.0% of the responses respectively. Chi-square test indicated that statistically there were significant differences (P<0.001) between extent of visit groups. Although the result does not clearly indicate the effect of contact with extension agent on adoption of AI technology, study by Langyintuo and Mekuria (2008) indicated that contact with extension staff exposes the farmer to extension education which would provide an effective way of showcasing the superiority of improved technology over the traditional and therefore stimulating adoption. Also Namwata *et al.* (2010) found out that increased extension services were significantly associated with adoption of improved agricultural technologies for Irish potatoes in Southern highlands of Tanzania.

Table 19: Distribution of respondents by extent of contact with extension agent

Visits	Adopters		Non adopters		Overall	
	n1	**%**	**n2**	**%**	**n**	**%**
Once a week	6	6.7	7	7.8	13	14.4
Once in a month	2	2.2	7	7.8	9	10.0
On request	27	30.0	41	45.5	68	75.6
Total	35	38.9	55	61.1	90	100.0

χ^2=72.467 DF=2 P value is less than 0.0001

4.4.2.4 Quality of extension service

Respondents were told to indicate whether the quality of extension services provided was adequate, inadequate or undecided. The majority of response (57.8%) indicated inadequate extension services and 36.7% of respondents indicated to have received adequate extension services (Table 20). Undecided respondents were very few. The distribution within classes between adopters and non adopters tended to be similar. Chi-square test indicated that statistically there was a significant difference (P<0.001) between levels of adequacy regarding quality of extension services.

Table 20: Proportion of respondents by quality of advice they receive from extension staff on AI

Levelof adequacy	Adopters		Non adopters		Overall	
	n1	**%**	**n2**	**%**	**n**	**%**
Adequate	13	14.5	20	22.2	33	36.7
Inadequate	19	21.1	33	36.7	52	57.8
Undecided	3	3.3	2	2.2	5	5.5
Tota l	35	38.9	55	61.1	90	100.0

χ^2=39.393 DF=2 P value is less than 0.0001

4.4.2.5 Availability of organizations that provide AI services

The availability of organizations that provide extension services particularly on the utilization of AI technology was investigated in this study (Table 21). Out of 90 respondents interviewed, 57.8% indicated lack of organizations which provided AI services and 42.2% of respondents indicated availability of organisation that provide AI services. Among adopters equal distribution of those with organisations and those without but among non-adopters there were slightly more people without organisations providing AI services. The findings imply institutions that provide AI service were not necessarily related to adoption or non adoption of AI technology.

Table 21: Distribution of respondents according to whether there were institutions that provide AI services in the area

Responses	Adopters		Non adopters		Overall	
	n_1	**%**	**n_2**	**%**	**n**	**%**
Yes	18	20.0	20	22.2	38	42.2
No	17	18.9	35	38.9	52	57.8
Total	35	38.9	55	61.1	90	100.0

χ^2 =2.178 DF=1 P value equals 0.1400

4.4.3 Access to agricultural credit

The influence of credit on adoption of AI technology was also examined during interviews. The majority (94.4%) of respondents had no access to agricultural credit in which 32(91%) out of 35 adopters and 53(96%) out 55 non adopters had no access to agricultural credit. Only a small proportion of 5.6% had access (Table 22). The difference between the dairy farmers who had access and those without access to credit was highly significant ($P<0.001$). Since the number of dairy farmers with access to agricultural credit was very low its effect on the adoption of AI technology could not be revealed. However, findings by Langituo and Mekuria (2008) and Namwata *et al.* (2010) indicated importance of access to agricultural credit on the adoption of technology. Also the study by Kaaya *et al.* (2005) indicated that more AI users had accessed agricultural credit than non AI users.

Table 22: Percentage of respondents by credit facilities spared to support them

Responses	Adopters		Non adopters		Overall	
	n_1	**%**	**n_2**	**%**	**n**	**%**
Yes	3	3.3	2	2.2	5	5.6
No	32	35.6	53	58.9	85	94.4
Total	35	38.9	55	61.1	90	100.0

χ^2 =71.111 DF=1 P value is less than 0.0001

4.4.4 Membership in dairy producers' associations

In most farming communities, farmers form or join associations or cooperatives of various kinds for all sorts of reasons. Such associations or cooperatives sometimes offer farmers the opportunity to have better access to information, which is an important condition for adopting an improved technology. Table 23 shows the proportion of respondents according to their responses on whether they joined dairy farmers groups or not. Although membership to an organization (i.e. Cooperative membership) is considered an important information source including among dairy farmers (Gamba, 2006; Odoemenem and Obinne, 2010), results from this study revealed that only 21.1% of the respondents were members of dairy farmers groups while the rest (78.9%) were not involved in any sort of dairy farmer groups. This finding shows that the potential of social-network (social capital) through dairy farmers' groups as a source of information and service provision has not been fully utilized in the study area. The difference between respondents with membership to farmer groups and those without was highly significant (P<0.001).

Table 23: Proportion of respondents by responses given for either being a member of dairy farmers group or not

Responses	Adopters		Non adopters		Overall	
	n_1	**%**	**n_2**	**%**	**n**	**%**
Yes	12	13.3	7	7.8	19	21.1
No	23	25.6	48	53.3	71	78.9
Total	35	38.9	55	61.1	90	100.0

χ^2 =40.000 DF=1 P value is less than 0.0001

4.5 Socio Psychological Attributes

4.5.1 Knowledge level of respondents on AI technology

There was a general trend in the number of adopters increasing from low knowledge (2.2%), medium (11.1%) to high (25.6%) (Table 24). On the other hand, for non adopters the obvious trend indicates reduction in number from low (27.8%), medium (26.7%) and high 6.7%). The reverse trend indicates that the higher the knowledge level the more likely the dairy farmer will adopt the AI technology. This is indicated by empirical result that out of 35 adopters, 23 (65.7%) had high knowledge level versus 6 (10.9%) had high knowledge level out of 55 non adopters interviewed. Gautam *et a.l* (2005) also indicated the effect of knowledge level on the successful implementation of upgrading of cattle using AI.

Table 24: Proportion of respondents by their knowledge level on AI technology

Knowledge Level	Adopters		Non adopters		Overall	
	n1	**%**	**n2**	**%**	**n**	**%**
High	23	25.6	6	6.6	29	32.2
Medium	10	11.1	24	26.7	34	37.8
Low	2	2.2	25	27.8	27	30.0
Total	35	38.9	55	61.1	90	100.0

χ^2 =0.867 DF=2. P value equals 0.6482

4.5.2 Attitudes of respondents towards AI technology

Adoption of any improved technology involves a process in which awareness is created, attitudes are changed and favourable conditions for adoption are provided. To examine preferences with respect to utilization of AI technology, respondents were asked to indicate whether they agree with various factors related to AI services. Fig. 8 shows 55 (61.1%) of respondents had unfavourable, 34 (37.8%) had favourable attitude and 1(1.1%) was undecided. These findings indicate there was a relationship between attitude and adoption of AI technology. This can be explained by the fact that the percentage of adopters almost coincides with the percentage of respondents with favourable attitude and the percentage of non adopters matched the percentage of respondents with unfavourable attitude. Sigh and Kaul (2002) indicated that changing attitudes of livestock owners towards AI through communication of massages regarding AI significantly influenced adoption of AI technology.

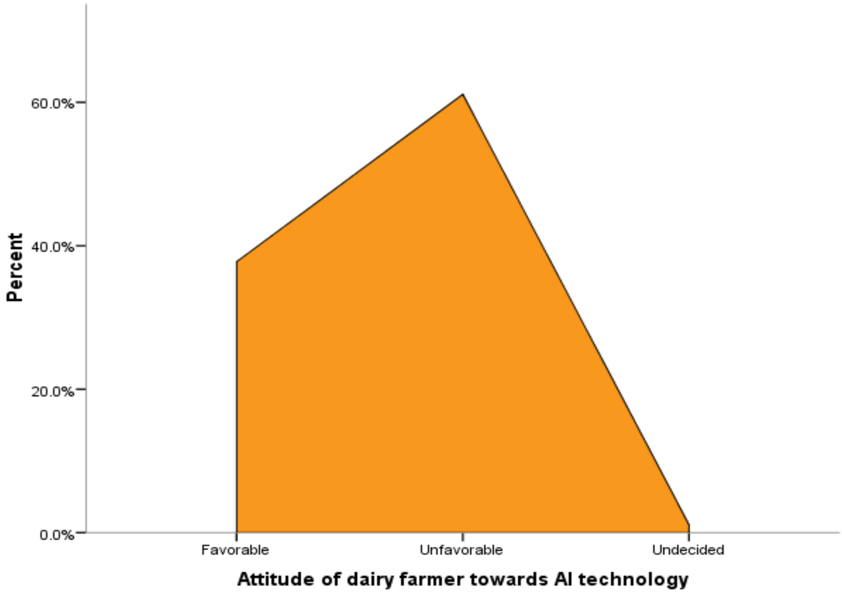

Figure 8: Distribution of respondents according to their attitudes towards AI technology

4.6 Factors Influencing Adoption of AI Technology -Tobit Regression Model

In analyzing factors influencing the farmers' decision to adopt the concept of AI utilization, it may not be enough to only know the probability that a farmer will adopt AI technology but it is also crucial to know the extent of continued utilization after adoption. To simultaneously explain probability of adoption and intensity of use of the technology, the Tobit model was employed. The interpretation of any fitted model requires ones ability to draw practical inferences from the coefficients estimated in the model. For linear models, in which the link function is the identity function, coefficients express a corresponding change in the dependent variable for a unit change in the independent variable. However, in the logit and Tobit models, these coefficients do not have a straightforward interpretation. The slope coefficients represent a change in the link function for a change of one unit in the independent variable. Proper interpretation of the coefficients depends on being able to give meaning to the difference between two values of the link function. In this case, a change in the level of any given characteristic (which is assumed to be directly linked to adoption) consists of two effects: (a) the change in the use intensities of AI technology, for those dairy farmers that are already adopters; and (b) the change in the probability of being an adopter (Langituo and Mekuria, 2005).

A summary of Tobit model estimates of the factors affecting utilization of AI technology among dairy farmers is presented in Table 25. Furthermore Table 26 shows a summary partial-derivative decomposition of marginal effects of the Tobit analysis which indicates adoption probability and use intensity of AI technology. Significant factors related to probability and intensity of AI adoption for the study included sex, education level, breed of dairy cattle, extent of extension visits and being a member of dairy farmers group or not. As expected, **sex of respondent (SEX)** was significant and indicated a negative influence on the adoption of AI technology and continued use after adoption. Dairy cattle tend to provide income to a household everyday from milk sales in which some of revenue could be used to cover household requirements which normally are handled by women. Sex exhibits the probability of adoption of -0.248 and use intensity -0.193 (Table 26), meaning that the probability of AI technology adoption by women is 25 per cent higher than that by men. And among those who already adopted AI, it is expected that the intensity of use of AI technology can be revealed in women's herds which would have, on average, about twenty percent more AI service than in men's herds.

Table 25: Tobit analysis on factors affecting adoption of AI technology

[1]Variable	Coefficient	Std Err	T-value	P>t
CONS	-1.230	1.791	-0.69	0.494
EDULEVEL	0.274	0.164	1.67*	0.100*
SEX	-0.529	0.280	-1.89*	0.062*
MARSTAT	-0.126	0.165	-0.76	0.448
OCUPATN	-0.037	0.063	-0.59	0.554
YRSDAIRY	0.013	0.011	1.15	0.256
BREDAIRY	-0.188	0.108	-1.75*	0.084*
COSTINS	-0.117	0.169	-0.69	0.492
DIFGETAI	0.350	0.152	2.30**	0.024**
INCOTHRS	- 0.047	0.329	-0.14	0.886
CREDT	-0.449	0.518	-0.87	0.389
DSTAISEV	0.008	0.016	0.50	0.615
VISITEXT	0.575	0.223	2.58**	0.012**
GRPMEB	0.340	0.155	1.99**	0.050**
/sigma	0.835	0.118	0.600	0.070
Number of obs = 90				
LR chi2(14) = 35.16				
Prob > chi2 = 0.0014				
Pseudo R2 = 0.2045				
Log likelihood = -68.389021				

[1]Go to page 43 for more elaboration of the variables.
*Significant at 10% level, ** significant at 5% level.

According to this finding if the sex of the respondent was a male the probability to adopt AI technology decreased. These findings are in conformity with those of Barry (2005) who found out that the probability of livestock adoption by women was higher than that of men. Also Wetengere (2009) when studying socio-economic factors critical for adoption of fish farming technology found out that sex was negatively related to the probability to adopt fish farming. In another study Namwata *et al.* (2010), they observed that being a male or married by a household head was positively and significantly associated with overall adoption.

Table 26: Summary of decomposition of marginal effects from significant Tobit results

[1]Variable	[2]dy/dx	Sig. level	Marginal Effects	
			Adoption Probability	Use Intensity
SEX	-0.529	10	-0.248	-0.193
EDULEVEL	0.274	10	0.058	0.037
BREDAIRY	-0.188	10	-0.124	-0.091
DIFGETAI	0.350	5	0. 136	0.103
VISITEXT	0.575	5	0.097	0.074
GRPMEB	0.340	5	0.152	0.109
z = 1.45				
F(z) = 0.32				
σ = 0.84				

[1]Go to page 43 for more elaboration of the variables.
[2]dy/dx is for discrete change of dummy variable from 0 to 1.

Farmer's education level (EDULEVEL) revealed a positive effect on adoption of AI technology and use intensity. The probable reason for the positive influence could be that educated people in urban and peri-urban were more likely to undertake livestock keeping than un-educated people. Level of education may affect investment decisions in many ways. Educated farmers are often thought to have access to literature such as research bulletins and hence to be better informed and more willing to adopt improved technologies than otherwise (Khode *et al.*, 2009). Usually, education and income are positively correlated, although not linearly. High-income households are more likely to have incentives for profitable and innovative activities. So, in general, education will tend to have a positive effect on investment. Table 26 shows education level to have the probability of 0.058 and use intensity of 0.037 implying that the probability that the educated dairy farmers would adopt AI technology was 5.8% and the intensity of use after adoption would be 3.7%. These findings are in line with previous studies that education was found to positively influence adoption of improved agricultural technologies (Alene *et al.,* 2000; Knight et al., 2003; Barreiro-Hurle *et al.,* 2009).

Breed of dairy cattle (BREDAIRY) had shown negative and significant coefficient with probability of -0.124 and use intensity of -0.091 (Table 26). The interpretation of this finding is that when approaching threshold on milk production that satisfies the farmer, each litre increase in milk production would reduce the probability of adoption of AI technology by 12% and reduction on continued use after adoption by 9%. The probable reason here is that adoption of AI technology is more likely to be done by dairy farmers owning unimproved or low grade cattle. Initially, farmers adopt AI technology for the purpose of improving their dairy cattle productivity and when such herds are improved to the farmers' satisfaction AI technology is only used for routine breeding. The farmers then may be inclined to use natural mating as it is less costly and readily available especially if they have acquired an improved bull via AI technology. These results are consistent with those reported by other researchers such as Kaaya *et al.* (2005) in Uganda and Ramesh (1995) who found out that slow growth of AI in Kerala, India had been attributed to equilibrium between the diffusion of AI technology and prevailing social-economic conditions in areas where the crossbreeding programme had been in operation for a long time.

Difficulty in getting AI service (DIFGETAI) is reflected when there is a problem on the availability of inseminators to respond to all AI calls. Supported by Kaaya *et al.* (2005) it is therefore associated with availability of adequate inseminators and general improvement in the AI services. The positive and significant effect shown by difficulty in getting AI service suggest that each additional inseminator joined the study area increased the probability of dairy farmers in the study area to adopt AI technology by 13.6% and use intensity by 10.3%.

Extension services are measured by the number of visits per month by the extension agent to a farmer. Farmers who had more extension contacts were more likely to access information on the benefits and availability of AI services and even be served by the best inseminators. The positive and significant effect indicated by **extent of contact with extension agent** (VISITEXT) on adoption and use intensity suggests when all other factors were kept constant; each additional extension contact a farmer received increased the probability of that dairy farmer to adopt AI technology by 9.7% and use intensity by 7.4%. Other researchers such as Alene *et al.* (2000) and Junge *et al.* (2009) reported similar results that each additional visit by the extension agent to a farmer increases the probability of adoption. Yet in another study, Namwata *et al.* (2010) reported that regular contact with extension agents made farmers being aware of new technologies and how they can be applied.

The empirical results emphasize the importance of access to social services such as **being a member of dairy farmers' group (**GRPMEB) in determining the adoption of AI technology. Consistent with the findings of Langituo and Mekuria (2008), a positive relationship is observed between membership to dairy farmers group and adoption of AI technology. The results suggest that the probability of getting a dairy farmer to adopt an AI technology would increase by 15.2% if he or she joined an association and the probability that he or she would continue to use AI technology after adoption would be 11% (Table 26).

Effect of marital status, occupation, years in dairying, owner of dairy cattle, income from other sources, access to agricultural credit and distance to AI centre were not significant (Table 25) indicating that they were not important predictors of adoption of AI technology in the study area. These observations contradict some findings reported in several previous studies such as Akinola *et al.* (2007), Namwata *et al.* (2010) and Kaaya *et al.* (2005) in which these factors were found to be important. This reflects the importance of contextual specific (i.e. type of technology and location) factors for adoption. Therefore, factors for adoption for improved agricultural technologies should not be generalized.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Based on the results of this study the following conclusions are made.

5.1.1 Rate of adoption of AI technology

The criterion for being considered as an adopter was to have been using AI alone or AI combined with natural service. Based on this criterion it can be concluded that the rate of adoption of AI technology in Kinondoni district was low, with less than 40% of dairy farmers using AI technology.

5.1.2 Factors affecting adoption of AI technology

Based on Tobit estimates, factors that affect adoption of AI technology can be categorised into those that positively influenced adoption and those that negatively influenced adoption. On the basis of these categorization factors, those that are positively associated with adoption and use intensity of AI after adoption included education level, difficulty in getting AI service, extent of extension visits and being a member of dairy farmers group or not. On the other hand, factors negatively associated with adoption and use intensity of AI technology after adoption were breed of dairy cattle and sex of head of household.

5.2 Recommendations

In view of the major findings of the study and the above conclusions, the following recommendations for policy and action can be made in order to increase adoption and uptake of AI technology.

5.2.1 Training of inseminators and improvement in the quality of AI service

There is a need to train more inseminators and the government should regulate all service providers to ensure high standards of service. In addition apart from improving the coverage of AI centres, it may also be necessary to extend the AI facilities to the farmers' door-step whenever it is possible.

5.2.2 Strengthening extension services

Extent of contacts of dairy farmers with extension agents was found to be an important factor influencing adoption of AI technology. This suggests that extension plays a very important role to enhance adoption of AI technology. Strengthening extension services is therefore important for the government and development partners involved in promoting dairy production. By way of scaling the technology up and out, policies and strategies that improve access to extension services should be instituted. Furthermore, since adoption of AI technology was also positively associated with education level of household head, extension personnel should not only concentrate with more educated dairy farmers, they should also work closely with new and less educated dairy farmers so as to stimulate more adoption of AI technology in study area.

5.2.3 Promote formation and strengthening of dairy farmers' groups

Being a member of dairy farmers group or not was indicated to be an important factor influencing adoption and use intensity of AI technology. Since there was no marked participation of dairy group's organizations in the district it is suggested that the government and development partners to invest in organizing dairy farmers to form associations. Such associations provide opportunities for farmers to interact effectively with one another. Those who have adopted AI technology could share their experiences with non-adopters to better inform their adoption decisions. Farmers' associations could also be used as conduits for extension message dissemination to ensure wider coverage. Also farmers' associations could evolve into service providers for distribution of inputs at fair prices including provision of AI service, milk collection centres and accessing competitive markets.

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APPENDIX

Appendix 1: Dairy Farmers' Questionnaire

Division ………………… Ward …………………Village………………Date…….

Questionnaire number …………… Name of dairy farmer …………………………

1.0 BACKGROUND INFORMATION

Please tick or circle the appropriate answer where applicable.

1.1 What is your level of education? 1 = No formal education [ ] 2 = Primary school [ ] 3 = Secondary school [ ] 4 = College and above [ ]

1.2 Sex: 1: Male [ ] 2 = Female [ ]

1.3 What is your age in years ……………………………….

1.4 Marital status: 1 = single [ ] 2 =Married [ ] 3 = divorced [ ] 4 = widow [ ]

1.5 How many people live in the household? …………….

1.6 How many participate in dairy activities?

2.0 SOCIAL ECONOMIC STATUS OF AI USERS AND NON AI USERS

2.1 What is your main occupation? 1 = Employed by government/NGO [ ], 2 = Not employed [ ], 3 = Petty business [ ], 4 = Craftsman [ ], 5 = Farming [ ], 6 = Fishing [ ], 7 = Casual labour [ ], 8 = other specify [ ]

2.2 When did you start keeping dairy cows? ……………………………………

2.3 Which breed of dairy cattle do you keep? 1= Friesian [ ], 2 = Ayrshire [ ], 3 = Jersey [ ] and 4 = Cross [ ]

2.4 Why did you start keeping dairy cows? 1 = Main economic enterprise [ ], 2 = supplementary enterprise [ ], 3 = Home milk consumption [ ], 4 = others (specify) [ ]

2.5 Where did you obtain your dairy cows? ……………………………………

2.6 How many dairy animals did you start with? ………………………………

2.7 Who is the owner of the dairy animals? 1 = Husband, 2 = Wife 3 = other (specify)

…………………………………………………………………….

2.8 How many dairy animals do you have now? ………………………………

2.9 What amount of income do you get from dairy activities per month? Tsh …

2.10 What other income generating activities other than dairying do you undertake?

………………………………………………………………………

2.11 Rank the income generating activities in order of importance ………………

2.12 What amount of income do you get from agriculture per year?........................

2.13 What amount of income do you get from trade per month?.............................

2.14 What amount of income do you get from salaried employment per month?.....

2.15 What amount of income do you get from other sources per month? …………

2.16 Do you experience low milk production in your herd? Yes / No.

3.0 ASSESSING KNOWLEDGE, ATTITUDE AND THE STATUS ON USE OR NON USE OF AI TECHNOLOGY BY DAIRY FARMERS

3.1 KNOWLEDGE LEVEL ON AI TECHNOLOGY

3.1.1 What is AI? ……………………………………………………………………….

3.1.2 Why is it important?..

3.1.3 What are the advantages of AI………………………………………………..

3.1.4 What are the limitations of AI?...

3.1.5 What are the advantages of crossbred animals? …………………………

3.1.6 What are the signs of heat in dairy cattle? ……………………………………

3.1.7 What is the age of first mating in dairy cattle? ……………………………….

3.1.8 What is the suitable time to get cows inseminated after heat detection? ……

3.1.9 What is the suitable time to get cows inseminated after parturition?................

3.2 USE OR NON USE OF AI TECHNOLOGY

3.2.1 Which mating technique do you use? 1=Natural [ ] GO TO NO. 3.2.2, 2 = natural+ AI [ ] GO TO NO. 3.2.13, 3 = AI [ ] GO TO NO. 3.2.25.

3.2.2 If natural mating, where do you get the bull? 1 = own bull [ ], 2 = neighbour [ ], 3 = other (specify) [ ]…………………………………………………

3.2.3 Are you aware borrowed bulls can cause disease threat to your herd? 1 = yes [ ], 2 = No

3.2.4 Do you mind the merit of the bull you use? 1 = yes [ ], 2 = No [ ].

3.2.5 What is the level of milk production per day per cow? ………………………

3.2.6 Does your cows' milk production levels satisfy you? 1 = Yes [ ] 2 = No [ ]

3.2.7 If no, how can you increase the milk production potential of your herd? 1 = Buying [ ], 2 = crossbreeding with good merit for high milk production bulls

3.2.8 Where do you think you can get the best bull for your herd?...........................

3.2.9 Are you aware of AI technology? 1= Yes [ ], 2=No [ ]

3.2.10 If yes, do you think AI can provide you with semen of the best bull you need? 1= Yes [ ], 2=No [ ]

3.2.11 What are the reasons for using natural mating? ....

3.2.12 Have you ever experienced any difficulties in getting the AI service? Yes/ No.

3.2.13 If natural mating + AI, give reasons why you are not using one mating technique? …………………………………………………………………

3.2.14 How do you use AI + natural mating? 1 = began with natural then AI, 2 = began with AI then natural, 3 = AI and natural always, 4 = other (specify)…

3.2.15 When using natural mating where do you get the bull? 1 = own bull [ ], 2 = neighbour's [ ], 3 = other (specify) [ ]……………………………………

3.2.18 If own bull, what is the cost of keeping a bull per month?...............................

3.2.19 If neighbour's what is the distance to the bull? …………..and what is the cost of using the bull? ....

3.2.20 What factors determine whether to use natural mating or AI? ………………

3.2.21 What advantages do you get from using both natural mating + AI? ....

3.2.22 What is the level of milk production per day per cow? ………………………

3.2.23 Does your cows' milk production potential satisfy you? 1 = Yes [ ] 2 = No [

3.2.24 Between the two mating techniques, which one contributes best to increased milk production potential of your herd? 1 = AI [ ], 2 = natural mating [ ], 3 = can not differentiate

3.2.25 If AI alone, for how long have you been using AI? …………………

3.2.25 Have you ever experienced any difficulties in getting the AI service? Yes/No.

3.2.26 If yes, mention them ……………………………

3.2.27 For a cow to conceive, how many times do you inseminate? 1 = once, 2 = twice, 3 = thee times.

3.2.28 What is the cost of insemination?................; What is the cost of semen alone?.................; what is the labour charge?..............................

3.2.29 How do you rate the cost of AI? 1 = very high, 2 = high, 3 = medium, 4 = low, 5 = very low

3.2.30 Have you ever used imported semen? Yes /No.

3.2.21 If yes, what are the merits of imported semen over that of NAIC? ………

3.2.32 If no, are you satisfied in using NAIC semen? Yes / No

3.3 Assessing Attitude of Dairy Farmers Towards AI Technology

Please indicate your agreement or disagreement with the following statements by circling the response that most nearly coincides with your own opinion about AI.

1 SA = Strongly Agree, 2 A = Agree, 3 U = Uncertain, 4 D = Disagree, 5 SD = Strongly Disagree

Statement & Opinion

1) Dairy farmers use AI because the service is readily available	1 2 3 4 5
2) Dairy farmers have knowledge on AI utilization	1 2 3 4 5
3) Dairy farmers use AI because it is a low cost technology	1 2 3 4 5
4) Dairy farmers use AI because it is easy to understand And implement	1 2 3 4 5
5) Dairy farmers use AI regardless of herd size	1 2 3 4 5
6) AI increases milk production potential of dairy cows	1 2 3 4 5
7) The market value of AI offsprings is higher	1 2 3 4 5
8) AI provides high motivation on future herd quality	1 2 3 4 5
9) AI is relatively culture compatible and women are involved	1 2 3 4 5
10) AI can be used in any type of the herd	1 2 3 4 5

4.0 Explore Institutional and Policy Environment that Affect the Adoption of AI Technology

4.1 Are there any cultural/beliefs hindering the use of AI technology? 1=yes [ ] 2 =No. [ ]

4.2 If yes name them ……………………………………………………………

4.3 Do government leaders ever address you on the use of AI technology in their regular speeches? Yes / No.

4.4 How regular are visits done by government leaders in your district/ward? 1 = once a year, 2 = twice a year, 3 = Thrice a year, 4 = more than 3 times per year.

4.5 Have you come across any credit facility which has spared to support dairy farmers to utilize AI for increased milk production? Yes / No.

4.6 How far is the distance to nearest AI service centre ………. km?

4.7 Do you have contact with the extension agent? Yes [ ], No [ ]

4.8 If yes how often does the extension officer visit you? i) Daily [ ] ii) once a week [ ] (iii) One in a month [ ] iv) one in three month [ ] v) other (specify[ ]

4.9 Do extension officers introduce AI technology during their routine advisory duties in your area? Yes / No.

4.10 How is the advice provided by the extension officer on AI technology? 1) Adequate [ ] 2) Inadequate [ ] 3) Undecided [ ]

4.11 Are there any organizations which are involved in the provision of extension services particularly on AI technology in your area? Yes [ ], No [ ]

4.12 If yes which organizations? …………………………………………………

4.1.3 If no, how do your acquire information on dairy husbandry? ………………

4.1.4 Have you ever been a member of a group/cooperative union of dairy farmers? Yes/No

4.1.5 If yes what services do you get for being a member?.......................................

4.1.6 If no, do you think is important to form a group/cooperative union? Yes/No.

4.1.7 What should be done to facilitate formation of such groups/cooperatives?

………………………………………………………………………………

4.1.7 If you are convinced to use AI where would you go for the service and why?

i) Madunga ii) Mema iii) Tegeta Kibaoni iv) Municipal center v) Mbezi