ASSESSMENT OF DAIRY PRODUCTION IN TANGA REGION: FARMERS' AWARENESS AND ADOPTION OF THE AVAILABLE TECHNOLOGIES FOR IMPROVING FEED QUALITY

BY

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DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN TROPICAL ANIMAL PRODUCTION OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

ABSTRACT

A study was carried out in three districts (Tanga, Muheza and Lushoto) in Tanga region. The aim of the study was to assess dairy production, farmers' awareness and adoption of available technologies for improving feed quality. Data were collected using informal and formal interviews where structured questionnaires were administered to 40 randomly selected smallholder dairy keepers in each districts. The data were analysed quantitatively and qualitatively using descriptive analysis and logit regression. Results indicated that all dairy farmers were aware of the introduced feed improvement technologies (FIT), which were fodder garden establishment, feed supplementation (energy, protein and minerals), and haymaking or use. Rate of adoption was higher on fodder garden establishment (63%) of the respondents and low in feed supplementation (15%) and least in hay use (8%). Land shortage; and high cost of supplementary feeds, seasonality in availability, low price of milk together with poor milk outlet, ineffective research-extension and farmers' linkage lowered adoption of fodder garden establishment and feed supplementation technology respectively. The intensity of adoption of fodder garden establishment, feed supplementation and mineral supplementation were 50%, 65% and 25%, respectively of the TADAT project recommendations. Factors that influenced adoption of fodder garden establishment positively ($P<0.01$) were: larger farm, attendance to training on dairy husbandry, closer distance to the milk selling centres and high price of milk in the dry season. Older age, low price of milk in the wet season and presence of other income generating activities influenced adoption of this technology ($P<0.01$) negatively. Larger household and low price of concentrates influenced positively ($P<0.01$) adoption of feed supplementation. Interventions to increase access to land, credit, market and education

with farmer participation will improve adoption of FTT. Strategies to assist dairy farmers to establish and manage cooperative societies to utilize economies of scales in milk marketing and acquisition of supplementary feeds and policy to increase milk utility and shelf life together with formalizing peri-urban and urban livestock keeping with legal backing is recommended.

DECLARATION

I, **Anselim Antoni Patrick Teendwa**, 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 University.

Signature .....

Date 17/11/2005

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ABBREVIATIONS AND SYMBOLS

Conc.	Concentrate
CP	Crude Protein
CRDB	Cooperative and Rural Development Bank
DALDO	District Agriculture and Livestock Development Officer
DANIDA	Danish International Development Agency
ENRECA	Enhancement of Research Capacity
FAO	Food And Agriculture Organization of The United Nations
FIT	Feed Improvement Technologies
HIT	Heifer In Trust
HPI	Heifer Project International
Km	Kilometre(s)
LITI	Livestock Training Institute
LPRI	Livestock Production Research Institute, Mpwapwa
LRC	Tanga Livestock Research Centre
lt	Litre (s)
MAC	Ministry of Agriculture and Cooperative
MAFS	Ministry of Agriculture and Food Security
MATI	Ministry of Agriculture Training Institute
MU	Makerere University
NGO	Non Government Organization
PHSL	Production and Health of Smallholder Livestock
SDEP	Tanga Smallholder Dairy Extension Programme
SECAP	Soil Erosion Control and Agroforesty Project
Spp	Specie
SUA	Sokoine University of Agriculture
SURUDE	Foundation for Sustainable Rural Development
TADAT	Tanga Dairy Trust
TAP	Tropical Animal Production
TDCU	Tanga Dairy Co operative Union

TDDP	Tanga Dairy Development Program
TSDDP	Tanga Smallholder Dairy Development Project
Tsh	Tanzania Shillings
URT	United Republic of Tanzania
$W^{0.75}$	Metabolic Body Weight

CHAPTER ONE

INTRODUCTION

1.1 Tanzania livestock sector

Tanzania is endowed with large livestock population, estimated to comprise 17.7 million cattle (FAO, 2003); 11.6 million goats, 3.5 million sheep and 47 million chickens (MOA, 2000). Although Tanzania ranks third in livestock population in Africa after Ethiopia and Sudan (FAO, 2003), it is far below other African countries in terms of milk production and consumption. Tanzania is estimated to produce 724 000 metric tonnes of milk, which is only 3.55% of total milk, produced in Africa and 0.14% of milk produced worldwide (FAO, 2003). Majority of milk consumed in Tanzania comes from the traditional herd, which constitutes about 79% of the total milk produced in the country and the remaining 21% was produced from exotic breeds (Kurwijila, 2002a).

The traditional herd is dominated by the Tanzania short horn zebu (TSZ) which is about 90% of the national cattle herd (URT, 2002) while improved dairy cattle are of *Bos taurus* types such as Friesian, Ayrshire, Jersey, and their crosses the local types *(Bos indicus)* such as TSZ, Ankole and Boran. The smallholder dairy farming is well developed in high rainfall and fertile cropping zones where zero grazing is incorporated into mixed farming. It is also practiced in and around urban centres where ready and profitable market exists (Mlozi, 2001). Majority of the introduced improved dairy cattle (64%) are found in the Northern zone where Kilimanjaro region account for 39%, Arusha 17% and Tanga 8%. Other regions including Iringa and Kagera account for 6% and 5% respectively and the rest account for 25% of the total population of the dairy cattle (Kurwijila and Kifaro,

2001). However, Kurwijila (2002a) pointed out that production from exotic breed-based dairy cattle population accounts for over 95% of marketed milk in Tanzania. Majority of smallholder's dairy farmers who are concentrated in highlands dominate milk production in Eastern Africa, where dairy cattle are the largest source of marketed milk. Karanja, (1999) estimated that smallholder farmers in Kenya contribute 56% and 70% of the total and marketed milk respectively. Similarly Muriuki, (2001) contend that large aggregate volumes of marketed milk nationally were made up of small quantities (on average 4-6 litres per household) sold by hundreds of thousands of smallholder households in Kenya.

Livestock production in Tanzania is organized into two sub-sectors namely the traditional sub-sector dominated by pastoralists and agro-pastoralist where traditional herd is dominant and commercial sub sector dominated by government ranches and dairy farms, and individual smallholder dairy farms where improved breeds are kept (Msangi, 2001). Almost all livestock products (milk and meat) in Tanzania come from the traditional sector, which is a low input – low output system (Kurwijila, 2002a; MoWLD, 2004).

1.2 Dairy industry sub sector

The Tanzanian dairy sector comprises of few graded and pure exotic breeds kept for commercial purposes through selling of milk. There are two companies dealing with dairy development namely Dairy Farms Company (DAFCO) responsible for running dairy farms for milk production and Tanzania Dairies Limited (TDL), which deals with milk processing (MoWLD, 2004). DAFCO own eight farms where only two (Kitulo and Ngerengere) are producing heifers for distribution to farmers. These companies are under privatization process in view of the fact that government has delegated the role of milk

production to private sector and remain with a task of providing regulatory and public support systems.

Tanzania government established large-scale dairy farms in order to meet the rapidly increasing demand for milk and milk products with ultimate goal of reducing importation of milk and milk products. The government policy was at first (in the 1960s and 1970s) to run large-scale state owned farms. Efforts towards large scale farming was channeled through the establishment of DAFCO in 1975 and later on through other Parastatals such as Tanzania Sisal Authority under the Mkonge Livestock Company (MLICO), National Agricultural and Food Company (NAFCO) and other institution like the Prisons, Agricultural and livestock Training Institute and the Agricultural University (Urassa, 1999). However, these farms performed below expectations (Mulangila, 1997; Urassa, 1999), due to numerous reasons including poor infrastructure. This led to a change of policy and shift of interest of donor and government efforts towards smallholder dairy development (Mulangila, 1997; Urassa, 1999).

1.3 Milk Production and Consumption

World milk production from cattle is estimated at 502 325 000 metric tonnes per year (FAO, 2003), with an average cow producing 5 307 litres per lactation for top producing cows in the European Union (Morgan, 1999). Africa carries 16% of the world dairy livestock but produces less than 4% of global milk production (Morgan, 1999) with an average cow producing only 454 litres/year. According to FAO (2003) Africa is estimated to produce 20 643 000 metric tonnes of milk annually. Considering ideal lactation yield of 305 days it gives an average of 1.5 litres/cow/day in Africa compared to 17.4 litres/cow/day in Europe.

Cow milk is an important protein source which is universally accepted and consumed by majority of the world's population wherever cattle are raised; the usage of milk from sheep, goat, camel and other less well known animals varies from one community to another within the same country, region or even district depending on cultural habits and preferences. Recommended milk consumption for the world stands at 105kg/capita/year (URT, 2002).

Milk production in many parts of Tanzania is vital as it provides a major opportunity for poverty alleviation of smallholders through the sale of milk and is sometimes the major source of animal protein in the human diet in rural areas who consume home-produced milk. Production systems range from mixed crop–livestock, to extensive and some intensive farming systems.

Milk consumption in Tanzania is estimated at 25kg/capita/year below those recommended for Africa and far below that recommended for the world (URT, 2002). Kurwijila (2002a) reports that milk consumption has risen faster in urban and peri-urban areas of Tanzania than in rural areas because of the growth in peri-urban dairy herds and the increased availability of milk and dairy products for urban consumers. Mlozi (2001) argue that the reasons for raising dairy cattle in urban areas were mainly to earn money and the resources encourage urban dwellers to undertake urban animal agriculture. In Dar es Salaam, for example, the dairy cattle herd increased from about 2 000 heads in 1984 to over 20 000 heads by 1995. Consequently, the per capita consumption is much higher in urban centres (40 litres/annum) than in rural areas (15–20 litres/annum) (Kurwijila, 2002a). Figures obtained by relating the estimated amounts of milk produced in a given country with the human population are taken as the per capita milk consumption statistics and they are

useful as general indicators of the level of milk availability to the general population but have limited value as criteria for assessing the nutritional role of milk in national diets.

1.4 Evolution of smallholder dairy farming in Tanga

Prior to 1985 Smallholder dairy production was virtually unknown in Tanga and supply of fresh milk was based on Parastatals dairy farms. One of the government's efforts towards smallholder dairy development was the establishment of Tanga Smallholder Dairy Extension Programme (SDEP) in two districts in Tanga region in 1985 with the support of Dutch government. The project covered Tanga and Muheza districts where five farmers owning a total of seven dairy cows were involved.

The SDEP has undergone various transformations since its inception and currently it has been transformed to Tanga Dairy Trust (TADAT). SDEP was changed into Tanga Smallholder Dairy Development Project (TSDDP) in 1990. The number of participating farmers increased to 1453 by 1994. The project area was expanded cover three additional districts, Pangani, Korogwe and Lushoto in 1994. The achievement was made possible under in calf heifer credit scheme (Heifer In Trust scheme), which was launched, in 1990. Three conditions were stipulated for a farmer to qualify to participate in the scheme.

- Establishment of a minimum of one acre of fodder garden of mainly Elephant grass and some legumes,
- Construction of an appropriate cow shed,
- Attend a training in dairy cattle husbandry at Buhuri Farmers Training Centre in Tanga for a period of two weeks.

In 1995, TSDDP was then changed to Tanga Dairy Development Program (TDDP) to accommodate medium scale dairy keepers. TDDP was transformed to Tanga Dairy Trust (TADAT) in 2000 to monitor and supervise formation of dairy farmer groups. According to Mulangila (1997), Smallholder dairy production in Tanga has increased significantly in the last one decade. The 2003 data shows that there are 3 678 dairy farmers with 10 107 dairy cattle under TADAT in Tanga region. The distribution of farmers and dairy cattle is as indicated in (Table 1).

Table 1: Farmers and dairy cattle under TADAT as at December 2003 in Tanga region

Description	Districts					Total
	Tanga	Muheza	Pangani	Korogwe	Lushoto	
No of Farmers	1 421	1 068	224	526	439	3 678
No of dairy cattle	4 210	2 874	951	1 124	948	10 107
No of cattle/household	2.96	2.69	4.25	2.14	2.16	2.75

Source (TADAT, 2003)

Feed input requirement for livestock differs with breeds and level of production. The feeding system in the study area that was introduced by the SDEP project is zero grazing type and commonest dairy cattle introduced were improved breed including Jersey, Friesian, Ayrshire and their crosses. These types of breeds have relatively high input requirements in terms of feeds. This implies that more labour is required for feed collection and feeding. The available labour should be used judicious since in integrated system crop production activities compete with dairy cattle activities for the available labour, which may be idle in the dry season.

1.5 Feed resources and seasonal fluctuation in quality and quantity.

Dairy production in Tanzania and particular in the study area was predominantly based on natural pastures and forages as well as crop residues. However, nutritional value of forages in Tanzania like in any other tropical countries varies with season being high in quality and quantity during the wet season and low in the dry season (Sarwatt, 1995; Mussa, 1998). Poor nutrition in terms of quality and quantity of feeds offered to dairy animals have been cited as major contributors to the low milk production by dairy cattle under smallholder dairy farmers in the tropics (Karanja,1999; Shem, 1993; Kimambo *et al.*, 1999). Poor nutrition causes starvation, depressed growth rate, infertility and low milk yields. Average milk production of dairy animals in Tanga is estimated at seven litres/cow/day (Mulangila, 1997), which is lower than the genetic potential of improved dairy cattle breeds under smallholder management. Sarwatt and Njau, (1990) reported an average milk production of up to 12 litres/cow/day. The major contributing factors to low milk production are shortage and poor quality of the feeds (Mulangila, 1997; Urassa, 1999).

A review of locally available literature by Massawe *et al.* (1997) indicated that research on forage production and utilization was mainly based on station (SUA and Livestock Production Research Institute (LPRI), Mpwapwa), and had given little or no consideration to socio economic issues, farmers' local knowledge, available resources and other constraints and priorities from farmers' perspectives.

Earlier adoption studies in developing countries addressed two main questions: The first is what determines whether a particular producer adopts or rejects an innovation and the second one is what determines the pattern of diffusion of the innovations through the population of potential adopters (Feder *et al.*, 1985). Despite the efforts that have been

made in studying adoption of innovations in agriculture world wide, very few studies (Kisusu, 2003) have been done in Tanzania with respect to adoption of innovations related to livestock and feed improvement technologies in particular.

1.6 Problem Statement

Existing literature shows that feed shortage in both quantity and quality is prominent in the tropics Tanzania inclusive. Livestock feeding during dry season is one of major problems in dairy cattle production in Tanga.

The SDEP, which has now been transformed to TADAT, introduced various feed improvement technologies to smallholder dairy farmers in Tanga region. Feed improvement technologies introduced include establishment of fodder gardens, hay making and use, mixing of maize bran, Leucaena leaf meal and cotton seedcake as source of energy and protein and use of mineral blocks. Introduction of feed improvement technologies at the area was intended to improve incomes and living standards of the farmers through increased milk production. Despite all these efforts, milk production remained to be low estimated at only seven litres/cow/day (Mulangila, 1997).

Few studies (Kisusu, 2003) have attempted to quantify the rate and intensity of adoption of feed improvement technologies in certain areas of Tanzania. Tanga region was not involved in these studies. Lack of empirical evidence that farmers use recommended practices of feed improvement technologies, and if they use to what extent they have adopted these recommendation is not well known, quantified and documented. Without such empirical evidence, it is not possible to assess the impact of livestock feeding technologies in milk production.

1.7 Justification of the Study

Increases in dairy cattle numbers from 18 592 in 1999 to 25 529 in 2002 in Tanga region have boosted the demand for animal feed Ministry of Agriculture and Food Security (MAFS 2002) cited by (Myaka *et al.*, 2003). The demand is more critical during the dry season where quantity and quality is low. Researchers have developed technologies to overcome the problem of dry season feeding. However, rate and extent of adoption is not well documented.

A study on rate and extent of adoption of introduced feed quality improvement technologies and reasons hindering the continued practice of the technologies in Tanga will generate basic information on farmers priority in adopting or rejecting introduced technologies. The results from the study will help researchers to design or modify technologies to suit farmers' needs.

Therefore, the aim of undertaking this study is to asses the farmers' awareness on feed quality improvement technologies; rate and extent of adoption: and the cause of failure in adoption and suggesting possible interventions.

1.8 Hypothesis of the Study

The hypothesis of the study is that:

- Low milk production is positively associated with Farmers' unawareness on available feed quality improvement technologies
- Farmers' direct participation in the dairy project is positively associated with the probability of adoption

- A set of explanatory variables (Institutional, Innovation, Farmers and Environmental characteristics) positively influence the decision to adopt feed quality improvement technologies for increased milk production

1.9 Objectives

1.9.1 General objective

To asses, the extent of farmers' awareness and adoption of available technologies for improving feed quality in Tanga region

1.9.2 Specific objectives

Specific objective were to

(i) assess farmers awareness on feed improvement technologies,

(ii) identify farmers strategies in feeding animals in dry season,

(iii) determine the rate of adoption of the introduced feed quality improvement technologies,

(iv) determine the extent (intensity) of adoption of the introduced feed quality improvement technologies,

(v) identify factors which influence the adoption of introduced feed quality improvement technologies,

CHAPTER TWO

LITERATURE REVIEW

2.1 Livestock Policy

The 1997 Agricultural and Livestock Policy was a result of merging Agricultural policy and Livestock Policy and revising the 1983 respective policies. The old (1983) agriculture and livestock policies fell under two separate ministries i.e. the Ministry of Agriculture and Ministry of livestock Development. The new (1997) policy, however, puts both policies under one ministry i.e. the Ministry of Agriculture and Cooperatives (MAC) with "agriculture" standing for both crops and livestock (Mbilinyi and Nyoni, 2000). However, currently the Agricultural and Livestock sector are under different ministries (i.e. MAFS and MoWLD), respectively. With the macro-economic policy reforms beginning in the mid-1980s, most agricultural and livestock production, processing and marketing have been delegated to the private sector. The government has accepted the role of providing regulatory and public support systems. With the reforms, input and output prices have been decontrolled, subsidies removed and the monopoly of the marketing boards eliminated (Mbilinyi and Nyoni, 2000; Mdoe *et al.*, 2000). The main goal of the Agricultural and Livestock Policy was the commercialization of smallholder cultivation and livestock keeping allowing surplus production and increased incomes. The policy adopted a top-down conception of extension, which call for the transfer of agricultural technology from experts to producers with the experts being a link between producers and researchers. Producers are thereby excluded from the research process and from interpretation of research results, or from basic innovation activities (Mbilinyi and Nyoni, 2000).

2.2 Contributions of Livestock to National Economy

The contribution of livestock to agricultural output varies considerably both between and within regions mainly owing to differing agro-ecological and economic conditions. In Tanzania, national economy the contribution of the livestock industry to both Agricultural and National Gross Domestic Product (GDP) is 13% and 6.1%, respectively. About 40% of the livestock GDP originates from beef production, 30% from dairy products and about 30% poultry and small stock (URT, 2003b).

The dairy sub-sector plays a crucial role in sustaining smallholder crop and dairy systems through nutrient cycles, it plays a role in sustaining high human population densities even in semi arid areas, and it is an important tool in reducing poverty in rural and peri-urban areas. Muriuki (2001) pointed out that crop-dairy systems support three quarters of Kenya's rural population which is the largest dairy sub-sector and with highest per capital milk available in sub-Saharan Africa. Thus, dairy sub-sector contributes directly through milk consumption and indirectly through income generation through the selling of milk.

2.3 Constraints to Performance of Livestock sector

Msechu (2001) pointed several factors attributing to low contribution of livestock sector to national economy. These include Policy and Institutional organizations where in the past four decades major and minor changes in ministries hosting the livestock sector, departmental organizational and policies relating to management of livestock have occurred. Furthermore, he argues that eight different ministries have hosted the livestock sector since independence. These changes affected performance of livestock sector since each time a change takes effect there is a time lag for adjustment. On the other hand,

Kurwijila and Kifaro (2001) argue that low genetic potential for milk production characterized by poor milk yields; short lactation length, long calving intervals and old age at first calving contribute to low contribution of livestock sector to the country GDP. Others include Animal health (diseases and parasites associated with hot and wet conditions) and nutrition associated with extreme climates; low quality tropical feeds which are generally high in fibre content and low in digestibility with short season of growth (Karanja, 1999; Urassa, 1999). Similar finding were reported in Kenya by Abate (1999), where inadequate feed resource was cited as the overall most limiting factor followed by disease particularly East Coast Fever (ECF), milk marketing was ranked third and genetic resources (breeding) was ranked fourth. Comparative advantage for livestock largely depends on the capacity of the natural resource base to support production of feed.

2.4 Feeding System in Dairy Farming

Main feeding systems in dairy farming sub sector are identified as zero grazing (intensive), partial grazing (semi intensive) and free range (extensive) (Okwir, 1998; Urassa, 1999). Types of feeding systems have been reported to influence milk yield. Animals under partial grazing system were reported to have high yield than zero grazing since animals were free to pick forages of their preferences and taste while grazing and also from supplemented feeds enables the animals to meet their requirement than zero grazed (Sarwatt and Njau, 1990).

2.4.1 Zero grazing system

Zero grazing system is an intensive milk production system, which is attractive in areas where land is scarce and farms are small and areas where prevalence of diseases like ECF

and Trypanosomiasis is high. This system is frequently referred to as "Green chop", "Cut and Carry" or "Soiling" (Orodho *et al.*, 1993; Urassa, 1999). The system involves total confinement of animals and feeds are brought to the animal. Zero grazing system uses improved dairy cattle breeds, which give a higher milk yield and require new techniques and higher standards of animal husbandry (Orodho *et al.*, 1993). The system is inevitable where land for grazing is limiting (Kimambo *et al.*, 1999) or where there is high incidence of diseases such as ECF and Trypanosomiasis as pointed out by Abate (1999). Mulangila *et al.* (1997) found these diseases to cause high mortality to dairy calves in smallholder farming systems in Tanga region. A similar finding was observed by TADAT (2002) where among the reported cases 77% was due to ECF and 12% due to Trypanosomiasis.

Pastures suitable for utilization in the zero grazing system involve tall-bunched grass types such as Napier, Setaria and Guatemala. Others include riverbanks and roadside and leaves. In the dry season, there is normally a short supply of good quality forages. Thus, farmers are forced to use conserved grasses in the form of hay and use of crop residues such as maize stover, rice straws, bean straws; banana leaves, banana pseudo stems and coffee pulp (Shem, 1993; Sarwatt, 1995). SDEP advocated Zero grazing as it reduces exposure of animals to disease and stress. However, labour requirement per livestock unit under zero grazing dairy production system has been found to be higher than that in the semi intensive and extensive systems (Okwir, 1998).

2.4.2 Partial grazing system

In this system, animals depend partially on natural pasture with minimal supplementation. Animals may be grazed for six to eight hours and when they return home, they are

supplemented with established forage and concentrates especially during milking (Urassa, 1999).

2.4.3 Free range-grazing system

This system is common where land scarcity is not a problem. Animals are grazed for a period of 9-12 hours and no supplementation is provided. Free range grazing system is practised by large and medium scale dairy farms. The system is also common for meat production under extensive management systems.

2.5 Dry season Feed Resources in the Tropics

There are two common seasons (wet and dry) in the tropics, which have implication on livestock feeds availability (Shem, 1993; Sarwatt, 1995; Mussa, 1998; Kimambo *et al.*, 1999). In wet season, there is enough natural pasture and of high quality with high protein and low fibre contents. The feed resources in the wet season are usually in excess of requirements and are usually wasted since most farmers, do not conserve the excess forage. The dry season is characterized by serious shortage of pasture, low in protein and high in fibre contents. The duration and severity of dry season vary with geographical location and from year to year thus affecting milk production differently.

Feeding of dairy cattle during the dry season is a major constraint to increase milk production in the tropics (Rushalaza and Lwoga, 1989; and Kimambo *et al.*, 1999). Feed resources commonest in tropics during dry season is mainly roughages, which are high in lignocellulosic cell wall, low in available energy, available carbohydrate such as sugars, starch and fructose, as well as nitrogen and certain minerals (Theander, 1981). Dairy production in Tanzania and other sub Sahara Africa is predominantly based on natural

pastures, forage as well as crop residues. In many parts of the world where the availability of high quality forage is limited, cereal straws from maize (*Zea mays*), wheat (*Triticum aestivum*) and rice (*Oryza sativa*) forms the main basic diets for ruminants (McDonald, *et al.*, 1998). However, due to high lignifications of crop residues for them to be used effectively to enhance optimal milk production of lactating cows, their nutritional characteristics and palatability must be improved.

Study by Massawe *et al.* (1997) conducted in three different locations i.e. Mwanza, Kilimanjaro and Morogoro regions indicated that despite the fact that the aim of keeping livestock differ with location, there are similarities in constraints related to forage utilization. In all locations, shortage of dry season forage and of low quality was considered severe constraints. Mlay (2001) reported that milk yield fall by more than 40% during dry season due to nutritional related constraints in which nitrogen, metabolizeble energy contents and organic matter digestibility decline with advancing dry season.

2.6 Classification of Feedstuffs for Ruminants

The domestic animals are classified as a ruminant whose stomach is divided into four compartments, and non-ruminants (monogastric) which have simple stomach leading to variations in digestion mechanism and hence feeds requirements (Van Soest, 1982; McDonald, *et al.*, 1998). Monogastric animals require concentrated feeds in terms of nutrients where ruminants require both concentrates and roughages. Generally feedstuffs for feeding ruminants have often been categorized into two broad classes i.e. Roughages and concentrates (Van Soest, 1982).

2.6 1 Concentrates

Concentrates are feeds with high-energy and crude protein. They are rich in cellular contents with low fibre content usually less than 10% on dry matter basis, low moisture content (Bondi, 1987) and high content of digestible energy per unit weight or volume (Van Soest, 1982). Concentrates include cereal grains and cereal by products; and oilseed cakes and meals and milling by products. The oil seed cakes and meals are the residues remaining after removal of the greater part of the oil from oilseeds. These residues are rich in protein (200-500g/kg) depending on extraction method thus valuable as feed for livestock. Cereal grains are essentially carbohydrate concentrates (McDonald, *et al.*, 1998). However, their use as dairy cattle feed is limited due to competition with human and monogastric animals.

2.6 2 Roughages

Roughages are feed characterized by high fibre content (cell walls) i.e. high content of structural carbohydrate usually between 25% and 30% fibre in the dry matter (Bondi, 1987) and they are bulky in nature and have low protein content. The high proportion of cell wall constituents in the pasture is associated with lowered digestibility of dry matter due to accumulation of lignin, which reduces the microbial activity in the rumen. Their digestible energy varies considerably within and between species depending on season, stage of growth and soil characteristics. Typical roughages are grasses and crop residues (straws and stovers).

Forages and roughages represent primarily the vegetative portions of plants and are characterized by their relatively high contents of structural carbohydrates and their bulk nature. The terms Forage and roughage are frequently used interchangeably. However,

forage usually denotes the entire plant or that part which is selectively grazed by the animal. The term roughage usually denotes only the vegetative portion of the plant, which is more fibrous, highly lignified and less digestible. Roughages are frequently obtained as a by-product or as crop residue associated with the primary production of reproductive parts (grain and tubers) (Ørskov, 1988).

Maize stover has a higher quality nutrient contents and more digestible nutrients than most other straws. The commonest legume straws are from beans and peas, which are richer in protein, calcium and magnesium than the cereal straws. Intake and digestibility of most cereal straws can be improved with alkali treatment or addition of nitrogen (N) in the form of non-protein nitrogen (NPN) or urea.

2.7 Feed Quality Improvement Methods

In order to improve productivity of smallholder dairying in the tropics it is necessary to improve quality of natural forages during the dry season. Thus, it is advisable to plan the feed resources in such a way that surplus quality forages is conserved during the wet season for use during the dry season or quality is improved during the dry season. Improvement of the nutritive value of roughages and crop residues and by-products could be approached through removal of the barrier coating the plant cells which prevents the utilization of its digestible nutrients (e.g. use of alkali like NaOH, urea or acid treatments in order to improve digestibility) and by supplementing them with the deficient nutrients. The commonest methods advocated to provide quality feeds throughout the year are discussed in the following sections.

2.7.1 Hay and silage making

Forage, crop residues and by-products are usually consumed fresh by domestic animals. In the tropics, during wet season, there is plenty of forage over and above livestock requirements and most of it is wasted. When these forages are at blooming stage, their nutritive value is usually high, thus they can be harvested and stored as hay or silage, which is the main forms of conservation, being advocated (Sarwatt, 1995).

Conservation can be achieved by sun drying (hay), artificial drying (meal), and addition of acids or fermentation (silage) (Mannetje, 2000).

2.7.1 1 Hay

Hay is a feed resulting from dehydration of green forage to a low moisture content of about 15-20%. It is a cheap method of conservation for a smallholder farmer, which can be achieved using simple equipments. This should be done at right stage of harvesting and fine weather for good quality hay. Grasses are usually harvested just before flowering when they have high dry matter and crude protein contents. If made after flowering they will be of low quality or when grasses are young they will be of high quality but low productivity (Muyekho, 1999).

2.7.1 2 Silage

Silage is a forage, or agricultural and industrial-by products preserved by acids, either added or produced by natural fermentation. Fresh forage is harvested, or by-products are collected; may be chopped or conditioned; additives may be added; and it is then stored in the absence of air so that facultative anaerobic bacteria, present on the forage or added as inoculants, can rapidly convert soluble carbohydrates into acids (Mannetje, 2000). Lack of

scientific information on controlling fermentation of tropical forages and appropriate and simple technologies for making silage on small scale have been cited as the most significant factors limiting adoption of ensiling (Sarwatt, 1995). Simple methods for silage making for small scale farmers have been proposed to include trench pits, concrete and bucket silos (Garcia, 2000). Mannetje (2000) proposed three considerations to be taken into account before embarking on a silage-making programme.

- Is there a need for silage making?
- If so, are there enough good quality forages or other products available to ensile?
- If so, can the conditions for good silage making be met?

Materials to be ensiled can be grasses, forage legumes, fodder crops such as maize and sorghum (*Sorghum bicolor*), crop residues or by-products. Aminah *et al.* (2000) stressed that forage sorghum and maize can be made into excellent silage without additives; where as Napier and *Setaria spp* can be ensiled into reasonable silage if grasses are cut at six-week re-growth. Fodder crop such as maize, Sorghum have been used extensively for silage making (Aminah *et al.*, 2000; Mannetje, 2000; Muyekho, 1999, Sarwatt *et al.*, 2001) due to their high dry matter (DM) content and Water Soluble Carbohydrate (WSC) available for fermentation. Sarwatt *et al.* (2001) found that addition of 3% urea to maize; sorghum and Rhodes grass (*Chloris gayana*) silage increased nitrogen content and elevated ammonia nitrogen (NH_3-N) concentration. High amounts of lactic acid were recorded at higher levels of molasses application. These improvements in silage characteristics were concurrently associated with improvements in feed intake and digestibility when compared to untreated silage.

2.7.2 Straws and stovers treatment with alkali.

Feeds available during the dry season are crop residues mainly rice straw and maize stover, which are essentially energy feeds, containing low levels of protein and minerals. After harvesting of various cereal crops such as millet, maize, rice and sorghum the commonest practice in East Africa is to graze livestock into the crop fields. However, this practice is not possible where land is limited and where farms for crop growing are far from homesteads.

Physical, chemical, and combination of physical and chemical methods to treat straws and stover using alkali, urea or combination of urea and alkali have been devised to enhance bioavailability of the nutrients in the roughages (McDonald *et al.*, 1998). When straw/stover are exposed to an alkali, the ester linkages between lignin and the cell wall polysaccharides, cellulose and hemi-cellulose, are hydrolyzed, thereby causing the carbohydrate to become more available to the microorganism in the rumen. Sodium hydroxide (NaOH) is the commonest alkali used followed by ammonia (NH_3) (McDonald *et al.*, 1998). Two commonest methods, which have been used extensively, are: a) Dipping/Soaking (Wet methods) and b) spraying methods (Dry methods) (Urio, 1981; Mtamakaya, 2002; Kimario, 2003).

2.7.2 1 Wet methods

Dip and Drip method involves dipping the straw/stover in alkali solution of known concentration for pre determined time after which the straw is lifted to drip. Urio (1981) using 4% sodium Hydroxide (NaOH) solution to treat maize cobs observed an improved digestibility from 55.6% to 64.1% and increase in dressed carcass weight in kg from 1.8 to 3.1. In another experiment, (Urio, 1981) observed improved organic matter digestibility for

dip treated straw to 73% compared to untreated straw, which were 50%. Similarly Biwi (1986) using NaOH `dip` treated maize stovers diet observed an increase in *in vivo* dry matter digestibility (IVDMD) and *in vivo* organic matter digestibility coefficients (IVOMD) of 7.47% and 6.93% units, respectively. Mtamakaya (2002) obtained higher values of dry matter digestibility (DMD) (63.3%) and organic matter digestibility (OMD) (68.5%) of rice straws treated with wood ash extract by soaking method compared with 55.8 and 61.0% for untreated straws, respectively. However, crude protein decreased from 4.4% to 3.7%. Kimario (2003) observed 21.1% improvement in dry matter intake (DMI) of rice straw treated with wood ash extract by soaking method, whereas spraying improved DMI by 7.8% units when compared with untreated rice straw. Moreover, feeding of rice straws either soaked or sprayed with ash extract improved daily weight gain by 40.1% and 35%, respectively. The wet method minimizes the amount of chemical and water used, since the alkali solution is used several times. Limitation of the wet method is on the losses of some nutrient and requirement of large vessels in which straws have to be soaked (Urio, 1981).

2.7.2 2 Dry methods

Dry/spraying methods involves spraying pre-determined amount of alkali solution in a given quantity of straw/stover and left to react for a pre-determined time (Urio, 1981; Mtamakaya, 2002). This method improves nutrient utilization with minimal loss of nutrients and it requires simple equipments like polythene sheets where the materials to be treated have to be placed and require less amount of water. Khanal *et al.* (1999) using rice and wheat straws treated with 4% urea sprinkled and ensiled for three weeks observed improved DMI of rice and wheat straw by 14.2% and 20.18%, respectively. However, DMD was not significantly differently but it was observed to be higher in treated than

untreated straws. Mgheni *et al.* (1993) using rice straws sprayed with urea solution 50g urea per kg of DM straw and placed in a silage pit and covered with polythene sheet for 14 days observed an increase in nitrogen from 7.0g/kg DM for untreated to 18.6g/kg DM for treated straw and improved DMD from 42.5% to 65.7%, for untreated and treated straw respectively. Daily straw DMI was observed to increase to 59.3g $^{-1}$ $W^{0.75}$ compared with 23.1g $^{-1}$ $W^{0.75}$ for urea sprayed rice straws (USRS) fed immediately after urea spraying. Similarly, Mgheni *et al.* (1993) observed higher weight gain of 49.1g per day for goats fed on urea treated rice straw supplemented with fishmeal compared with 13.0 g per day for animals fed on untreated rice straws supplemented with fishmeal. Kimambo *et al.* (1998) observed that treating maize stover with alkali derived from sawdust and fire wood ashes, NaOH and urea increases the *in vitro* DMD and DM degradability of maize stover when compared to untreated. The authors also pointed out that sawdust ash treated maize stover had 48h DM degradability of 81.1% compared to NaOH and urea treated maize stover (75.3% and 62.1% respectively). Both soaking and spraying methods have shown to improve digestibility of treated straws implying that either method could be used for treating straws.

2.7.3 Supplementation

Various energy, protein, minerals and vitamins sources have been used to reduce nutrient deficiencies. Energy source could be from established fodder garden and use of cereal grains and cereal by products, while protein source could be from established fodder of leguminous plants, established multipurpose trees and by products from oil industries. Where supplementary feeding is done, agro-industrial by-products form the main feed resources.

Supplementation could be achieved through molasses or urea feeding which is offered in a mixture with molasses sprinkled on to the roughage or dissolved in water and sprinkled on the roughages; or administered in drinking water (Kimambo *et al.*, 1999). It can be done also by introducing a legume or supplements rich in protein, non-protein nitrogen, vitamin A and/or minerals (Naga, 1986). Kakengi *et al.* (1999) found that 2.6kg DM of Leucaena Leaf Meal (LLM) can substitute 1.8kgDM of Cotton Seedcake (CSC) without affecting cattle performance. Cows supplemented with LLM gained more weight and had higher milk yield than those under control (supplemented with cotton seed hulls (CSH) and maize bran (MB) only at a rate of 1.8kg/DM. The use of multipurpose tree to supplement natural grasses is also common. In the study by Sarwatt *et al.* (2000) *Moringa oleifera* (MOOL) was used to replace, conventional protein source like Sunflower Seedcake (SSC) by 50% and obtained higher DMI and metabolizable energy intake (MEI). Study by Biwi (1986) indicated that with optimum supplementation of concentrates untreated maize stover could maintain reasonable milk yield. According to Methu *et al.* (1996) animals supplemented with 3.2kg/d of CSC (DM basis) and 150g/d of a mineral pre-mix offered in two meals at each milking resulted in improved maize stover intake with increasing level of offer hence TDMI and milk production. Mlay (2001) reported that supplementary feeds that contain a mixture of maize bran and sunflower cake fed at about 35% of total DM intake improved intake and digestibility of poor quality roughage increased milk yield compared to supplementing with plain maize bran. The productivity of many areas in the tropics is restricted by nitrogen and other nutrient limitations and the unsuitability of some native species to high-intensity grazing. Introduction of nitrogen-fixing legumes into natural pastures and high-productive grasses or additions of fertilizer can increase biomass production. Addition of phosphorus, nitrogen, and sulphur can result in large growth responses, which lead to increased total biomass production. Control of pasture utilization

through manipulation of stocking rates have been advocated as means of improving feed quality.

Mineral supplementation in dairy cows cannot be avoided in adoption of improved dairy technologies (Mathewman, 1993). The commonest and essential minerals to be supplied regularly include calcium, phosphorous, iron, and magnesium. Minerals are useful in helping animals to increase growth rate, milk yield and against diseases. Church (1991) argues that lack of minerals in cattle is depicted on low growth rate and fall in milk volume.

Technologies to improve feed quality and utilization in Tanga have been attempted by SDEP and these include fodder garden establishment, supplementation with energy and protein concentrate such as maize bran (MB), Leucaena leaf meal (LLM), cotton seedcake (CSC), sunflower seedcake (SSC) and minerals.

2.8 Adoption of Technologies

According to Ingold (2002), cited by Chi and Yamada (2004) definition of the term "technology" differ widely, depending on whether the intention is to embrace the totality of human works, in all societies and during all epochs. Rogers (1995) define Technology as an idea, practice or object that is perceived as new by an individual or other unit of adoption. Chi and Yamada (2004) argues that technology comprises of two components; the hardware, which consists of physical tool, that embodies technology and the software, which consists of information base for the tool. This study adopts the definition of Rogers (1995). The introduction of new technologies has been an approach to overcome barriers to agricultural advancement.

Adoption processes refer to series of changes that take place within an individual with regard to an innovation. These changes start from the moment a farmer first become aware of that innovation to the final decision to use it or not (Rogers, 1983). Adoption of innovation is defined as a decision to apply innovation and continues to use it (Van de Ban and Hawkins, 1996). However, to distinguish between individual (farm-level) adoption and aggregate adoption Feder *et al.* (1985) defines final adoption at the level of the individual farmer as the degree of use of a new technology in long-run equilibrium when the farmer has full information about the new technology and its potential. Aggregate adoption is measured by the aggregate level of use of a specific new technology within a given geographical area or a given population. Adoption at the farm level is related to the decisions made by farmers to use particular technology in the development process.

2.8.1 Stages of adoption

Adoption is a gradual process, which involves sequential steps. Van de Ban and Hawkins (1996) identified five stages of adoption as:

- Awareness stage in which the farmer or potential innovator hears about the innovation for the first time.
- Interest building stage in which farmer(s) seeks more information about the innovation.
- Evaluation stage in which the farmer(s) weigh the advantages and disadvantages of using the innovation.
- Trial stage in which the farmer(s) test the innovation on small scale to avoid risk associated with using innovations.

- Adoption stage in which the farmer applies the innovation on large scale in preference to the old technologies.

Individual in the social system do not adopt an innovation at the same time and same rate. Most agricultural innovations change or are modified in the process of adoption and diffusion. Feder and Slade (1984) emphasized that during the initial phase of adoption, larger farmers are likely to allocate more resources to the acquisition of information and will therefore posses higher levels of cumulative information at any given period, other factors held constant. They further advocate that certain level of cumulative information must be attained before adoption of innovation takes place. These imply that farmers with better access to information and more human capital endowments in form of formal and informal education and experience will adopt earlier than others. Thus, in reality farmers all over the world, seldom adopt complete packages and rarely comply exactly with the recommendations made when it comes to their specific needs.

Recommendations may be presented to farmers as a package of several practices, some components of the package may be adopted first, others may be adopted later, and others may never find wide spread acceptance. Some technologies are adopted more rapidly than others because farmers perceive them to have desired characteristics. As a result, Rogers (1983) proposed five adopters' categories after evidence found in many empirical studies. These are:

- Innovators, who are venturesome, risk takers, have good contacts outside peer groups, can cope with high degree of uncertainty, they are internally motivated and may or may not be respected by peers.

- Early adopters they are respectable, more integrated into local social system than innovators, opinion leaders, make judicious innovation decisions and internally motivated.
- Early majority who deliberate adopt innovations just before the average, they follow others in adopting innovations, but rarely show the way and they are externally motivated.
- Late majority they are sceptical and adopt slightly later than average, they adopt for economic or peer pressure reasons, unwilling to risk scarce resources and they are externally motivated, and
- Laggards are the traditional and last group to adopt, they have almost no opinion leadership, their point of reference is the past and has limited resources thus unwilling to risk. These five categories of adopters form a bell-shaped frequency curve.

Successful introduction of technologies in developing countries requires an understanding of the priorities and concern of smallholder farmers at the grassroots. However, rate of adoption by the farming community has varied considerably depending not only upon merit, but also upon social and economic factors. Lekule and Petersen (1997) pointed out that many technologies have been developed by researchers on stations and sent to farmers for adoption; and even where on-farm studies have been conducted, often the farmers are taken as observers and are not actively involved. The social economic and social-cultural environment under which farmers operate could hamper adoption of potentially useful technologies developed by researchers.

2.9 Studies on Factors Influencing Adoption of technologies

The development of appropriate technology is a necessary condition, but insufficient for ensuring its continued use by the recipient (Byerlee and Heisey, 1992). Means of technology transfer that provide farmers with inputs and information is needed to enhance adoption. The level at which farmers are involved in the whole process of technology development and transfer is very crucial (Kauzeni 1988; Lekule and Petersen, 1997). The constraint to the rapid adoption of innovations involves factors such as lack of credit facility, limited access to information, aversion to risk, inadequate farm size, inadequate incentives associated with farm tenure system arrangements, insufficient human capital, absence of equipment to relieve labour shortages (thus preventing timeliness of operations), chaotic supply of complimentary inputs (such as seeds, chemicals, and drugs); and inappropriate transportation infrastructure (Feder *et al.*,1985). Others include poor planning, lack of time and resources and conflict of interest between various stakeholders. Various studies have indicated different factors that influence adoption of technologies.

2.9.1 Studies on factors influencing adoption of crop technologies

Study by Msuya (1998) using descriptive analysis found that high cost of technology, complexity, high labour requirement, insect pests, lack of credit facility and information from extension services were the major factors that affected the adoption of hybrid maize in Mwanga district. Study by Mwanga (2002) using logit model found that numbers of years in formal school, number of livestock units, market opportunities, family size, location relatively to urban centres, exposure to research intervention and seed source as the main factors influencing adoption of improved sorghum, while family size, seed source and location relatively to nearby town centres influenced adoption of improved pearl millet innovations in Dodoma region. Elala, (1999) Using logistic regression

analysis revealed that shortage of land, number of adult oxen owned by the farmers, low price of produce, extension services and absence of credit strongly and significantly influenced adoption of improved maize production technologies in Awassa district in Ethiopia. Using logistic regression model Ouma *et al.* (2002) identified factors influencing the adoption of improved maize variety in Embu District, Kenya to be agro ecological zone, gender, use of manure, and hiring labour. Herath and Takeya (2003) using logit analysis identified variables related to farmers awareness and attitudes towards intercropping of immature rubber stands, extension contacts, education level and experience with farming others crops to be positively associated with the probability of adoption by rubber smallholders in Srilanka. Negatu and Parikh (1999) established that farmer's perception about grain yield and marketability of product to be the most important factors influencing adoption decisions.

2.9.2 Studies on factors influencing adoption of livestock technologies

Most studies on dairy development emphasize on adoption of technologies, which include breeding, feeding and animal health, husbandry and production (Kisusu, 2003). Adoption of livestock technologies, is affected by several factors (both static and dynamic), including agricultural potential, changes in access to markets, population growth, land tenure policy, changes in participation in credit, extension programs, education, and community natural resource management (Mdoe, 1993; Mattee, 1994; Kisusu, 2003).

Moris (1981), cited by Mattee (1994) reported a total rejection of innovation of modernizing or commercialization of traditional semi nomadic production of the Maasai pastoralists. The reasons being

- False assumption that Maasai were beef producers eager to enter the commercial livestock market.

- Ranching association were not compatible to their traditional system of decision-making and governance, which was strongly adhered.
- Rotational grazing was not superior to their transhumance.

Two studies conducted by Ngasa (1979) and Kjaerby (1983), cited by Mattee (1994) looking on adoption of oxenization by small-scale farmers established conflicting reason on low adoption. Ngasa established that inadequate training of farmers and lack of interest on part of village leadership was the reason for low adoption where, Kjaerby advocated the following reasons

- Lack of cash to buy oxen,
- emotional attachment to cattle,
- unsuitable soils and topography and
- Government contradictory policies which encouraged both oxenization and tractornization.

Ox cultivation is labour saving technology but its adoption is most likely to be encouraged by labour shortage. Despite of introduction of improved breeds of cattle in Tanga Urassa (1999) reported majority of dairy farmers (71%) opting for natural services in serving their cows and only (30%) used Artificial insemination (AI) due to higher cost of AI i.e. Tsh 2 500-4 000 per service compared to Tsh 200 to 2 000 per service using local bulls. Kisusu (2003) using logistic regression model identified that age of households head, number of people in the households, type of cattle breed owned before the project and daily milk consumption were the factors influencing adoption of improved dairy technologies in Dodoma region, suggesting that aged farmer have more experience than young farmers, more people provide required labour for caring dairy cattle and better breed is associated with high milk yield and high income. Using Participatory Rural Appraisal (PRA) Massawe *et al.* (1997) and Mtenga *et al.* (1999) found that ineffective research-extension

linkage to be among the factors limiting adoption of livestock technologies. Nicholson *et al.* (1999) identified factors influencing adoption of livestock technologies to include age, education, family size, income, price and gender. Other factors include market, extension visits, credit and storage facilities.

2.9.3 Studies on factors influencing adoption of other technologies

Using probit models, Senkondo *et al.* (1998) found that farm size, number of family members working in the farm, experience in farming and extent of knowledge in Rain Water Harvesting (RWH) technologies were significant in explaining the intensity of adoption of RWH technologies. Kalineza (2000) using logistic regression model identified that adoption of soil conservation practices were influenced by awareness of the land degradation problems and ownership of the land. Mvena and Mattee (1988) contend that lack of credits, limited accesses to information, knowledge and inadequate incentive associated with farm tenure arrangements to be main factors that limited adoption of improved grain storage in Tanzania. Makauki (2000) using descriptive analysis reported that cultural beliefs (Taboos), short time of exposure to innovations, low level of motivation, lack of adequate extension services, land scarcity and the attitude that trees reduce crop yield due to excessive shade limited adoption of multipurpose tree planting in Turiani.

Many studies group factors influencing adoption differently. For example Msuya, (1998) grouped them into four categories i.e. Institutional, Innovation, Farmers and Environmental characteristics. Nicholson *et al.* (1999) grouped the factors into four categories namely socio-economic, Institutional, Farm, and Technological characteristics while, Kalineza, (2000) classified factors into five categories (Institutional, Farmers,

Innovation, Environmental characteristics and policy factors. Machumu (1995) classified the factors into five categories (Farmers, Innovation, Institutional, Environmental and infrastructural characteristics). Elala (1999) grouped the factors into six categories (Farmers, economic, community prestige, Institutional, Innovation, and Environmental characteristics). Senkondo *et al.* (1999) grouped factors affecting adoption of technologies into three categories namely technology characteristics, biophysical/farm characteristics and farmers characteristics. It can be deduced that different studies identify different sets of factors that influence adoption of innovations and that the variations are due to diverse socio-economic, geographical and environmental circumstances under which different farming communities operate, methodology used and type of technology studied. This study groups the limiting factors into four broad categories: i.e. Institutional, Innovation, Farmers and Environmental characteristics, approach similar to that of Msuya, (1998).

2.10 Factors Influencing Adoption of Innovations

2.10.1 Institutional characteristics

Two categories of institutions have been identified i.e. institutions with cultural background and institutions with political background (Umas, 1993). Furthermore, Kajembe (1994) argue that politically defined institutions are based on consensus and are normally few whereas cultural based institutions depend on cultural norms to regulate behaviour. Politically defined institutions are derived from publicly operated systems for providing support services to farmers. They include institutions such as research, credit, market and extension services (Machumu, 1995). Weak and inefficient agricultural institutions have been mentioned as the reasons for stagnation of the agricultural sector (Msuya, 1998). Kauzeni (1988) argued that the slow rate of adoption is frequently an indication of project methodology rather than unwillingness of farmers to adopt

technology. Furthermore, he argues that the failure of many projects is due to lack of consultation to the ultimate user of innovation. Each of the politically defined institutional characteristic is discussed in the following sections.

a) Research

Agricultural and livestock research and training institutions participate in technology generation, packaging and dissemination. Technologies developed have contributed to a tremendous surge in agricultural and livestock productivity and output. Strong collaboration involving linkage between the research and training institutions, extension agents and the farming community that could form a joint forum for participating in technology generation, packaging and dissemination for the benefit of the farmers in the community is foremost (Sicilima, 2003). This would avoid the delivery of conflicting extension messages to the farmers by different actors working in the farming community, and motivate farmers to increase their agricultural and livestock production. Other anticipated benefit of such collaboration is to provide the frontline extension workers (FEWs) with an opportunity to meet with scientists from the training and research institutions who would update them on the new technologies that are available (Sicilima, 2003).

Through a combined effort, the collaboration would have a bigger impact in increasing agricultural and livestock production and therefore improve the standard of living of the population in the community. Hence, research to be useful it should be farmers based and allows farmers participation in the problem identification. Therefore, it is through these publicly and privately operated systems, that can assist farmers, enable them to identify and analyse their production constraints, and become aware of opportunity for improvement.

b) Credit facilities

Farmers often lacked initial capital for acquisition of dairy cow and financial resources to purchase inputs. A sound credit policy helps to alleviate financial constraint either by providing inputs when credit is given in kind or allowing them to buy these inputs when cash credit is considered without constraining their consumption plans. Credit service is an important element in modernizing agriculture because it allows the use of other factors of production. CMMYT (1993) contend that farmers who do not utilize agricultural technologies may complain of lack of cash or credit as a principal factor limiting their utilization. Credit to smallholder farmers is one of the strategies for promoting adoption of improved crop and livestock technologies. Governments have often used credit programmes to promote agricultural output (Myaka *et al.*, 2003). Findings by Mogaka (1993) point out that zero grazing of dairy cows is not widely adopted in Kisii Kenya because most smallholders are apprehensive about its high cost and likelihood for non-profitability. Furthermore he contend that the adoption of zero-grazing is constrained mainly by lack of credit facilities, lack of initial capital, poor infrastructure, unavailability of pedigree breeds and inefficient utilization of fodder and on-farm by-products. Credit policy could play a more efficient and equitable role in development if appropriate policies are adopted. However, advancing credit to smallholder farmers for encouraging technology adoption is a complex policy issue. Among the related issues are amount and form of credit, the interest charged, targeting of specific farmers' groups and specific activities, and repayment schemes. It is assumed that credit will encourage intensification of the smallholder farming system thus adopt feed improvement technologies. Hence, it can be concluded that credit is an effective policy option to encourage adoption of intensive agricultural technologies.

c) Market

Marketing includes those agencies and services involved in the storage, transport, processing and sale of farm input and output. Input supply and access to potential market are fundamental for adoption of innovation (CMMYT, 1993). Adoption of a new production technology is expected to have important market effects by changing the optimal levels of outputs hence calling for market considerations. Producers may benefit from the adoption of a new technology through opportunities to lower production costs, either by increasing outputs from the same inputs or by maintaining the same output from reduced inputs. The lack of market for the agricultural produce in the country results from poor transportation network and market liberalization policies, which have encouraged the importation of cheap subsidized agricultural products at the expense of locally produced crop and livestock products (Mbilinyi and Nyoni, 2000).

The nature of milk and its derivatives partly explains the high transaction costs associated with dairying. This may involve substantial losses due to spoilage and result in small quantities marketed, thereby limiting marketing outlets for small dairy producers. MoWLD, (2004) point out that study on post harvest milk loses in Tanzania has indicated a total loss in the entire market chain of 16% during the dry season and 25% or more during the wet season. Dairy farmer's co-operatives and other farmer groups, if efficiently managed, can improve the market position of smallholder farmers through collective actions (Kurwijila 2002b). Milk marketing has been cited to constraint adoption of dairy technology in Sub-Saharan Africa (ILCA, 1993; Mathewman, 1993; Mdoe, 1993). Provision of guaranteed market, transport and storage facilities for milk encourages farmers to increase milk production (Mathewman, 1993, Machumu, 1995). Massawe *et al.* (1997) argues that effort to increase milk production through better utilization of forage should go hand in hand with improvement of other infrastructure to facilitate marketing.

CMMYT (1993) argue that a new technology may lead to increased output, but if the extra production cannot be utilized or marketed effectively, the technology may be rejected.

d) Extension services

It has been contended that extension services tend to focus on farmers who appear more receptive to new ideas (Mvena and Mattee 1988; Wambura, 1988). It is further argued that extension resources are focused on "early adopters" who are usually richer, better educated, more progressive farmers with larger than average farms and who are in better position to follow extension advice. Those farmers have high levels of extension contact than others. Insisting on role of extension worker on technology dissemination, Senkondo *et al.* (1999) pointed out that contribution of extension workers in knowledge dissemination on Rain water harvesting (RWH) technologies was low due to absence of RWH extension package in District Agriculture offices, Poor training of extension workers in RWH technologies and the extension workers orientation to soil and water conservation rather than in RWH. Lack of in-depth knowledge and practical experience of silage making was among the factor cited to contribute to non-adoption of silage making in Central and West India (Rangnekar, 2000). Inefficient extension services have been attributed to problems related to management, planning and lack of effective extension – research linkage. Thus in order for extension services to be effective it will have to take the interests of the clients as perceived by the clients themselves and there must be interventions in the form of extension packages and trained extension staff.

2.10.2 Innovation characteristics

Farmer's decision to adopt a new agriculture technology in preferences to other alternative (old) technologies depends on complex factors. One of the factors is farmers'

perception of the characteristics of the new technology vis-à-vis that of the existing old technology (Negatu and Parikh, 1999). A given agricultural technology embodies a number of input characteristics that may influence adoption decision. According to Rogers (1983), five major types of technology characteristics that influence adoption are: i) Relative advantages ii) Compatibility iii) Complexity iv) Trial ability and v) Observability. These characteristics enable new technologies to be rapidly and widely adopted or not.

a) Relative advantages

Is the degree to which an innovation is perceived as been better than what it is intended to replace, advantageous to the adopter relative to the old way of doing things. This may be reflected in reduced labour costs, reduction in demand for labour to do unpleasant tasks or increased productivity caused by the new technology (Rogers 1995). The adoption of a new technology is a choice between two alternatives, the traditional technology and the new one and farmers are assumed to make decisions by choosing the alternatives that maximizes their perceived utility (Senkondo, 2000). Farmers are likely to adopt the new technology if the utility of the technology is higher than utility derived from the traditional technology. Farmers will adopt technologies that give high returns to investment and with a high risk reducing effect relative to the current technology. It is generally understood that risk-averse framers are reluctant to invest in innovations of which they have little first-hand experience. Mshana (1977), cited by Mattee (1994) reported widely adoption of Artificial insemination (AI) an innovation introduced to high potential densely populated areas of Kilimanjaro. Okwir (1998) contend that AI is the most predominant breeding practices under zero grazing system. Kisusu (2003) reported rejection of similar innovation in Dodoma, where farmers preferred natural mating by bulls due to risk associated with artificial insemination. This finding coincide with that of Schreiber (2002) who reported farmers rejection of AI technology in Nyandarua Kenya due to lack of

information on its advantages; the services was not easily available; and low milk prices, and thus their incomes, did not allow such an investment. Furthermore, Schreiber (2002) argue that in Kiambu, majority of farmers adopted AI and accepted introduced improved dairy breeds. A substantial minority introduced new protein-rich fodder crops and methods of calculating rations, reduced their stocking rates (resulting in a further specialization in milk production), started purchasing concentrate feeds, and improved their farm structures (for example, by installing and maintaining feeding stalls). Kisusu (2003) reported that introduced improved dairy cattle in Dodoma reduced leisure time during rain and dry seasons since the introduced technology was labour intensive and due to more acreage cultivated.

b) Compatibility

Is the degree to which an innovation is perceived as being consistent with existing values, past experiences and needs of the potential adopters. A technology that is clearly compatible, profitable and reliable with farmers farming systems will be adopted relatively faster (CMMYT, 1993; Rogers, 1995). Rogers (1995) argued that the compatibility of a technology as perceived by members of social system is positively related to its rate of adoption. Rangnekar (2000) established that non-adoption of silage making in Central and West India by majority of women was due to smell where some animals took time to eat and some refused to eat the silage.

c) Complexity

Is the degree to which an innovation is perceived relatively difficult to understand and use. Technology with more numbers of activities to be done to adopt and to use compared to old technology diffuses slowly, as it requires adopter to develop new skills and understanding (CMMYT, 1993). Numbers of years may be required for a farmer to develop the required technical know how. Rangnekar (2000) argue that most farmers (90%) in Central and Western India involved in demonstrations and who received

subsidies adopted silage making technology for a short period because the process was cumbersome, labour intensive and the benefit was not commensurate with effort and time. Furthermore, farmers pointed out that their animals were low milk yielders thus cost and trouble in silage making will not provide adequate returns. However, convenient factors may override the cost factor.

d) Trial ability

Is the degree to which an innovation may be experimented on a limited basis. An innovation that can be tried on small scale will generally be adopted more rapidly than innovations that cannot be tried. If technology requires a big capital outlay, it might not be adopted even if it is profitable especially to resource poor farmers with limited access to capital (Rogers, 1995).

e) Observability

Is the degree to which the results of an innovation are visible to other members in the community. Results of some innovations are easily observed and communicated to others, where some innovations are difficult to explain to others. The easier it is for individuals to see the results of an innovation, the more likely they are to adopt (Rogers, 1995).

2.10.3 Farmers characteristics

Traditionally, the failure by farmers to adopt innovation has been blamed on farmers' socio-cultural milieu of beliefs, attitudes, values and tradition practices (Mvena and Mattee, 1988). However, it has been recognized more recently that there are alternative explanations such as characteristics of individual farmers that can be used as explanatory variables on understanding adoptions patterns. These factors include age, education, gender that may predispose a farmer to take an interest on innovation and resources such as income, land size, number of animals owned that may make it easier for a farmer to

alter practices (CIMMYT, 1993; Nkonoki, 1994). The way farmers perceive a new technology influences positively and significantly the adoption rate of that technology.

a) Age

Young and energetic people have proved to be more venturesome, active and ready to try innovations (Nannai, 1993; Rogers, 1995). CIMMYT (1993) assert that older farmer may have more experience, resources or authority that would give them more possibilities for trying innovations. It is possible that the number of years in farming influences adoption of new technologies because of the possibility of a farmer to develop technical know how. Nevertheless, their receptivity to new ideas and technologies typically decreases with age (John, 1995). There is inconsistency of findings about relationship between age and innovativeness, thus Adesina and Baidu-Forson, (1995) concluded that there is no agreement in the adoption literature concerning the effect of age on adoption as the effect of age on adoption tends to be location and technology specific.

b) Education level

In Tanzania majority of farmers in the village have low formal education and rely on traditional farming practices. The farmer's educational background is a potential factor in determining the willingness to accept and proper use of an innovation (Swanson *et al.*, 1984). Education makes a farmer more open-minded to advice from an extension agent or more able to deal with technical innovations. Education helps an individual to become more critically aware of the need and scope for social change. The way of thinking is very insightful and powerful tool, which helps an individual to study problems in their surrounding and identifying available alternatives. Therefore, for technology that is more complex education is expected to play a vital role (CIMMYT, 1993). Feder and Slade (1984) argue that as a farmer accumulates knowledge, he can reasonably be expected to produce more output with a given bundle of inputs. They further argue that provided the

innovation is profitable, the accumulation of favourable experiences will eventually induce most farmers to adopt the new technology.

c) Gender

Refers to socially or culturally defined roles of each sex (men and women) and class (e.g. children, adults and youth) and social relationship between them as formed by society, ruled by cultural norms and values and not biological differences (Huvisa, 2003). The gender relation can be socially constructed or deconstructed because of behaviour of men and women themselves. Gender relation is therefore considered historical, changeable and subject to transformation through everyday happening as well as periodic moment of crisis. In most rural societies, the social status of women is inferior to that of men (Kikopa, 1981). Thus, they are the disadvantaged group especially when it comes to the introduction of new technologies. CIMMYT (1993) contended that because women play a key role in most of the agricultural systems, it is important that adoption studies consider the degree to which a new technology reaches female farmers. Similarly, most of the food producers in Africa are women and yet most technologies are promoted to men or through them. However, most technologies are considered gender neutral, but often become gender biased during introduction and use by the societies (Stephens, 1992). Female farmers tend to adopt improved technologies at lower rate than male farmers (Doss and Morris, 2001). Gender-linked differences in the adoption of modern maize varieties and chemical fertilizers result from gender –linked differences in access to complementary inputs (Doss and Morris, 2001). The authors concluded that for ensuring more widespread and equitable adoption of improved technologies, it is necessary to introduce measures that ensure better access for women to complimentary inputs, especially land, labour and extension services in agricultural systems. Furthermore, Nikkoi (1998), cited by Huvisa (2003) explaining position, role and contribution of women reported that women constitute 50% of the world's population, and one thirds of

the world's workforce, they work two thirds of the world's working hours, earn one tenth of the world's income and own 1/100 of the world's property. Since in most developing countries women do not have right over resources as well as decision making because of cultural constraints the role played by them should not be undermined when considering adoption of technologies as a pre-requisite for development process.

Labour roles played by women in animal production have been shown to vary according to type of animals kept and production systems. Those roles are also affected by cultural factors and economic constraints (Kurwijila and Mdoe, 1989). In all animal production systems, women's roles commonly cited include milking, feeding of animals, processing milk and collecting animals' wastes for fuel and manure, and marketing of milk and milk products. Rangnekar (1994) studied women's involvement in animal production in the semi-arid regions of the Indian states of Gujarat and Rajasthan and found that the feeding, cleaning and milking of dairy animals are tasks which are undertaken predominantly by women, except in rich families, where women tend not to work with animals.

d) Income

Wealthier farmers have better accesses to extension information, credit and market facilities and stand better chances to use their own resources to experiment with new innovations especially if it involves the purchase of inputs (CIMMYT, 1993). Farmers with more resources in terms of capital, land and labour are able to take advantages of new technologies and practices. The extension system also tends to favour certain categories of farmers. Wambura (1988) found that young, richer and better-educated farmers had higher extension contacts than poorer, older and less educated farmers. Appropriate livestock technology development and transfer strategies should thus ensure adequate economic returns to livestock farmers, optimal production with minimal input.

e) Farm Size

Depending on innovation characteristics and situational settings, farm size can have an effect on the rate of adoption. The relationship of farm size to adoption depends on factors such as labour requirements, land tenure arrangements, risk preferences, fixed adoptions costs, human capital and credit constraints (Feder *et al.*, 1985). Larger farmers are more likely to adopt new technologies because they can spread the costs over a wide range of outputs than it is possible for small farms (Hussain *et al.*, 1994). Senkondo *et al.* (1999) when assessing RWH technologies found that farmers with large farms were able to adopt rainwater harvesting technologies in their farms than those with small farms, possibly because they were more able to take risks of experiment with the new technology. There is a positive correlation of farm size and adoption of innovations. In this regard Jamison and Lawrence (1982), found a significant relationship between farm size and the adoption of high yielding seed varieties and use of fertilizers. However, in other situations household with small farms may adopt new technology such as soil conservation practices to prevent soil erosion from reducing the farm under demand for increased subsistence production (Anim, 1999). Huvisa (2003) observed that farmers with land ownership and education participated more in tree planting activities than farmers without land ownership and education.

f) Land acquisition

In Tanzania, all land is publicly owned and vested in state. Nevertheless, maintenance and improvement of the quality of the land will depend significantly on the land user (MOA, 1995). However, in practice most agricultural land is held under either Customary or communal systems where its use could be dictated by norms and social settings prevailing in the area (Mlambiti, 1994). Land ownership right is one of the factors which influence adoption of technology positively or negatively. Farmers are not ready to invest on rented land, which may not be available to them in the next season. As pointed by Makauki

(2000), mode of land acquisition affected the adoption, success and realizations of agroforestry innovations.

g) Social culture

In most Sub Saharan Africa, involvement of people in agricultural activities is influenced by the prevailing cultural background, which includes beliefs, attitude, behaviour and traditional practices of the people in the given area. Culture influences the pattern of decision making in the societies. Boresup (1983) contend that culture determines the type of activities in which women choose to take part. Cultural rules and norms are important as part of the institutions and are essential for the society to function smoothly (Holden, 1996). Huvisa (2003) assert that presence of gender disparity related to access to extension services could be attributed to Muslim societies where by in Islamic culture, women are not allowed to discuss issues outside their houses especially to a male stranger.

2.10.4 Environmental characteristics

Land quality and soil type may be important factors influencing the acceptance of new technology. Management practices do differ depending on type of soil, topography and moisture retention capacity. On the other hand, climatic factors play obvious role in the management of the farming systems. Climate (rainfall distribution and pattern, temperature), soil and other physical factors have a major influence on the levels of technology to be used by farmers such as type of crops to be planted and type of animals to be raised (CIMMYT, 1993). Risk conditions of weather such as floods, drought and water logging have been reported to give challenges to smallholder farmers (Mvena and Matee, 1988). Chi and Yamada (2004) argues that the biophysical environment, which influences the adoption of innovations, includes the conditions of the farm such as its

location, availability of resources and other facilities such as roads, markets, transportation, pests, rainfall distribution, soil type, water, services, and electricity.

Attempt by various development projects to remove constraints, which limit adoption, was expected to result not only in the adoption of the improved practices but also change in output; which was expected to increase average farm income (Feder *et al.*, 1985). However, these expectations have not been realized. Therefore, adoption study look specifically about each component of the package, knowing that individual component may be adopted at times and under different conditions.

CHAPTER THREE

MATERIALS AND METHODS

3.1 The Study Area

The study was conducted in three districts (Tanga, Muheza and Lushoto) in Tanga region. These districts were purposefully sampled to represent distinctive climatic variation ranging from hot and humid coast to sub-temperate climate in Lushoto district and districts covered by the TADAT program.

Tanga region is situated at the extreme north-east corner of Tanzania between latitude 4^0 and 6^0 south of Equator and longitude 37^0-39^0 east of the Greenwich meridian. The altitude of the region varies from 0 meter above sea level in Tanga district to 2 000 meters in Lushoto district. Most areas receive rainfall averaging 750 mm per year with the coastal area receiving about 1 100 to 1 400 mm and decreasing inland but with the exception of the Usambara Mountains, where, depending upon altitude, the amount may exceed 2 000 mm per year (URT, 1997).

The region experiences four distinct seasons namely the hot and dry season from January to March; the long rainy season from April to June; the cool and dry season from July to September and the short rainy season from October to December. Temperature does not vary greatly with the exception of the mountain areas. During the hot and dry season, day and night, temperature varies from 30^0C to 33^0C and 26^0 to 30^0C, respectively. During the cool and dry season day time temperature ranges from 23^0C and 28^0C while at night it ranges from 20^0C to 24^0C (Mulangila, 1997). The region occupies an area of 27 348 sq

km, being about 3% of total area of the country. Tanga shares borders with Kenya to the north, Morogoro and Coast regions to the south, and Kilimanjaro and Arusha regions to the west. To the east, it is bordered by the Indian Ocean. Mligaji river forms a large part of the border in the South (URT, 1997). The region is divided into seven administrative districts namely Tanga, Muheza, Pangani, Korogwe, Handeni, Kilindi and Lushoto (URT, 2003a).

Tanga region has a population of 1 642 015 (URT, 2003a), where 797 240 are males and 844 775 are females, with a growth rate of 1.8% and population density of 61 person per sq km and it is the sixth with the highest population density in the country (URT,2003a). The number of household was 356 993 with an average household size of 4.6. The main ethnic groups include Sambaa being main ethnic group in the Usambara Mountains and low lands of Muheza, account for nearly 40% of the region's total population in Korogwe and Lushoto, Zigua, Bondei and Digo. Small ethnic groups are Segeju, Duruma, Mbugu and Pare. Asians and Europeans occupy the urban centres but they account for a very small percentage of the population (URT, 1997). Livestock keeping was the second dominant economic activity after agriculture. The region was estimated to have 276 739 cattle population of which 25 529 cattle are of improved dairy breeds (MAFS, 2002) cited by (Myaka *et al.*, 2003).

3.2 Conceptual Framework

Adoption of agricultural innovation depends largely on availability of information, farmers' characteristics and availability of resources. However, factors affecting adoption of innovation differ across countries and are location specific. Identification of important variable for efficient data collection was based on objective of the study. The adoption of

technologies is influenced by background variables, institutional and economics factors and technology characteristics.

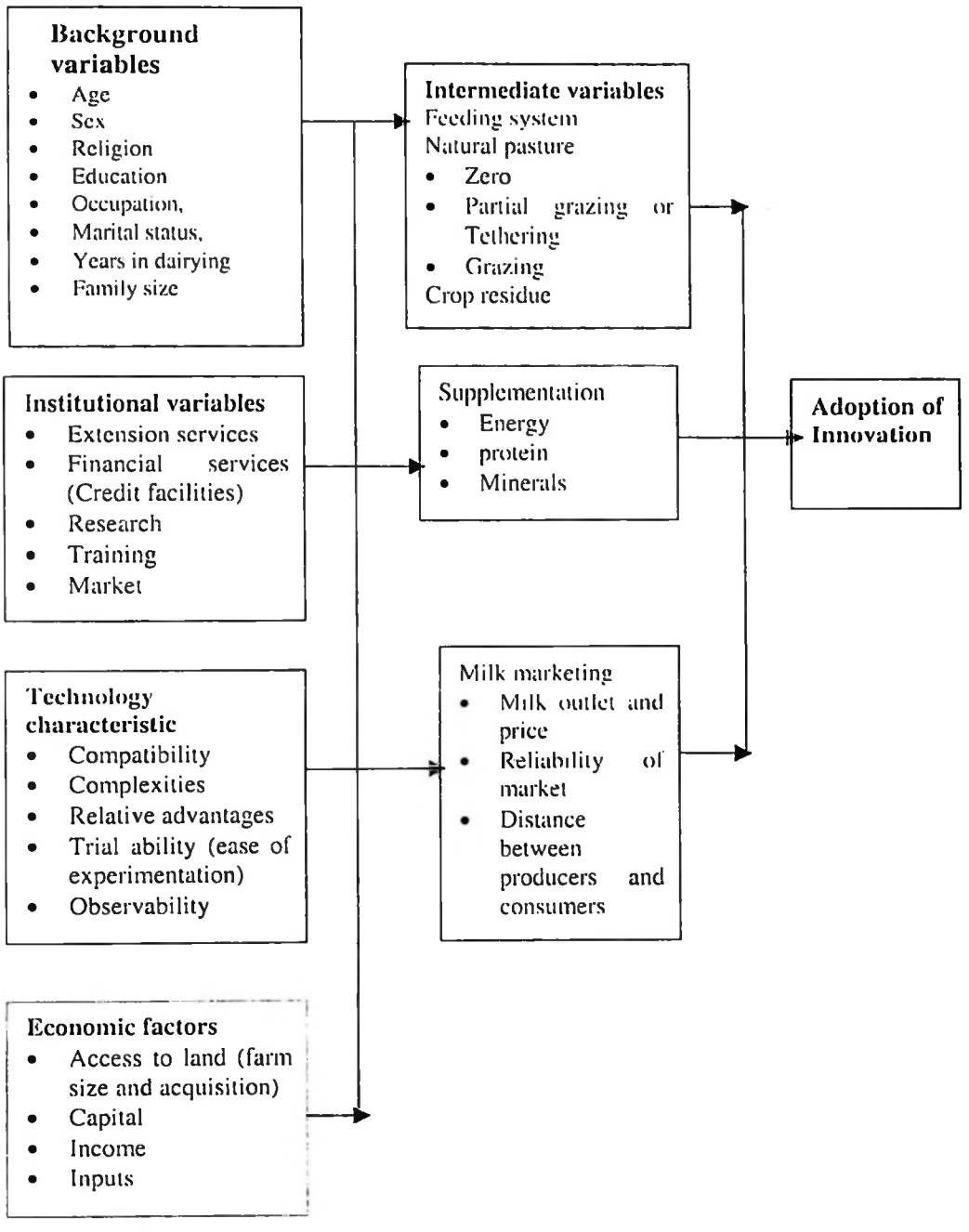

Figure 1: Conceptual framework for analyzing factors affecting adoption of feed improvement technologies

3.3 Research Design

A cross sectional research design was adopted; such design according to Babbie (1994) allows collection of information at one point in time, from a selected sample of respondents. The design was considered favourable because of limited time for data collection. The design is also suitable for descriptive interpretations and determination of relationships between and within variables.

3.4 Sampling Procedures

Population of the study consisted of smallholder dairy farmers in the selected districts. The sample frame was a list of smallholder farmers keeping dairy animals. Farmers were selected randomly from the sample population of farmers who keep dairy cattle in each of the four wards selected from each district, thus ten farmers were interviewed from each ward making a total of forty farmers per district.

3.5 Data collection

A preliminary survey was done for a researcher to become accustomed to the study areas in December 2003. Necessary comprehensive information was collected for questionnaire development.

3.5.1 Key informants

A purposeful sampling approach was adopted in selecting nine key informants three from each district. Key informants were targeted to include one from each district agriculture and livestock office responsible for smallholder dairy farmers, one representing the

TADAT project in each district and one extension officer. According to Mettrick (1993), key informants are not only members of the clientele, but often knowledgeable outsiders.

3.5.2 Focused group discussions

Selection of members of Focused group discussions followed random sampling where members ranging from 11 to 15 were selected from a population of farmers who keep dairy animals. Two focused group discussions of combined sex and age were conducted in Muheza, Tanga, and one in Lushoto.

3.5.3 Participant observation

The approach was adopted aiming at crosschecking and verifying the validity of the information given by respondents' during interviews. Ascertain size of established fodder garden and type of fodder grown, observation of pasture and grasses mixture in the feeding troughs to ascertain identified species.

3.5.4 Pre-testing of questionnaire

Questionnaires were pre tested in Magilla ward in Muheza district to check accuracy and validity of the information so as to make necessary additions, exclusion, and alteration of questions to make sure that they answer the study objectives (Mettrick, 1993). Ten farmers were used and were excluded during actual data collection.

3.5.5 Primary data

Both quantitative and qualitative methods were used to collect information from respondent. Primary data were collected from respondent using structured and semi-

structured questionnaires (Appendix 1). An interview was carried out by visiting respondents at their homesteads. To minimize the problem of data irregularity and non-response the researcher carried out data collection himself, with assistance of one enumerator in each district trained by researcher for one day as proposed by Vaus (1993). The questionnaires were formulated in English but were administered in Kiswahili language, which was spoken by all respondents.

The questionnaires focused on assessment of awareness of farmers on feed improvement technologies, types of technologies, which are available to farmers, rate and extent of adoption, factors associated with adoption of technologies such as farmer's characteristics (gender involvement, education level, age, farm size, income and year in dairying) as farmers differ a great deal in access to the resources. For example apart from dairy farming, respondents were asked to indicate other types of income generating activities. It was assumed that farmers with other sources of income would have extra income to support their dairy activities, hence influencing adoption of technology. In addition, respondents were asked to give their observed opinion on their cow production potential.

It was deemed necessary to evaluate how cropping systems contribute to livestock feed since most often smallholder dairy farmer integrates animal production into cropping systems.

Respondents were asked to give source and price of feed supplements; class of animals fed, frequencies of feeding; and amount and mixing ratio of feed supplement. Also, questionnaires focused on other factors such as: Institutional factors (credit facilities, market of milk produced, research and extension services); environmental factors (soil, climate); characteristic of technologies (relative advantage, compatibility, complexity and ease of experimentation) and cultural aspects related to feed quality improvement.

3.5.6 Secondary data

Secondary data were collected from reports and documents from SDEP through its transformation to TADAT, District Livestock Offices and the Sokoine National Agricultural Library (SNAL) in Morogoro.

3.6 Data Analysis

The data were analysed quantitatively and qualitatively using Statistical Package for Social Science (SPSS, 2002) computer software. Descriptive analysis mainly on frequency distribution, cross tabulation, comparison of means was done. Chi-square tests were conducted to compare the relationship between different variables. Regression analysis was carried out to establish causal-effect relationship between the dependent and independent variables. According to Senkondo *et al.*, (1998) different models have been used in describing the factors affecting adoption of technologies. These include probit models, Discriminant models and logit models.

The data was analysed using logit Model, which follow the cumulative logit distribution. However, the distribution of error term is close to that of probit models which follow the cumulative normal distribution of the random error term and the choice between these two models was based on the practical concerns such as personal preferences, experience, availability and flexibility of computer software as pointed by Senkondo *et al.*;(1998). Logit model have been widely used in different adoption studies. The model helps to assess various factors that affect adoption of a given technology, and provide predicted probabilities of adoption. Three logistic regression equations were estimated to identify factors influencing the probabilities of farmers adopting fodder garden; use of supplementary feeds and hay use or making.

Empirical Model

Logit model in describing the factors affecting adoption of technologies transformed using natural logarithm is: $Ln\ (Pi/\ (1-Pi)) = Zi = \alpha + \beta 1X1 + \beta 2X2 + \text{---} + \beta n + Xn + \varepsilon$

- Where Pi = Probability of adopting feed improvement technologies (FIT)
- 1-Pi = Probability of not adopting feed improvement technologies
- α = Intercept which is a constant
- $\beta 1, \beta 2 \text{---} \beta n$ = Regression coefficient to be estimated
- X1, X2---Xn=Set of independent variables (Institutional, Innovation, Farmers and Environmental characteristics)
- ε = Error term common to all observations

Dependent variable whether farmer has adopted FIT or not is a dummy variable (1=Adopted and 0 otherwise). Adopters and non-adopter were categorized according to the technology as follows:

a) Fodder garden establishment (T_1) =Adopter were defined as farmers with 0.1ha (1 acre = 0.405 ha) of established fodder garden or more.

b) Supplementation (cereal milling by-products, oil cakes and mineral) (T_2) =Adopter were defined as farmers who uses cereal milling by-products as energy source ≥2kg/day; oilseed cakes or legume leaf meal as protein source≥0.5kg and mineral ≥20g /day to compound their ration and feeding their animal a minimum of 2kg of compounded ration per day.

c) Hay making and use (T_3) =Adopter were defined as farmers who make or buy hay to feed animals.

Independent variables were as specified in (Appendix 2) which was assumed to have influence on the probability of adoption (Senkondo *et al.*, 1999; Mwanga, 2002).

Probability of adoption depends on the characteristics of the farmers. If the estimated coefficient of a particular variable is positive, it means that higher values of that variable result in a higher probability of adoption. A lower value implies a lower probability of adoption. According to Herath and Takeya (2003), many technology adoption studies distinguish between the rates of adoption (i.e. Proportion of farmers adopting the technology) and the intensity of adoption (defined based on the level of use of technology). Adoption rate was measured by the percentage of farmers using each technology among the identified one. Intensity or extent of adoption was measured, for example, by the proportion of land under fodder garden, and amount of supplementation feed used at recommended mixing ratio.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Farmers Demographic Characteristics

The demographic background characteristics of the respondent interviewed are discussed in this section. The explanatory variables considered include education level, age of respondent, gender, marital status, religion, household size, main occupation of respondent and other source of income. A summary of demographic results is presented in Table 2.

4.1.1 Education level

The majority of respondents in the study area attained primary education represented by 70%, 55% and 50% in Tanga, Lushoto and Muheza districts, respectively. Only a small proportion of farmers had no formal education in all districts. Only 5% in Tanga and Lushoto and 3% in Muheza had no formal education. Thus, majority of respondents were able to read and write and to communicate with extension officer in different ways (posters, leaflets, newsletters, and magazine). Higher level of education increases a farmer's ability to learn innovation easily and increases the probability of adopting feed improvement technology. However, this is only true for complex technologies as pointed by Feder and Slade (1984) and CIMMYT, (1993). Huvisa (2003) reported a trend where majority of respondents had primary education (88%) and farmers with no formal education were 1%. This finding was not exception to those reported by Msangi, (2001) and Makauki, (2000).

4.1.2 Age

The age of respondents ranged from 19 years to a maximum of 74 years. The majority of respondents in Tanga were between 46-60 years represented by 45% of the respondents. In Muheza and Lushoto, respondents were from 30-45 years represented by 58% and 43%, respectively. This is the active age group responsible for making decision on the use of particular technologies. Respondents with age less than 30 years were fewer in all districts represented by 8%. Chi-square test indicated that statistically there were significant difference ($P<0.05$) between age groups. Respondent with age above 60 years were fewer in all districts represented by 9%. Majority of respondents in all districts were aged between 30-60 years. Very few youths (8%) were interested in dairy farming, majority preferred to work in non-farm occupations or migrate out of the village to urban areas. Older farmers tended to withdraw from the labour force since the dairy keeping is labour intensive and very involving. John (1995) argues that older people have more experience but their receptivity to new ideas and technology decrease with age. Age of farmers has an impact on experience, wealth and decision-making all of which affect rate and extent of adoption of new technology.

4.1.3 Marital status

The majority of respondents in all districts were married where Lushoto was having the highest number of respondent 93% followed by Tanga and Muheza, which had 88%. However, few widowed and single farmers representing 3% and 8% of all respondents, respectively were observed. There were no divorcees among the respondents implying stable societies. The married household had advantages over single and divorced on effective use of the owned resources and sharing managerial skills within the family and provision of labour force.

4.1.4 Gender

In all districts men were the majority of the respondents interviewed representing 75%, 73% and 60% for Lushoto, Tanga and Muheza districts, respectively. Men were also the owners of the dairy animals in all districts. Despite the effort made by the SDEP project to allow equal participation of men and women, men appeared to dominate in all districts. Inferiority of women in most rural societies as pointed by Kikopa, (1981) could attribute to this trend. Furthermore, women's workload is one of the major factors that were cited to hinder their participation in development programmes (Nannai, 1993). Similarly Mwaipopo-Aku (1994) argues that women in rural areas often have heavy workloads and little time to participate in different forum and associations for development and more so for assessing technologies. Chi and Yamada (2004) contend that most of women do not have access to technical training because they are busy with household chores and caring of children, and they have no time to attend training. These results conform to other findings, which reported disparity between men and women in access to different resources and services (Makauki, 2000; Msangi, 2001; Huvisa, 2003). Machumu (1995) observed that selection of farmers to join Sasakawa Global 2000 project in Dodoma rural gave equal chances to both men and women, however during implementation men were more represented.

4.1.5 Religion

Majority of the respondent in Muheza (85%) and Lushoto (53%) were Christian while in Tanga majority of respondents (70%) were Muslims. Statistically there was significant difference ($P<0.05$) in religion between districts. Tendency of female farmers not to mix with male farmers in the meetings due to their religious beliefs particularly for Muslims was a factor, which hinders adoption of FIT as was recorded during focused group discussions. Pre-conceived ideas have been shown to cause rejection of innovations or

adopted slowly as farmers have limited access to information as pointed by Huvisa, (2003).

4.1.6 Household size

The average household sizes of respondents in all districts were between 5-10 persons, as indicated by 78% of the respondents in Tanga and Lushoto, and 73% in Muheza districts. Households, with members greater than ten represented 11% of the respondent and less than five members were 13% of the total respondents. Household size comprised of parents, children and dependants. The observed household size in the current study is relatively higher than the regions' average of 4.6 persons (URT, 2003a) implying that since dairying is labour intensive more people are required to accomplish the responsibility. The household size is an important variable, which determine the available labour for dairy activities and other farming activities hence implication on adoption of technology.

Table 2: Background characteristics of respondent in Tanga, Muheza and Lushoto districts

Variable	Location					
	Tanga (n=40)	Muheza (n=40)	Lushoto (n=40)	Total (N=120)	χ2	Prob.
Education Level						
No formal	2 (5.0)	1 (2.5)	2 (5.0)	5 (4.2)	7.44	0.282
Primary	28 (70.0)	20 (50.0)	22 (55.0)	70 (58.3)		
secondary	6 (15.0)	8 (20.0)	4 (10.0)	18 (15.0)		
College/graduate	4 (10.0)	11 (27.5)	12 (30.0)	27 (22.5)		
Sex						
Male	29 (72.5)	24 (60.0)	30 (75.0)	83 (69.2)	2.423	0.298
Female	11 (27.5)	16 (40.0)	10 (25.0)	37 (30.8)		
Age(years)						
<30	6 (15.0)	2 (5.0)	2 (5.0)	10 (8.3)	12.651	0.049*
30-45	16 (40.0)	23 (57.5)	17 (42.5)	56 (46.7)		
46-60	18 (45.0)	10 (25.0)	15 (37.5)	43 (35.8)		
>60	0(0.0)	5 (12.5)	6 (15.0)	11 (9.2)		
Religion						
Muslim	28 (70.0)	6 (15.0)	19 (47.5)	53 (44.2)	24.804	0.000***
Christian	12 (30.1)	34 (85.0)	21 (52.5)	67 (55.8)		
Marital status						
Single	5 (12.5)	3 (7.5)	1 (2.5)	9 (7.5)	4.741	0.315
Married	35.(87.5)	35 (87.5)	37 (92.5)	107 (89.2)		
Widowed	0(0.0)	2 (5.0)	2 (5.0)	4 (3.3)		
Household size						
<5	6 (15.0)	5 (12.5)	5 (12.5)	16 (13.3)	1.290	0.863
5-10	31 (77.5)	29 (72.5)	31 (77.5)	91 (75.8)		
>10	3 (7.5)	6 (15.0)	4 (10.0)	13 (10.8)		
Main occupation						
Employed	11 (25.0)	13 (32.5)	17(42.5)	40 (33.3)	6.572	0.583
Business	5 (12.5)	6 (15.0)	6 (15.0)	17 (14.2)		
Dairy farming	12 (30.0)	11 (27.5)	9 (22.5)	37 (26.7)		
Crop farming	10 (25.0)	10 (25.0)	7 (17.5)	27 (22.5)		
Others	3 (7.5)	1 (2.5)	1 (2.5)	4 (3.3)		
Income activities than dairying						
Employment	11(27.5)	15(40.5)	16(41.0)	42(36.2)		
Business	5(12.5)	11(29.7)	7(17.9)	23(19.8)		
Others[1]	6(15.0)	4(10.8)	5(12.8)	15(12.9)		
Crop Farming	30(75.0)	22(59.5)	31(79.5)	83(71.6)		

- Figures in parenthesis are percentage and those out of parenthesis are frequencies.
- [1](casual labour, bricks making, tailoring, carpentry, charcoal making, lumbering and masonry).
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).

4.1.7 Main occupation of respondents

Respondents interviewed were living in urban and peri-urban setting some being civil servants and other retired officers and crop farmers. The majority (43%) of respondents in Lushoto were employed as civil servants followed by dairy farming (23%), whereas in Tanga majority (30%) of respondents who were involved in dairy farming were retired officers followed by those who were employed as civil servants and in Non Government Organization (NGOs) and those in crop farming representing 25% of the respondents. In Muheza majority (33%) were employed as civil servants and in NGOs followed by dairying 28% and crop farming 25%. Respondents with other activities were the least in all districts. Employment (as civil servants and in NGO) was the overall main occupation in all districts as observed by majority (33%) of the total respondents, while dairy farming was ranked as a second main occupation by (27%) of the respondents. The finding is similar to those reported by Mlozi (2001) who argued that people in urban and peri-urban areas especially civil workers are engaged in dairy farming to supplement their low incomes implying that after their retirement dairying become their main economic activities.

4.1.8 Other income generating activities

Other income generating activities apart from dairying in the study area were identified as farming (72%), employment (36%), business (20%), and other activities (13%) which include: (casual labours, brick making, tailoring, carpentry, charcoal making, lumbering and masonry), as indicated in (Table.2). Crop farming ranked first in all districts as the major source of income generation apart from dairying, followed by employment, then business and lastly other activities. Dairy livestock production is considered as a valuable source of income to complement crop production (Msangi, 2001). Involvement of farmers

in more than one income generating activity help to spread risks associated with new technologies. Substantial level of income is needed for a smallholder farmer to be able to provide the necessary health care required for the improved animals.

4.2. Institutional Characteristics

The explanatory variables for providing support services were identified to include research and training centres, extension services to farmers, credit services, and marketing.

4.2.1 Livestock research and Training centres

Tanga Livestock Research Centre (LRC), Buhuri, and Mlingano Training Institutes are publicly operated systems, which assist farmers in technology generation, packaging and dissemination. The mean distance in km from respondents' residence to training and research centres were 25.71 and 23.89 for Tanga and Muheza districts, respectively (Table 3). Those institutions are located in Tanga district whereas in Lushoto there was no Research or Training Institute thus dairy farmers had to travel to Tanga about 175 km from Lushoto for training. The uptake by farmers of new technologies was not mentioned to be contributed by research institution being nearer or far to the respondents' residence. Farmers acknowledged the contribution of Training institutions during basic course on animal husbandry. Sicilima (2003) argued that strong collaboration between the research and training institutions, extension system and the farming community to be most important joint forum in technology generation, packaging and dissemination for the benefit of the farmers in the community.

Table 3: Distance from respondent residence to Training and Research Centres in Tanga, Muheza and Lushoto districts

Variable	Location					
	Tanga (n=39)	Muheza (n=40)	[a] Lushoto (n=40)	Total (N=119)	χ^2	*Prob.*
Distance to training centre (km)						
Mean	18.89	28.90		23.89	21.440	0.000***
Maximum	29.00	39.00		39.00		
Minimum	8.00	5.00		5.00		
s.e	1.28	0.82		0.94		
Distance to research centre (km)						
Mean	16.61	34.80		25.71	16.914	0.000***
Maximum	27.50	37.00		37.00		
Minimum	6.00	33.00		6.08		
s.e	1.29	0.14		1.21		

- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).
- [a] Respondents from Lushoto had to travel 175 km to Tanga for training thus could not establish distance.

4.2.1.1 Training on Dairy Husbandry

The SDEP project required that the farmer be trained on dairy husbandry and management practices for a maximum of two weeks at Livestock Training Institute (LITI) Buhuri formerly under full sponsorships of the project but later dairy farmers were required to contribute. On completion of the training farmers were given seeds and or seedlings of fodder to establish at their farms.

Majority (66%) of Smallholder dairy farmers in the study area received training on dairy husbandry before starting dairying. Training was conducted by the project for two weeks at Livestock Training Institute (LITI) Buhuri as reported by (89%) of the respondents (Table 4). All farmers who attended training found it to be useful after starting dairy and all admitted that they learned the following technologies for improving feed quality: Fodder garden establishment; energy, protein and mineral supplementation and making

and use of hay (Table 4). However, some farmers received skills on dairy husbandry through other farmers and parents.

All respondents interviewed reported that the technologies introduced are truly needed for increased milk production if followed carefully and that there is no cultural/beliefs, which hinder the practising of introduced technologies. More farmers (96%) were interested in further training and showed more interest on treatment of sick animals (61%) which is a technical issue but cost of treating animals was high thus contributing to such trend, followed by general husbandry (32%). This was also observed during focused group discussion where farmers complained on high cost associated with consultation and treatment of animals. However, pertaining to animal health services, the 1997 Agricultural and Livestock policy insist that "farm level disease control is the duty of livestock keeper and he or she should buy the services, drugs, vaccines and other inputs from the private sector" (Mbilinyi and Nyoni, 2000).

Table 4: Training of smallholder dairy farmers in Tanga, Muheza and Lushoto districts

Variable	Location			Total	χ2	Prob.
	Tanga	Muheza	Lushoto			
Training prior to starting dairy						
Yes	38(95.0)	21(53.8)	19(47.5)	78(65.5)	23.498	0.000***
No	2(5.0)	18(46.2)	21(52.5)	41(34.5)		
Duration of training						
1 week	1(2.6)	0(0.0)	1(5.3)	2(2.6)	1.416	0.841
2 weeks	36(94.7)	20(95.2)	17(89.5)	73(93.6)		
>2 years	1(2.6)	1(4.8)	1(5.3)	3(3.8)		
Training place						
LITI Buhuri	35(92.1)	20(95.0)	14(73.7)	69(88.5)	7.242	0.124
In the ward	2(5.3)	0(0.0)	4(21.1)	6(7.7)		
Others[1]	1(2.6)	1(4.8)	1(5.3)	3(3.8)		
Useful of training and learning of FIT						
Yes	38(100.0)	21(100.0)	19(100.0)	78(100.0)		
No	0(0.0)	0(0.0)	0(0.0)	0(0.0)		
Usefulness						
Animals management	38(100.0)	21(100.0)	19(100)	78(100)		
Mixing of feeds	0(0.0)	5(23.8)	1(5.3)	6(7.2)		
Disease diagnosis	0(0.0)	2(9.5)	0(0.0)	2(3.6)		
Sponsor of Training						
TADAT	37(97.4)	19(90.5)	17(89.5)	73(93.6)	2.315	0.678
Tanzania Government	1(2.6)	1(4.8)	1(5.3)	3(3.8)		
Others[2]	0(0.0)	1(4.8)	1(5.3)	3(3.8)		
Need of more training						
Yes	37(97.4)	21(100)	17(89.5)	75(96.2)	3.284	0.194
No	1(2.6)	0(0.0)	2(10.5)	3(3.8)		
More training on						
Diseases diagnosis	2(5.4)	5(23.8)	1(5.9)	8(10.7)		
Treatment of animals	20(54.1)	12(57.1)	14(82.4)	46(61.3)		
General husbandry	16(43.2)	6(28.6)	2(18.7)	24(32.0)		

- Figures in parenthesis are percentage and those out of parenthesis are frequencies.
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).
- [1](MATI Uyole, LITI Tengeru and SUA), [2](HPI, SECAP)

4.2.1.2 Sustainability of the project training program

In order to enhance sustainability of the project training program dairy cattle keepers were asked to contribute money, which has been increased from second phase of the project in each phase to date. In the first phase, farmers were not asked to contribute. Contributions of dairy farmers are summarized in (Table 5). Majority of respondents (47%) contributed Tsh 8 000 per person, followed by 30% of respondents who contributed Tsh 10 000, then 16% of respondents who contributed Tsh 5 000 and lastly 8% of respondent who did not contribute. The TADAT project approach of providing a pregnant heifer to a dairy farmer who in turn is required to pay back to the scheme a pregnant heifer born on his/her farm is another way of maintaining sustainability of the project (TADAT, 2003).

Table 5: Farmers' contribution to training for sustainability of project in Tanga, Muheza and Lushoto districts

Farmer's contribution to training.(Tsh)	Location			Total	$\chi 2$	Prob.
	Tanga	Muheza	Lushoto			
5 000	2(5.3)	5(23.8)	5(27.8)	12(15.6)	17.825	0.007**
8 000	25(65.8)	7(33.3)	4(22.2)	36(46.8)		
10 000	10(26.3)	5(23.8)	8(44.4)	23(29.9)		
Did not contribute	1(2.6)	4(19.4)	1(5.6)	6(7.8)		

- Figures in parenthesis are percentage and those out of parenthesis are frequencies
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).

4.2.2 Extension services

Initially the government extension staffs were responsible for providing extension services to all farmers in the villages. Pertaining to livestock, they were tasked to disseminate information related to husbandry, breeding, nutrition and health services. However, after establishment of the project some government extension staffs were seconded to the SDEP project to provide extension services and innovations introduced to participating dairy farmers only. They were tasked to visit farmers twice a month and they were provided

with motorcycles and toping up allowances. The effect of this approach of the project is now observed as frequencies of visits are reduced gradually as the project pulls out. Other NGOs identified to offer livestock extension services include Soil Erosion Control and Agroforesty Project (SECAP) in Lushoto and Heifer Project International (HPI) through the Anglican Church in Muheza.

The study identified and assessed the main sources and channels of information to respondents. Most important sources of information for the respondents on feed improvement technologies and general animal husbandry was through the two weeks Farmers training course offered and mainly sponsored by the dairy project and substantial contribution from respondents at LITI Buhuri. All respondents admitted to have contact with extension staffs be it that of government, project or other NGOs and the quality of the advice given to them to be adequate (Table 6). Frequency of visit by extension were observed to be once a month by (43%), followed by those who were visited when they make a call to the project extension officer after the year 2002, whereas before that, they were being visited twice a month. It was observed that since 2002 TADAT project reduced services provided by project extension officer as the project was withdrawing from offering extension services. Frequency of visits were significantly ($P<0.001$) different between districts. This was contributed by the change of TADAT policy towards formation of farmer groups and reduced subsidies to extension workers.

Government extension officers who visited dairy farmers were mainly concerned on health, reproductive performance (pregnancy diagnosis or artificial insemination) and not on nutrition per se. They did not have specific package on FIT such as crop residue treatment. Lack of extension package, in-depth knowledge and practical experience in new

technologies has been cited to contribute to failure of technology dissemination (Senkondo *et al.*, 1999, Rangnekar, 2000).

Table 6: Extension services in Tanga, Muheza and Lushoto districts

Variable	Location					
	Tanga	Muheza	Lushoto	Total	χ2	Prob.
Extension visit	40(100.0)	40(100.0)	40(100.0)	120(100.0)		
Adequate of services	40(100.0)	40(100.0)	40(100.0)	120(100.0)		
Frequency of visit						
Once a week	2(5.0)	0(0.0)	1(2.5)	3(2.5)	38.146	0.000***
Once a month	19(47.5)	15(37.5)	17(42.5)	51(42.5)		
Twice a month	6(15.0)	1(2.5)	5(12.5)	12(10.0)		
Thrice a month	6(15.0)	0(0.0)	1(2.5)	7(5.8)		
Once every 3 months	2(5.0)	1(2.5)	8(20.0)	11(9.2)		
Unless you make a call[1]	5(12.5)	23(57.5)	8(20.0)	36(30.0)		
Other NGO offering extension						
Yes	0(0.0)	2(5.0)	3(7.5)	5(4.2)	2.922	2.232
No	40(100.0)	38(95.0)	37(92.5)	115(95.8)		

- Figures in parenthesis are percentage and those out of parenthesis are frequencies.
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).
- Note [1] before 2002 visit was twice a month.

➢ **Source of information to farmer who did not attend training**

Other important sources of information as indicated in (Table 7) for the farmers were HPI through the Anglican Church in Muheza and SECAP in Lushoto. Farmers who did not attend training on livestock husbandry and management obtained knowledge through: neighbours and extension officers (53%), experience from parents, neighbour and extension officers (40%), experience from other farmers (5%) and one respondent (3%)) indicted that he acquired knowledge through reading journals and books. Source of information to farmer who did not attend training differed significantly (P<0.001) between districts. Apart from NGOs offering extension services in Lushoto and Muheza there were other dairy farmers and parents who contributed to dairy husbandry knowledge dissemination.

Table 7: Source of information to farmer who did not attend training in Tanga, Muheza and Lushoto districts

Variable	Location					
	Tanga	Muheza	Lushoto	Total	χ2	Prob.
Information to farmer who did not attend training						
A	1(2.4)	12(29.3)	8(19.5)	21(52.5)	24.68	0.000***
B	0(0.0)	7(17.1)	9(22.0)	16(40.0)		
C	1(2.4)	0(0.0)	0(0.0)	1(2.5)		
D	0(0.0)	0(0.0)	2(4.9)	2(5.0)		

- Figures in parenthesis are percentage and those out of parenthesis are frequencies
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).
- *A*=Neighbour & extension officers; *B*=Experience from Parents, Neighbour & extension officers; *C*=Reading journals and book; *D* Experience from other farmers
- Result are based on multiple response

4.2.3 Credit services

Lack of initial capital for acquisition of dairy cow was prominent in all districts where project assisted in all districts whereas extra money for running costs (implying use of input) before the cow starts producing milk for sale was a task of individual dairy farmer. Apart from the project, Lushoto and Muheza were having a local system of acquiring dairy animal known as *Ng'ombe wa Mbolea*. All farmers in Tanga and Lushoto did not have access to credit and credit access were highly different (P<0.001) between districts. Accessibility and availability of credit for smallholder farmers was observed in Muheza alone where from 1998 to 2004 about 18% received credit (Table 8). Easy access to credit and market and means of processing milk to increase shelf life are thought to enhance adoption of the feed improvement technology (Mdoe, 1993; Kurwijila 2002b).

Table 8: Credit availability in Tanga, Muheza and Lushoto districts

Access to credit	*Location*					
	Tanga	Muheza	Lushoto	Total	χ2	Prob.
Yes	0(0.0)	7(17.5)	0(0.0)	7(5.8)	14.867	0.001***
No	40(100.0)	33(82.5)	40(100.0)	113(94.2)		

- Figures in parenthesis are percentage and those out of parenthesis are frequencies
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).

Most respondents (86%) obtained credit from a branch of Tanga Dairy Co operative Union (TDCU) and only 14% obtained from Cooperative and Rural Development Bank (CRDB) (Table 9). The credit facilities were limited to farmers who sell their milk to the co-operatives societies where the price of milk was slightly lower than the free market but farmers were assured of place to sell their milk and due to low price it was revealed during focused group discussion that dairy farmers do sell part of their milk to TDCU and the other part to private operators. Credit was used for purchasing inputs (29%) such as concentrate feeds and drugs. Other uses of credit include paying schools fees (29%), house building (29%) and purchase of cattle (14%). The absence of credit facility is one of the causes of low level of concentrate use in the study area; since credit acquisition could mean improving purchasing power of supplementary feeds. Credit facilities are reported to be vital in technology adoption (Lyatuu, 1994). Machumu (1995) argues that provision of credit was among the factors that influenced the adoption of agriculture technologies where withdrawal of credit has rendered farmers unable to buy fertilizers. On the other hand, Feder *et al.* (1985) argue that access to credit may not encourage adoption if it entails restrictions on input use where a rational dairy farmer will evade the restrictions.

Table 9: Credit source, value and uses in Muheza district

		Credit value (Tsh)			Uses of credit	
Credit source	n=7	Max	Min	Mean	uses	n
TDCU	6(85.8)	140 000	11 400	60 914.29	Feeds purchase	2(28.6)
					School fees	2(28.6)
					House building	2(28.6)
CRDB	1(14.2)				Cattle purchase	1(14.2)

- Figures in parenthesis are percentage and those out of parenthesis are frequencies
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).
- TDCU-Tanga Dairy Co operative Union
- CRDB-Cooperative and Rural Development Bank

4.2.4 Milk production, consumption and marketing services

4.2.4.1 Milk production potential as perceived by farmers

Majority of respondents (63%) reported their animals to produce milk below their genetic potential (Table 10). The perceived genetic potential was significantly ($P<0.001$) different between districts and mean average being 12.42 litres/cow per day. Reasons identified for the cause of low milk production included inadequacy of feeds and high cost of supplementary feeds (80%); Feeds not adequate (5%) High cost of supplementary feeds (2%), Seasonality in availability of supplementary feeds (2%) and animals were at their first calving (4%). However, some farmers (6%) argued that their animals produced to their genetic potential, but production was low due to poor breeds. The result given by respondents corresponds to actual situation observed during data collection by researcher implying that respondents were aware that their animal could produce more if impediments such as feed inadequacy and high cost of supplementary feeds are solved.

Table 10: Cow milk yield potential as perceived by farmers in Tanga, Muheza and Lushoto districts

Variable	Location					
	[a]Tanga	Muheza	Lushoto	Total	$\chi 2$	Prob.
Cow produce to anticipation						
Yes	18(46.2)	10(25.0)	16(40.0)	44(37.0)	4.029	0.133
No	21(53.8)	30(75.0)	24(60.0)	75(63.0)		
Perceived potential					F	Sig.
Mean	13.86	13.20	10.23	12.42	10.683	0.000***
s.e	0.67	0.63	0.47	0.37		
Minimum	6.00	5.00	1.00	1.00		
Maximum	24.00	27.00	15.00	24.00		
Cause of low milk yield					$\chi 2$	Prob.
Feeds insufficient	0(0.0)	4(13.3)	0(0.0)	4(5.0)	16.592	0.084
Supplementary feeds costly	1(4.5)	1(3.3)	0(0.0)	2(2.5)		
Feeds shortage and high cost	19(86.4)	22(73.3)	23(95.8)	64(80.0)		
Seasonality in availability	0(0.0)	2(6.7)	0(0.0)	2(2.5)		
First calving	1(4.5)	1(3.3)	1(4.2)	3(3.8)		
Poor breed	1(4.5)	0(0.0)	4(12.9)	5(6.2)		

- Figures in parenthesis are percentage and those out of parenthesis are frequencies
- *, **, *** = Significant (P<0.05), (P<0.01) and (P<0.001).
- [a] One farmer had in-calf heifer

4.2.4.2 Milk production, consumption and sale

Milk yield, consumption and selling price is as indicated in (Table 11). Milk yield ranged from two to 24lt/cow/day with majority of the farmers (48%) producing between six to 10 lt/cow/day. However, the average mean yield of 8.46 differed significantly (P<0.001) between districts where Tanga district had the highest mean yield (9.84) followed by Muheza (8.65) and Lushoto (6.94). The yield was lower than the perceived genetic potential of (12.42 lt/cow/day) (as reported by majority of respondents (81%) citing feed shortage and high cost of supplementary feeds as a cause). Generally, farmers in Tanga district had the highest milk yield implying better management in view of the fact that the

breeds kept in all districts were similar. Level of use of concentrate supplementation was higher in Tanga compared to other districts.

Milk consumption in litres per household was higher in Lushoto with a mean of (1.61); followed by Tanga (1.41) and Muheza had the least (1.05). In all districts majority of respondents (56%) consumed between one to two litres of milk per day per household. Higher consumption of milk in Lushoto could be attributed to absence of ready market for milk produced.

Average milk sold in litres per day was higher in Tanga with a mean of (14.14) followed by Muheza (13.14) and Lushoto (7.14). Selling price of milk was observed to be high during the dry season with mean of 202.44 Tsh/lt while in the wet season prices was low with mean of 179.37 Tsh/lt, implying that supply in the dry season was low compared to wet season thus higher demand than supply. The surplus milk reported to occur during the wet season lead to a low milk price. The prices were significantly different ($P<0.001$) between districts and between seasons, due to availability of outlet where in Tanga and Muheza TDCU and other private business operators who collected and transported milk to Dar es salaam assuring smallholders dairy farmers market of their products through organized marketing channels.

Table 11: Milk production, consumption and marketing in Tanga, Muheza and Lushoto districts

Variable	Location					
	[a]Tanga (n=39)	Muheza (n=40)	Lushoto (n=40)	Total (N=119)	F	Sig.
Milk production (lt/cow/day)						
Mean	9.84	8.65	6.94	8.46	5.260	0.007***
s.e	0.70	0.71	0.46	0.38		
Minimum	2.50	2.00	2.50	2.00		
Maximum	24.00	19.50	16.00	24.00		
Percentage milk yield distribution (lt/cow/day)					χ^2	*Prob.*
<6	5(12.8)	12(30.0)	14(35.0)	31(26.1)	11.080	0.086
6-10	19(48.7)	17(42.5)	21(52.5)	57(47.9)		
10-15	11(28.2)	6(15.5)	4(10.0)	21(17.6)		
>15	4(10.3)	5(12.5)	1(2.5)	10(8.4)		
Milk consumption (lt/day/household)					F	Sig.
Mean	1.41	1.05	1.61	1.36	5.208	0.007***
s.e	0.12	0.08	0.15	0.07		
Minimum	0.50	0.00	0.50	0.00		
Maximum	4.50	2.00	4.00	4.50		
Percentage Consumption distribution (lt/household)					χ^2	*Prob.*
<1	4(10.3)	10(27.0)	4(10.0)	18(15.5)	16.196	0.013*
1-2	21(53.8)	24(64.9)	20(56.0)	65(56.0)		
2-3	13(33.3)	3(8.1)	12(24.1)	28(24.1)		
>3	1(2.6)	0(0.0)	4(10.0)	5(4.3)		
Milk sold ((lt/day/household)					F	Sig.
Mean	14.14	13.14	7.14	11.45	8.533	0.000
s.e	1.50	1.46	0.82	0.79		
Minimum	3.00	2.50	2.00	2.00		
Maximum	46.00	40.00	30.00	46.00		
Milk selling price						
Dry season (Tsh/lt)					F	Sig.
Mean	202.05	218.75	186.50	202.44	16.594	0.000***
s.e	4.99	2.29	4.19	2.58		
Minimum	150.00	200.00	100.00	100.00		
Maximum	260.00	250.00	200.00	260.00		
Wet season (Tsh/lt)					F	Sig.
Mean	178.46	193.13	166.50	179.37	14.668	0.000***
s.e	4.13	1.48	4.19	2.24		
Minimum	120.00	180.00	80.00	80.00		
Maximum	220.00	210.00	180.00	220.00		

- Figures in parenthesis are percentage and those out of parenthesis are frequencies
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).
- [a] One farmer had in-calf heifer

The increased milk yields, which cannot be utilized or marketed effectively, had been cited to cause rejection of technologies intended for increased milk yield (Mdoe, 1993; Massawe *et al.*, 1997). Milk prices paid by TDCU and other business operators to producers have failed to keep pace with increases in input prices, and payments for milk supplied have been delayed, exposing farmers to higher risks and irregular cash flow. Good price and market trigger voluminous production of milk and offers dairy farmers an opportunity to increase their income and an incentive to invest in new technologies (Kurwijila, 2002a).

4.2.4.3 Structure of price of milk

Arrangement of milk price is the negotiation between producers and buyers/consumers. These prices fluctuate with seasons being high in dry season due to low supply as opposed to high demand. Milk producers prefer to sell directly to consumers where they can obtain a high price. Despite the fact that TDCU pay dairy farmers promptly their milk prices are slightly lower compared to other operators thus, dairy farmers are unwilling to sell their milk to TDCU. Citing some of the factors that lead to failure of milk processing plant, Kurwijila, (2002b) argues that milk producers prefer to sell directly to consumers where they can obtain a high price, whereas milk processing plants pay dairy farmers only about 50–60% of the price dairy farmers get by selling directly to consumers leading in those plants to operate at less than 50% of installed capacity.

4.2.4.4 Milk marketing (outlet) and pricing

Marketing is one of the major problems that livestock producers face. Problems in marketing are associated with low effective domestic demand, inadequate marketing

infrastructure, inadequate market information, inadequate entrepreneurship, informal livestock trade and out dated legislations (MoWLD, 2004).

All farmers in Muheza and majority in Tanga (97%) districts had reported ready market for milk produced where in Lushoto majority (63%) had no ready market for milk produced. A highly significant difference ($P<0.001$) between districts regarding ready milk market was observed (Table 12). The identified outlets for milk produced include, private business operators, cooperative societies, hotels, retail *kiosks* and neighbours (individuals consumers at household level). The outlets of milk was highly significantly different ($P<0.001$) between districts where, Muheza had more organized outlet channels followed by Tanga and Lushoto the least. In Tanga private business operators (41%) followed by neighbours (39%) were the most common outlets; whereas in Muheza TDCU branch was leading (48%) followed by private business (Tanga Fresh) operator (38%) and in Lushoto (70%) of respondents indicated that major outlet was the neighbours followed by hotels which was reported by (18%) of respondents. Timely marketing and to the right buyer who pays at right time is important in the whole production system of milk since milk is highly perishable. Similar outlets were reported by Mdoe (1993) in Kilimanjaro. Milk outlet channels were more advanced in Muheza than in others districts where, market-oriented institutions were evolving and private sector service providers were stepping into the arena.

Although Lushoto's climate indicate considerable potential for a profitable dairy production low price based on agreement between producers (sellers) and consumers (buyers) and unreliable market for milk produced justify why farmers are reluctant to invest more in dairy technologies. Lushoto district is about 372 km from Dar es Salaam city, which absorbs most milk, produced in the district and along the coastal belt. Lack of

storage facilities and other means of processing milk compel farmers to sell milk at whatever price available. Distance to the selling centres was also mentioned to affect selling of evening milk. Milk selling centres referred to informal and formal collection points established by TDCU and private business milk traders. Tanga has the furthest selling centre with a mean of (3.25km), followed by Muheza (2.94km) and lastly Lushoto (0.87km). Near to selling centre was found to be related to the means of outlet, whereas those with short distance sold their milk to neighbours, while, those with long distances to the selling centres were unable to sell evening milk. Greater distance and poor infrastructure, less developed private sector are among the factors, which have been cited to contribute to low price of milk in Kenya (Mogaka, 1993). Likewise, (Urassa, 1999; Msangi, 2001) argues that problems in milk marketing include low prices, price fluctuations/unstable prices and delayed payments. Massawe *et al.* (1997) reported that absence of milk collection centres contributed to farmers' unwillingness to invest more on feeding for more milk production. Machumu (1995) argues 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 12: Milk outlet in Tanga, Muheza and Lushoto districts

Variable	Location			Total	χ^2	*Prob.*
	Tanga	Muheza	Lushoto			
Ready milk market						
Yes	38(97.4)	40(100.0)	15(37.5)	93(78.2)	58.389	0.000***
No	1(2.6)	0(0.0)	25(62.5)	26(21.8)		
Milk outlet						
Private trader	16(41.0)	15(37.5)	1(2.5)	32(26.9)	91.620	0.000***
Neighbour	15(38.5)	0(0.0)	28(70.0)	43(36.1)		
Kiosks	2(5.1)	6(15.4)	0(0.0)	8(6.7)		
TDCU	6(15.4)	19(47.5)	0(0.0)	25(21.0)		
Hotels	0(0.0)	0(0.0)	4(10.0)	4(3.4)		
Hotels and neighbour	0(0.0)	0(0.0)	7(17.5)	7(5.9)		
Distance to selling centre (km)						
Mean	3.25	2.94	0.87	2.19	1.536	0.222
Maximum	13.00	10.00	1.50	13.00		
Minimum	0.30	0.50	0.30	0.30		
s.e	0.90	0.53	0.17	0.42		

- Figures in parenthesis are percentage and those out of parenthesis are frequencies
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).
- s.e. standard error.

4.2.4.5 Income accrued from milk and its uses

The gross monthly household income from the sale of milk ranged from a minimum of 6 000 to a maximum Tsh 250 000 (Table 13). Muheza had the highest income (Tsh 250 000) and Lushoto had the lowest (Tsh 6 000). However majority of the farmers in all districts had income of less than Tsh 75 000 per month. During the focused group discussion, it was revealed that about 50% of the income from milk was used for maintaining health of the animals and paying hired labour. Other income is used for other household expenditure (renovating houses, purchasing land for building a new house and improving farmland and paying school fees) with smaller amounts used in purchase of concentrates attributing to low use of supplements. Disclosing the contribution of improved dairy cattle Kisusu (2003) pointed out that households, which participated in the project, had more material assets, increased financial ability to meet costs for social services such as medical

services, school fees and uniform. Other studies by Safari *et al.* (2000) and Msangi, (2001) in Turiani revealed that income from the sale of milk goes towards school fees for children, improved housing, clothing and transport facilities (such as bicycles). The income is also used to pay hired labour since a large percentage of dairy farmers use hired labour.

Table 13: Income accrued from milk in Tanga, Muheza and Lushoto districts

Variable	Location					
	Tanga	Muheza	Lushoto	Total	F	Sig.
Monthly milk income (Tsh)						
Maximum	189 000	250 000	90 000	250 000	11.649	0.000
Minimum	15 000	15 000	6 000	6 000		
Mean	72 343.59	79 238.50	35 972.50	62 435.63		
s.e	6 867.38	9 166.99	2 971.66	4 285.55		
Milk income distribution (Tsh)						
<75 000	22(56.4)	25(62.5)	38(95.0)	83(70.4)	18.362	0.005
75 000-100 000	8(20.5)	5(12.5)	2(5.0)	15(12.6)		
100 000-150 000	6(15.4)	6(15.0)	0(0.0)	12(10.0)		
>200 000	3(7.7)	4(10.0)	0(0.0)	7(7.0)		

- Figures in parenthesis are percentage and those out of parenthesis are frequencies
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).

4.3 Environmental Factors

The two focused groups, each with 15 participants agreed unanimously that among the environmental factors affecting adoption of fodder garden establishment in Tanga district to include sandy soil, termites and occasionally occurrence of prolonged dry period where established fodder garden dried up. During data collection observation revealed that the soil was of sandy type which had low fertility and low moisture retention capacity. Absence of alternative ways for irrigating pasture plots and infertile soils contributed to low adoption of fodder garden establishment. The environmental factors were noted in Tanga district only. Kauzeni (1988) observed that environmental factors including climatic, edaphic or soil factors and prevailing pests and diseases differ from one

geographical area to another even within short distances meaning that recommendation must be specific to suit local conditions of the area under study.

4.4 Dairy Cattle Management

4.4.1 Feeding, cleaning and milking of dairy animals

Feeding, cleaning and milking of dairy animals are summarized in (Table 14). The results indicate that milking of cows in Tanga and Lushoto was done by family and hired labour (55%) whereas in Muheza it was done by household labour (35%). Feeding in all districts was mostly done by hired and household labour as indicated by 60%, 55%, and 53% for Lushoto, Muheza and Tanga respectively. Cleaning of barn in Tanga and Lushoto was mostly done by family and hired labour (50% and 53%), respectively, while in Muheza it was, done by hired labour (35%) as indicated in (Table 14). Labour for milking and barn cleaning was observed to be significantly ($P<0.001$) different between districts. Muheza benefited more on hired labour who migrated to that area to work in sisal estates and orange farms. They usually become idle during off-seasons thus they are willing to provide labour on dairying. The household members observed to participate in providing labour in the dairying were between 3-6 people as observed by majority of respondents (62%).

Table 14: Dairy cattle management in Tanga, Muheza and Lushoto districts

Variable	Location			Total	χ2	Prob.
	Tanga	Muheza	Lushoto			
Milking						
Wife	2(5.0)	4(10.0)	1(2.5)	7(5.8)	22.566	0.004***
Husband	4(10.0)	3(7.5)	2(5.0)	9(7.5)		
Household labour	11(27.5)	14(35.0)	10(25.0)	35(29.2)		
Hired labour	1(2.5)	12(30.0)	5(12.5)	18(15.0)		
Hired and household labour	22(55.0)	7(17.5)	22(55.0)	51(42.5)		
Feeding						
Wife	3(7.5)	0(0.0)	1(2.5)	4(3.3)	10.736	0.217
Husband	1(2.5)	1(2.5)	0(0.0)	2(1.2)		
Household labour	15(37.5)	12(30.0)	10(25.0)	37(30.8)		
Hired labour	0(0.0)	5(12.5)	5(12.5)	10(8.3)		
Hired and household labour	21(52.5)	22(55.0)	24(60.0)	67(55.8)		
Barn cleaning						
Wife	4(10.0)	2(5.0)	1(2.5)	7(5.8)	19.099	0.014*
Husband	1(2.5)	1(2.5)	0(0.0)	2(1.7)		
Household labour	14(35.0)	13(32.5)	10(25.0)	37(30.8)		
Hired labour	1(2.5)	14(35.0)	8(20.0)	23(19.2)		
Hired and household labour	20(50.0)	10(25.0)	21(52.5)	51(42.5)		
Members Participating in dairy activities						
<3	12(30.0)	12(30.0)	17(42.5)	41(34.2)	2.680	0.613
3-6	27(67.5)	27(67.5)	21(52.5)	75(62.5)		
>6	1(2.5)	1(2.5)	2(5.0)	4(3.3)		

- Figures in parenthesis are percentage and those out of parenthesis are frequencies
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).

Most of the dairy farmers who were not engaged in systematic livestock care, complained of negligence on hired labour that they did not fetch enough pasture and of good quality to feed their animals. This was also ascertained by the researcher where during administration of the questionnaire, body conditions of those animals fed by hired labour were very poor as compared to those fed by the owner, implying that farmers are more committed to the work and suggesting that hired labour may require close supervision. Insisting on the importance of household labour Massawe *et al.* (1998a) found farmers to be more efficient in both stripping and baling of maize stover hay compared to labourers. Labour available for farm operations and dairy husbandry is governed by size of the household labour force and other factors such as alternative activities. Potentially household labour is composed of husband, wife, and children above14 years. Children below 14 years are assumed to be economically inactive since they are mostly in schools and available for farm activities only during holidays and weekends. Hired labour was found to be a common practice in the study area given that some of the dairy keepers are employed. Both household labour and hired labour was important in dairy husbandry and comply with findings by Okwir (1998) that hired labour was used to supplement household labour in Mpigi district in Uganda. Mlay (2001) observed that 96% of farmers in Morogoro used hired labour mostly youths to manage their dairy animals.

Results indicated that most households have three to six members participating in dairy activities. Similarly, Okwir (1998) found that labour required for zero grazing was provided by the household members. Exotic animals and their crosses have relatively high feed requirement implying more labour requirement for feed collection and feeding and this has an influence for farmer to adopt FIT. Thus, it can be summarized that feeding, cleaning and milking of dairy animals in the study area were provided by household and hired labour.

4.5 Resources acquisition and ownership

4.5.1 Herd size and composition; sources and ownership of dairy cows

4.5.1.1 Herd size and composition for dairy and other livestock

The dairy herd size was found to comprise of Milking cows, Dry cows, Heifers up to two years, Bull of greater than 1.5 years and those between 1-1.5 years; and Male calves and Female calves of less than one year (Table 15). Milking cows occupied large proportion of the herd in all districts. The smallholder dairy sector is composed of individuals owning a few numbers of dairy cows, mostly between one and five head. The mean herd size per household was higher in Muheza (5.35), followed by Tanga (4.0) and Lushoto (3.3) which had the lowest.

Table 15: Dairy herd size and composition per household in Tanga, Muheza and Lushoto districts

Livestock category	Location									Overall total			
	Tanga			Muheza			Lushoto						
	n	Range	Mean	n	Range	Mean	n	Range	Mean	n	Range	Mean	F
Milking cows	40	1-4	1.6	40	1-8	1.8	38	1-3	1.3	119	1-8	1.5	2.664
Dry cows	4	1-3	1.8	15	1-3	1.5	13	1-2	1.1	32	1-3	1.38	1.231
Heifers 1-2 years	1	1-1	1.0	6	1-2	1.3	5	1-2	1.2	12	1-2	1.25	0.246
Bulls>1.5 years	3	1-1	1.0	9	1-2	1.1	3	1-1	1.0	15	1-2	1.07	0.300
Bulls 1-1.5 years	16	1-3	1.5	23	1-3	1.5	13	1-3	1.2	52	1-3	1.42	0.789
Male calves<1year	21	1-2	1.2	15	1-5	2.1	19	1-2	1.1	55	1-5	1.40	11.317***
Female calves<1year	25	1-3	1.4	27	1-4	1.3	18	1-2	1.1	70	1-4	1.33	0.984
Total dairy herd		1-9	4.00		1-19	5.35		1-9	3.30		1-19	4.22	4.796**

- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).
- n-number of respondents out of the 40 interviewees

On average each family has 4.22 dairy cattle and there was significant (P<0.05) difference between districts regarding number of cattle per family. Number of female calves has an implication on replacement stock available to each household. Study by Msangi (2001) in Turiani reported similar variation in dairy herd composition.

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	Tanga			Muheza			Lushoto						
	n	Range	Mean	n	Range	Mean	n	Range	Mean	n	Range	Mean	F
Milking cows	40	1-4	1.6	40	1-8	1.8	38	1-3	1.3	119	1-8	1.5	2.664
Dry cows	4	1-3	1.8	15	1-3	1.5	13	1-2	1.1	32	1-3	1.38	1.231
Heifers 1-2 years	1	1-1	1.0	6	1-2	1.3	5	1-2	1.2	12	1-2	1.25	0.246
Bulls>1.5 years	3	1-1	1.0	9	1-2	1.1	3	1-1	1.0	15	1-2	1.07	0.300
Bulls 1-1.5 years	16	1-3	1.5	23	1-3	1.5	13	1-3	1.2	52	1-3	1.42	0.789
Male calves<1year	21	1-2	1.2	15	1-5	2.1	19	1-2	1.1	55	1-5	1.40	11.317***
Female calves<1year	25	1-3	1.4	27	1-4	1.3	18	1-2	1.1	70	1-4	1.33	0.984
Total dairy herd		1-9	4.00		1-19	5.35		1-9	3.30		1-19	4.22	4.796**

- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).
- n-number of respondents out of the 40 interviewees

On average each family has 4.22 dairy cattle and there was significant (P<0.05) difference between districts regarding number of cattle per family. Number of female calves has an implication on replacement stock available to each household. Study by Msangi (2001) in Turiani reported similar variation in dairy herd composition.

Other livestock such as (Tanzania Short horn Zebu (TSZ), goat, sheep, pigs, donkeys, chicken, ducks and dogs) were thought to increase household income to farmer hence purchasing power of inputs (Table 16). Possession of other types of livestock has also an implication of household labour required to attend dairy animals and priority in resources allocation. Goats, chicken and ducks were found in all districts, where pigs were found in Muheza only. Donkeys were found in Tanga and Muheza and were used for pasture collection.

Table 16: Herd size of other livestock in Tanga, Muheza and Lushoto districts

Other livestock	Location									Total			
	Tanga			Muheza			Lushoto						
	n	Range	mean	n	Range	mean	n	Range	mean	n	Range	Mean	F
Zebu	4	1-10	4.75				3	1-2	1.67	7	1-10	3.43	0.718
Goats	12	1-16	6.33	4	1-8	4.25	12	1-16	2.17	28	1-16	4.25	4.213
Sheep	1	6	6.00				13	1-10	2.46	14	1-10	2.71	0.828
Pigs				4	1-12	4.75				4	1-12	4.75	0.000***
Donkeys	1	1-2	1.25	4	1	1.00				12	1-2	1.17	0.500
Chickens	32	3-500	36.62	24	2-200	23.08	35	4-45	14.26	91	2-500	24.45	1.368
Ducks	8	2-16	5.13	9	1-30	9.89	8	1-12	4.63	25	1-30	6.68	1.853
Dogs	8	1-4	2.38	2	1-2	1.50				10	1-4	2.20	0.346

- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).
- n-number of respondents out of the 40 interviewees

4.5.1.2 Sources, ownership and purpose of keeping dairy cows

a) Purpose of keeping dairy cows

Respondents indicated different purposes for keeping dairy animals. Ninety-five percent keep dairy animals as a source of supplementary income. Few of the respondents (5%) had undertaken dairy as a main income-generating activity. This implies that dairying was not considered as a main income generating activity. These results conform to those reported by Mdoe and Nyange (1995) that people in urban areas especially civil workers are engaged in dairy farming to supplement their low incomes because of increased cost of living. Likewise, Mlozi (2001) reported that reasons which encourage urban dwellers to

undertake urban animal agriculture to include government paying little salary to her employees and poor national economy.

b) Ownership of dairy cows

In all districts majority of cows are owned by men as reported by 69% of the respondents (Table 17). Only 28% of cows' owners were women. The policy of TADAT was to ensure equal participation of women in acquisition of dairy animals. Stephens (1992) point out that most technologies are considered gender neutral but during introduction and use by societies, they become gender biased. The discrepancies in ownership have also been reported elsewhere (Mollel *et al.*, 1999; Msangi, 2001; Huvisa, 2003).

c) Sources of dairy cows

The main source of dairy cows was TADAT (66%). Other farmers (24%) purchased dairy cows from their own saving, and few (12%) obtained from other sources such as gift and informal credit scheme between farmers locally known as *'ngombe wa mbolea'*. In that, system farmer was given a cow by another farmer to feed until calving and select one calf in an alternating with the owner. The system was common in Lushoto and less common in Muheza as reported by 18% and 13% of respondents, respectively. The system was not practised in Tanga (Table 17). About 94% of respondents started dairying with one cow. This result is comparable to those reported by Msangi (2001) where most farmers in Turiani obtained dairy animals from Non Government Organization (NGOs). Source of dairy cows were significantly different ($P<0.001$) between districts. Lushoto has the highest proportion (38%) of respondents who obtained dairy cows by purchasing from their own saving since the project was introduced late in the district. A dairy cow is a very valuable and expensive animal and owning one entails a number of risks. The biggest risk is losing the animal due to bad management or diseases thus for farmers who have no experience of livestock keeping starting with one animal was appropriate. Capital to

acquire the animal and place to keep the animal are the pre-requisites for owning dairy cows.

Table 17: Ownership, source and purpose of keeping dairy cows in Tanga, Muheza and Lushoto districts

Variable	Location			Total	χ2	Prob.
	Tanga	Muheza	Lushoto			
Number of Cow at start						
One	36(90.0)	39(97.5)	38(95.0)	113(94.1)	6.324	0.776
Two	4(10.0)	0(0.0)	1(2.5)	5(4.3)		
Three	0(0.0)	1(2.5)	1(2.5)	2(1.6)		
Source of animals						
Bought cash	4(10.0)	10(25.0)	15(37.5)	29(24.2)	19.1	0.001**
Project (SDEP/TADAT)	36(90.0)	25(62.5)	18(45.0)	79(65.8)		
Others[1]	0(0.0)	5(12.5)	7(17.5)	12(10.0)		
Owner of cow						
Husband	29(72.5)	24(60.0)	30(75.0)	83(69.2)	3.611	0.461
Wife	10(25.0)	15(37.5)	8(20.0)	33(27.5)		
Both	1(2.5)	1(2.5)	2(5.0)	4(3.3)		
Aim of dairying						
Main economic activity	1(2.5)	4(10.0)	1(2.5)	6(5.0)	3.158	2.06
Supplementary income	39(97.5)	36(90.0)	39(97.5)	114(95.0)		

- Figures in parenthesis are percentage and those out of parenthesis are frequencies
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).
- [1]gift, informal loan

4.5.1.3 Project approach in provision of dairy cows

Tanga Smallholder Dairy Extension Programme (SDEP) operated in the study area using top down approach where farmers were not consulted or involved in designing, decision making and implementation of the projects. However, considering low economic status of the farmers and project's policy of providing in-calf heifer and pasture seeds farmers accepted the approach. Good dairy cows are always expensive (Orodho *et al.*, 1993) where TADAT estimate the price of in calf heifer to be Tsh 300 000 and often difficult to obtain. NGOs have been reported to assist farmers in acquisition of dairy animals such as SURUDE and HPI (Urassa, 1999; Msangi, 2001). Acknowledging contribution of NGOs

in development of dairy industry in Tanzania Msangi (2001) reported that 44% and 38% of breeding stock for Turiani dairy farmers were obtained from Heifer In Trust scheme (HIT) and SURUDE, respectively.

4.5.1.4 Participation to the project

It was deemed necessary to identify the respondents when they joined the project given that the selection criteria were based on random sampling among the livestock keepers in the study area. Majority (68%) respondents participated in the project and Tanga district had the highest proportion (95%) followed by Muheza (63%) and Lushoto had the least (45%) and this differ significantly ($P<0.001$) between districts (Table 18). The proportion of farmers who joined the project was higher (44%) in the fourth phase 2000-2004(TADAT). In the first phase 1985-1989 (SDEP), none of the interviewed respondent joined the project. In second phase 1990-1994 (TSDDP), only 12% joined the project and in the third phase 1995-1999 (TDDP), the number increased to (43%).

Table 18: Farmers participation to the dairy project in Tanga, Muheza and Lushoto districts

Variable	Location			Total	χ2	Prob.
	Tanga	Muheza	Lushoto			
Participation						
Yes	38(95.0)	25(62.5)	18(45.0)	81(67.5)	23.476	0.000***
No	2(5.0)	15(37.5)	22(55.0)	39(32.5)		
Year joined the project	n=38	n=25	n=18	N=81		
1985-1989(SDEP)					5.647	0.227
1990-1994(TSDDP)	5(13.2)	5(20.0)	0(0.0)	10(12.4)		
1995-1999(TDDP)	16(42.1)	12(48.0)	7(38.9)	35(43.2)		
2000-2004(TADAT)	17(44.7)	8(32.0)	11(61.1)	36(44.4)		
Reasons for late participation						
Not in the village	9(23.7)	6(24.0)	1(5.6)	16(19.8)	47.188	0.000***
Concentrated on farming	0(0.0)	1(4.0)	1(5.6)	2(2.5)		
Not aware	2(5.3)	8(32.0)	5(27.8)	15(18.5)		
Cumbersome work	12(31.6)	1(4.0)	1(5.6)	14(17.3)		
Schooling	5(13.2)	2(8.0)	0(0.0)	7(8.6)		
No land for keeping cow	10(26.3)	7(28.7)	3(16.7)	20(24.7)		
Program introduced late	0(0.0)	0(0.0)	7(38.9)	7(8.6)		

- Figures in parenthesis are percentage and those out of parenthesis are frequencies
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).

Reasons cited for late participation in the project differed significantly (P<0.001) between districts. In Tanga district livestock keeping was perceived to be cumbersome (32%), lack of land for keeping cattle (26%), farmers living outside the village (24%) and others were schooling (13%). Reasons cited in Muheza include, farmers not aware of the project activities (32%), lack of land for keeping cattle (29%), farmers living outside the village (24%). Respondents in Lushoto cited the following reasons: Program was introduced late in the district (39%), not aware of the project activities (28%), not in the village (17%). Furthermore, during focused group discussion it was revealed that young people prefer to work outside the village. Dairying as a new innovation takes time for individuals to see the

results as pointed by Rogers (1995), hence causing delay of dairy farmers to join the project. The way dairy farmers perceive dairy keeping technology influences adoption rate as pointed in studies by (Nkonoki, 1994; Negatu and Parikh, 1999). Young and energetic people have proved to be more venturesome, active and ready to try new innovations (Nannai, 1993) but they lack land resource (Lyatuu, 1995).

4.5.2 Farm size owned, mode of acquisition and utilization

4.5.2.1 Farm size owned

Farm sizes have an effect on the rate of adoption depending on innovation characteristics and situational settings. Majority of respondents (96%) in the study area own land. Farm size per household ranged from a minimum of 0.1ha to a maximum of 12.15ha with an average of 1.97 ha (Table 19). Most of the respondents (59%) own less than 2ha of land and only (3%) of respondents owned more than six ha of land (Table 19). Farm size is important as it may dictate the total land to be allocated for fodder garden establishment in relation to other food and cash crops. Land ownership is a factor for keeping livestock and most frequently young people lack this resource thus they may not be able to invest in dairy keeping, since certain threshold of farm size is necessary before the adoption of fodder garden. Results on land sizes observed in the current study are in line with those of Lyatuu (1994), who argued that traditional farming systems in Africa are characterized by small farm size. Anim, (1999) pointed out that in other situations households with small farms may adopt a new technology to increase production.

4.5.2.2 Mode of Land acquisition and utilization

Security of land tends to increase adoption of technology related to land (Anim, 1999). Fodder garden establishment inevitably require land, which is limited in high potential area. Possession of land, mode of acquisition and distribution dictate decision of how to use it. Modes of land acquisition affect the utilizations whether to plant short-term crops, annual or long-term crops. It was deemed necessary to evaluate method of land acquisition and its uses in relation to fodder garden and other crops and result are summarized in (Table 19).

a) Mode of Land acquisition

Most agricultural land in peri-urban was held under customary systems where its use is decided by norms and social settings prevailing in the area where in urban area the land was allocated by the government. The areas were acquired through purchasing (62%), inheritance (31%), renting (24%), allocation by central government (14%) and allocation by village government (7%) as shown in (Table 19). All districts had the highest number of respondents who acquired land through purchasing. Msangi (2001) observed related trends in Turiani, where majority (74%) of respondents obtained land through purchasing while few respondents (31%) were allocated by village government. Acquisition of land differs between districts. In Lushoto land inheritance where parents provide part of their land to their sons, ranked second (50%) while in Tanga allocation of land by central government ranked second (27%). In Muheza rented land ranked second (33%). The variation was due to the fact that, Muheza dairy farmers were living closer to Sisal estates (peri-urban) and in Tanga majority of the farmers were living in urban area. Dairy farmers with purchased land or land allocated by central government had higher chance of adopting fodder garden establishment than rented land since they have long-lasting land user right. The conventional wisdom is that dairy farmers are not ready to invest in land,

which may not be available in the subsequent seasons such as rented land. However since the land allocated by central government is in form of house plot the area partitioned for fodder garden establishment is relatively small.

b) Land utilization

Majority of dairy farmers (64%) in all districts allocated less than 1ha of land for food crops. Land allocated for cash crops is less than 1ha as reported by 56% of respondents and was highly significantly ($P<0.001$) different between districts. Land allocated for fodder establishment was less than 0.2ha as reported by majority of respondent (49%) and differed ($P<0.001$) between districts. Tanga and Lushoto districts had majority of their respondents (65% and 46%, respectively) allocating 0.2-0.5ha of land for fodder garden than farmers in Muheza district. Land allocated for food and cash crops were larger than those allocated for fodder garden establishment.

c) Fodder crop grown

The dominant pasture in the established fodder garden in Tanga and Muheza was Elephant/Napier grass *(Pennisetum purpureum)* reported by 100% and 82% of respondents, respectively, whereas in Lushoto 49% of respondents reported to grow Elephant/Napier grass *(Pennisetum purpureum)* and Guatemala grass *(Tripsacum laxum)* (Table 19).

Table 19: Land acquisition and utilization in Tanga, Muheza and Lushoto districts

Variable	Location					
	Tanga	Muheza	Lushoto	Total	$\chi 2$	Prob.
Owning land						
Yes	37(92.5)	40(100.0)	38(95.5)	115(95.8)	2.922	0.232
No	3(7.5)	0(0.0)	2(5.0)	5(4.2)		
Farm size/ Household (ha)					F	Sig
Maximum	12.15	10.13	8.07	12.15	1.491	0.23
Minimum	0.1	0.1	0.1	0.1		
Mean	2.38	1.78	1.71	1.96		
s.e	0.35	0.29	0.26	0.17		
Farm size distribution (ha)						
<2	19(51.4)	24 (60.0)	25(65.8)	68 (59.1)	6.655	0.354
2-4	9 (24.3)	13 (32.5)	9 (23.7)	31 (27.0)		
4-6	8 (21.6)	2 (5.0)	3 (7.9)	13 (11.3)		
>6	1 (2.7)	1 (2.5)	1 (2.6)	3 (2.6)		
Acquisition method [1]	n=37	n=40	n=38	N=115		
Inherited	7(18.9)	10(25.0)	19(50.0)	36(31.3)		
Rented/leased	6(16.2)	13(32.5)	9(23.7)	28 (24.3)		
Purchased	20(54.1)	24(60.0)	27(71.1)	71 (61.7)		
Village government	4(10.8)	3(7.5)	1(2.6)	8(7.0)		
Central government	10(27.0)	5(12.5)	1(2.6)	16(13.6)		
Land utilization (ha)						
Food crops	n=35	n=37	n=24	N=107	$\chi 2$	Prob.
<1	22(69.9)	22(59.5)	24(68.6)	68(63.6)	3.408	0.756
1-1.5	5(14.3)	7(18.9)	7(20.0)	19(17.7)		
1.5-2	5(14.3)	5(13.5)	1(2.9)	11(10.3)		
>2	3(8.6)	3(8.1)	3(8.6)	9(8.4)		
Cash crops	n=24	n=19	n=28	N=71		
<1	7(29.2)	10(52.6)	23(82.1)	40(56.3)	23.531	0.001***
1-1.5	9(37.5)	3(15.8)	2(7.1)	14(19.7)		
1.5-2	1(4.2)	4(21.1)	0(0.0)	5(7.0)		
>2	7(29.2)	2(10.5)	3(3.0)	12(17.0)		
Fodder garden	n=20	n=19	n=37	N=76		
<0.2	7(35.0)	17(89.5)	13(35.1)	37(48.7)	22.733	0.000***
0.2-0.5	13(65.0)	1(5.3)	17(45.9)	31(40.8)		
>0.5	0(0.0)	1(5.3)	7(18.9)	8(10.5)		
Fodder crop grown						
Napier	20(100.0)	16(84.2)	2(5.4)	38(50.0)	58.366	0.000***
Guatemala	0(0.0)	0(0.0)	1(2.7)	1(1.3)		
Napier and Guatemala	0(0.0)	3(15.8)	34(91.9)	37(48.7)		

- Figures in parenthesis are percentage and those out of parenthesis are frequencies
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).
- [1] Result based on multiple responses
- s.e. standard error,

Established grasses were used as basal diet in the dry seasons in Lushoto. These grasses were valued as high yielding forage with short-cycle thus several harvests could be obtained per year. During focused group discussion farmers reported higher biomass yield in Guatemala grasses than Napier. These conform to findings reported by Mtengeti *et al.* (1989) that Elephant and Guatemala grasses are high yielding fodder, with higher DM in Guatemala grass (86.5 tDM/ha) than Napier grass (56.9 tDM/ha) at all stages of growth and that they should be promoted to small scale dairy farmers. However, farmers argued that they obtain higher milk yield when feeding Napier grass than when feeding Guatemala. Mtengeti *et al.* (1989) also reported higher percentage CP at all stage of growth for elephant (23.95%) than Guatemala (16.62 %) grasses, respectively, however the CP decreased with increasing stage of growth for both species.

4.5.2.3 Decision-making on land use and FIT

The results on decision-making on land use and FIT are summarized in Table 20. The decision on land use was made by both husband and wife in Muheza (50%) while in Tanga and Lushoto decision was made by husband as indicated by 51% and 43% of the respondents, respectively. The same trend was observed on decision making regarding the use of FIT where (48%) of respondents made decision jointly in Muheza. In Tanga and Lushoto, decision regarding use of FIT was made by husbands as indicated by 57% and 45% of the respondents, respectively. Decision on land use and FIT has an implication on resources ownership and hence the influence on adoption of technology. Huvisa (2003) found participation of both men and women in decision making from household level to the village government though men participated more than women did. Makauki (2000) in his study on factors affecting adoption of agroforestry farming systems found that decision to adopt agroforestry innovation was reached more jointly than by male alone. However,

Senkondo (2000) argue that decision making on what, how, when to produce and combination of resources depend on type of decision. For example, decision on labour use on crops production was done jointly, whereas tree to be grown and area to plant trees by men.

Table 20: Decision making on land use and FIT in Tanga, Muheza and Lushoto districts

Decision on	Location			Total	$\chi 2$	Prob.
	Tanga	Muheza	Lushoto			
Land use						
husband	20(51.3)	9(22.5)	17(42.5)	46(38.7)	7.291	0.121
Wife	7(17.9)	11(27.5)	8(20.0)	26(21.8)		
both	12(30.8)	20(50.0)	15(37.5)	47(39.5)		
Use of FIT						
husband	20(52.6)	12(30.0)	18(45.0)	50(42.4)	4.454	0.348
Wife	6(15.8)	9(22.5)	6(15.0)	21(17.8)		
both	12(31.6)	19(47.5)	16(40.0)	47(39.8)		

- Figures in parenthesis are percentage and those out of parenthesis are frequencies
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).

4.5.2.4 Cropping systems

The by-products from food and cash crops do contribute to feeds for livestock and they can be fed when green or when dry. The area devoted for crops have indirect influence on livestock feed available in dry season.

a) Food crops

Food crops grown vary with districts; however, maize was major food crop grown for home consumption in all districts as reported by (37%) of respondents (Table 21). Other food crops grown in order of importance are cassava (21%), beans (12%), Irish potatoes (8%) mainly in Lushoto, horticultural produce and others (banana, peas, groundnuts, sweet potatoes and sugar cane). Production of bananas is highest in Muheza, (18%) followed by Lushoto (17%).

Table 21: Food and cash crop cultivated in Tanga, Muheza and Lushoto districts

Variable	Location			
	Tanga	Muheza	Lushoto	Total
Food crop				
Maize	34(40.5)	39(49.4)	35(27.8)	108(37.4)
Cassava	33(39.3)	18(22.8)	9(7.1)	60(20.8)
Beans	1(1.2)	5(6.3)	29(23.0)	35(12.1)
Horticultural produce[1]	1(1.2)	12(15.2)	8(6.3)	21(7.3)
Others [2]	15(17.9)	5(6.3)	21(16.7)	41(14.2)
Irish potatoes	0(0.0)	0(0.0)	24(19.0)	24(8.3)
Cash crop				
Orange	11(12.1)	15(16.5)	0(0.0)	26(28.6)
Coconut (*Cocos nucifera)*	21(23.1)	6(6.6)	0(0.0)	27(29.7)
Horticultural produce[1]	3(3.3)	6(6.6)	23(23.3)	32(35.2)
Maize, beans and cassava	19(20.9)	19(20.9)	21(23.1)	59(64.8)
Cashewnut (*Anacardium occidentale)*	12(13.2)	1(1.1)	0(0.0)	13(14.3)
Others[3]	4(4.4)	1(1.1)	9(9.9)	14(15.4)
Irish potatoes	0(0.0)	0(0.0)	20(22.0)	20(22.0)
Coffee	0(0.0)	0(0.0)	10(11.0)	10(11.0)
Beans	0(0.0)	0(0.0)	11(12.1)	11(12.1)

- Figures in parenthesis are percentage and those out of parenthesis are frequencies, based on multiple response.
- [1] Cardamon, Pepper, Tomato and Cabbage
- [2] banana, peas, groundnuts, sweet potatoes and sugar cane
- [3] Teak (*Tectona grandis*), Gravilia (*Gravilia robusta*), Wattle and Mango (*Mangifera indica*) trees.

Most of the food crops grown in the study area provide residues for feeding livestock where 53% of respondents used crop residues for 2 to 4 weeks during the dry season as one of the copping strategies to overcome feed deficiency (Table 23). Crop residues used include maize stovers/straws, beans straws, cowpea's straws, groundnuts husks, sugarcane tops, banana stems/leaves and sweet potatoes vines.

b) Cash crops

The most common cash crops grown in the study area differ between districts (Table 21). Despite the maize and beans being major food crop in all districts it also plays a big role as a source of income for most families as reported by majority (65%) of the respondents in

the study area. Irish potatoes, Arabica coffee and beans were observed to be important cash crops in Lushoto district, whereas orange, coconut and cashew nuts were observed to be important in Tanga and Muheza. Based on aforesaid reasons there is a potential of using stovers/straws as feed for dairy animals whether fed green or dry considering the limited land for fodder establishment and crop growing as majority of the farmers own small farms.

4.6 Feeding and Feed Resources

4.6.1 Feeding system and seasonality in feeds availability

Zero grazing was practised by 99% of the respondents (Table 22), and this system. was practised throughout the year. The system is being encouraged by most dairy projects such as Foundation for Sustainable Rural Development (SURUDE) project in Turiani and HPI in most part of Tanzania (Safari *et al.*, 2000; Msangi, 2001).

Table 22: Feeding system in Tanga, Muheza and Lushoto districts

Variable	Location			Total	χ2	Prob.
	Tanga	Muheza	Lushoto			
Feeding system						
Zero grazing	39(97.5)	40(100.0)	40(100.0)	119(99.2)	2.017	0.365
Tethering	1(2.5)	0(0.0)	0(0.0)	1(0.8)		
Season practised						
Throughout the year	39(97.5)	40(100.0)	40(100.0)	119(99.2)	2.017	0.365
Wet	1(2.5)	0(0.0)	0(0.0)	1(0.8)		

- Figures in parenthesis are percentage and those out of parenthesis are frequencies
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).

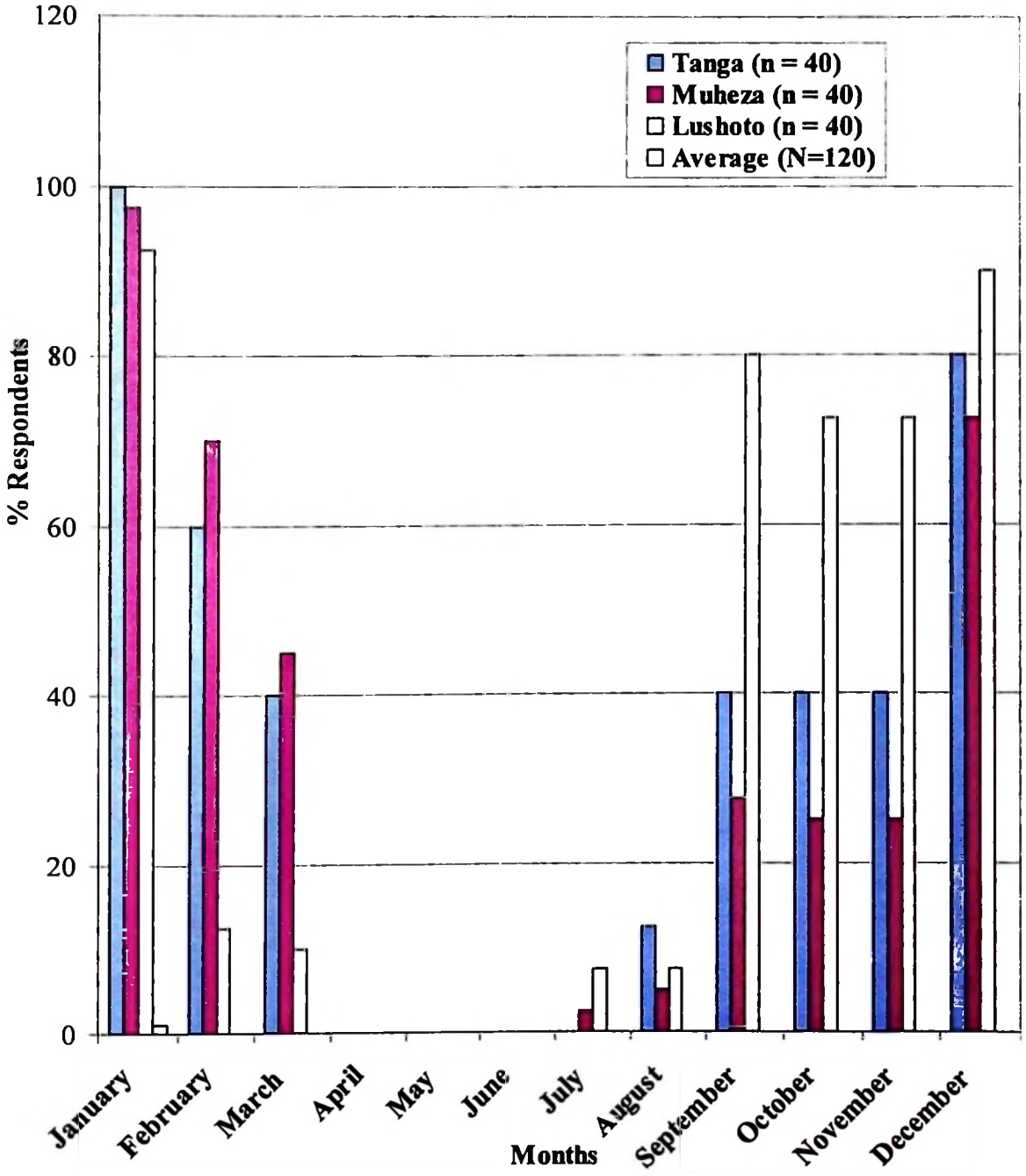

Figure 2: Months with feed shortage in Tanga, Muheza and Lushoto districts

Note % Respondents based on multiple responses

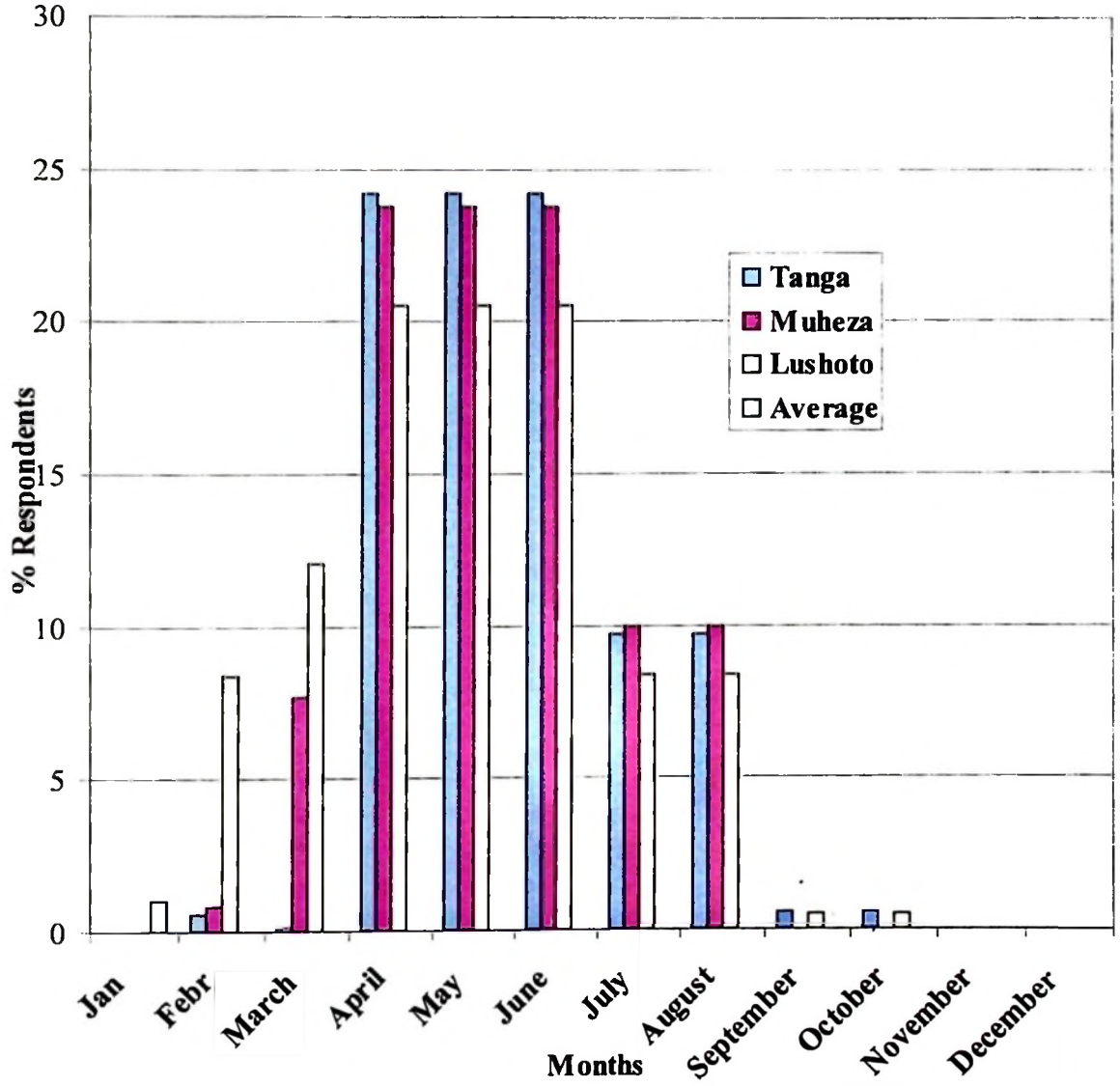

Figure 3: Months with excess feed in Tanga, Muheza and Lushoto districts

Note % Respondents based on multiple responses

Feed shortage was observed to occur in all districts where dairy farmers spent more time to collect pasture along the riverbanks and used crop residues as reported in Table 24 and 25 respectively. The problem was more prominent from September to March as indicated in (Figure 2). All respondents established that there was no action taken when there was excess feed. This could be attributed to the fact that occurrence of excess feeds correspond with the period of highest farm activities as shown in (Figure 4) which occur between February and June. This may imply that instead of using available labour force for pasture collection and storage it is used for agricultural activities since crop farming is reported to be the first income generating activities other than dairying. Farm activities identified are land preparation, planting and weeding.

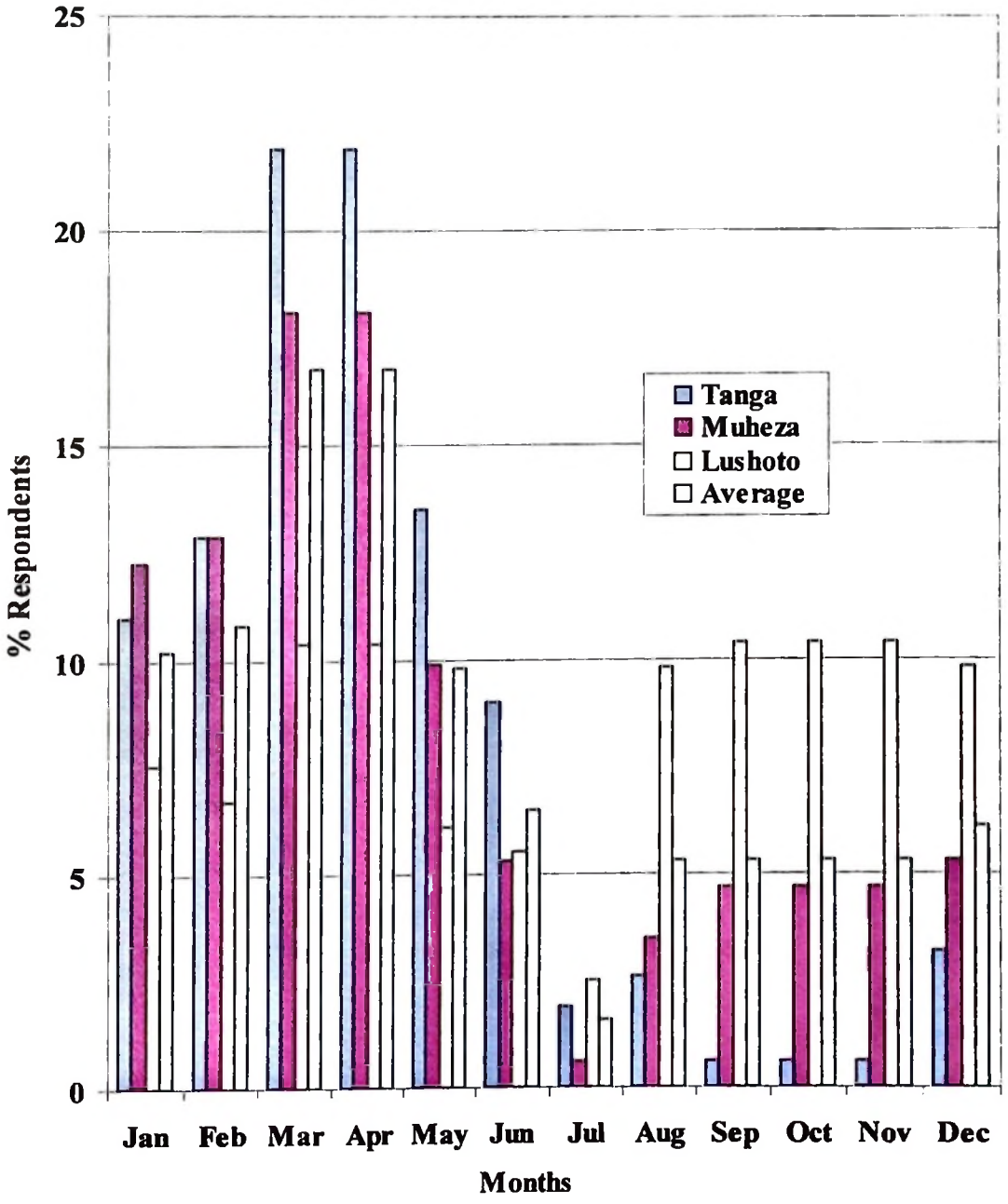

Figure 4: Period of highest farm activities Tanga, Muheza and Lushoto districts

4.6.2 Feed resources in the study area

The major feed materials during wet and dry season among others were the natural forage, crop residues and cultivated fodder. Farmers were found to be well aware of locally existing grasses, creepers, bushes and weed which were utilized as main feed materials during wet and dry seasons (Table 23). Dairy livestock keepers have identified a number of local species as beneficial and important for feeding their dairy animals. Among the grass and legumes, species identified include Congo grass *(Panicum maximum)*, *Cynodon spp.*, *Leucaena leucocephala*, Glycine (*Neonotonia wightii*), Blue pea *(Clitoria ternatea)*, Siratro (*Macroptilium atropurpureum*), *Commelina spp.*, Knut grass, Black jack (*Biden pilosa*) and *Rotboellia spp.* (Table 23).

Sweet potato vines *(Ipomoea batatas)* were also frequently harvested and fed to livestock to supplement low quality cut-and-carry grass herbage to increase milk yields of cows and growth of calves. Sweet potato whole vines are high in crude protein content of around 18% (Orodho *et al.*, 1993).

Table 23: Feed resources used in wet and dry seasons in Tanga, Muheza and Lushoto districts

Season	Feed materials	Location			Total
		Tanga	Muheza	Lushoto	
Dry	*Cynodon spp.*	39 (97.5)	36 (90.0)	39 (97.5)	114 (95.0)
	Napier grass	27 (67.5)	20 (50.0)	39 (97.5)	86 (71.7)
	Potatoe vines	33 (82.5)	30 (75.0)	1 (2.5)	64 (53.3)
	Commelina spp.	37 (92.5)	34 (85.0)	37 (92.5)	108 (90.0)
	Neonotonia wightii	36 (90.0)	35 (87.5)	34 (85.0)	105 (87.5)
	Guatemala	0 (0.0)	0 (0.0)	40 (100.0)	40 (33.3)
	Crop residues	32 (80.0)	25 (62.5)	40 (100.0)	97 (80.8)
	Crop harvest[1]	2 (5.0)	13 (32.5)	21 (52.5)	36 (30.0)
	Leucaena sp	8 (20.0)	13 (32.5)	2 (5.0)	23 (19.2)
	Clitoria ternatea	4 (10.0)	17 (42.5)	0 (0.0)	21 (17.5)
	Panicum spp.	37 (92.5)	40 (100.0)	24 (60.0)	101 (84.2)
	Knut grass	2 (5.0)	3 (7.5)	0 (0.0)	5 (4.2)
	Rotboellia spp	35 (87.5)	32 (80.0)	0 (0.0)	67 (55.8)
	Macroptilium spp	26 (65.0)	16 (40)	0 (0.0)	42 (35.0)
	Hay	10 (25.0)	0 (0.0)	0 (0.0)	10 (8.7)
	Black jack	0 (0.0)	0 (0.0)	33 (82.5)	33 (27.5)
Wet	*Cynodon sp*	40(100.0)	33 (82.5)	40 (100.0)	113 (94.2)
	Napier grass	17 (42.5)	9 (22.5)	39 (97.5)	65 (54.2)
	Potatoe vines	29 (72.5)	23 (57.5)	14 (35.0)	66 (55.0)
	Commelina spp.	33 (82.5)	36 (90.0)	36 (90.0)	105 (87.5)
	Neonotonia wightii	33 (82.5)	33 (82.5)	40 (100.0)	106 (83.3)
	Guatemala	0 (0.0)	1 (2.5)	39 (97.5)	40 (33.3)
	Crop residues	0 (0.0)	4 (10.0)	1 (2.5)	5 (4.2)
	Crop harvest[1]	18 (45.0)	28 (70.0)	29 (72.5)	75 (62.5)
	Leucaena sp	3 (7.5)	3 (7.5)	0 (0.0)	6 (5.5)
	Clitoria ternatea	9 (22.5)	23 (57.5)	0 (0.0)	32 (26.7)
	Panicum spp.	40 (100.0)	40 (100.0)	32 (80.0)	112 (93.3)
	Knut grass	37 (92.5)	39 (97.5)	2 (5.0)	78 (65.0)
	Rotboellia sp	36 (90.0)	29 (72.5)	0 (0.0)	65 (54.2)
	Macroptilium spp	25 (62.5)	19 (47.5)	2 (2.5)	46(38.3)
	Black jack	0 (0.0)	0 (0.0)	35 (87.5)	35 (29.2)

- Figures in parenthesis are percentage and those out of parenthesis are frequencies, based on multiple response.
- [1] Green leaves of maize and Banana

Some of the species such as *Panicum maximum, Cynodon spp, Neonotonia wightii, Clitoria ternatea, Macroptilium atropurpureum, Commelina spp.*, were extensively used in all districts while other species were specific to particular districts. Eleven species of local grasses and legume pastures were identified as summarized in (Table 23). The study revealed imbalance between grasses and legumes pasture in the study area whereby pasture collected ready for feeding dairy cows rarely had legumes.

4.6.3 Source of Feeds during dry and wet season

The main sources of feed materials in wet and dry season are as indicated in (Table 24). The main sources of feed materials in wet season for all districts were farmers own farms or from neighbours' farms, represented by 100% of respondents in Lushoto and 98% in Tanga and Muheza. The second and third sources varied across districts where in Lushoto other sources such as road side, open space ranked second represented by 80% followed by fodder garden represented by 78%. In Tanga, the second source was coconut plantations represented by 70% and third was other source such as (roadside) represented by 68%. In Muheza coconut plantation was ranked second represented by 63% and swampy area ranked third represented by 50%.

Table 24: Source of feeds in dry and wet season in Tanga, Muheza and Lushoto districts

Season	Source	Location			Total
		Tanga	Muheza	Lushoto	
Wet	Crop farm (farmers own/neighbours farms)	37 (97.5)	37 (97.5)	40 (100.0)	116 (96.7)
	Fodder gardens	3 (7.5)	2 (5.0)	31 (77.5)	36 (30.0)
	River banks	2 (5.0)	5 (12.5)	1 (2.5)	8 (6.7)
	Swampy areas	11 (27.5)	20 (50.0)	8 (20.0)	39 (32.5)
	Coconut plantations	28 (70.0)	25 (62.5)	0 (0.0)	53 (44.2)
	Sisal estates	4 (10.0)	13 (32.5)	0 (0.0)	17 (14.2)
	Other [1]	27 (67.5)	10 (25.0)	32 (80.0)	69 (57.5)
	Fodder purchase	0 (0.0)	0 (0.0)	3 (7.5)	3 (2.5)
Dry	Crop farm	22 (55.0)	16 (40.0)	33 (82.5)	71 (59.2)
	Fodder gardens	2 (5.0)	3 (7.5)	24 (60.0)	29 (24.2)
	River banks	29 (72.5)	28 (70.0)	4 (10.0)	61 (50.8)
	Swampy areas	31 (77.5)	36 (90.0)	28 (70.0)	95 (79.2)
	Coconut plantations	22 (55.0)	25 (62.5)	0 (0.0)	47 (39.2)
	Sisal estates	6 (15.0)	9 (22.5)	0 (0.0)	15 (12.5)
	Hay purchase	10 (25.0)	0 (0.0)	0 (0.0)	10 (8.7)
	Other [1]	6 (15.0)	2 (5.0)	10 (25.0)	18 (15.0)
	Crop residues	2 (5.0)	8 (20.0)	18 (45.0)	28 (23.3)
	Fodder purchase	0 (0.0)	0 (0.0)	17 (42.5)	17 (14.2)

- Figures in parenthesis are percentage and those out of parenthesis are frequencies, based on multiple response.
- [1] roadside, open spaces

Main sources of feed materials during the dry season in Tanga and Muheza districts were found to be swampy areas represented by (78%) and (90%), respectively, while in Lushoto the main source was farmers own farms represented by (83%) of the respondents. The second source was riverbanks for Tanga (73%) and Muheza (70%) and for Lushoto's second source was swampy areas representing (70%) in the district. However, hay purchase was practised only in Tanga during long dry season and fodder purchase from other farmers who do not keep dairy animals was practised in Lushoto. The source of feeds in dry season has an implication on the need to obtain green forage, which has relatively high crude protein for mixing with poor quality feeds to improve intake of the

poor quality forage and stimulate growth of rumen microbes. The source has also an implication on distance, time and labour devoted for pasture collection.

4.6.4 Time spent collecting pasture in both dry and wet seasons

Pasture collection was reported to be labour and time demanding activity taking a maximum of eight and a minimum of half hours, with an average of fours hours to collect pasture in the dry season (Table 25). In the wet season pasture collection, take a maximum of five and minimum of half hours, with an average of one and half hours for a load sufficient to feed one cow for farmers who do not posses bicycle. Duration for pasture collection differed significantly ($P<0.001$) between districts in the dry season (Table 25). In the dry and wet seasons, time spent in Lushoto was significantly ($P<0.001$) less than time spent in other districts. Grass collection in Tanga takes a maximum of eight hours, and in Muheza and Lushoto, it takes six hours in the dry season. During the wet season, time is reduced to a maximum of five, four and three hours for Tanga, Muheza and Lushoto respectively. One will expect farmers to adopt technologies of feed storage during wet season where pastures are in excess and time for collection is minimal. Massawe *et al.* (1998b) observed roadside sellers of pasture to use eight hours labour time to fetch 40-45kg load of grass in dry season and the time is reduced to one to two hours in the rain season. It can be deduced that farmers were not concerned on labour force wasted in fetching grasses during the dry season since there were no alternative use of the available labour force.

Table 25: Time spent collecting pasture sufficient for one cow both in dry and wet seasons in Tanga, Muheza and Lushoto districts

Location	Dry					Wet				
	Max	Min	Mean	s.e	F	Max	Min	Mean	s.e.	F
Tanga	8	2	4.46	0.26[a]	4.322**	5	0.5	1.81	0.16[a]	7.015***
Muheza	6	2	4.04	0.18[ab]		4	0.5	1.86	0.14[a]	
Lushoto	6	0.5	3.60	0.19[bc]		3	0.5	1.21	0.09[b]	
Total	8	0.5	4.04	0.12		5	0.5	1.63	0.09	

- Figures with the same superscripts within columns are not significant difference
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).

4.6.5 Use of Crop residues

Crop residues was used in all districts (Table 26) where highest proportion was in Lushoto (100%), followed by Muheza (88%) and lastly Tanga district (85%). The use of crop residues was statistically different (P<0.05) between districts. Maize stover was the leading crop residue used in all districts followed by bean haulms, banana pseudo stems and leaves in Lushoto and Muheza where in Tanga, cow peas straws and groundnuts husks ranked second and third, respectively. Other crop residues used includes sugarcane tops practiced in Tanga and Lushoto and sweet potato vines, which were practiced in Tanga and Muheza as, indicated in (Figure 5). Maize stovers/straws, beans straws and groundnuts straws have been reported to be common crop residues used in high rainfall and cropping zones where dairy farming is incorporated into mixed farming (Massawe *et al.*, 1998b; Mussa *et al.*, 1998 and Urassa, 1999). These crop residues are available in the dry season; although they are poor nutritionally, they provide bulk basal diet for ruminants.

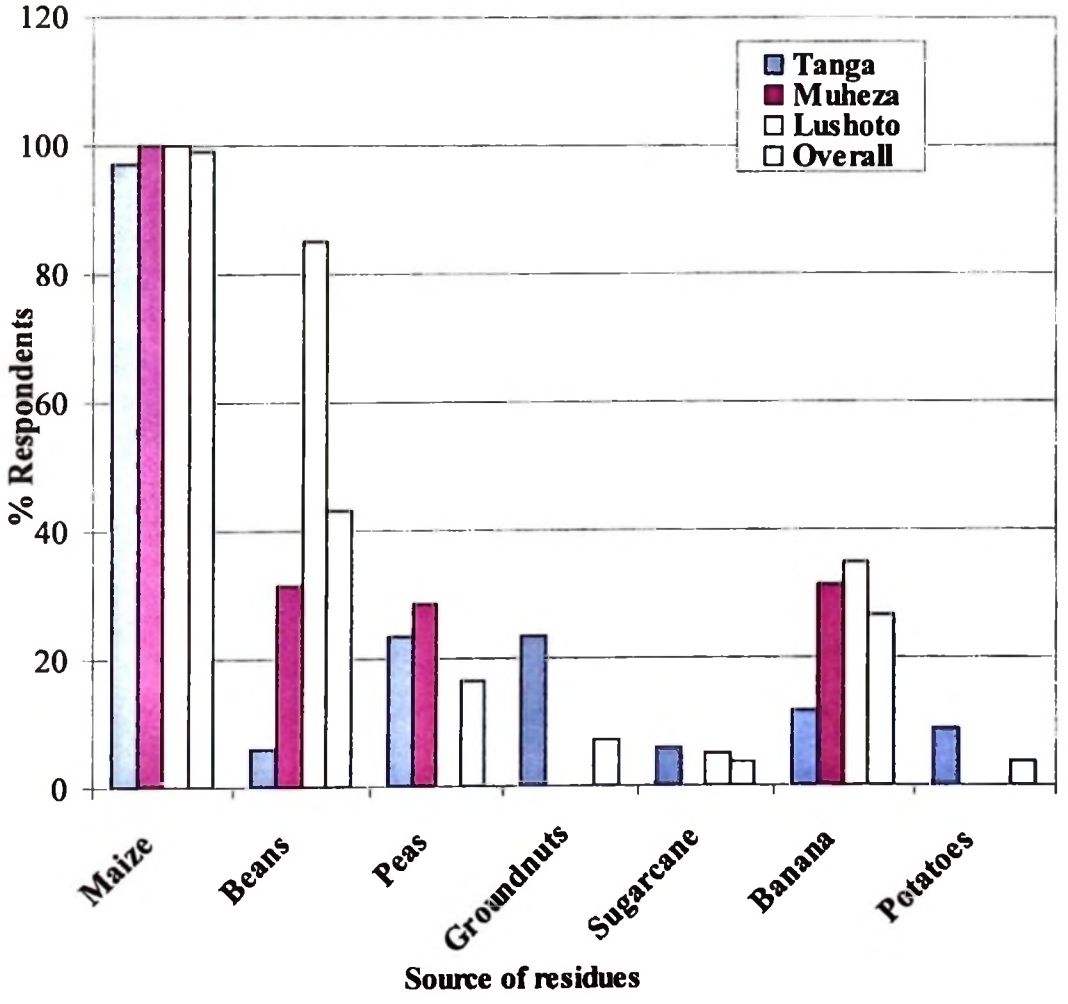

Figure 5: Sources of crop residues used in Tanga, Muheza and Lushoto districts

Treatment of crop residues was practiced in all districts with different extents ($P<0.05$) between districts, with highest percent in Tanga (82%), followed by Muheza (63%). In Lushoto 50% were treating crop residues while 50% were not treating.

The commonest treatment method practiced was chopping of straws and stovers practiced by 51%, 41% and 40% of farmers in Lushoto, Tanga and Muheza, respectively. Chopping reduces wastage of available crop residues hence increases efficiency of utilization. Methu *et al.* (1998) observed lower intake of unchopped urea treated maize compared to the chopped urea treated maize stems implying increased surface area for chemical reaction and rate of swallowing and passage. However, chopping is likely to reduce selectivity of the animal. The second form of treatment involves chopping and sprinkling with water mixed with common salt. This is also practiced in all districts. The third form of treatment involves chopping and sprinkling with Magadi (Sodium sesquicarbonate), a natural occurring alkali practiced in Tanga and Muheza districts. The methods of treatment differed significantly ($P<0.05$) between districts. The respondents knew about the procedure for treating crop residues from other farmers. For those who were using magadi or salt did not have uniform quantity of water, magadi or salt. Crop residues available were low in nutritive value and their bulky nature were constraint to feed intake and prevented the animals from consuming sufficient amounts to meet daily energy requirement.

Table 26: Crop residues utilization in Tanga, Muheza and Lushoto districts

Variable	Location			Total	$\chi 2$	Prob.
	Tanga	Muheza	Lushoto			
Use of crop residues						
Yes	34(85.0)	35(87.5)	40(100.0)	109(90.8)	6.205	0.045*
No	6(15.0)	5(12.5)	0(0.0)	11(9.2)		
Type of crop residues [a]						
Maize stovers/straws	33(97.1)	35(100.0)	40(100.0)	108(99.1)		
Bean straws	2(5.9)	11(31.4)	34(85.0)	47(43.1)		
Peas straws	8(23.5)	10(28.6)	0(0.0)	18(16.5)		
Groundnuts husks	8(23.5)	0(0.0)	0(0.0)	8(7.3)		
Sugarcane tops	2(5.9)	0(0.0)	2(5.0)	4(3.7)		
Banana pseudo stems/leaves	4(11.8)	11(31.4)	14(35.0)	29(26.6)		
Potatoe vines	3(8.8)	1(2.9)	0(0.0)	4(3.7)		
Treatment of crop residues						
Yes	28(82.4)	22(62.9)	20(50.0)	70(64.2)	8.414	0.015**
No	6(17.6)	13(37.1)	20(50.0)	39(35.8)		
Form of treatment [a]						
Chopping	14(41.2)	14(40.0)	20(51.3)	48(44.4)	9.873	0.043*
Chopping and salted water	12(35.2)	15(42.9)	19(48.7)	46(42.6)		
Chopping and Magadi	8(23.5)	6(17.1)	0(0.0)	14(13.0)		
Reasons for not treating [a]						
Not knowledgeable	4(66.7)	13(72.2)	8(33.3)	25(52.1)	13.056	0.042*
Raw material not available	1(16.7)	3(16.7)	2(8.3)	6(12.5)		
Not economical	0(0.0)	1(5.6)	11(45.8)	12(25.0)		
Raw materials expènsive	1(16.7)	1(5.6)	3(12.5)	5(10.4)		
Duration of use of crop residues						
<2 weeks	13(46.4)	5(22.7)	2(10.0)	20(28.6)	14.319	0.026**
2-4 weeks	10(35.7)	13(59.1)	14(70.0)	37(52.9)		
>4weeks<2months	0(0.0)	2(9.1)	3(15.0)	5(7.1)		
>2months	5(17.9)	2(9.1)	1(5.0)	8(11.4)		

- Figures in parenthesis are percentage and those out of parenthesis are frequencies
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).
- [a] Result based on multiple responses

Reasons advanced for failure to treat the crop residue are; farmers not knowledgeable (52%) implying that extension approach appeared to have not succeeded in disseminating information about crop residue treatment or did not have extension package on crop residue treatment; raw material not available (13%), raw materials observed to be expensive (10%) in all districts and not economical (25%) observed in Lushoto and Muheza and reasons pointed were significantly different ($P<0.05$) between districts. Maize stover /straws and bean straws were stored in cow shed.

Majority of farmers used crop residue for two to four weeks as observed by 53% of respondents. Moreover, Lushoto has the longest storage as observed by (70%), followed by Muheza which have (59%) of the respondents while in Tanga most farmers (46%) used the conserved feeds in less than two weeks. However, few farmers (11%) used crop residues in more than two months. Duration of use of crop residues were significantly different ($P<0.05$) between districts. Mussa *et al.* (1998) pointed out that stored crop residues in barns may last up to the early part of wet season depending on size of cultivated farm and distance to homestead from the area of production.

4.7. Feed Supplementation

4.7.1 Energy and protein supplementation

This study revealed that the amount of energy and protein supplements used was low during dry season attributed to high price and low supply in the dry season. The SDEP project through its transformation to TADAT was having a policy of providing an in-calf heifer with a record of production of above seven litres of milk per day thus recommended feed supplementation (energy and protein) of 4kg/cow/day or 2kg/cow/milking with protein source and energy source mixture at a ratio of 1:3. Concentrates were fed to

animals but not at the recommended levels as reported by 97% of the respondents (Table 27).

Source of Energy Concentrates used were maize bran (MB) reported by 97% and wheat meal (WM) used by 3% of respondents. The use of energy concentrates was significantly different ($P<0.01$) between districts. The difference is attributed to variation in availability and price where wheat meal was available in more convenient price in Lushoto. Protein concentrate source were Cotton seedcake (CSC) used by 52% farmers, Sunflower seedcake (SSC) used by 28% farmers, and Leucaena leaf meal (LLM) used by 74% farmers. The LLM was only prepared in Tanga and Muheza districts where Leucaena grow naturally. Reasons for not supplementing or low use of feed supplement than recommended were reported to include high price, scarcity and seasonality in availability. Farmers were not aware of other fodder trees such as *Gliricidia sepium*, Calliandra ssp, Sesbania spp, *Moris alba* and Manihot species which are good sources of protein despite of their considerable quantities of anti-nutritional and or toxic compounds. Farmers' usually dry leaf of leuacaena and feed at low level thus could be the reason why they have not encountered toxicity problem. Prices of concentrates fluctuated with season being extremely high in the dry season and moderately high in the wet season in the local markets. The amount of concentrate supplemented fluctuated between and within districts being high during harvesting period thus high supplementation in wet season. Milk price was low to justify their use (Table 27).

Most dairy farmers supplemented their animals with energy rich supplement (maize bran and Wheat meal) while protein rich supplements were rarely used. Consequently, they were used to specific group/groups of animals that respond best to supplementation. The dairy farmers' priority in feeding concentrates was higher for milking dairy cows which

was reported by (38%) of respondents, followed by milking herd and calves (25%) and few dairy farmers fed concentrate to all animals (24%). The classes of animals fed differed ($P<0.001$) significantly between districts.

Majority of respondents (77%) fed concentrate to the animal at the time of milking (morning and evening), followed by (19%) of respondents who fed their animals once a day (morning during milking) and lastly 4% of respondents fed once in noon when giving drinking water. Frequencies of feeding supplementary feeds differed ($P<0.001$) between districts where price and availability was the main factors contributing to variation. The recommended mixing ratio of protein to energy of 1:3 was practised by 35% of respondents and differed ($P<0.001$) significantly between districts. However, it was revealed that some farmers used their own modified mixing ratios ranging from 1:1, 1:2, 1.5:4 reported by 1%, 13% and 18% respectively. Twenty eight percent of respondents did not mix and 5% of respondents did not measure the concentrate used. Only 55% of dairy farmers in Tanga practiced the recommended mixing protein energy ratio of 1:3 where in Muheza they were 34% and 35% in Lushoto.

The amount of concentrate fed ranged from 0.5 to 5 kg/cow/day with an average of 2.6kg/cow/day. The amounts fed differed ($P<0.01$) significantly between districts with Tanga having the highest amount of offer and Lushoto having the least.

Table 27: Energy and protein concentrate uses in Tanga, Muheza and Lushoto districts

Variable	Location					
	Tanga	Muheza	Lushoto	Total	χ2	Prob.
Use of Concentrate						
Yes	40(100.0)	38(95.0)	38(95.0)	116(96.6)	2.018	0.365
No	0(0.0)	2(5.0)	2(5.0)	4(3.4)		
Energy source						
Maize bran	40(100.0)	38(100.0)	34(89.5)	112(96.6)	8.504	0.014**
Wheat meal	0(0.0)	0(0.0)	4(10.5)	4(3.4)		
Protein source[1]						
CSC	29(72.5)	8(23.5)	8(66.7)	45(52.3)		
SSC	3(7.5)	15(44.1)	6(50.0)	24(27.9)		
LLM	30(75.0)	34(100.0)	0(0.0)	64(74.4)		
Class of animal fed	n=18	n=34	n=34	N=81		
Milking herd	6(15.0)	11(29.7)	27(71.1)	44(38.3)	48.738	0.000***
Pregnant herd	2(1.7)	0(0.0)	0(0.0)	2(1.7)		
Milking and pregnant herd	3(7.5)	9(24.3)	0(0.0)	12(10.4)		
All animals	17(42.5)	3(8.1)	8(21.1)	28(24.3)		
Milking herd and calves	12(30.0)	14(37.8)	3(7.9)	29(25.2)		
Frequency of feeding						
Milking (morning and evening)	37(92.5)	34(91.9)	18(47.4)	89(77.4)	29.688	0.000***
Noon (when giving drinking water)	1(2.5)	0(0.0)	3(7..9)	4(3.5)		
Only morning when milking	2(5.0)	3(8.1)	17(44.7)	22(19.1)		
Reasons for not using/mixing to recommended ratios[1]						
Price is high	0(0.0)	4(11.8)	0(0.0)	4(4.7)		
Not available throughout the year	0(0.0)	4(11.8)	0(0.0)	4(4.7)		
Increase production cost	0(0.0)	1(2..9)	5(14.7)	6(7.0)		
Milk price is low to justify use	0(0.0)	0(0.0)	15(44.1)	15(17.4)		
Price is high and not available	18(100.0)	29(85.3)	34(100.0)	81(94.2)		
Mixing ratio(P:E)[2]						
1:3	22(55.0)	13(34.2)	6(15.8)	41(35.3)	61.680	0.000***
1:1	0(0.0)	1(2.6)	0(0.0)	1(0.9)		
1:2	7(17.5)	7(18.4)	1(2.6)	15(12.9)		
1.5:4	10(25.0)	8(21.1)	3(7.9)	21(18.1)		
Not measured	1(2.5)	4(10.5)	1(2.6)	6(5.2)		
Not mixed	0(0.0)	5(13.2)	27(71.1)	32(27.6)		
Amount fed (kg/d)					F	Sig
maximum	5	5	5	5	3.047	0.049
minimum	1	1	0.5	0.5		
average	2.88	2.69	2.26	2.6		

- Figures in parenthesis are percentage and those out of parenthesis are frequencies
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).
- Cotton seedcake (CSC), Sunflower seedcake (SSC), and Leucaena leaf meal (LLM)
- [1] Based on multiple responses
- [2] P: E protein energy ratio; sig=significance

The level of use was higher during wet season where supplementary feeds were relatively cheaper and availability was higher as compared to dry season as reported during focused group discussion in the study area. The higher use of MB as major source of energy supplementation could be due to the fact that maize meal is a staple food in most homesteads where it is estimated that 15% of maize processed produce about 420 000 tones of MB per year in Tanzania (Mlay, 2001). Most supplementary feed were purchased from feed and drug stockists. Mollel *et al.* (1999) found similar trend where commonest supplementary feeds used were mixture of Maize bran and sunflower seed cake and were supplemented during milking time; and mineral supplementation was practiced by very few farmers and very irregularly in Turiani Morogoro. Comparable trends of high cost of concentrate feeds have been reported by Massawe *et al.* (1997) to be severe in Kilimanjaro and medium in Morogoro thus affecting quantity of concentrate fed to the animals. Feeding accounts for almost 70% of the cost of livestock production (Rangnekar, 1994). High costs of supplementary feeds as perceived by dairy farmers have been attributed as the cause of low uses of supplementary feeds (Mlay, 2001).

4.7.2 Mineral supplementation

Majority of respondents (93%) in the study area used mineral supplements. Level of mineral supplementation varied between districts ranging from 20g to 100g/cow/day. All respondents in Tanga used minerals whereas majority (92%) and (85%) in Muheza and Lushoto, respectively used mineral (Table 28). Mineral supplement used includes Dairy Macklicks, mineral blocks, (which contain mainly calcium, phosphorous, magnesium and zinc), common salt, and combination of dairy Macklicks and common salt as reported by 80%, 13%, 5% and 3%, respectively and differed ($P<0.001$) significantly between districts (Table 28).

Level of use of mineral supplement was low in all districts ranging from 20g to 40g as reported by (47%) and 36% of respondents, respectively. The Recommended level of mineral supplementation by SDEP project through its transformation to TADAT for milking cow was 80g/cow/d of calcium, phosphorous, magnesium, zinc and sodium in combination. The use of minerals differed significantly ($P<0.05$) between districts. Seventy nine percent of dairy farmers used dairy Macklicks and it was significantly different ($P<0.001$) between districts. The deviation in the use of minerals is attributed to transportation costs. Tanga and Muheza districts are closer to point of entry and manufacturing industries than Lushoto district. Also in some parts of Tanga, coast belt common salt is locally available compared to Lushoto hence leading to disparity in price and availability.

Minerals were fed separately or in combination with the concentrates twice a day during milking as reported by 61% of the respondents, followed by those who fed only when minerals are available reported by 18% and those who fed once a day as reported by 14% of respondents. The result differ significantly ($P<0.001$) between districts.

Table 28: Mineral utilization by farmers in Tanga, Muheza and Lushoto districts

Variable	Location			Total	χ2	Prob.
	Tanga	Muheza	Lushoto			
Use of mineral						
Yes	40(100.0)	37(92.0)	34(85.0)	111(92.5)	6.486	0.039*
No	0(0.0)	3(7.5)	6(15.0)	9(7.5)		
Mineral used						
Dairy Macklick	32(80.0)	37(100.0)	20(57.1)	89(79.5)	22.988	0.001***
Common salt	2(5.0)	0(0.0)	4(11.4)	6(5.4)		
Dairy Macklick and common salt	0(0.0)	0(0.0)	3(8.6)	3(2.7)		
Mineral block	6(15.0)	0(0.0)	8(22.9)	14(12.5)		
Amount fed (g/d)						
20	19(47.5)	17(45.9)	16(48.5)	52(47.3)	22.003	0.005**
40	15(37.5)	17(45.9)	7(21.2)	39(35.5)		
100	0(0.0)	0(0.0)	2(6.1)	2(1.8)		
Not measured	0(0.0)	3(8.1)	0(0.0)	3(2.7)		
Left to leak (*Ad lib*)	6(15.0)	0(0.0)	8(24.2)	14(12.7)		
Feeding Frequency						
Twice a day(milking)	37(92.5)	25(67.7)	7(18.9)	69(60.5)	66.685	0.000***
Once a day	1(2.5)	10(27.0)	5(13.5)	16(14.0)		
Once a week	0(0.0)	1(2.7)	1(2.7)	2(1.8)		
When available	2(5.0)	1(2.7)	18(48.6)	21(18.4)		
Left to leak	0(0.0)	0(0.0)	6(16.2)	6(5.3)		
Class of animal fed						
Milking herd	6(15.0)	11(29.7)	27(71.1)	44(38.3)	48.738	0.000***
Pregnant herd	2(5.0)	0(0.0)	0(0.0)	2(1.7)		
Milking and pregnant herd	3(7.5)	9(24.3)	0(0.0)	12(10.4)		
All animals	17(42.5)	3(8.1)	8(21.1)	28(24.3)		
Milking herd and calves	12(30.0)	14(37.8)	3(7.9)	29(25.2)		
Reasons for not using mineral as per recommendation						
High price		1(33.3)	0(0.0)	1(7.7)	9.244	0.055
Not available throughout the year		0(0.0)	1(10.0)	1(7.7)		
Increase in production costs		2(66.7)	1(10.0)	3(23.2)		
Low milk price to justify use		0(0.0)	2(20.0)	2(15.4)		
High price and not available		0(0.0)	6(60.0)	6(46.2)		

- Figures in parenthesis are percentage and those out of parenthesis are frequencies
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).

Class of animals fed minerals include: milking herd 38%; milking heard and calves 25% and all animals 24% and class of animal fed differ significantly (P<0.001) between districts. This trend was similar to the one used for concentrates. Respondents gave the reasons for failure or low level of use of minerals to include high price and uneven supply (46%), increase in production costs (23%) and low milk price to justify their use (15%). Variation in supplementation of animals with concentrate and minerals is also common in other areas of Tanzania where zero grazing of dairy cattle is practised. Msangi (2001) reported farmers under SURUDE that they were offering 2.9kg/cow/day of concentrates and 50g of minerals/cow/day, while those under HPI were offering 2.7kg/cow/day and 30g/cow/day of concentrates and minerals to lactating cows, respectively, during milking. Low uses of concentrates and minerals supplement have been reported widely. For examples, Kisusu (2003) reported that 94% of project and 87% non-project farmers fed mineral block weighing 0.5kg/month in Dodoma. Okwir (1998) reported that dairy farmers in Mpigi district in Uganda supplemented 2.54kg/cow/day of concentrate and 41.1g /cow/day of mineral lick and the quantity decreased with the change of grazing system i.e. semi intensive to extensive.

4.7.3 Conservation of feeds as hay

Conservation of feeds as hay was one of new technologies introduced by SDEP. However, this technology was not practised due to numerous reasons such as absence of pasture suitable for hay making reported by 95% of respondents in Lushoto, insufficient pasture for hay making as reported by 87% and 83% in Muheza and Tanga districts, respectively (Table 30). Hay making was also perceived to be labour intensive in Tanga (60%) and Lushoto districts (35%). Few respondents (4%) cited low income as a contributing factor. Hay making was not a priority for dairy farmers because of i) Time and labour constraints

to cut and dry grasses for hay making. ii) Period of excess pasture coincided with period of higher farm labour demands on land preparation, planting and weeding. Thus, hay making was not compatible with the existing farming systems.

4.7.4 Price of supplementary feeds

Majority (63%) of respondents in the study area reported the price of maize bran to range from 81 to100 Tsh/kg and price differed significantly ($P<0.001$) between districts (Table 29). CSC price varied from 150 to 200 Tsh/kg as reported by 62% of respondents and differed ($P<0.05$) between districts. SSC was used in the study areas where highest price was observed in Lushoto to range from 151 to 230 Tsh/kg followed by Tanga ranging from 100 to 150 Tsh/kg and lastly Muheza where the price was less than 100 Tsh/kg. LLM was practised in Tanga and Muheza and price was 80-100 Tsh/kg as reported by 81% and this differed significantly ($P<0.01$) between districts. Price of minerals was reported by majority respondents (60%) to range between Tshs 600-800 and differed significantly ($P<0.001$) between districts. The price was reported to be higher in Lushoto where 65% reported price to be more than 1000Tsh/kg.

Table 29: Price of supplementary feeds in Tanga, Muheza and Lushoto districts (Tsh/Kg)

Variable	Location					
	Tanga	Muheza	Lushoto	Total	$\chi 2$	Prob.
MB	n=40	n=38	n=38	N=116		
<60	4(10.0)	0(0.0)	0(0.0)	4(3.4)	41.882	0.000***
60-80	21(52.5)	2(5.3)	5(13.2)	28(24.1)		
81-100	11(27.5)	31(81.6)	31(81.6)	73(62.9)		
>101	4(10.0)	5(5.3)	2(5.3)	11(9.5)		
CSC	n=29	n=8	n=8	N=45		
<150	5(17.2)	0(0.0)	0(0.0)	5(11.1)	12.691	0.048*
150-200	17(58.6)	8(100.0)	3(37.5)	28(62.2)		
201-250	4(13.8)	0(0.0)	4(50.0)	8(17.8)		
>250	3(10.3)	0(0.0)	1(12.5)	4(8.9)		
SSC	n=3	n=15	n=6	N=24		
<100	1(33.3)	6(40.0)	0(0.0)	7(29.1)	2.229	0.328
100-150	2(66.7)	4(26.7)	1(16.7)	7(29.1)		
151-230	0(0.0)	5(33.3)	5(83.3)	10(41.8)		
LLM	n=30	n=34		N=64		
<80	1(3.3)	4(11.8)		5(7.8)	9.819	0.007**
80-100	22(73.3)	30(88.2)		52(81.3)		
101-120	7(23.3)	0(0.0)		7(10.9)		
Minerals	n=40	n=37	n=34	N=111		
<600	2(5.0)	0(0.0)	3(8.8)	5(4.5)	79.541	0.000***
600-800	30(75.0)	36(97.3)	1(2.9)	67(60.4)		
801-1000	6(15.0)	1(2.7)	8(23.5)	15(13.5)		
>1000	2(5.2)	0(0.0)	22(64.7)	24(21.6)		
Hay(Tsh/bale)	n=10					
600-800	9(90.0)					
>900	1(10.0)					

- Figures in parenthesis are percentage and those out of parenthesis are frequencies
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).
- Maize bran (MB); Cotton seedcake (CSC); Sunflower seedcake (SSC); Leucaena leaf meal (LLM)

Majority (90%) of those who used hay reported price to range between 600-800 Tsh/bale (Table 29). The prices of supplementary feeds were higher in Lushoto due to transportation costs since most of the supplementary feeds were purchased in Dar es Salaam and sometimes from Tanga and transported to Lushoto.

4.8 Farmers awareness on FIT

Majority (98%) of the interviewed respondents were found to be aware of FIT (Table 30). Tanga has the highest respondents (100%) followed by Muheza and Lushoto (98%). Technologies, which all farmers were found to be aware of fodder garden establishment, concentrate supplementation and hay making or use (Table 30). Technologies practiced included fodder garden establishment (70%), concentrate supplementation (97%) and hay use (25%). Lushoto had the highest percentage of farmers with fodder gardens and this was a result of the Soil Erosion Control and Agroforesty Project (SECAP), which was introduced in the area since 1985. This project advocated establishment of fodder strips of Guatemala grass along the contours to control soil erosion where those without cattle do sale the fodder to dairy cattle keepers. All respondents were aware of FIT as a true need for increased milk production, and improvement in the health and reproductive efficiency of the animals if implemented accurately, whereas no cultural beliefs, social norms and superstitions were identified as constraints to the adoption of feed improvement technologies.

Table 30: Awareness on FIT introduced in Tanga, Muheza and Lushoto districts

Variable	Location			Total	$\chi 2$	Prob.
	Tanga	Muheza	Lushoto			
Aware of FIT						
Yes	40(100.0)	39(97.5)	39(97.5)	118(98.3)	1.017	0.601
No	0(0.0)	1(2.5)	1(2.5)	2(1.7)		
Awareness on [1]						
Fodder garden	40(100.0)	39(100.0)	39(100.0)	118(100.0)		
Supplementation	40(100.0)	39(100.0)	39(100.0)	118(100.0)		
Hay making/ use	40(100.0)	39(100.0)	39(100.0)	118(100.0)		
Technologies practiced [1]						
Fodder garden	23(57.5)	20(52.6)	39(100)	82(70.1)		
Supplementation	40(100.0)	37(97.4)	37(94.9)	114(97.4)		
Hay making/ use	10(25.0)	0(0.0)	0(0.0)	10(6.8)		
Reasons for not practising introduced FIT [1]						
Pasture unavailability	29(82.9)	34(87.2)	0(0.0)	63(55.3)		
Absent of hay grass	1(2.9)	0(0.0)	38(95.0)	39(34.2)		
Land scarcity	6(17.1)	19(48.7)	0(0.0)	25(21.9)		
Labour scarcity	0(0.0)	4(10.3)	0(0.0)	4(3.5)		
Income very low	0(0.0)	2(5.1)	2(5.0)	4(3.5)		
Labour intensive	21(60.0)	1(2.6)	40(35.1)	62(54.4)		
Hay uses						
Yes	10(25.0)	N/A	N/A	N/A		
No	30(75.0)	N/A	N/A	N/A		
Amount used (bales/seasons)	31	N/A	N/A	N/A		

- Figures in parenthesis are percentage and those out of parenthesis are frequencies
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).
- [1] Result based on multiple responses
- N/A= Not applicable

4.9 Adoption of FIT

4.9.1 Fodder garden establishment

Adoptions for various technologies are summarized in Table 31. Adoption of fodder garden establishment was higher in Lushoto (93%) compared to Tanga (50%) and Muheza (48%) and significantly ($P<0.01$) different between adopters and non-adopters. Reasons for these variations were similar to those pointed out for awareness. Dairy farmers far away from urban centre had higher options of obtaining pasture from own and neighbour farms due to the large farm size. Availability of pasture along the river banks and swampy areas also lowered adoption of fodder garden establishment.

- **Reason that motivated smallholder dairy farmer to establish fodder garden**

Respondents in the study area who established fodder garden admitted that motives that contributed to adoption as summarized in (Table 32) include, adequate information received from the project extension officers, easy to understand and implement the technology; less labour and time requirement, increased milk above ordinary production. Fodder garden establishment was well matched with culture and women were involved during fodder establishment. The higher adoption rate of fodder garden in Lushoto is explained by fact that the district is in upland areas with higher problems of soil erosion, and declining communal areas for fetching forage.

Table 31: Adoption of FIT in Tanga, Muheza and Lushoto districts

Technology	Location	N	Adopter	Non-adopter	χ^2	Prob.
Fodder garden	Tanga	40	20(50.0)	20(50.0)	22.033	0.000***
	Muheza	40	19(47.5)	21(52.5)		
	Lushoto	40	37(92.5)	3(7.5)		
	Total		76(63.3)	44(36.7)		
Energy source	Tanga	40	32(80.0)	8(20.0)	6.934	0.0341*
	Muheza	36	19(52.8)	17(47.2)		
	Lushoto	36	21(58.3)	15(41.7)		
	Total		72(64.3)	40(35.7)		
Protein source	Tanga	40	28(70.0)	12(30.0)	10.251	0.006***
	Muheza	31	11(35.5)	20(64.5)		
	Lushoto	12	4(33.3)	8(66.7)		
	Total		43(51.8)	40(48.2)		
Mineral supplement	Tanga	40	15(37.5)	25(62.5)	2.894	0.235
	Muheza	37	17(45.9)	20(54.1)		
	Lushoto	34	9(26.5)	25(73.5)		
	Total		41(36.9)	70(63.1)		
Combination (energy and protein) source	Tanga	40	9(22.5)	31(77.5)	3.425	0.180
	Muheza	38	5(13.2)	33(86.8)		
	Lushoto	38	3(7.9)	35(92.1)		
	Total		17(14.7)	99(85.3)		
Hay uses	Tanga	30	10(25.0)	30(75.0)		

- Figures in parenthesis are percentage and those out of parenthesis are frequencies
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).

Similarly, years of farming experience, mode of land acquisition and average annual precipitation influenced higher adoption of planted fodder in Lushoto district (i.e. Guatemala and Napier grass). However, the following reasons were mentioned to contribute to low adoption of fodder garden establishment in Tanga and Muheza districts: unavailability of capital/cash/ credit facilities (96%), difficult to acquire raw materials (input), high cost in implementing the technology and. These reasons differed (P<0.05) between districts. The variation in districts is attributed by lack of milk-marketing strategies and the low milk prices in wet season, aggravated by the lack of facilities for the

collection, preservation and transportation of milk, limited access to land, credit and poor infrastructure limited adoption of FIT in Lushoto.

Table 32: Reasons that motivated dairy farmer to use fodder garden in Tanga, Muheza and Lushoto districts

Variable	Location					
	Tanga (n=20)	Muheza (n=19)	Lushoto (n=37)	Total (N=76)	χ2	Prob.
1Adequate information	All					
2. Easy/cheaper to use/implement	All					
3.Availability of capital/Credit facilities	19(95.0)	17(89.5)	37(100.0)	73(96.1)	11.020	0.004***
4. Less labour	All					
5.Less Time	All					
6. Increase milk	All					
7. Easy to acquire input	15(75.0)	11(57.9)	36(97.3)	62(81.6)	13.751	0.001***
8. Herd size small	13(65.0)	12(63.2)	34(91.9)	59(77.6)	8.463	0.015**
9. Farm size big	16(80.0)	16(84.2)	36(97.3)	68(89.5)	4.869	0.088
10 Culture compatible	All					
11.Women involved	All					
12.Low cost in implementing	13(65.0)	5(26.3)	37(100.0)	55(72.4)	34.822	0.000***

- Number in bracket shows percentage of farmer disagreed to Characteristic.
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).
- All=refer to all farmer agreed to characteristic.

4.9.2 Supplementary feeds

The adoption rates for supplementary feeds were very low (15%) when considering farmers who used a mixing ratio of (2kg of energy source, 0.5kg of protein source and 20g minerals) to compound ration and feed a minimum of 2kg of compounded ration. Tanga had the highest adoption rate (23%) followed by Muheza (13%) and Lushoto was the least in adoption feeds supplementation. Dairy farmers in the study area fed less than the recommended level of supplementary feeds. The main reasons cited by dairy farmers for not using supplementary feeds at the recommended levels were high costs, seasonality and unavailability of supplementary feeds. Lack of credit facilities and input costs of supplementary feeds was considered higher than the income from milk due to low milk

prices. Distance from respondents' residence to urban centres influenced adoption of supplementary feeds in Tanga. Higher levels of use of combined energy and protein supplements source was reported in Tanga (23%), followed by Muheza (13%) and Lushoto was the least (8%). Higher levels of mineral use were observed in Muheza (46%). Use of energy and protein was significantly different ($P<0.05$ and <0.001) between adopters and non-adopters, respectively.

- **Reasons that motivated smallholder dairy farmers to use supplementary feeds**

Respondents who used supplementary feeds agreed that they were motivated by factors presented in (Table 33) which include adequate information received from the project extension officers, easy to understand and implement, less labour and time requirements, increased milk above ordinary production, and compatibility with culture and womens' involvement. The following factors were mentioned to lower motivation for adopting supplementary feeding. These includes unavailability of capital/cash/ credit facilities (94%); difficulty of acquiring raw materials (input) (85%), small herd size (59%) and high cost of implementation of the technology. These factors were different between districts and the differences were more prominent in Lushoto, which had the lowest price of milk and unorganized milk market channels.

Table 33: Reasons that motivated dairy farmer to use supplementary feeds in Tanga, Muheza and Lushoto districts

Reason	Location					
	Tanga (n=40)	Muheza (n=40)	Lushoto (n=40)	Total (N=120)	χ2	Prob.
1Adequate information	All					
2. Easy/cheaper to use/implement	All					
3.Availability of capital/Credit facilities	40(100.0)	30((81.1)	38(100.0)	108(93.9)	15.713	0.000***
4. Less labour	All					
5.Less Time	All					
6. Increase milk	All					
7. Easy to acquire input	32(80.0)	29(78.4)	37(97.4)	98(85.2)	6.692	0.035*
8. Herd size small	19(47.5)	14(37.8)	35(92.1)	68(59.1)	26.278	0.000***
9. Farm size big	38(95.0)	34(91.9)	38(100.0)	110(95.7)	3.026	0.220
10.Culture compatible	All					
11.Women involved	All					
12.Low cost in implementing	39(97.5)	23(62.2)	38(100.0)	100(87.0)	29.675	0.000***

- Number in bracket shows percentage of farmer who disagreed to reason.
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).
- All=all farmers agreed to reason.

4.9.3 Hay making and use

Production of hay under dairy farmers' conditions does not necessarily require any kind of mechanization as compared to medium and large scale farms, but require extra labour and time for cutting, drying, transporting, and storage of hay. Low adoption of hay making and use (25%) was attributed to perception that hay making was a time and Labour intensive technology whereas purchasing and use required capital. Hired labour for pasture collection was reported to be cheaper than hay making and period with excess forage for hay making coincided with highest farm activities such as planting, weeding and harvesting where majority value crop farming which pay more than dairying. Unobserved

direct benefits from increased milk production as result of feeding hay, due to low price and unreliable milk market constrained adoption of hay technology. It was reported during focused group discussion that hay was used only in acute feed shortage resulted from prolonged drought.

➢ **Major reasons that motivated smallholder dairy farmers to use hay**

The respondents who used hay in Tanga were motivated by the reasons summarized in (Table 34) which include satisfactory information from the project extension officers, easy to understand and implement; less labour and time requirement, increased milk production above ordinary yield, culture compatibility and women involvement are motive for using hay. Moreover, all farmers pointed out that: capital/cash/ credit facilities were not available, cost in implementing the technology i.e. hay purchase was high and big farm size did not motivate them to use hay. Small herd size (70%), difficult in acquisition of raw materials (input) (90%) were also reported to contribute to low motive for adoption.

Table 34: Reasons that motivated dairy farmer to use hay in Tanga district

Characteristic of technology	Agree	Disagree
1Adequate information	All	
2. Easy/cheaper to use/implement	All	
3.Availability of capital/Credit facilities		All
4. Less labour	All	
5.Less Time	All	
6. Increase milk	All	
7. Easy to acquire input	1(10.0)	9(90.0)
8. Herd size small	3(30)	7(70)
9. Farm size big		All
10.Culture compatible	All	
11.Women involved	All	
12.Low cost in implementing		All

- Number in bracket shows percentage of farmer who disagreed to reason.
- All=all farmers agreed/disagreed to reason.
- N= 10 Respondents

4.10 Intensity of adoption of FIT

Level of use of a particular technology may sometimes differ from recommended rate/levels; thus, where a technology is adopted it is important to comprehend to what extent the technology has been adopted. Adopters may claim to have adopted the technology but comparatively they use less than the required standards (CIMMYT, 1993). Intensity of adoption was determined by the level of adopted units against the recommended amount and expressed as percentage as proposed by Senkondo *et al.*, (1998). Intensity of adoption of introduced technology is summarized in Table 35. Intensity of adoption of fodder garden establishment was 50% of the project recommendations, implying that area of land per household under fodder was half the project recommendations. Land scarcity may attribute to this trend because although most respondents (96%) owned land, the areas were less than 2ha. Feed supplementation at the mixing ratio of protein to energy of 1:3 was observed to have an intensity of 65% meaning that larger proportion of farmers mixed energy and protein feed based on project recommendation but fed their animals less than recommended (Table 35).

Table 35: Extent (Intensity) of adoption of introduced FIT in Tanga, Muheza and Lushoto districts

Technology	Project's recommendation	Current practices	Farmers on current Practices (%)	Intensity (%)
Fodder garden establishment (ha/household)	0.4	0.2	49	50
Feed supplementation[1] (kg/cow/day)	4	2.6	35	65
Minerals (g/cow/day)	80	20	61	25

[1]P: E mixing ratio 1:3,

High price, scarcity and seasonality in availability of the concentrate feeds in local markets contributed to improper mixing and feeding of concentrates feeds. The use of mineral had a low intensity of 25%. Lushoto district had the majority (49%) of

respondents using the lower level (20g) of mineral supplement where this discrepancy was attributed to transportation cost. Other reasons for failure or low use of minerals in the study areas includes, high price, seasonality in availability, increases production cost, low price of milk to justify their use. Senkondo *et al.* (1998) argue that determination of intensity of adoption helps to adjust the gap between the actual and the recommended amounts. Similarly, intensity of use provides correct measure on policy reforms (Kisusu, 2003). For example, low intensity may be a sign of ineffective technology despite the fact that it has been adopted.

4.11 Farmers' opinion on use of introduced FIT in the study area

Opinion of dairy farmers on fodder garden establishment, use of supplementary feeds and hay making and use are summarized in Table 36. Majority of farmers (86% and 99%) are determined to continue with fodder establishment and use of supplementary feeds, respectively whereas only a few farmers (28%) intend to continue with hay making and use. Farmers opinion on fodder garden establishment and hay making and use differed ($P<0.001$) between districts. Hay making had not been adopted by most farmers and does not appear to be adopted in the near future. The sustainability of introduced technology depends on factors summarized in Table 37. The furtherance on fodder garden establishment depends on acquisition of more land as reported by 54% of respondents. Increase of milk price and livestock numbers influences the establishment of fodder garden as reported by 23% and 18%, respectively.

Table 36: Farmers' opinions on use of introduced FIT in Tanga, Muheza and Lushoto districts

Variable	Location			Total	χ2	Prob.
	Tanga	Muheza	Lushoto			
Fodder garden						
Yes	29(72.5)	35(87.5)	39(97.5)	103(85.8)	10.417	0.005***
No	11(27.5)	5(12.5)	1(2.5)	17(14.2)		
Supplementation						
Yes	40(100.0)	40(100.0)	39(97.5)	119(99.2)	2.017	0.365
No	0(0.0)	0(0.0)	1(2.5)	1(0.8)		
Hay making/use						
Yes	11(27.5)	2(5.0)	0(0.0)	13(10.8)	17.771	0.000***
No	29(72.5)	38(95.0)	40(100.0)	107(89.2)		

- Figures in parenthesis are percentage and those out of parenthesis are frequencies
- *, **, ***= Significant (P<0.05), (P<0.01) and (P<0.001).

Increase of milk price was more prominent in Lushoto as reported by 60% of respondents and land acquisition was a major factor in Muheza and Tanga as reported by 70% and 37% of respondents in Muheza and Tanga, respectively. Similar reason that shortage of land hamper adoption of land related technologies have been reported elsewhere (Elala, 1999; Senkondo *et al.*, 1998; Makauki, 2000). Future use of feed supplements will be influenced by the availability of supplementary feeds and milk fetching high price as reported by 84% and 24% of respondents, respectively. Availability of supplementary feeds was reported in all districts, milk fetching good price was observed only in Lushoto by 73% of respondents. Several studies have indicated that milk marketing constraint adoption of dairy technology in Sub-Saharan Africa (ILCA, 1993; Mathewman, 1993; Msoc, 1993). For example, Massawe *et al.* (1997) argues that effort to increase milk production through better utilization of forage should go hand in hand with enhancement of other infrastructure to facilitate milk marketing.

Table 37: Farmers opinions on use of introduced FIT in Tanga, Muheza and Lushoto districts

Technology	Factor	Location			Total
		Tanga	Muheza	Lushoto	
Fodder garden	Income increases	1(2.5)	3(7.5)	2(5.0)	6(5.0)
	Acquire more land	15(37.5)	28(70.0)	22(55.0)	65(54.2)
	Milk fetch high price	3(7.5)	0(0.0)	24(60.0)	27(22.5)
	Livestock increases	9(22.5)	4(10.0)	8(20.0)	21(17.5)
	Find high yielding cow	2(5.0)	1(2.5)	5(6.7)	8(6.7)
	Enough rainfall	3(7.5)	0(0.0)	0(0.0)	3(2.5)
Supplementary feeds	Income increase	2(5.0)	15(37.5)	0(0.0)	17(14.2)
	Milk fetch high price	0(0.0)	0(0.0)	29(72.5)	29(24.2)
	Livestock increases	0(0.0)	3(7.5)	1(2.5)	4(3.3)
	Feeds available	39(97.5)	23(57.5)	39(97.5)	101(84.2)

- Figures in parenthesis are percentage and those out of parenthesis are frequencies

4.12 Factors Influencing the Adoption of Technology

4.12.1 Factors influencing the adoption of fodder garden establishment

Results on factors influencing the adoption of fodder garden establishment are presented in Table 38. From the analysis the model had overall cases correct prediction rate of 86% and significantly at ($P<0.001$). Negelkerke R square showed the coefficient of determination between adopting fodder garden establishment and various independent variables, to be above 60%. This suggests that the selected independent variables sufficiently explained the probability of adopting the technology. Empirical evidence shows that seven out of the sixteen variables considered proved to have significant influence on adoption of fodder garden in the study area. Four of these, farm size, training on dairy husbandry, distance to the milk selling centres and price of milk in dry season were positive and significant. Age, price of milk in wet season and other income generating activities were negative but significant. Larger farm was observed to influence adoption of fodder garden. Thus, farmers with larger farm have higher probability of adopting fodder garden establishment. Dairy farmers living nearer to the urban centre tend

to own small plots (land size) hence lower adoption of fodder establishment, compared to farmers living in peri-urban areas. These results, matches with findings by Hussain *et al.* (1994) and Senkondo *et al.* (1999) who found that farmers with large farms were able to adopt technology than those with small farms. The result compare to those of Msuya, (1998) who found that farm size was among the factors that influenced adoption of hybrid maize in Mwanga district.

Attending training on dairy husbandry influenced adoption of fodder garden establishment positively, implying that training imparts knowledge to farmers on importance of established fodders garden in the dry season. Kisusu (2003) found similar trend where training on animal husbandry was important factor in adoption of improved dairy technologies. Similarly Ngasa (1979), cited by Mattee (1994) argued that inadequate training of farmers was one of the reason for low adoption of oxenization.

Closer distance from respondents' residence to the milk selling centres positively and significantly influenced adoption. Dairy farmer living nearer to the selling centres tends to sale all milk produced where respondents living far away fail to sell evening milk. Higher dry season milk price positively and significantly influenced the adoption of fodder garden establishment implying that substantial increases of milk price increases purchasing power. Increased income widen the chance of purchasing more land thus probability of more land devoted for fodder garden establishment. More or less similar trend was reported by Kisusu (2003) who observed increase of crop acreage for the major crops grown in Dodoma (maize, rice and millet) as result of introduced improved livestock technologies.

Table 38: Relationship between factors influencing adoption of fodder garden in Tanga, Muheza and Lushoto districts

Explanatory variable	Full name of coded variable	β	s.e	significance
AGE	Age of respondent	-0.143	0.062	0.022**
FARMH	Total land owned	0.508	0.243	0.036**
NONFAMILY	Total number in household	0.205	0.222	0.356
CREDDAIRY	Access to credit facilities	4.320	2.342	0.065
TRAIDAIRY	Attend animal husbandry course	4.756	1.657	0.004***
DISSELCE	Distance to milk sell centre	0.470	0.179	0.009***
TOTALIV	Total dairy cattle owned	0.348	0.190	0.67
PRICE DRY	Price of milk dry season	0.246	0.088	0.005***
PRICE WET	Price of milk wet season	-0.296	0.105	0.005***
DISTRESE	Distance to research centre	-0.032	0.099	0.746
NEARTRAI	Distance to training institution	-0.087	0.135	0.517
EDUC	Education of respondent	0.290	0.176	0.100
OTHERINC	Off dairy income generating activities	-4.691	2.114	0.026**
EXDAIRY	Dairying experience	0.077	0.132	0.556
INCDAIR	Income from milk sell	0.000	0.000	0.216
SEX	Gender of respondent	1.553	1.129	0.169
CONSTANT		4.193	6.364	0.510

- -Log likelihood 47.168, Cox & Snell R square 0.470, Negelkerke R square 0.627, Overall case predicted correctly 85.7%.
- *, **, *** = level of significances at 5%, 1% and 0.1% respectively.
- Negative sign prediction.

Low price of milk in wet season negatively and significantly influenced adoption of fodder garden establishment. Excess milk and lowered price discourage farmers from using more plots for establishment of fodder garden thus allocating more of available land for crop farming, which generates more income. Likewise availability of natural green forage during the wet season over and above livestock requirement in the communal land and open areas as pointed by Sarwatt, (1995) and Muyekho, (1999) render fodder garden establishment unnecessary option.

Probability of adopting fodder garden establishment decreased with age. Older dairy farmers have experience and accumulated capital for some time thus they can afford to invest in new technologies. However, with increasing age dairy farmers are unwilling to

take risk and receptivity of new technologies decrease with age as pointed by John, (1995). Other income generating activities negatively and significantly influenced adoption of fodder garden establishment. These imply that income accrued from other source was not likely to be used for fodder garden since majority (72%) of dairy farmers reported crop farming to rank first as other source of income apart from dairying. Rational dairy farmers will adopt technologies, which give high return to investment where milk price was observed to be low.

Other factors (members in the household, acquisition of credit for dairy purpose, total dairy livestock owned, distance to research and training centres, education, experience in dairying, income from sale of milk, and sex) did not have significant influence on adoption of fodder garden establishment. This is explained by the fact that fodder garden establishment is not a complex technology and can be experimented in limited basis as observed by CIMMYT, (1993) and Rogers, (1995). Furthermore, distance to research and training centres were negatively related to adoption of fodder garden implying that research-extension and farmer linkage was important in the adoption of this technology; farmers needed some knowledge on fodder garden establishment before they can adopt it. The results imply that policies to increase access to land and market will improve adoption of fodder garden establishment.

4.12.2 Factors influencing the adoption of feed supplementation

Results summarizing factors influencing the adoption of feed supplementation are presented in Table 39. From the analysis the model had overall cases correct prediction rate of 90% and significantly ($P<0.01$). Negelkerke R square indicated that the coefficient of determination between adopting feed supplementation and various independent

variables, to be above 50%. This suggests that the selected independent variables sufficiently explained the probability of adopting the technology.

Results show that three out of eleven factors examined significantly influenced adoption of feed supplementation. Two out of three factors have positive influence on adoption. These are large household and lower price of concentrates. Older age of respondent influenced adoption negatively. Large household influenced adoption positively and significantly. The possible explanation is the fact that family members provide required labour for dairy cattle management to increase milk yield with subsequent allocation of accrued income to purchase supplementary feed. Rangnekar, (2000) reported feed to account 70% of production cost in India whereas Msangi, (2001) and Kisusu, (2003) reported 55% and 35% for Turiani and Dodoma dairy farmers respectively. Average price of concentrate had a positive influence on the probability of adoption, where prices were low particularly during the harvesting period and more farmers used concentrates. Older age of farmers influenced adoption negatively implying that older farmers are not likely to use supplementary feeds given the fact that they have experience and accumulated income but are not wiling to invest in technology, which do not give higher utility given the low price of milk and unreliable market.

Table 39: Relationship between factors influencing adoption of feed supplementation in Tanga, Muheza and Lushoto districts

Explanatory variable	Full name of coded variable	β	s.e	significance
AGE	Age of respondent	-0.197	0.089	0.026**
NONFAMILY	Total number in household	0.753	0.345	0.029**
TOTALIV	Total dairy cattle owned	0.147	0.176	0.405
DISSELCE	Distance to milk sell centre	-0.202	0.172	0.240
TRAIDAIRY	Attend animal husbandry course	0.691	1.272	0.567
AVERPRIC(C)	Average price concentrate	0.056	0.023	0.017**
EXDAIRY	Dairying experience	-0.086	0.145	0.554
NEARTRAI	Distance to training institution	-0.025	0.060	0.679
PRICE DRY	Price of milk dry season	0.054	0.036	0.134
PRICE WET	Price of milk wet season	-0.035	0.037	0.346
EDUC	Education of respondent	-0.216	0.215	0.314
CONSTANT		-13.019	8.393	0.121

- -Log likelihood 32.843, Cox & Snell R square 0.333, Negelkerke R square 0.549. Overall case predicted correctly 90.3%.
- *, **, *** = level of significances at 5%, 1% and 0.1% respectively.
- Negative sign prediction.

Other variables hypothesized to influence adoption were positive but not significant. These are total dairy livestock owned, attending training on dairy husbandry and price of milk in the dry season. Likewise distance to the milk selling centres, experience in dairying, near distance to training centres, price of milk in wet season and years of education of farmer had negative coefficients and were not significant.

4.12.3 Factors influencing the adoption of Hay making or use

Factors influencing the adoption of hay making or use are presented in Table 40. The model had overall cases correct prediction rate of 94% and significantly at (P<0.001). Negelkerke R square showed the coefficient of determination between adopting hay making or use and other independent variables to be above 60%. This suggests that the selected independent variables sufficiently explained the probability of adopting the

technology. Among the nine considered factors, two variables influenced adoption negatively and they were not significant. These were age of the respondent and distance to the research centres. However, respondents in Tanga districts showed a positive response during focused group discussion that they can purchase and use hay if it can be commercially made and sold at reasonable prices in period with prolonged drought thus its use is dictated by extent of drought. Age of respondents on adoption of technologies tend to be location and technologic specific as pointed by Adesina and Baidu-Forson (1995). Purchasing of hay and use may be rejected by older dairy farmers who have experience on alternative way of solving dry season feeds shortage where their receptivity to new ideas and technologies decrease with age as pointed by John, (1995). Respondents being nearer to research centres did not influence adoption implying weak coordination in technology development and dissemination as pointed in many studies (Massawe *et al.*, 1997; Mtenga *et al.*, 1999; Sicilima, 2003).

Table 40: Relationship between factors influencing adoption of Hay making or use in Tanga, Muheza and Lushoto districts

Explanatory variable	Full name of coded variable	β	s.e	significance
EDUC	Education of respondent	0.079	0.206	0.703
AGE	Age of respondent	-0.104	0.086	0.227
NONFAMILY	Total number in household	0.761	0.493	0.123
TOTALIV	Total dairy cattle owned	0.371	0.245	0.131
NEARTRAI	Distance to training institution	0.664	0.506	0.190
AVERPRICE(M)	Average price of milk	0.002	0.035	0.952
SEX	Gender of respondent	0.302	0.120	0.788
EXDAIRY	Dairying experience	0.085	0.193	0.658
DISTRESE	Distance to research centre	-0.913	0.546	0.094
CONSTANT		-3.695	6.970	0.596

- -Log likelihood 28.239, Cox & Snell R square 0.331, Negelkerke R square 0.622, Overall case predicted correctly 93.7%, - Negative sign prediction.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Study was conducted to asses' dairy production, extent of farmers' awareness and adoption of available technologies for improving feed quality in Tanga region. Five conclusions are summarized in the next sections.

5.1.1 Farmers' awareness on feed improvement technologies

The outcome of the study showed that all dairy farmers were aware of introduced feed improvement technologies which were fodder garden establishment, concentrate supplementation (energy, protein and minerals), and hay making. Thus Low milk production was not associated with farmers' unawareness on available feed quality improvement technologies, but was associated with improper use and implementation of introduced feed improvement technologies.

5.1.2 Farmers strategies in feeding animals in dry season

Based on the findings of the study, dairy farmers were knowledgeable on available natural forages used to feed livestock as basal diets. Period of feed scarcity during the dry season were reported to last for seven months, from September to March. Pasture collection was labour and time demanding activity taking a maximum of eight and a minimum of half hours, with an average of fours hours in the dry season. The animals were stall-fed throughout the year, and were managed by family and hired labour. To overcome dry season feed shortage farmers depended on natural green forage from swampy areas, crop

farms, riverbanks, coconut plantation, established fodder garden and crop residues. The commonest physical and chemical methods used to treat crop residues was chopping of straws and stovers, chopping and sprinkling with water mixed with common salt, and chopping and sprinkling with Magadi (Sodium sesquicarbonate), a natural occurring alkali.

5.1.3 Rate of adoption of the introduced FIT

The findings indicated that rate of adoption was higher on fodder garden establishment (63%) followed by concentrate supplementation (15%) and hay use (8%). High price of supplementary feeds coupled with seasonality in availability was identified as a major factor contributing to low adoption of this FIT in the study area. Furthermore, absence of market and low price of milk constrained adoption of concentrate supplementation in Lushoto. Probability of adoption of FIT was associated with farmers' direct participation in the project coupled with input prices and availability and milk price.

5.1.4 Intensity of adoption of introduced FIT

The study revealed that intensity of adoption of fodder garden establishment was 50% where land under fodder garden was less than 0.2ha compared to 0.4ha proposed by the project. Feed supplementation had an intensity of 65%. The feeding rate was recorded at 2.6kg/cow/day compared to 4kg/cow/day and mineral supplementation 25% i.e. 20g/cow/day compared to 80g/cow/day. Reasons cited for such trends include land scarcity for fodder garden and high price and seasonality in availability of feeds and mineral supplements.

5.1.5 Factors influencing adoption of introduced FIT

Large farm, attendance to training on dairy husbandry, closer distance to the milk selling centres and high price of milk in dry season positively and significantly influenced adoption of fodder garden establishment. However, age of respondent, price of milk in wet season and other income generating activities influenced negatively but significantly. This implies that farmers with larger farms, who attended training on dairy husbandry, living closer to the milk selling centres and high price of milk in dry season increases the probability of adopting fodder garden establishment. Excess milk and low price in wet season discourage farmers from using more plots for fodder garden establishment, hence allocating more of available land for crop farming, which give high return to investment. Older farmers have experience and accumulated capital, but unwilling to take risk. Large household and lower price of concentrates positively and significantly influenced adoption of feed supplements whereas; older age of farmers influenced adoption negatively. Large household provided required labour for dairying leading to increased milk yield with subsequent allocation of accrued income to purchase supplementary feed. Low price of supplementary feeds particularly during the harvesting period increased the probability of using concentrates. Adoption of hay making and use was not influenced by any of considered factor since it was used in prolonged draught only.

5.2 Recommendations

Ministry of Water and Livestock Development need to develop policy in collaboration with NGOs and Private sector, which will encourage milk utility such as drinking and processing to increase shelf life and price.

Ministry of Co-operatives and Marketing through its extension workers need to impart knowledge and skills and assist dairy farmer on how to establish and manage Dairy

farmers' cooperative societies to utilize economies of scales in milk marketing and acquisition of supplementary feeds. Thus, assist in collection and transportation of milk, which cannot be sold locally in the area and take, advantages of economies of scale and reduce transactions costs that are incurred by individual producers to look for buyers for their small quantities of milk. The co-operative society could purchase dairy input (feeds supplements and minerals) from input supplier outside the districts at discounts. For example, using the same vehicle to transport milk to Dar es Salaam city and transport dairy inputs such as concentrates and minerals supplements back to the district to improve adoption of feed supplementation.

Due to rapid growth of peri-urban and urban livestock keeping the Ministry of Land in collaboration with District councils, need to formalize livestock keeping with legal backing and establish minimum acreage by-laws which will be allocated to peri-urban and urban smallholder dairy livestock keepers to enhance adoption of fodder garden.

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APPENDICES

Appendix 1: Questionnaires used for assessment on farmers awareness and adoption of available technologies for improving feed quality in Tanga region

District.....Division.....Ward.....Village.....

Questionnaire number.....Name of farmer.....

A BACKGROUND INFORMATION

Please tick or circle the appropriate answer where applicable.

A1 What is your level of education? 1= No formal education [ ] 2 = Primary school [ ] 3= Secondary school [ ] 4=Collage and above [ ]

A2 Sex: 1= Male [ ] 2=Female [ ]

A3 Religion: 1= Muslim [ ] 2=Christian [ ] 3=traditional [ ] 4=others (specify) [ ]

A4 What is your age in years.....

A5 Marital status: 1=single [ ] 2=married [ ] 3=divorced [ ] 4=widow [ ]

A6 What is the size of your family? ..... (Numbers).

A7 How many participate in dairy activities?

A8 Main Occupations:

i) Employed by government/NGO [ ] ii) Not employed [ ] iii) Petty business [ ] iv) Tailor [ ] v) Farming [ ] vi) Fishing [ ] vii) Carpentry [ ] viii) Casual labour [ ] ix) Other specify [ ] ...

A9 Household Farm size.....acres

A10What is the estimated land used for:

i) Pasture and Fodder production.....acres. Mention Pasture and Fodder grown.....

ii) Food crop production.....acres. Mention food crops grown.....

iii) Cash crop production.....acres. Mention cash crop grown.....

A11 How did you acquire the land?

i) Inherited [ ] ii) Rented [ ] iii) Bought [ ] iv) Allocated by village authority [ ] v) Others (specify).....

A12 If different plot were acquired differently please specify how each plot was obtained.

B HERD INFORMATION

B1 When did you start keeping dairy cows? .....

B2 Why did you start keeping dairy cows?

1=Main economic enterprise [ ] 2=Supplementary enterprise [ ] 3= Home milk consumption [ ] 4=others (specify) [ ]

B3 Where did you obtain you dairy cows?.....

B4 How many dairy animals did you start with?.....

B5 Who is the owner of the dairy animal? 1=Husband, 2=Wife 3 =Other (specify).....

B6How many dairy animals do you have now?

Class of live.	Milking cow	Dry cow	Bull >1.5 years	Bull 1 -1.5 years	Heifer1-2years	Calves <1 year	
Total						M	F

Livestock enterprise

B7 What other types of livestock do you keep?

Type	Indigenous cattle	Goats	Sheep	Pigs	Donkeys	Chickens	Others (specify)
Total							

B8 What income do you get from dairy activities? Tsh per months.....

B9 What are other income generating activities other than dairying? .....

B10 Rank the income generating activities in B9 in order of importance? .....

B11 Who does the following operations?

i) Milking: 1= Husband [ ] 2=Wife [ ] 3= Children [ ] 4=Hired labour [ ]

ii) Feeding: 1= Husband [ ] 2=Wife [ ] 3=Children [ ] 4=Hired labour [ ]

iii) Cleaning of barn: 1= Husband [ ] 2=Wife [ ] 3=Children [ ] 4=Hired labour [ ]

B12 Which periods of the year are you faced with highest farm activities? (Months).....

B13Which farm activities?.....

C FEEDING SYSTEM

C1What systems of feeding are you practicing? 1=zero grazing [ ] 2= partial grazing [ ] 3=tethering [ ] 4=others (specify) [ ]

C2 Which season, do you practice the mentioned feeding system? 1=Wet [ ] 2= dry [ ] 3=throughout the year [ ].

a) Pasture/fodder

C3 What are the main sources of feed materials commonly used as livestock feed in wet season? ...

Rank in order of importance.....

C4 What are the main sources of feed materials commonly used as livestock feed in dry season? ...

Rank in order of importance.....

C5 What are the main sources of feed materials commonly used as livestock feed available throughout the year?.....

Rank in order of importance.....

C6 Name of feed materials used in: i) dry seasons.....ii) Wet seasons.....iii) Both wet and dry seasons.....

C7 How long does it take to collect pasture in: i) Dry season.....hours

ii) Wet season.....hours

C8 Do you experience a period of feed shortage where pasture/fodder/forage are not adequate? 1= yes [ ] GO TO C9 2=No [ ] GO TO C 11

C9Which period of the year feed shortage do occur? (State months).....

C10What do you do when pastures are not adequate to overcome problem of feed shortage? ....

C11 Do you experience period of excess forage 1=Yes [ ] GO TO C12, 2= No [ ] GO TO C 15

C12 Which period of the year? (Months).....

C13 Does your cows produce milk to their expected potential? 1=Yes [ ], 2= No [ ]

C14 What is the expected potential lt of milk per day.....

C15 What could be the reason for production below potential? i) High costs of supplementary feeds ii) Inadequate pasture iii) Seasonality in feeds availability iv) Combination of 1 and 2 v) Others (specify).....

C16 What are the major problems encountered in feeding your animals?.....

b) Crop residues

C17 Do you feed crop residues to your animals? 1=Yes [ ] GO TO C18, 2= No [ ] GO TO C21

C18 What type of crop residues are you feeding? (Mention) .....

C19 Do you treat them before feeding? 1=Yes [ ] GO TO C20, 2= No [ ] why not treat?...

C20 If yes indicates type of crop residues and treatment involved.

Type of crop residues	Treatment involved
1	
2	

c) Energy and Protein Concentrate

C21 Do you feed concentrate to your cows? 1=Yes [ ] GO TO C22, 2= No. [ ] GO TO C24

C22 i) When do you feed?.....ii) Amount fed to each animal.....

C23 What are the types of concentrate used? .....

C24 What is your mixing ratio?.....

C25 If not using why? 1=Not available in time, 2= Price is high, 3=Not available in required quantity, 4 others (specify) .....

d) Minerals supplements

C26 Do you offer minerals supplements to your cows? 1=Yes [ ] GO TO C27, 2= No [ ] GO TO C28

C27 which minerals? Mention them .....

C28 If no why?.....

C29 How frequently do you feed concentrate and minerals supplements to you animals? 1=During milking 2= Once a week 3= Twice a week 4=once a month 5= twice a month 6= only when supplement are available.

C30 Which class of animals do you feed concentrate and mineral supplement? 1=milking herd, 2=pregnant animals, 3= 1 and 2, 4=all animals, 5= other (specify)

C31 Give purchasing price in Tanzania shillings per kg of each concentrate and minerals used? i.e. maize bran..., cotton seedcake,... Sunflower seedcake,.....leucaena leaf meal,..... minerals.....and hay per bale...

D AWARENESS ON THE AVAILABLE TECHNOLOGIES

D1 Did you participate in the Tanga Small holder Dairy Development Project (TSDDP) which is now transformed to Tanga Dairy Trust (TADAT) 1=Yes[ ] GO TO D2, 2= No[ ] GO TO D4

D2 If yes since when?.....1=TSDEP (1985-1989, 2=TSDDP (1990-1994), 3=TDDP (1995-1999), 4=TADAT (2000-2004)

D3 If you did not participate in the project in its first phase could you give reason as to why you did not...

D4 Are your aware of feed improvement technologies introduced by the project? 1=Yes [ ] GO TO D5, 2= No [ ]

D5 What are the feed improvement technologies introduced by the project?.....

D6 Which of these technologies in D5 are your practicing?.....

D7 For each practiced technology quantify it? E.g. Area under fodder garden.....

C21 Do you feed concentrate to your cows? 1=Yes [ ] GO TO C22, 2= No. [ ] GO TO C24

C22 i) When do you feed?.....ii) Amount fed to each animal.....

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D6 Which of these technologies in D5 are your practicing?.....

D7 For each practiced technology quantify it? E.g. Area under fodder garden.....

Hay quantity produced.... or purchased..... Concentrate type.....and quantity used....

D8 Among the technology introduced by the project mention those which you are not practicing

D9 Give reason of why not practicing technology mentioned in D8.....

D10 For those who have adopted technologies. Which of the following statements accurately describe the major reason motivated to use FIT. Key 1=AGREE, 2=DISAGREE.

Characteristic of technology	*Technologies*		
	Fodder garden establishment	Use of concentrate	Hay making/ Purchasing
1. Adequate information from extension agent			
2. Easy to understand /cheaper to use/implement			
3. Availability of capital/cash/ credit facilities			
4. Less labour required			
5. Less time consuming			
6 Increase milk above ordinary production			
7. Easy to acquire raw materials (input)			
8. Herd size is small			
9. Farm size big			
10. Culture compatible			
11. Women were involved			
12.Low cost in implementing the technology			
13. Others (specify)			

D11Who makes decision on the use of following?

i) Feed improvement technologies? 1=Husband [ ] 2=wife [ ] 3=both [ ]

ii) Land use? 1=Husband [ ] 2=wife [ ] 3=both [ ]

D12 What is your future plans or would you be able to continue with the activities being promoted on:

a) Fodder garden establishment?..... 1=Yes Explain 2=No Explain

b) Use of supplementary feeds?.....1= Yes Explain 2=No Explain

c) Use of hay?.....1= Yes Explain 2=No Explain

D13 In your view, do you think feed improvement technologies introduced are the true needs for increasing milk production? 1=Yes Explain 2=No Explain

E TRAINING AND EXTENSION SERVICES

E1 Did you receive training on dairy husbandry before starting dairy enterprise? 1=Yes [ ] GO TO E2 2= No. [ ] GO TO E8

E2 If yes from where.....

E3 For how long? 1=1 week [ ] 2= 2 weeks [ ] 3=1month [ ] 4=over 2months [ ]

E4 Who sponsored the training?.....

E5 During the training did your learn on feed improvement technologies 1=Yes [ ] Explain technologies learned, 2=No [ ]

E6 Was the training useful after starting the dairy enterprise? 1=Yes Explain 2=No Explain

E7 Do you still needs more training on dairy husbandry? Yes [ ] No [ ]

E8 Are there any cultural/ beliefs hindering the use of feed technologies? 1=Yes [ ] 2=No [ ]

E9 If yes name them.....

E10 How far is the distance to i) Nearest Research centre...km ii) Training Institution...km

E 11 Do you have contact with the extension agent? Yes [ ] GO TO E 12, No[ ] GO TO E16

E12 If Yes how often does the extension officer visit you? i) Daily [ ] ii) once a week [ ] iii) once in a month [ ] iv) once in three month[ ] v) other (specify) [ ]

E13 Is the advice provided by the extension officer on feed improvement technologies practices? i) Adequate [ ] ii) Inadequate [ ] iii) Undecided [ ]

E14 Apart from the project is there any other organization providing extension service particularly on feed improvement technologies? Yes [ ] GO TO E 15, No[ ] GO TO E14

E15 If yes which organization?.....

E16 If no how do your acquire information on dairy husbandry?.....

F MILK PRODUCTION, CONSUMPTION AND MARKETING

F1 Please kindly give the amount of milk produced per cow per day in lts? Morning .....Evening .....

F2 Please kindly give the amount of milk consumed per day in lts.....

F3 Please kindly give the amount of milk sold per day in lts.....

F4 Please kindly give the price of milk sold per day during 2003/04 in lts: i) dry season.....ii) wet season....

F5 Do you have a ready market of milk produced? Yes [ ] GO TO F 6, No [ ] GO TO F 8

F6 If yes what is the market 1=Business, 2=Neighbour 3=kiosk 4= others specify....

F7 How far is the selling centre from you residence?.....

F8 What are the problems do you face in disposing milk produced?.....

F9 How do you overcome those problems in E8 above?.....

G CREDIT FACILITY

G1 Have you ever obtained credit for dairying purposes? Yes [ ] No [ ]

G2 If yes fill the following table.

Year obtained	*Credit Source*	*Credit Forms*	*Uses of credit*	*Amount/Value of credit in Tsh*

Appendix 2: Explanatory variables hypothesized to influence adoption of FIT

Variable and label	Description of variable	Type of measure	Likely sign	Explanation behind
AGE (X1)	Age of respondent	Number in years	+ or -	Aged farmer may have access to improved technology, but risk averseness increase with age
EDUC (X2)	Education of respondent	Number of years in school	+	More years, more exposure and higher capacity to grasp new idea
SEX (X3)	Gender of respondent	Dummy (1=Male, 0=female)	+ or -	Depending on culture male, adopt differently, female have less access to resource.
FARMH (X4)	Total land owned	ha	+	More land to allocate for new crops, access to information and credit
NONFAMILY (X5)	Total number in household	Numbers	+	More people more labour, adopt better technology to increase income
EXDAIRY (X6)	Dairying experience	Number in years	+	Experienced farmers are more likely to try new innovation
OTHERINC (X7)	Off dairy income generating activities	Dummy (1=without, 0=otherwise)	+ or -	May or may not adopt technologies of inferior outcome
TOTALIV (X8)	Total dairy Livestock owned by farmers	Numbers	+	Farmers with more livestock are better placed in terms of risk bearing ability, access to information, resources and extensions services
CREDDAIRY (X9)	Access to credit facilities	Dummy (1=access, 0=otherwise)	+	Access to credit enhance adoption Initial cost to resource poor farmer
MILKMAR (X10)	Access to market for milk	Dummy (1=access, 0=otherwise)	+	High price of output. Sales to consumer no middleman
TRAIDAIRY (X11)	Attend animal husbandry course	Dummy (1=Attend, 0=Otherwise)	+	Training on dairy husbandry expose farmer to new information and subsequent adoption
DISSELCE (12)	Distance to milk sell centre	km	- or +	Near to urban easy marketing and high Price of milk, rural or peri-urban land size is large thus determine adoption
PRICE WET (13)	Price of milk wet season	Tsh	-	Low milk price in wet season decrease probability of adoption
PRICE DRY (14)	Price of milk dry season	Tsh	+	High milk price in dry season increase probability of adoption due to increased income
AVERPRIC (15)	Average price concentrate	Tsh	+	Average cost for purchasing of technology improve adoption
NEARTRAIN (16)	Distance to training institution	km	-	Near to training institute more exposure to various technology more likely to adopt
DISTRESE (17)	Distance to research centre	km	+	Closer to research centre higher probability of adoption
INCDAIR (18)	Income from milk sell	Tsh	- or +	Higher income from milk sell higher probability of adoption and vice versa