A STUDY OF THE FACTORS INFLUENCING OFFTAKE AND MARKETING OF MILK AND MILK PRODUCTS AROUND DODOMA TOWN

BY

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ABSTRACT

This work was carried out in Dodoma Urban district to study the milk production situation and the existing milk utilization options in the areas sorrounding Dodoma town in central Tanzania. The study was carried out by the use of a questionnaire, observations and direct recording. Fifty producer households and 61 non - producer households were interviewed. In addition, a total of 20 batches of milk produced by 20 households were evaluated for fat recovery efficiency using traditional churning methods.

The results showed that there were on average 33 head of cattle per household. Cattle demography composed of 46 % cows, of which 21 % were in milk; 15 % heifers, 21 % males and 24 % calves. The calving rate was less than 50 %. The lactation length was on average 9.72 ± 2.34 months with a coefficient of variation of 24 %. Mortality rates were 17.6 % and 3.8 % for calves and adult cattle respectively. On average 70 % of the cows produced milk in the range of 0.25 - 0.50 l of milk per day, while the rest produced above 0.50 to 2.00 l per day.

Watering of animals was done once per day in 94 % of the herds and for the rest it was done twice per day. Grazing time was on average 7.38 h for herds that grazed continuously during the day and 6.48 h for herds that had partial rest in kraals during the day.

Producer households utilized 43.5 %, 32.0 % and 23.4 % of the milk for household processing, direct consumption and sales respectively. Non - producer consumers obtained milk through purchases. Of the 61 non-producer households, 57 % obtained milk within the village, 28.6 % between 2 and 10 km and 14 % from more than 10 km. Consuming households living far away from the producers were supplied with milk through bicycle-boys as intermediaries. Milk price which ranged between TSh.26.60 and TSh.120.00 per litre of milk was positively correlated ($r = 0.68$) to distance from the source.

For producer households, the amount of milk sold was significantly dependent ($P < 0.001$) on total milk production per household per day. Household consumption and household processing decreased the amount of milk sold significantly ($P<0.001$). Family size was positively and significantly ($P< 0.05$) correlated to herd size, daily milk output and processing with coeficients of correlations of 0.69, 0.66 and 0.66 respectively.

Only fermented milk, butter and ghee were found to be produced with buttermilk as a by - product in the fat recovery process. The capacity of gourds that were used in churning sour milk ranged betwwen 4.5 to 28.0 l while the average volume of milk churned was 3.6 l (range 1.3 to 7.5 l) representing a churn capacity fill of 31 % on average (range 6.8 to 62.5 %). The sour milk churned had

a pH range of 3 to 5 and was churned at an average temperature of 26 °C. Churning time averaged 28.8 minutes (range 10 to 50 minutes). Overall efficiency of fat recovery using traditional churning methods ranged between 57.5 % and 85 % with an average of 71.6 %.

It is concluded that the production levels and management systems, milk marketing and milk processing coefficients found in this study are similar to those reported elsewhere for traditional agro-pastoral systems in Africa. Recommendations that could bring about improvements in all the aspects studied are given.

DECLARATION

I, CHIGUNJE NICANORY HARUN ARAUDOBA, do hereby declare to the Senate of the Sokoine University of Agriculture that this dissertation has not been submitted for a higher degree award in any other University.

Signature:.....

Date:1-9-1993

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DEDICATION

This work is dedicated to my parents

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LIST OF ABBREVIATION

AOAC	Association of Official Analytical Chemists
CCM	Chama cha Mapinduzi
DAFCO	Dairy Farming Company
h	Hour
IDF	International Dairy Federation
ILCA	International Livestock Centre for Africa
km	Kilometres
kg	kilogram
l	Litre
MALD	Ministry of Agriculture and Livestock Development
m.a.s.l.	metres above sea level
MC	Moisture content
ml	mililitres
mm	milimetres
TBS	Tanzania Bureau of Standards
TDL	Tanzania Dairies Limited
TS	Total Solids
SAS	Statistical Analysis Systems
SNF	Solids Not Fat
SPSS	Statistical Package for Social Sciences
TSh	Tanzania shillings

1. INTRODUCTION

Milk and its products have traditionally been an important food item in most parts of Tanzania. As a source of protein milk is important particularly among some nutritionally vulnerable groups, that is children and lactating mothers. For the pastoral systems, milk meets up to 25 % of the family's caloric requirements, and has an important economic value (Kerven 1987).

Milk consumption levels in Tanzania, however, remain low by international standards. Per capita milk consumption was estimated at 22.2 l in 1977 and targeted to rise to 24.8 l in 1981 (Mpelumbe *et al.* 1978) and 30 l by the year 2 000 (Ministry of Agriculture and Livestock Development MALD 1984).

In Tanzania, milk is produced from four main sources namely; parastatal farms, government institutions, smallholder commercial farmers and the traditional sector. The parastatal farms, government institutions and the small scale commercial farmers are considered to be commercially oriented and own about 200 000 (MALD 1988) grade and pure exotic cattle while the traditional sector which owns about 12.4 million heads of cattle is considered to be non-commercial (MALD 1988). The big herd owned by the traditional sector contributes up to 80 % of all the milk produced in the country (MALD 1988).

Currently, the government and donor agencies concentrate their efforts on intensive dairy production and milk processing based on high technology plants designed to make foreign milk products. This fact is explicitly indicated in the Livestock Policy for Tanzania (MALD 1984) which puts emphasis on the expansion and reinforcement of commercial dairy farms under the Dairy Farming Company (DAFCO) and milk processing by the Tanzania Dairies Limited (TDL). The policy also aims at encouraging smallholder commercial farmers by providing them with pure or grade heifers, veterinary support and technical advice. The policy, however, does not show clear plans for the indigenous systems of milk production, processing and marketing of the traditional products and the welfare of the people who make them.

It is assumed that the traditional sector in Tanzania will remain the major supplier of milk to the increasing human population in the country for a long time to come. This is because of the large traditional herd and the dominance of the zebu cattle in this sector which are genetically well adapted to the climate, diseases and parasites found in the tropics (Galukande *et al.* 1962). The other contributing factor to this fact is the need for foreign exchange to import exotic cattle for milk

production or for upgrading the local herd which is in most cases not available when needed.

Despite this fact, there is little information on the local production systems, collection, processing and marketing channels in the traditional sector.

Objectives of the study

This study was an attempt to look at the potential and limitations of the traditional herd in terms of milk production, milk processing and milk and milk products utilization options in a semi-arid area surrounding Dodoma town.

The specific objectives of this study were:

a. To characterize milk production systems, and milk production levels within and around Dodoma urban areas.

b. To determine factors influencing milk utilization options and type of products made at the household level.

c. To determine the efficiency of household level milk processing in relation to product recovery and quality.

d. To describe the marketing channels for milk and milk products from production areas to Dodoma Municipality.

2. LITERATURE REVIEW

2.1 Herd management

Management of the herd entails all the processes involved in raising the herd to achieve the production target. In general terms, herd management differs in different production systems, that is, it depends on whether the herd is for milk production, meat production or dual purpose. The management will also depend on the age of the animal, physiological status and its sex.

Despite the differences in the management in different herds, some management practices are common to different groups of animals. These practices include feeding and watering of the animals, disease control, milking and disposals (Williamson and Payne 1978).

2.1.1 Cattle ownership

In the traditional sector, cattle ownership is almost entirely by individuals, with herd sizes ranging from a few heads to several hundreds or at times to a few thousands (Chikaka and Foote 1978). Okanta (1991) has reported that the number of cattle in smallholder farms in the plains of Accra in Ghana varied from 20 to 200 with a few herds with up to 500 head. A survey of 50 households in Mara region in Tanzania by Chikaka and Foote (1978)

revealed that the herd sizes in the sample ranged from 17 to 143, and the number of cows milked at the time of the survey ranged from 3 to 42 per household. Another observation from the study was that the number of cattle owned depended on the age of the owner as shown in Table 2.1.

From this table it is seen that smallest herds were owned by the youngest farmers while the largest herds by the older people aged between 51 - 70 years. This trend could be attributed to the fact that older people are less responsive in disposing of their cattle, as for the older age groups, social or cultural values take precedence as the main stay of cattle keeping (Msechu 1988).

Studies in Mbeya by Akarro (1987) revealed that cultural background, type of agro-ecological zone and management tend to influence herd ownership patterns. This study indicates that ownership of the cattle ranged from 25 % to 70 % of the family population.

2.1.2 Herd composition

Herd composition or demography can be defined as the relative number of different age groups and sex of animals given as a percentage of the total herd.

Table 2.1 : Sample smallholders: Cattle ownership by producer age groups, 1976

Age in years	No. of herds	Cattle owned by producer					Total[1]
		Cows					
		Milking	Dry	Heifers	Bulls	Calves	
30 - 40	2	12	2	6	8	11	40
41 - 50	8	21	6	12	8	22	68
51 - 60	26	21	4	10	7	21	63
61 - 70	10	22	4	8	7	21	62
Over 70	4	21	8	14	12	23	78
Average		21	5	10	8	21	65

[1] Figures may not add up to 100 due to rounding

Source : Chikaka and Foote (1978)

The age and particularly the sex composition of herds is regulated by their function, these being, investment, draught power and meat or milk for subsistence (Wilson 1986). In the study by Wilson (1986) on cattle husbandry in the agro-pastoral system in Central Mali it was found that in herds where milk is the major product, the percentage of breeding females was approximately 40 % and about 25 - 27 % of the herd can be expected to be lactating at any one time (see Table 2.2). The results showed that the sedentary ethnic groups used their herds mainly for milk production and draught as a result had proportionately higher percentages of castrates which are used for draught. On the other hand, transhumant ethnic groups who kept cattle for milk production alone, had the highest proportion of females above 3 years and the lowest proportion of castrates.

Other studies (Wilson and Clarke 1976; Meadows and White 1979) in southern Sudan and in the southern pastoral districts of Kenya showed the following trends or proportions on herd basis: bulls and steers (32 %), cows and heifers (60 %) and calves (17 %).

In conclusion it can be noted that in many livestock production systems the number of females is higher than that of other groups.

Table 2.2: Cattle herd demography in central Mali

Ethnic group	Type of Management	Use of herd	Sex and age of herd (% of total herd)								
			Males				Females				Castrate
			Less than 1yr	1-3 yr	3 yr and above	Total	Less than 1yr	1-3 yr	3yr and above	Total	
Bambara	Sedentary	Milk and draught	5.6	8.5	32.7	46.8	6.2	11.3	35.7	53.2	32.3
Mixed	Sedentary	Draught and Milk	7.2	9.3	46.3	62.8	5.7	11.1	20.2	37.0	43.4
Rimaibe	Sedentary	Milk and draught	15.0	13.0	8.0	36.0	15.0	12.0	38.0	65.0	7.0
Fulani	Transhumant	Milk and Transport	9.9	12.0	15.0	36.0	10.2	15.2	36.1	62.0	9.3
Fulani	Transhumant	Milk	9.0	6.0	6.0	21.0	10.0	24.0	45.0	79.0	4.0
Tuareg	Nomadic	Milk and transport	16.3	9.3	12.2	37.8	9.8	14.7	37.6	62.1	12.9

Source: Wilson (1986)

Note: Not all percentages add up to 100 because of rounding

2.1.3 Grazing management

Natural pastures are the main and cheap sources of nutrients to cattle managed extensively. Under the agro-pastoral or pastoral systems , the herds are generally grazed over communal areas belonging to the traditional communities. There is generally very little or no supplementary feeding in the herds, either for the calves or for the adults, especially during the dry season when grazing pastures are very poor in terms of quantity and quality (Okanta 1991).

Mgheni and Petersen (1986) reported that, grazing hours in the extensive husbandry system practiced within tribal zones limit animal productivity in terms of growth rate, reproductive performance and production of meat or milk. These authors reported a maximum allowance of grazing hours of between 4 -5 per day. Grazing hours in Karnal India were reported by Agarwal and Sharma (1986) as being on average 7.6 hours per day. They also reported that some herds grazed for less than 3 hours a day and others for more than 8 hours a day.

Long grazing periods have the advantage of allowing the animals to forage more feed to satisfy their nutritional requriements for increased production. In

this respect night grazing for cattle in the milking herd is recommended (Williamson and Payne 1978). Night grazing is prevented in many cases in the traditonal sector by fear of predatory animals and possibility of theft (Chikaka and Foote 1978).

2.1.4 Watering management

Water is more vital for the maintenance of the animals life than any other food component. It is the main constituent of all body fluids, being essential for the transport of nutrients to body tissues and the excretion of waste products through the urine and faeces. Water requirements increase with growth, processes such as lactation and with increased physical exercise as when animals are worked and when the animal is subjected to heat stress or grazed on too fibrous feed like hay (Castle and Watkins 1984; Schimidt and Van Vleck 1974).

Water requirements apparently vary between different species, between breeds or varieties within species and between individuals within breeds (Williamson and Payne 1978). Oba and Lusigi (1987) reported that during periods of severe drought, the pastoralists of Northern Kenya (Borana and Gabra), kept livestock away from water for much longer periods than during a normal dry season and

distance to water is substantially increased. Under these conditions cattle are watered every three or four days while sheep and goats are watered once every five to seven days. Other results (Baudelaire 1972) indicated that during the dry season, cattle must drink once a day or once every two days, according to whether they are being raised by intensive farming or extensive ranching. Average water requirements of some livestock in the semi-arid tropics are summarized in Table 2.3.

While the results by Williamson and Payne (1978) as shown in Table 2.3 recommend a higher frequency of drinking in goats and sheep, Oba and Lusigi (1987) reported higher frequencies in cattle than in goats and sheep. From these results, camels have the lowest frequency of drinking water. However, the reported drinking frequencies in cattle are lower than those recommended by Castle and Watkins (1984) who recommend an ample supply of water especially to cows in milk which should get as much water as they need throughout the grazing period to increase milk production since over 85 % of the milk is water. It is therefore apparent that the water intake in semi-arid zones is not enough to support high milk yield.

Table 2.3 : Average water requirements of some types of livestock in semi-arid tropics in the dry season

Type of livestock	Average daily water requirements (l)	Frequency of drinking
Camel	60 - 80	Every 4-5 days or longer
Cattle	30 - 40	Every 1-3 days
Sheep	4 - 5	Every 1-2 days
Goats	4 - 5	Preferably once a day

Source : Williamson and Payne (1978).

2.1.5 Calf rearing

It is absolutely essential for the new-born calf to drink an adequate amount of the cows first milk - colostrum; ideally as soon as possible after birth and certainly within the first 18 hours of life (Webster 1984). Colostrum carries the maternal antibodies essential to protect the calf from the infections it will experience in early life, before it generates its own active system of immunity. Brignole and Scott (1980) have shown that the calves which fail to drink sufficient colostrum early on have a greatly increased risk of succumbing to infection. Other results (Roy 1970) have indicated that calves that did not receive colostrum had higher mortality rates (9 %) than those that received colostrum (4 %).

(a) Feeding systems

Some traditional calf rearing systems encourage consumption of colostrum. Kerven (1987) reporting on the rearing systems in South Darfur, Sudan, showed that when a herd's milk output is not greater than can be handled by available labour, the usual practice is to allow the calf to take all the milk for the first 10 days of its life and thereafter to milk two of the cow's teats until the calf is several months old. The calf will then he allowed to

suckle only one teat until it is about 6 months old after which almost all the milk will be taken for human use.

The consumption of milk by calves is controlled by tethering them when the herd is in camp and taken to water and pastures separately from the adult herd (Kerven 1987). Similar rearing principles have been reported by Wagenaar *et al.* (1986) in Mali and Niger. The rearing systems do not incorporate supplementary feeding for calves. The lack of supplementary feeding in calves was also reported by Okanta (1991). In the absence of supplementary feeding in calves and where milk offtake is high the result is a negative implication for vigour and health of calves (Coppock *et al.* 1990).

(b) Weaning systems

Deliberate weaning is practiced by some tribes. Nicholson (1984) reported that the Delta Fulani wean their calves at the age of 11 - 12 months for the purpose of inducing oestrus in cows. Fulani herders smear dung on the teats to discourage the calf while the pastoralists of the Accra plains tie a piece of rope to the calf's nose and the Somali tie a strip of thorn to the nose of the calf to inhibit suckling (Nicholson 1984).

The feeding and weaning systems all require a balance between the welfare of the calf and the needs of the human being in terms of milk as food or cash earner. The mentioned practices seem to have been evolved to cater for these two important antagonistic needs of the farmer, that is the survival of the calf and the use of milk by man to the extent that an equilibrium can be considered to have been established.

2.1.6 Milking practices

Traditionally milk is harvested by hand and no machine milking has been reported in this sector. It is common practice to milk cows twice a day; in the morning and in the evening (Mgheni and Petersen 1986; Majubwa 1987).

In India, Agarwal and Sharma (1986) report that the animals are generally milked in the stall of the milk producers twice per day. They further report that about 33 % of the households were milking their animals once a day when the animals were in the advanced stage of lactation or yield was very low.

Otchere (1982) (as cited by Nicholson 1984) reports that in the Maasai and Borana societies, hand milking is done before cattle leave their night enclosures and again on their return in the evening. He further reports that the White Fulani cattle in Nigeria are milked only once in the morning. The Fulani tribe in Mali, milk their animals in the evening and the calves remain with their dams throughout the night (Diallo *et al.* 1981).

2.2 Age at first calving

Age at puberty is an important determinant of reproductive efficiency. Whereas puberty is a gradual quantitative phenomenon occuring when the gonads begin to secrete sufficient steroids to stimulate the growth of the genital organs and the development of secondary sexual characteristics (Mukasa - Mugerwa 1989), reproductive efficiency is defined as the measure of varying degrees of fertility (Bath *et al.* 1985).

Bos indicus cattle reach puberty later than purebred *Bos taurus* cattle or *Bos taurus* x *Bos indicus* crossbreeds. This is due to genetic and environmental factors, including nutrition, disease, temperature and season of birth (Gordon 1983).

A review by Mukasa - Mugerwa (1989) reported estimates of age at puberty in *Bos indicus* cattle in the tropics and sub-tropics to range between 16 and 40 months (Table 2.4).

In other studies (N'diaye 1982 and Sangare 1983, as cited by Wilson 1986) conducted in the Fulani and Tuareg societies, the age at first calving was found to be between 48 to 49 and 62 months respectively. Wilson (1986) reported that in long studies in the millet and rice sub-systems around Niono, the average age of first calving of 20 heifers, the exact age of which were known, was 49.5 ± 3.4 months. Other results (Mbah *et al.* 1991) indicate that age at first calving in Guladi zebu in Adamawa Cameroon is 53 ± 8.5 months.

Studies on age at first calving in Tanzania (Machunda 1977) working with zebu cattle in Singida, Arusha, Mwanza and Mara regions showed a mean age at first calving of 4 - 5 years with a low calving rate of 50 %. Akarro (1987) studying the performance of the traditional herd in Mbeya region reported the mean age at first calving to be between 3 and 4 years. The relative earlier age at first calving reported by Akarro (1984) for Mbeya region compared to that by Machunda (1977) can be

Table 2.4 Some estimates of age at puberty among *Bos indicus* cattle in the tropics and sub tropics

Breed	Location	Estimate (mo)
Boran	Kenya	15.6
Africander	Louisian (USA)	18.1
Mashona	Central Africa	19.0
Sokoto Guladi	Nigeria	19.0-23.5
Brahman	Florida (USA)	19.4
Angoni	C. Africa	20.0
Africander	C. Africa	20.0
Kankrej	India	22.5
Zebu	Ethiopia	22.6
Brahman	Venezuela	23.3
Brahman x Sahiwal	Tanzania	26.0
Brahman	Louisian (USA)	27.2
Haryana	India	30.0
Zebu	Somalia	31.5
Gir	India	36.7
Red Sindhi	India	36.7
Ankole	Rwanda	37.0
White Fulani	Nigeria	40.2

Source: Mukasa - Mugerwa (1989).

attributed to the bigger nutritional potential of the Southern highlands where Mbeya region belongs as compared to the general poor climatic condition of the regions of Singida, Arusha, Mwanza and Mara.

2.3 Milk yield and lactation length

Several methods are now employed to measure the milk secreting ability of the cow. It is generally accepted to measure milk yield in weight (kg) or volume (l), such that one litre of milk is considered to be equivalent to one kg of milk, although the exact equivalent is 1.03 kg (Castle and Watkins 1984). Genetic and environmental factors influence milk production. Every genetic group of cows has its milk producing potential. Among the environmental factors known to affect milk yield are age, parity, year, season, farm or management and nutrition (Sing and Jain 1988; Kiwuwa 1974).

Lactation length denotes the period when a cow is in milk and it is used as a measurement of the total amount of milk produced during the lactation. Williamson and Payne (1978) suggested that this period begins on the fourth day after calving and ends when the cow goes dry.

2.3.1 Milk yield

In high-yielding *Bos taurus* animals milk offtake is a reliable indicator of total milk yield since let-down and retention problems are rare (Nicholson 1984). In contrast, in *Bos indicus* cattle milk let down will not be readily achieved without the stimulus of their calves (Nicholson 1984; Mgheni and Petersen 1986; Majubwa 1987).

In modern milking systems involving *Bos taurus* cattle, milk is measured volumetrically, that is, in litres, rather than weighed - for example in graduated recording jars, or by flow meter from a bulk tank (Castle and Watkins 1984). In determining milk yield in *Bos indicus* cattle, many efforts have been made to objectively determine milk yield in this group of cattle by inducing milk let-down without the calf but these have proved to be difficult. Some of the techniques used include the weekly administration of oxytocin to allow complete milking out, before and after weighing of calves using dial scales with calf slings and using calf dummies covered with dead calves skin (Nicholson 1984).

Because of the complications involved in determining the actual amount of milk production in *Bos indicus* most figures indicated by many authors are estimates. Some of these estimates are shown in Table 2.5. The lower

Table 2.5: Estimated lactation yield (kg) of Zebu cattle under pastoral conditions

Breed	Location	Yield per cow (kg)	Record period (mo)
White Fulani	Nigeria	535	6
Maasai	Kenya	800	10
Delta Fulani	Mali	430	6
Boran	Ethiopia	680	7
Boran	Kenya	518	7

Source : Adapted from Nicholson (1984)

estimate of 578 kg over 7 months for Boran in Kenya may be due to the drier environment when compared to the estimated yield in the same group of cattle in Ethiopia over the same recording period. It could also be due to genetic differences between the two strains of the Boran found in the two countries.

Many other authors have reported on the milk yield in Zebu cattle. These include Mbah, Tawah and Messine (1991), Butterworth and McNitt (1984) and Getz (1974) who reported lactation yields of 373.7 ± 49.4 kg for Guladi zebu, 308 kg for Malawi zebu and 410 - 900 kg for Tanzania Shorthorn Zebu respectively.

Because many traditional systems do not record their production activities other researchers concentrate on daily yields which can easily be evaluated. Among these are Alberro and Haile - Mariam (1982) who reported a daily yield of 2 litres by shorthorn zebu in Ethiopia. Other results (Wilson 1986) have indicated that offtake usually varies from 0.4 - 0.9 l per day per cow milked, but may rise to 2.5 l per day in the growing season for agropastoral systems in Central Mali. The same author found that milk supply depended more on the number of cows being milked than on the individual yield, this being a function of the time of calving. It is therefore

understood that the milk supply fluctuates widely over the year.

2.3.2 Lactation length

Lactation length is considered to be highly variable. Due to the great variations in lactation length, a 305 day lactation length has been internationally accepted as a standard (Johansson 1961).

Because lactation length in zebu cattle is directly related to suckling of the calf, and because many traditional systems do not practice forced weaning of their calves, the lactation length in this sector is very variable. Such variation is shown in Table 2.6.

2.4 Calving rates and calving interval

2.4.1 Calving rates

Calving rate is defined as the number of calves born as a percentage of the number of cows bred (Williamson and Payne 1978).

Calving rate in a herd depends on the fertility of the herd which is a parameter dependent on a number of factors. These factors include non-pathological factors and pathological factors. Asdell (1968) and Ensminger (1968) named the non-pathological factors as being under

Table 2.6 : Average lactation length in Zebu cattle

Type of cattle	Location	Lactation length (mo)	Author(s)
White Fulani	Nigeria	6	Nicholson (1984)
Maasai	Kenya	10	Nicholson (1984)
Baggara and Fellata	South Darfur (Sudan)	10-12	Kerven (1987)
Kenana	Sudan	6.6	Saeed, Ward and Light *et al.* (1987)
Zebu	Ethiopia	Less than 7	Gryseels and Anderson (1983)
Zebu	E. Africa	8	Mahadevan (1966)
Zebu	Tanzania	4-7	Chikaka and Foote (1978)
Zebu	Tanzania	3-4	MALD (1988)

Mo = Months

feeding, vitamin and mineral deficiencies, and inheritance while the pathological factors include diseases like Brucellosis, Vibriosis and Trichomoniasis.

Herd fertility will also depend on the bull to cow ratio such that Minish and Fox (1982) have indicated that young bulls can be put at the 1:30 ratio and mature bulls at 1:60 ratio. Table 2.7 shows the relationship between bull to cow ratio as far as fertility rate is concerned, when the state of health, nutrition environment and level of management of the bulls and cows are optimum.

Many researchers have reported on the calving rates in the traditional sector. These include Willison and Clarke (1976), Hall (1973) and International Livestock Centre for Africa - ILCA (1983) who put it at 65 %, 50 % and 75 % respectively. Other results by Wilson (1982) indicate that calving rates in traditionally managed herds in Mali are in the range of 53 - 59 % and they can go up to 76 % in good years.

2.4.2 Calving interval

Calving interval refers to the period between consecutive calvings and is a function of days open (period from calving to next conception) and gestation length (Agyemang and Nkhonjera 1986). Since gestation

Table 2.7: **Pregnancy rates of breeding herds with various bull to cow ratios (average bull age 2 years)**

Farm	A	B	C	D	E	F	G
Bull to female ratio	1/25	1/44	1/44	1/43	1/60	1/60	1/60
Bulls' age(s) (yr)	2-4	2	2	2	2	2	2
Female pregnant after 21 days (%)	74	64	73	19	40	72	63

Source: Minish and Fox (1982)

length is more or less constant for a given breed, the number of days open to conception become the sole variable of calving interval (Danasoury and Bayoumi 1963, Auran 1974).

Indigenous cattle have long calving intervals. The calving interval in this group of cattle has been shown to be influenced by environmental factors, that is, management and nutrition. Kidner (1981) noted that long calving intervals in Kenya were due to too much reliance on pasture and little or no concentrate feeding during post-lactation dry period. He further cautioned that if body weight losses are not corrected before the cow calves down again, irregular heat periods and long calving intervals should be expected.

Long calving intervals reduce the number of calves that will be produced in the life time of the dam (Mahadevan and Hutchson 1964). Schmidt and Van Vleck (1974) recommended open periods of 60 - 90 days as being ideal for efficient production in dairy herds. Sartone and Ladeth (1985) indicated that calving interval was related to yield of milk and its protein content such that cows with high milk and protein yields tended to have a long calving interval.

A review by Mgheni and Petersen (1986) on the calving interval in zebu cattle reveal the results shown in Table 2.8. The results show that zebu cattle of West Africa which are smaller in size have relatively short calving intervals when compared to the large sized Indian zebu. In all the cases, the calving interval in zebu cattle is found to be not less than a year. This argument is also supported by the findings of Sing, Rent and Jain (1986) and MALD (1988) who report intervals of 598 ± 18 days and 540 - 720 days respectively.

2.5 Mortality

2.5.1 Calf mortality

Calf mortality rate is defined as the number of calves that die in a given period compared to the number of calves born for that same period, usually one year, and is given as a percentage.

Calf mortality is an important economic parameter in zebu cattle as well as in cross-bred animals or pure bred *taurus* breeds. It is mainly associated with the adaptability of cattle, nutrition, diseases and other management practices in the farm.

Table 2.8 : Variability of calving interval in Zebu

Breed	Country	Calving interval (days)
Red Sindhi	India	427 - 540
Haviana	"	444 - 631
Tharpakar	"	430 - 457
Sahiwal	Kenya	439 - 580
Sahiwal	Kenya	450
N'Dama	Ivory Coast	440
White Fulani	Nigeria	365 - 450
Bulana	Sudan	416
Kenana	Sudan	395

Source : Extracted from Mgheni and Petersen (1986)

Milk production in zebu cattle is induced by the presence of the calf due to the high maternal instincts in this group of cattle (Nicholson 1984, Majubwa 1987). Due to this reason, milk production cannot be sustained after the death of the calf. It can therefore be concluded that calf mortality in zebu cattle is more serious a parameter as far as milk production is concerned.

In the traditional sector, calf mortality is often as high as 50 % (Williamson and Payne 1978). In a study in Kagera region, Tanzania, Mutagwaba *et al.* (1991) put it at between 26.0 - 27.2 %.

Sex differences in calves as far as calf mortality rate is concerned have been reported. Ranatunga (1965) have reported mortality rates in male calves and female calves as being 6.4 and 5.2 % respectively. Other results by Odedra (1979), support sex differences in calf mortality. The author reports age and sex differences in mortality rate in Gir calves. Table 2.9 summarizes the results. In all age groups the mortality in male calves was higher than the mortality in female calves. The reason to this was considered to be management differences between female calves and male calves where the former are cared for more as future replacements of the milking herd.

Table 2.9 : Age and sex - wise mortality rate in Gir calves

Age groups	Mortality rate (%)	
	Male	Female
Birth - 1 month	6.16	4.20
1 month - 3 months	3.42	2.58
3 months - 6 months	0.88	0.53
6 months - 1 year	0.59	0.26
Birth - 6 months	10.19	7.15
Birth - 1 year	10.47	7.28

Source : Odedra (1979)

2.5.2 Adult cattle mortality

Adult cattle mortality is not very high in most cases and varies a lot. Wilkins *et al.* (1979) report a mortality rate of 2.9 % in adult zebu cattle. This rate is similar to that reported by ILCA (1978) in Maure and Peul cattle in Mali. Other results for zebu cattle in East Africa are 23 % (Williamson and Payne 1978). Mgheni and Petersen (1986) reported that in Tanzania the adult cattle mortality in Tanzania Shorthorn Zebu ranges between 8.1 % to 23.5 %.

2.6 Milk and milk products utilization

Cow milk is used for different purposes by traditional farmers. With the exception of the regions in which collection is organized, milk is generally consumed on the spot or sold in the neighbourhood in a liquid state without any prior treatment. But a certain proportion of the production which varies greatly in the regions, may undergo traditional processing. This is the case particularly where the producers have no outlet for their milk in the neighbourhood. It is therefore transformed into fermented milk, butter or ghee (Larrat and Veisseyre 1989).

Although the manufacture of many dairy products necessitates high technical and capital inputs, there is a range of products suitable for small scale processing at the farm level using simple equipment. Some of the common products in the traditional sector are fermented milk (O'Mahony and Peters 1987), butter and ghee (O' Mahony 1988).

2.6.1 Fermented milk

Production of fermented milk is widely spread in Tanzania. In most tribes milk is allowed to ferment naturally without addition of starter culture (Ryoba and Kurwijila 1991). The souring of milk has a number of advantages; it retards the growth of undesirable microorganisms such as pathogens and putrifactive bacteria and makes churning easier (O'Mahony 1988). Natural fermentation of milk exploits lactic-acid producing streptococci and lactobacilli which are present in any type of milk (Waters-Bayer 1986).

Milk is collected over a number of days in a clay pot vessel of 2 - 4 l volumetric capacity or a bottle gourd (O'Mahony and Bekele 1985) which are produced locally and allowed to develop acidity up to 1 % lactic acid. In cold weather the container is kept near the fire to keep it warm. Fermented milk is normally smoked

using specific wood which produce ambers in the fire (Shallo 1987, Kurwijila 1988). Smoking appears to improve the flavour and extend the shelf life up to 20 days to 3 months (Bekele and Kasaye 1987). Soured milk is consumed as a side dish or churned to butter.

2.6.2 Butter making

Butter can be produced under small scale conditions by churning either sour whole milk or ripened cream (O'Mahony and Bekele 1985). The milk is usually agitated by placing the churn on a mat or on the floor and rolling it to and fro. It can also be agitated by shaking the churn on the lap or hung from a tripod. The churn is normally a bottle gourd or an earthware jar, but any water tight vessel of required volume is suitable (O'Mahony and Bekele 1985).

The gourds are washed with hot water and scrubbed with a curved stick. For rinsing, two or three lots of very hot water are shaken in the gourd until all the milk residues are removed and the gourd is placed for a whole day in the sun (Shallo and Hansen 1973). After drying the gourd, smoking is conducted by placing the glowing ambers of a fire from a special tree inside the gourd and pressed against the inner wall.

The efficiency of churning, normally measured as the amount of fat recovered from a given amount of milk churned is highly variable in traditionally churned milk. The efficiency of churning being affected by a number of factors including, the percentage of fat in the whole milk churned, the acidity of the churned milk, and the temperature of the milk. (O'Mahony and Bekele 1985). Other factors are the capacity of the churn, amount filled and extent of agitation (O'Mahony and Peters 1987).

The influence of the different factors affecting churning efficiency of milk was studied by O'Mahony and Bekele (1985) and summarized their results as shown in Table 2.10.

The data presented in the table reveal that churning time was long on most of the 25 farms studied. However, some other factors could probably have affected the extremely long churning times in some farms which also showed higher fat recovery. Milk acidity was high on nearly all of them. Churns were usually either over-filled or under-filled. In conclusion these researchers noted that, in addition to being labour intensive, traditional churning methods are inadequate to cope with a substantial increase in milk supply.

Table 2.10: Churning efficiency observed on 25 farms in the Ethiopian highlands, 1983 - 84

Farm	Qty of milk (l)	Acidity % LA	Fat in whole milk (%)	Milk temp (^{0}C)	Churning time (min)	Fat in butter milk (%)	Fat recovery (%)
1	4	0.92	4.2	19	18	1.0	76
2	4	0.90	5.5	17	39	1.0	81
3	5	1.05	5.2	17	88	1.0	80
4	3	1.15	5.3	19	34	1.1	79
5	17	1.04	4.0	17	219	0.5	87
6	10	0.70	4.3	23	52	0.9	56
7	17	1.03	3.5	19	95	0.7	80
8	2	0.75	4.3	22	35	0.6	86
9	12	0.88	3.4	19	72	0.3	91
10	9	0.90	4.9	12	63	0.6	87
11	18	1.03	4.5	18	98	1.6	64
12	17	0.43	3.6	19	303	0.3	91
13	5	0.83	3.2	17	89	2.0	37
14	5	0.88	4.1	17	53	1.5	63
15	7	0.93	2.3	18	114	0.9	60
16	3	0.30	6.0	17	67	1.2	80
17	3	0.78	4.4	19	40	2.0	60
18	19	1.00	4.7	17	111	1.8	62
19	17	1.00	4.7	17	96	1.4	70
20	19	1.00	4.7	17	146	0.8	83
21	7	0.86	4.7	19	39	1.0	78
22	7	0.90	4.5	25	46	0.7	84
23	11	0.61	4.5	16	145	0.3	93
24	17	1.00	5.0	16	105	1.4	72
25	5	1.02	5.2	20	75	1.2	76

Source : O'Mahony and Bekele (1985)

2.6.3 Ghee making

Many people in the rural areas do not use butter as a spread on bread or baking. Most of the butter is converted to ghee (Ryoba and Kurwijila 1991).

Ghee, also known as butteroil, or dry butter fat, consists of fat which is almost completely free from water, protein, milk sugar and mineral substances (McDowall 1953).

The principle behind ghee making is the removal of moisture from butter, but in India, the product may be made by direct evaporation of milk or cream (Madan and Rajorhia 1975).

Melting butter is achieved by heating the butter in a saucepan made of clay or stainless steel cooking pan over a slow fire until all the moisture has evaporated (Ryoba and Kurwijila 1991). Other studies (O'Mahony and Peters 1987) indicate that butter melting is achieved by heating it to 60^{0}C in an equal volume of water followed by centrifugal separation which gives a good butterfat yield, free from non-fat milk solids and containing not more than 1.5 % moisture. After heating the ghee is left to cool and is packed in normal bottles at room temperature.

Things to observe during heating of the butter is to avoid excessive foaming which causes a lot of losses and

overheating at the bottom of the vessel which causes burnt flavour and colour changes. These can be counter effected by using big vessels for melting and frequent stirring (Ryoba and Kurwijila 1991).

2.6.4 Quality of the products

Quality of the milk products can be considered in terms of keeping time without spoilage and on the composition of the desirable constituents of that particular product.

The International Dairy Federation - IDF (1961) describes keeping quality as a function of bacteriological metabolism and catalytic reactions due to the presence of certain metals. These factors are further influenced by milking hygiene, cleanliness of milking equipment and other environmental influences like feeding, weather and place where the cows live.

The shelf life of naturally fermented or sour milk is only 72 h at ambient temperature (Ali 1990). Shallo (1987) and Kurwijila (1988) report that smoke application among some tribes improve the flavour and keeping quality. Similar results are reported by Bekele and Kassaye (1987) who report increased keeping quality of smoked sour milk up to 20 days to 3 months.

Butter is normally overchurned and not washed, factors which favour a high moisture content in butter with consequent short shelf life. Since the smallholder farmers do not have refrigerators butter is prone to deterioration (O'Mahony 1988).

Ghee can keep for 1 - 3 years (Bekele and Kassaye 1987) at room temperature because the heat treatment, low moisture content and salt addition in ghee, prevents development of hydrolytic rancidity, growth of microorganisms and has a preservative effect (O'Mahony 1988).

The composition of different dairy products and by-products depending on the process involved were studied and summarized by O'Mahony and Peters (1987) the results are shown in Table 2.11.

Other results O'Mahony and Bekele (1985) indicate that traditional buttermaking produces butter of a highly variable moisture content, that is, between 2 - 43 % (mostly less than 16 %).

The moisture content in milk and milk products influences the rate of bacterial growth and thus affecting their storage stability. The low moisture content of

butter and ghee retard bacterial growth, and as a result, they keep longer than whole milk and buttermilk (McDowall 1953). Table 2.11 shows that moisture content decreases with the processes of producing the milk products. It can be expected therefore, that ghee will keep longer than butter, buttermilk and milk in that order. This suggestion is verified by the findings of Bekele and Kasaye (1987) and Ali (1990).

2.7 Marketing and consumption patterns

Marketing includes all those business activities involved in the flow of goods and services from production to consumption (Brokken and Williams 1990).

In every case where production is by smallholders and dispersed, and where equipment of farms is inadequate to ensure good keeping quality of the milk, and where the producer has no rapid means of transport which would permit him to deliver to the plants or retail shops himself, directly and very rapidly, the establishment of collecting depots become necessary (Larrat and Veisseyre 1969).

Milk collection and transportation is geared at providing milk to the community. It is of little importance whether transport from the farm to the

Table 2.11: Process and composition of dairy products and by-products

Process	Dairy production	Moisture	Fat	Non-fat solids
Natural fermentation	Sour milk	88.5	2.2	9.3
Churning sour milk	Butter milk	91.5	1.4	6.9
	Butter	16.5	80.5	3.0
Moisture removal by boiling	Butter oil (ghee)	0.1	99.8	0.1

Source : Extracted from O'Mahony and Peters (1987)

collecting centre is by porters, pack animals, bicycles or carts provided the journey is done in less than 3 hours and the containers used correspond to the standards set to achieve the best hygienic results (that is, water tightness, hermetic covering, easy to clean, sterilizable) and are protected from the rays of the sun (Larrat and Veisseyre 1969).

In Tanzania because of the breakdown of the established collection routes managed by processing plants, milk vendors have started to collect milk and sell directly in towns (MALD 1988). The Dairy Development Programme (MALD 1988) indicates that fresh milk intake by TDL processing plants has declined over the past decade due to breakdown of collection vehicles, cooling centres, deterioration of roads, ageing of machinery and failure of some plants to pay farmers for milk delivered. Majubwa (1987) in a study of milk marketing in the Masai of Morogoro district reported that the common methods for transportation of liquid milk was by headloads, by women, followed by children and by bicycles among the youth.

Most of the traditional dairy products are marketed through interhousehold sales and exchange, rural trading centres and the common weekly rural market days (Ashimogo and Kurwijila 1990, Majubwa 1987).

In Tanzania, milk consumption in rural areas depends on the role of livestock in various farming systems. Mpelumbe *et al.* (1978) reported an average consumption of 60 ml per day of milk per head, while Majubwa (1987) reported an average of 2.4 l per day per head for Masai people living in Morogoro rural district. Average consumption figures of 0.84 l and 1.75 l per day per head have been reported respectively for small scale households and large scale group ranches in Kenya (de Leeuw, Bekele and Grandin 1984). Other consumption figures for Tanzania include those reported by MALD (1983) who estimated the per caput milk consumption to be 22.4 l in 1983 and targeted to rise to 28.0 l by the year 1990 and Kurwijila (1988) who estimated a national average consumption of milk to be about 22.4 l and 39.0 l for the year 1986 for rural and urban consumers respectively.

From a global point of view, a great number of factors influence the marketing and consumption of dairy products. Among these factors are family size (Agarwal and Sharma 1986), age and education level of household head (Tambi and Vabi 1990). Others are daily herd production of milk (Prabahan and Sivaselvam (1986), marketing distance (Kurwijila and Mdoe 1989) and income of the household (Seyoum 1989). Other factors are herd size, value of farm assets and expenditure on inputs (Tambi and

Vabi 1990) and price of the product (Seyoum 1989; Debrah and Anteneh 1991).

2.7.1 Family size and milk consumption

The family size of a household is expected to influence the amount of milk consumed. Big families will consume more than small families under normal circumstances. Table 2.12 shows the relationships between family size, milk output, consumption and sales. Other results (Prabahan and Sivaselvam 1986) show the relationship between production, consumption and sales of milk in sample households as summarized in Table 2.13. The results in these tables show that consumption was more related to production than on the family size *per se*: For example, from Table 2.12, families with more than 16 members consumed less milk than families in the 8 - 11 members group because the former had a lower production of milk than the latter. However average sales were higher in the biggest families than the smallest ones, perhaps due to the big obligations by the bigger families for making purchases to meet other family demands.

From Table 2.13 it was observed that the landless and small farmer households did not retain milk for processing to milk products. Among landless and small farmer households 23.14 % and 28 % of the milk was being

Table 2.12: Family size in relation to milk output, consumption and sales in Karnal, India

Family size	Households	Output (l)		Consumption (l)			Sales (l)		
	Number	Total	Average[a]	Total	Average	%[b]	Total	Average	%[c]
0 - 3	2	10	5.0	4.8	2.4	48.0	5.0	1.0	20.0
4 - 7	7	99.5	14.2	23.8	3.4	23.9	50.5	7.2	50.7
8 - 11	11	558.0	50.7	122.5	11.1	36.2	200.5	18.2	59.3
12 - 15	2	126.5	15.8	62.0	8.5	53.5	47.5	5.9	37.3
16 - above	3	94.5	31.5	32.0	10.6	33.9	53.9	17.3	61.1
Total or average	31	888.5	22.1	251.1	8.1	37.5	358.5	11.6	58.6

Source: Agarwal and Sharma (1986)

[a] Average of Total with respect to number of households

[b] Percentage of total consumption with respect to total output

[c] Percentage of total sales with respect to total output.

Table 2.13: Production, consumption and sale of milk by sample households

Land holding (acres)	Milk prod/ household/ day (kg)	Milk prod/ animal/ day (kg)	Per capita consu- ption of milk/ day (kg)	Consumption per house hold per day (kg) Unpro- cessed milk	Proce- ssed milk	Total	% Total produ- ction	Sale of milk/ house hold/day	% Total produ- ction	% Contri- bution to marketed surplus
Landless	3.490	1.120	0.176	0.300	-	0.300	23.14	2.990	76.86	19.51
Small	3.900	2.350	0.124	1.120	-	1.120	28.22	2.840	71.78	18.53
Medium	8.450	2.400	0.415	2.220	0.380	2.600	40.27	3.850	59.73	25.10
Large	10.720	2.480	0.384	3.260	1.121	4.381	45.72	5.339	56.28	34.83

Source : Prabahan and Sivaselvan (1986)

used for household consumption respectively. As land holding size increased, daily milk production also increased and the quantity retained for home consumption also increased. The percentage share of milk sold to total production declined as land holding size increased.

2.7.2 Marketing distance

It is generally held that given the poor transportation systems in the traditional marketing systems; those involved in the marketing of milk, or milk products spent a lot of time walking to the market places and so the quantity and frequency of carrying their products to the markets is low. Kurwijila and Mdoe (1989) report an average frequency for sending milk to the market for Kilimanjaro highlands, Tanzania to be about twice a week. Studies elsewhere (Coppock, *et al.* 1990) have shown that on an annual basis, households within 10 km of market, sold dairy products twice per week on average, whereas those beyond 20 km only sold once per month. The study also showed that peasants near milk collection centres appeared to sell more fresh milk and less butter and cheese than those farther from the centres. Peasant producers near Addis Ababa sold more milk, butter and cheese per household than those farther away.

2.7.3 Income

The influence of income on the consumption of dairy products has not been widely studied in Tanzania. Studies on the influence of income on the consumption of other food items however have been done (Mrema 1984). In the study, it was shown that as the income increased, consumption of goods of animal protein origin (meat and fish) increased. A similar relationship can be assumed to exist between income and the consumption of milk and milk products.

Household survey information for urban Chad showed that at low income levels, relative expenditure on milk actually falls as income rises, suggesting that there are other food and/or household priorities to fulfil (Seyoum 1989). The same study revealed that at higher income levels the proportion of expenditure on milk increases consistently with income while at the same time there appears to be a switch from curd towards more fresh milk consumption, and supplementation with condensed milk as income goes up.

The consumer surveys in West Africa, suggest that milk and milk products consumption patterns are influenced by income growth.

2.7.4 Price

The price of dairy products influences both the amount that will be offered in the market and that which will be purchased by the final consumer (Debrah and Anteneh 1991; Seyoum 1989; Chikaka and Foote 1978).

Chikaka and Foote (1978) studying marketing trends of dairy products in Mara region, Tanzania reported that price had a minor influence on milk in the area since milk was a traditional component of the diets of most families. A similar observation was made by Seyoum (1989) who found that in West Africa, the influence of price on milk consumption patterns was shadowed by other factors like, differences in consumption habits, in milk quality, in marketing and in price policies. In Ethiopia, the sale of milk was not directly influenced by price but rather by the reliability of the outlet (Debrah and Anteneh 1991). This means that farmers would sell more of their dairy products when the possibility of having their products bought exists, than where high prices are offered but the reliability for selling of the products is low.

CHAPTER 3

MATERIALS AND METHODS

3.1 The study area

3.1.1 Geographical location

Dodoma town is the major administrative and business centre of Dodoma region situated in Central Tanzania (Figure 1). The town is in Dodoma urban district which is one of the four districts of Dodoma region. The others are Dodoma rural, Kondoa and Mpwapwa (Figure 2). It extends from 6°S to 6°30'S and from 35°E to 36°E covering an area of about 6794 square kilometres.

3.1.2 Climate and topography

The topography of the district has an altitude range of 200 m to 1500 m.a.s.l. and annual rainfall ranging from 400 to 600 mm under a unimodal pattern. It lies in ecological zones IV and V according to the classification system of Pratt and Gwynne (1977). These are respectively, semi-arid to arid.

3.1.3 Soils and vegetation

Soils are predominantly sandy and sandy loamy with limited support to a wide range of crops or permanent pastures. The dominant grass species in the area are

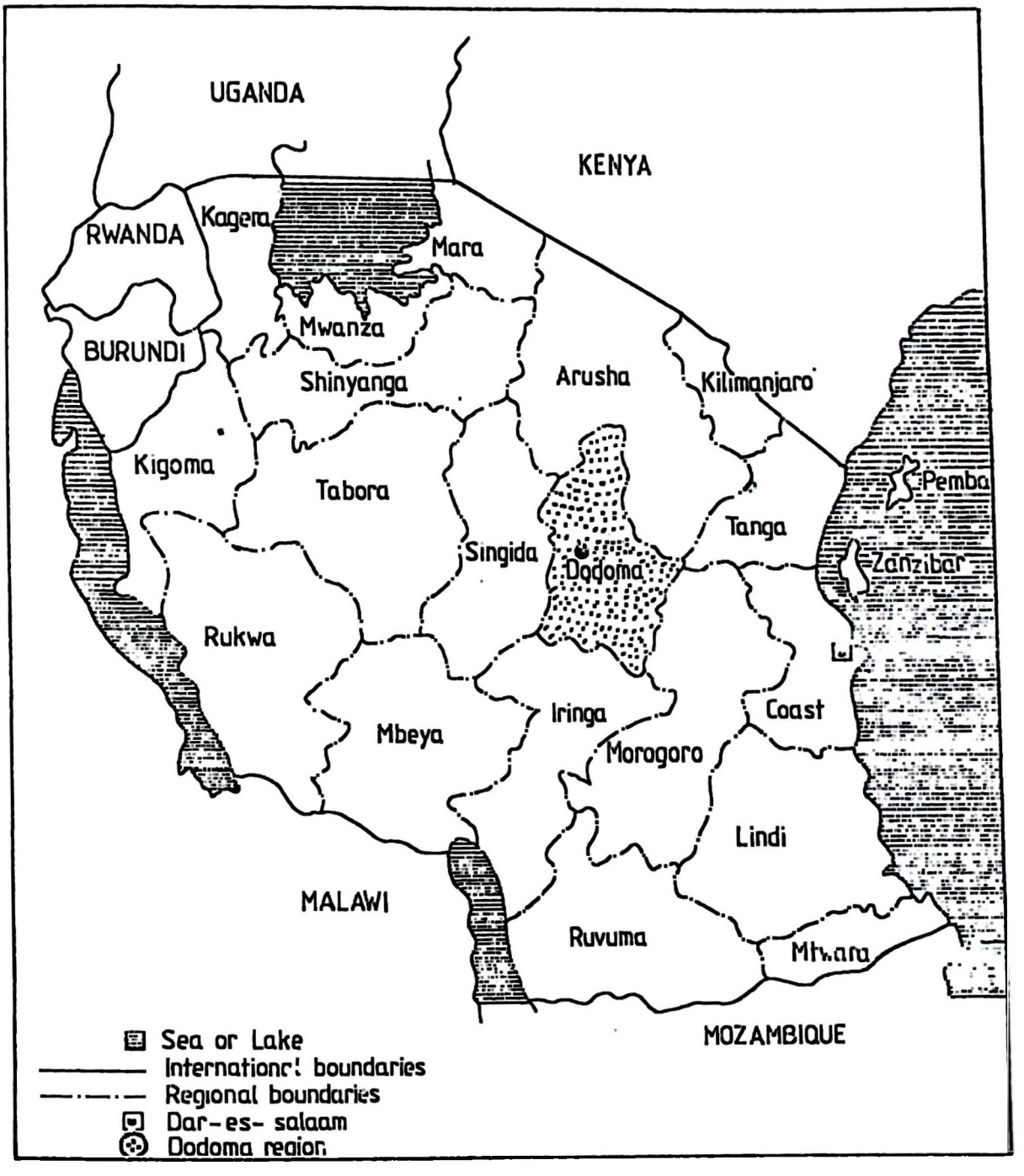


Fig. 1 : Map of Tanzania: Regional boundaries

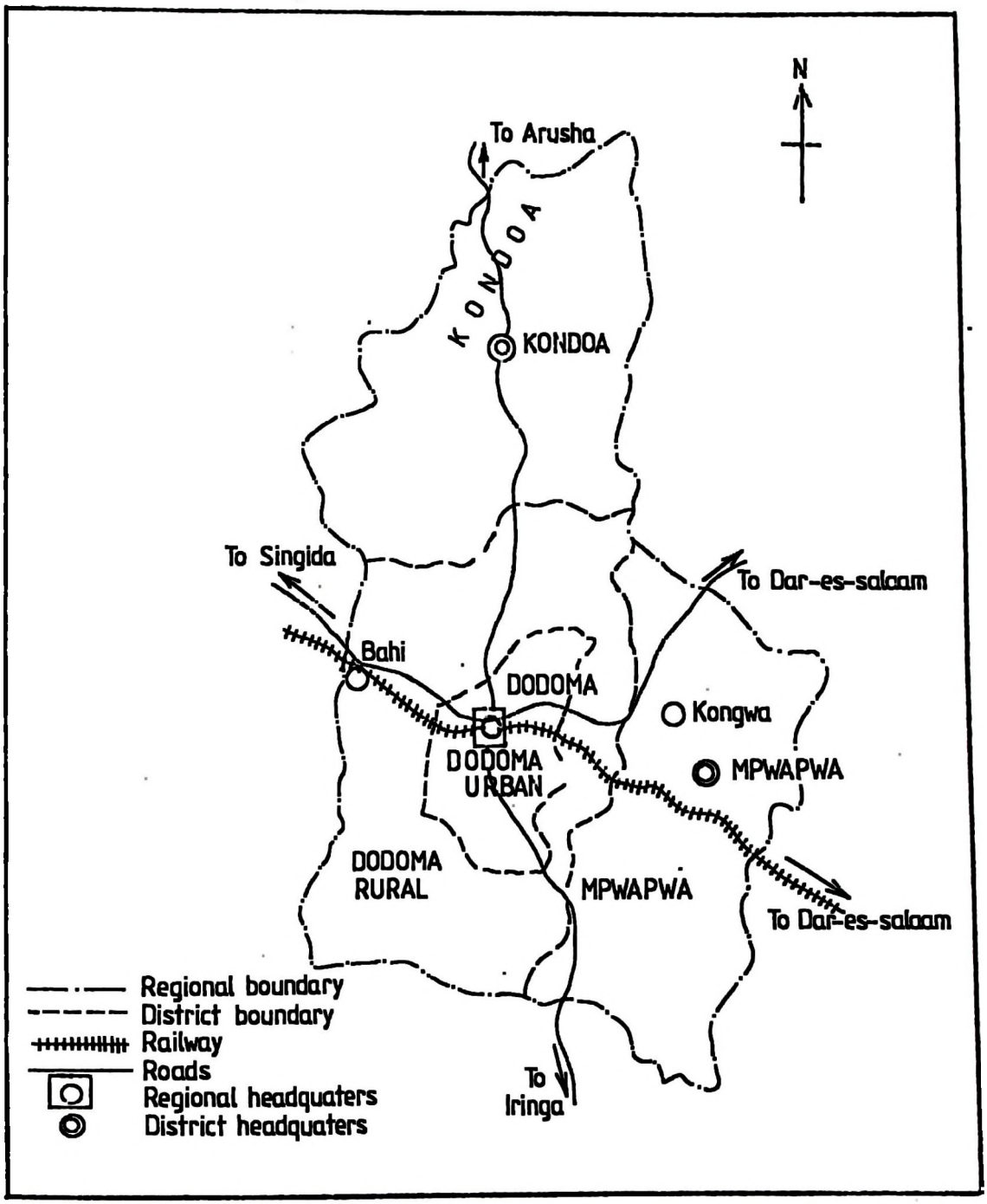


Fig. 2. Map of Dodoma region: District boundaries
Source. George Philip and Sons, Ltd (1978)

Setaria, *Themeda*, *Pennisetum*, *Chloris*, *Aristida* and *Cymbopogon* (District Livestock Officer 1991 personal communication). Water sources are mainly shallow wells along seasonal rivers, bore holes and dams.

3.1.4 Administrative zones

Administratively, Dodoma urban district is divided into 7 divisions, 16 wards and 38 villages.

3.1.5 Population distribution

The villages that surround the town have their inhabitants practicing typical rural life.

The human population was put at 203 833 people out of which 74 677 (34.6 %) were urban dwellers and 129 156 (63.4 %) were typical rural people with 38 013 cattle keepers (Bureau of Statistics 1988).

3.1.6 Livestock population

According to the livestock census of 1984 (MALD 1986) the district had 85 269 indigenous cattle (among which 34 286 were mature cows), 573 grade cattle (among which 212 were mature cows), 54 094 goats and 10 081 sheep.

3.1.7 Milk production and supply

The urban centre harbours both the regional headquaters and the country's new capital and is a potential area for consumption of dairy products as its population is expanding rapidly. Although the rural people are the major producers of milk and other dairy products, some milk is produced within the town from grade cattle.

Four main routes for supplying dairy products to Dodoma urban centre are identified, these are : the Dodoma - Dar es Salaam road, Dodoma - Singida road, Dodoma - Arusha road and Dodoma - Iringa road. Other minor routes from villages which are not strategically located to the four main routes also contribute in feeding the urban centre with dairy products.

3.2 Data collection

In this study eight villages and the town centre were surveyed (see Fig. 3). The information on villages considered both production and consumption of milk and milk products while consumption only was considered for town centre holdings.

The process of data collection in this study was organized in three main forms; field survey of households, milk processing sessions in the field, sampling of milk and milk products and laboratory analysis of milk and milk products. The procedures involved in all the cases are detailed below.

3.2.1 Household surveys

In this study the target population was defined as dairy market participants operating within a 60 km radius of Dodoma town. This population included (a) cattle keepers who produce milk for home use or for sale to individual consumers directly or indirectly to consumers through other market intermediaries; (b) individuals involved in traditional processing of milk and milk by-products and (c) consumers of milk and milk products who buy the products directly from the producers or other intermediaries.

3.2.1.1 Sample size of producers

In deciding the sample size at district level for cattle keepers the means and standard deviations of key variables were considered, these included herd size, calving rates, proportion of cows and heifers over three

years in milk. Figures used in arriving at the sample size required in the survey were those obtained from a study by Ibbe (1977) who studied cattle productivity in Singida district and a similar study by Farris and Sullivan (1977) on the Tanzania Livestock Meat subsector.

In those studies the largest standard deviation was associated with calving rate (S = 15). In order to obtain the minimum number of herds to be studied the following calculations were involved. If this calving rate is interpreted as the population average based on discrete variable, then according to Snedecor and Cochran (1989), the sample size was given by :

$$n = \frac{4pq}{L^2}$$

Where

n = Sample size

p = mean for calving rate

q = 100 - p

L - allowable error in the sample mean (at 5 % that the error exceeds L)

From the mentioned studies, calving rate showed a mean of 48.5 %, thus the required sample size was :

$$n = \frac{4\ (48.5)\ (51.5)}{5^2} = 400$$

This sample size represents females of breeding age. Based on Farris and Sullivan (1977), herds have an average of 8 females of breeding age. Therefore a total of 50 herds for the district were required. The number of herds also implies the number of responding households that were interviewed at the producer level.

3.2.1.2 Sample size of consumers

In obtaining the sample size for milk and milk products consumers, information on similar studies done elsewhere were used. These studies included that of Achuonjei and Debrah (1990) who studied the efficiency of fresh milk marketing in Mali around Bamako area and that by Debrah (1990) who did a similar study around Addis Ababa in Ethiopia. Another related study was that of Tambi and Vabi (1990) around Bamenda in Cameroon. All these studies suggest that a sample of 50 - 200 respondents can give satisfactory results in describing dairy marketing transctions in an area. During the study, a total of 61 consumers were inteviewed.

3.2.1.3 Selection of villages

Two villages were selected along each supply route. The study villages were selected basing on their location to the dairy products supply routes and distance from the town centre. For each supply route to the town, villages selected were the nearest village and the furthest one. This was considered to be a prerequisite in describing price differences and consumption patterns for people living near the town and those far away from it.

After failing to get representative villages along the Dodoma-Singida road, other villages outside the supply routes were selected to bring the number of villages surveyed to eight (Fig. 3).

3.2.1.4 Selection of producers

The 50 producer households were equally divided to the villages selected for the study. However, during the study, the actual number of responding households was not equal for all villages due to absence of selected respondents at the time of inteviewing. The number of respondents is summarized in Table 3.1. From the number of herds in each study village the responding households were selected by simple random sampling by the use of

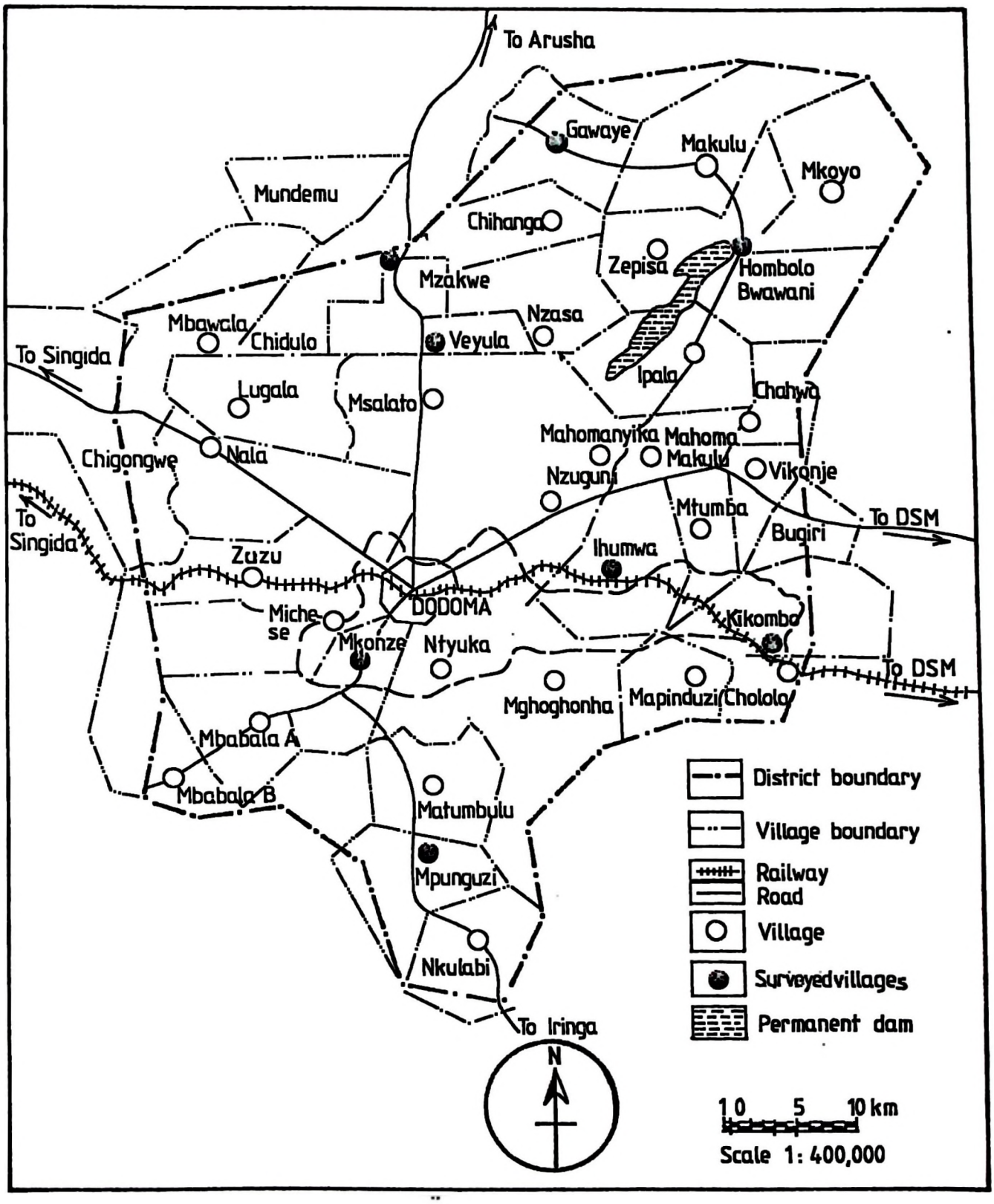


Fig. 3. Dodoma Urban District : Village boundaries
Source: Capital Development Authority, (CDA), Planning Unit

Table 3.1 : Number of respondents used in the survey villages/urban centre.

Village/ location	Distance from town centre (km)	Respondent categories		
		Producers	Consumers	Processing
Gawaye	48	5	4	0
Hombolo-Bwawani	40	5	4	0
Ihumwa	16	7	4	20
Kikombo	35	7	4	0
Mkonze	8	7	4	0
Mpunguzi	36	7	4	0
Mzakwe	23	7	5	0
Veyula	20	5	3	0
Urban Centre	-	0	29	0
Total		50	61	20

random tables from a list of the livestock keepers obtained from the villages' Chama cha Mapinduzi (CCM) office.

3.2.1.5 Selection of consumers

Stratified sampling was employed in selection of consumers who were non producers of dairy products. The strata were based on income category. Four categories were identified as high, medium, low and poor income groups. From these strata sampling units were taken by simple random sampling by the use of random tables.

For the village consumers, households were selected from a list of village households kept in the village CCM office and who were known to keep no cattle. Income of the households was estimated by assistance from village leaders who could estimate the income groups of their people by considering their day to day economic activities.

The determination of consumer households in the urban centre was a bit difficult due to the diversed nature of the activities of the inhabitants. The approach to this issue was to make a list of the common activities or enterprises employing many people and estimate the income

generated by each activity. From these economic activities respondents were picked at random and visited at the places of their work or activity. During the visits, the researcher was accompanied by the Ward Councillor who was responsible for making the necessary introductions.

3.2.1.6 Households visits

Visits to producer households were made by the reseacher in the company of the Village Livestock Extension Officer, Revenue Collector and the Party Branch Secretary who were of much use in verifying the information given by the respondents and enhanced the confidence of the farmers during the question - answer sessions.

The information on household characteristics were obtained on the basis of a questionnaire (Appendix 3) on-spot observation and recording.

The information on producers included (i) age of the household head (ii) level of education of the household head (iii) family size (iv) herd size and composition and (v) average milk production of individual cows and the herd in general (vi) Herd reproductive performance. Other

information included were household milk consumption (fresh or sour), milk processed and marketed.

Only a few producers used utensils of known volumetric capacity for milk meant for home use, only milk for sale was measured in bottles that were found to be equivalent to 0.75 l by measuring the amount in a one litre glass measuring jar. The milk for home use was recorded by the author directly into the measuring jar after the milking session during the survey day.

3.2.2 Milk processing efficiency

Milk churning was performed by a team of 20 volunteering women in 20 households in Ihumwa village situated along the Dodoma - Dar es Salaam road. The location of the village provided for easy transportation of samples from the village to the analytical laboratories in the Department of Animal Science at Sokoine University of Agriculture in Morogoro, about 250 km east of the study village along the same road.

The volunteering women were obtained through negotiations done during home visits to households that were known to process milk to butter and ghee during the study period. The study was conducted during the dry season when milk production was low and so only a few

households with enough milk were engaged in processing of their milk.

3.2.2.1 The butter churns

The churns were made of cylindrical bottle gourds of varying capacity. Milk was collected in the bottle gourd for two or three consecutive days and left to develop a certain level of acidity naturally.

3.2.2.2 The churning process

Before the churning process started, all lots of milk were smoked by special herbs depending on individual tastes to impart flavour of the buttermilk, butter and ghee. The common herbs used belonged to the Capparidaceae family, *Boscia mossambincensis* and *Boscia angustifolia* var. *Corymbosa*. Most women indicated a strong belief that smoking of milk enhances separation but this claim was not investigated. After smoking, the bottle gourd was placed in a net like hanger woven from ropes made of baobab tree barks which was hung from the main post of the house. The bottle gourd was closed by a tight fitting cork and rope tightened at the junction of the bottle gourd and the cork. From this position, the bottle gourd was swung to and fro until a bouncing sound against the wall of the churn was heard. The cork was removed and the amount of butter coalescing around the cork was used to determine

the end of the churning process. This point depended very much on the experience of the operator rather than on a particular level of churning.

When the churning was considered to be complete the cork was removed and the buttermilk poured into a different container leaving the coalesced butter in the churning bottle gourd. The butter was then poured in a wide basin like container and kneeded with cold water to remove any remaining milk and placed in another bottle gourd or pot where many lots can be accumulated pending preparation of ghee.

3.2.2.3. Measurements taken during churning sessions

The records taken during churning sessions included: (i) capacities of the churns, (ii) amount of milk churned (iii) level of acidity (pH), (iv) milk temperature and (v) time spent in churning.

Churn size

The capacities of the churns were measured volumetrically by filling them with water to the brim and the water being poured into 4 l containers, and amounts less than 4 l were measured by a 1 l glass measuring jar.

Amount of milk churned

The amounts of milk churned were recorded by measuring with the glass jar during milking sessions when the accumulation of milk was done.

Level of acidity (pH)

The level of milk acidity was measured colorimetrically by the use of indicator paper strips in the range of 1.0 - 5.0 pH scale. After smoking, a dipper was used to draw a sample of milk into which the paper strip was inserted and the colour change marched against a plate of pH scales to determine the level of acidity.

Milk temperature

The temperature of the milk was measured by inserting a lactometer fitted with a thermometer in the milk in the bottle gourd after the milk had been smoked ready for churning. The temperature was recorded while the thermometer was being held in the milk in the bottle gourd.

Time spent in churning

Time of churning was recorded as T_i at the beginning of the exercise and T_e at the end by using a stop watch. The time of churning was obtained from the relationship $T_e - T_i$.

Sampling of milk and milk products

During churning sessions, samples of whole milk, and butter milk, butter and ghee were taken for laboratory analysis in the Dairy Technology Laboratory at the Department of Animal Science at Sokoine University of Agriculture.

Sampling whole milk

Whole milk was sampled from the milk lot that was to be churned by the use of a metal dipper after stirring the milk and placed in 50 ml milk sample bottles where one tablet of potassium dichromate had been placed to preserve the milk before the samples were deep frozen at the University.

Sampling of buttermilk

The sampling of buttermilk was similar to that of whole milk. The samples were taken from the milk that was poured out of the bottle gourds after the churning process was completed. The buttermilk was treated like the whole milk samples.

Ghee making

Ghee was made by the group of women that were involved in butter making.

Butter was evaporated in clay pots under a low fire. Stirring was constant until a cracking sound was heard when moisture was considered to be driven off from the butter. The clay pot was removed from the fire and left to settle and cool under open air. After settling and cooling the ghee was poured into gourds, bottles or pots for storage. No straining of the ghee was observed in all cases, and so the purity of the ghee depended on the efficiency of the process of decantation.

Sampling of butter and ghee

These products were sampled according to the sampling technique for chemical or physical analysis as described by IDF (1980).

The samples of butter and ghee were placed and transported in sample cups with tight fitting lids and deep frozen without prior preservation of the samples in the field as these products can keep longer at ambient conditions when compared to whole milk or buttermilk.

3.3 Analytical methods

The analysis of whole milk, buttermilk, butter and ghee to determine their quality in terms of butterfat content, moisture content and solids not fat, was done in the Dairy Technology Laboratory of the Department of

Animal Science and Production at Sokoine University of Agriculture. The methods used are outlined in detail below.

3.3.1.1 Butterfat content in whole milk and buttermilk

Butterfat content for fat in whole milk and buttermilk was determined according to the steps outlined in the Gerber Test for the determination of fat in milk described by McDowall (1953). However, the method was modified to fit the conditions of the samples at the time of analysis. Because the samples were deep frozen they were first warmed in a water bath at 45 ^{0}C until the samples had thawed completely. The samples were then cooled at room temperature followed by mixing by turning the sample bottle up and down without shaking. This step was followed by weighing 11 g of the milk instead of the conventional 11 ml due to the coagulation of the samples such that siphoning by a pipette was not possible.

From these results, efficiency of fat recovery (FR) was obtained from the following relationship:

$$\% FR = \frac{Mf - BMf}{Mf}$$

where % FR - Percent fat recovery

Mf - Fat content in whole milk (%)

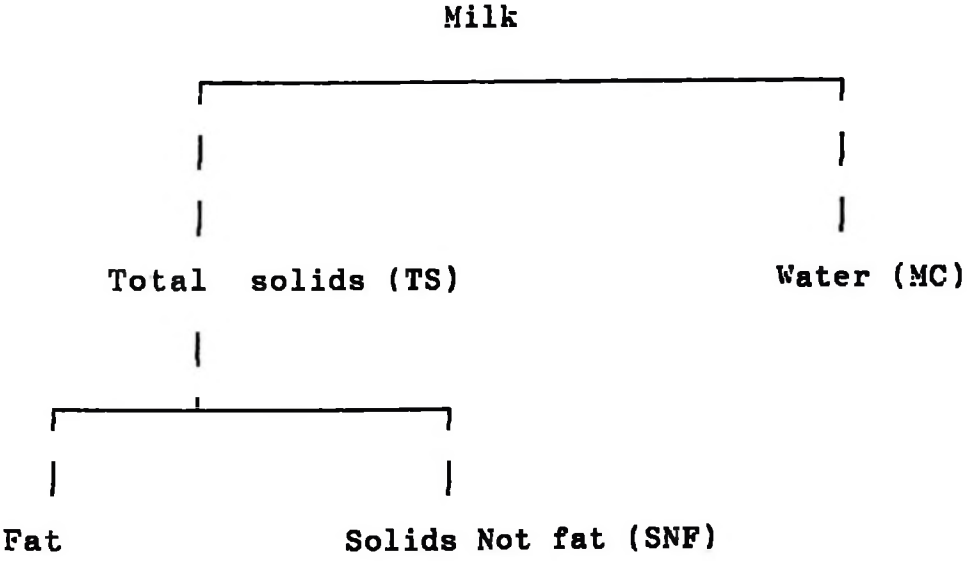
BMf - Fat content in buttermilk (%)

3.3.1.2 Moisture content in whole milk and buttermilk

The moisture content in whole milk and butter milk was determined indirectly by the method for the determination of total solids (TS) in milk under methods 925.23 of the Association of Official Analytical Chemists (AOAC) as outlined in Official Methods of Analysis of AOAC (1990). From the results of the TS, the moisture content was obtained from the relationship: % MC = 100 - % TS.

3.3.1.3 Solids Not Fat (SNF) in whole milk and buttermilk

Solids Not Fat (SNF) were determined by difference from the following consideration of milk constituents.



Calculation of Solids Not Fat (SNF)

From the Gerber Test results, the proportion of fat obtained was substracted from the TS determined under section 3.3.1.2 of this thesis. The SNF was determined by

difference from the relationship:

% TS - Fat = % SNF

3.3.1.4 Moisture in butter and ghee

a. Moisture in butter

The moisture content in butter was determined according to the standard method developed by the International Dairy Federation - IDF (1960), International Standard FIL-IDF 10: 1960 for the determination of the moisture content of butter.

b. Moisture in ghee

The method adopted for the determination of moisture in ghee was that of the Tanzania Bureau of Standards, Method 253: 1985 on Butter-Methods of sampling and Test.

3.3.1.5 Fat in butter and ghee

a. Fat in butter

The fat content in butter was obtained by difference from 100 less the percentages of water content and solids-non-fat content of butter. The latter two were determined

according to the International Standard 80: 1977 developed by IDF (1977) on Butter-Determination of water, solids - non - fat and fat contents on the same test portion.

b. Fat in ghee

Fat content in ghee was determined by the method developed by IDF (1964) for the determination of the fat content of butter oil: FIL-IDF 24 : 1964.

3.3.1.6 Solids-non-fat in butter and ghee

a. Solids-non-fat in butter

The solids-non-fat component of butter was determined by the method mentioned under section 3.3.1.5 (a) of this thesis.

b. Solids-non-fat in ghee

The solids non-fat in ghee also known as curd was determined by employing Method TZS 253 : 1983 of Tanzania Bureau of Standards. This method used the technique of calculating the percentage by mass.

3.3.2 Data analysis

Standard statistical procedures were used to asses the level of production parameters in cattle and quality of milk and milk products. Percentage levels were used in evaluating some parameters. Correlation analysis was made between selected variables from the survey data.

In studying the factors influencing the amount of milk sold at household level and the churning efficiency for churning the milk, regression techniques were used to identify and rank the main factors affecting the two parameters. Multiple regression was used here because the analysis provided a measure of the relations among the set of variables for the purpose of predicting the dependent variable or estimation of specified coefficients.

Two models were developed for the study, each for a given parameter as follows :

Equation 1. Milk sold per household:

$Y = a_0 + a_1X_1 + a_2X_2\ a_3X_3 + a_4X_4 + a_5X_5 + a_6X_6 + a_7X_7 + a_8X_8 + e$

where :

Y = Amount of milk sold per producing household (l)

a_0, a_1 ----a_8 = Sample coefficients

X_1 = Age of household head (years)

X_2 = Education level of household head (years)

X_3 = Family size

X_4 = Herd size

X_5 = Milk production per household (l)

X_6 = Amount of milk consumed fresh per household (l)

X_7 = Amount of milk consumed sour per household (l)

X_8 = Amount of milk processed (l)

e = Cummulative error

4. RESULTS

4.1 Background information

The survey revealed that all the villages studied were established during the villagization programme of 1970.

The villages are virtually accessible throughout the year with a road net work maintained by the Municipal council. However, public transport is not very reliable as it relies on a few vehicles, mainly privately owned pick-ups.

Information obtained from the District Livestock Development Officer (DLDO) indicated that between 1986 - 1990, the annual rainfall ranged from 263 mm to 799 mm with an average annual rainfall of 531 mm. The daily mean temperature for the same period was on average 23 ^{0}C with a range of 22.7 - 23.5 ^{0}C. According to Rutherberg (1971), this study area may be classified as dry savanna with 6 - 8.5 arid months.

The human and livestock populations of the study villages are summarized in Table 4.1 and the veterinary support facilities are shown in Appendix 1.

Table 4.1 : Human and livestock populations in study villages

Name of village	Human population				Cattle	Goats	Sheep	Total human population	Total animal population	Human to animal population ratio
	Adult		Children							
	Men	Women	Under 10 yr	Over 10 yr						
Gawaye	1429	1520	800	700	4000	1500	200	4754	5700	1:1.2
Hombolo	2125	2315	800	310	3140	2000	1500	5550	6640	1:1.2
Ihumwa	1232	1425	(3360)[1]		2191	1439	171	6017	3501	1:0.6
Kikombo	844	921	(1885)		na	na	na	1765	na	-
Mkonzo	766	560	186	202	1243	943	151	2014	2337	1:1.2
Mpunguzi	1399	1957	(3153)		3193	1982	612	6509	5767	1:0.9
Mzakwe	450	536	186	620	3643	150	172	1792	3995	1:2.2
Veyula	967[2]		(1502)		1755	822	152	2469	2729	1:1.1

[1]Figures in brackets show the total number of children as age groups were not separated

[2]The figure is a total of all adults as the sexes were not separated

na - Not available

Every village had one or more Livestock Extension Officer who was responsible for the day to day administration of the livestock activities. During campaigns, like vaccinations, the resident technician was supported by staff from the district headquarters and other villages.

4.2 Cattle management patterns and practices

4.2.1 Cattle ownership

Table 4.2 shows the relationship between the age of the cattle owners and cattle demography. It was found that herd sizes increased with age of the owner in general terms. Except for the youngest cattle owner who had a large herd and the oldest owners who had the smallest herds, the other age groups seem to conform to the general observation of herd size increasing with age of the owner. Large herds were owned by people in the age groups of between 50 - 79 years old owning a total of 37 herds and there was only one herd in the under 30 years of age category. The results also showed that for herd composition across age groups the number of cows out numbered that of other sex groups. Also the results showed that in general, the number of milking cows was larger than that of dry cows in 38 herds, smaller in one herd and was the same in 11 herds. This trend implies

Table 4.2: **Cattle demography and ownership by age groups in sample households**

Age in years	No of house-holds	Herd composition as owned per producer					
		cows					
		Milk-ing	Dry	Hei-fers	Males	Calves	Average herd size per age group
20-29	11	10	13	2	10	10	45
30-39	4	4	2	4	6	4	20
40-49	6	4	2	5	2	4	17
50-59	13	11	4	8	6	10	39
60-69	15	10	7	7	5	10	39
70-79	9	5	15	7	6	15	58
80 and above	2	2	2	0	1	2	8
Average per household	-	8	7	5	7	8	33

that milk production, though generally considered as a by-product, while beef production and social or cultural values are taken as the main products of cattle keeping in the traditional sector, has a marked role in the socio-economic aspects of the cattle keeper. The number of male animals was large giving a ratio of male to female of 1: 2 when heifers were excluded and 1: 3 when heifers were included. The study also showed that most herds were owned by men (Table 4.3). Out of the 50 herds studied only one herd was under the ownership of a woman constituting a mere 2 % of the studied herds.

4.2.2 Milking practices

Milking practices as shown in Table 4.3 showed that milking was dominated by women (92 %). Men or alternating between men and women had the same frequency (4 % each). The women also are the custodians of the milk and any money accruing from the sale of milk or milk products. Milking was done twice a day in all households. Normally the milkers had one big container - a bottle gourd or bucket where all the milk harvested for the session was stored. After the milking session was complete, the milk was then alloted for sale, processing or direct consumption and placed in the respective containers.

Table 4.3 : Management practices

Practice	Category	Gawa-ye	Hombo-lo	Ihunwa	Kiko-mbo	Mkonze	Mpungu-zi	Mzakwe	Veyula	Total res-	% of
Ownership by sex	M	5	4	7	7	7	7	7	5	49	98
	W	0	1	0	0	0	0	0	0	1	2
Milkers by sex	M	1	1	0	0	0	0	0	0	2	4
	W	4	4	7	6	7	6	7	5	46	92
	M or W	5	0	0	1	0	1	0	0	2	4
Milking frequ-	Once/day	0	0	0	0	0	0	0	0	0	0
ncy	Twice/day	5	5	7	7	7	7	7	5	50	100
Washing of	Yes	0	0	0	1	0	1	0	1	3	6
udder	No	5	5	7	6	7	6	7	4	47	94
Straining of	Yes	1	1	0	0	0	0	0	2	4	8
milk	No	4	4	7	7	7	7	7	4	47	92
Watering	Once/day	5	3	7	7	7	7	7	4	47	94
frequency	Twice/day	0	2	0	0	0	0	0	1	3	6
	Skip a day	0	0	0	0	0	0	0	0	0	0
Grazing patterns	a)	4	1	6	6	7	5	7	3	39	78
	b)	1	4	1	1	0	2	0	2	11	22
Dipping frequency	c)	0	1	0	0	0	0	0	1	2	4
	d)	5	4	7	7	7	7	7	4	48	96
Vaccinations	Yes	4	4	5	6	6	6	1	5	37	74
	No	1	2	2	1	1	1	6	0	13	26

M = Men W = Women a) Continuos for the day b) Resting during the day
c) Once per week d) Less frequently

Of the 50 herds surveyed, only 3 households (6 %) practiced washing of the udder before milking and only 4 households (8 %) strained their milk after milking. To most of the farmers the initial suckling of the calf before milking was considered enough to clean the udder.

4.2.3 Water availability

Water availability in the area was not as critical as one would expect for a semi-arid area like Dodoma. This was due to the seasonal rivers which supplied plenty of water during the wet season. In the dry season shallow wells were dug along these rivers whereby water was obtained within a depth of 1.5 - 3.5 m and the water drawn by a special container was poured in a water trough by the herd boys. Of the studied villages, Hombolo-Bwawani had a permanent dam, while Kikombo, Mkonze and Mpunguzi had seasonal dams that could keep water for up to 8 months in a year. The results in Table 4.3 show that 94 % of the herds drink water once per day and the rest drink water twice per day. Lower frequencies than these were not reported.

4.2.4 Veterinary services

Results from the survey indicated that veterinary services rendered in the villages included vaccinations, dipping, treatments and castration. Of these only

vaccinations and dipping frequency were investigated. Table 4.3 shows that during the year 1990/91 74 % of the herds were vaccinated against Foot and Mouth Disease, Anthrax and Blackquarter. The other herds were withheld by the owners fearing to loose their cattle through death arising from post vaccination reactions. This fear cropped up from the vaccinations of the year 1989/90 where this coincided with a problem of cattle dying from other reasons but the farmers attributed it to the vaccination program.

Dipping was practiced weekly in only 4 % of the herds while 96 % of the herds dipped their livestock less frequently (Table 4.3). This was due to breakdown of dips, lack of acaricide and distant location of dips. During the survey period only one dip was functioning in Mzakwe village (see Fig.3). Moreover, of the eight villages surveyed only three had dips within the village (Appendix 1). This made cattle dipping not to be popular in the area.

4.2.5 Grazing management

Cattle were grazed under two major systems, these being throughout the day or graze in two sessions, that is, morning session and afternoon session with a break during the afternoon. Of the 50 herds studied, 78 % were

practicing continuous grazing for the day while 22 % were having a break during the afternoon (Table 4.3). Cattle were grazed on communal lands. There were no village border restrictions in grazing between villages. Table 4.4 shows that, on average, cattle grazed for 7.38 hours per day for herds that grazed continuously and 6.48 hours for herds that rested in kraals during the noon.

4.3 Milk yield and lactation length

The average milk yield for cows is given in Figure 4. The results show that most cows were producing between 0.25 - 0.5 l of milk per cow per day. These cows were also found in most of the herds. A few cows were producing above 1.50 l of milk per day in only a few herds. These herds were found to have cattle of mixed blood, especially crosses of Ayrshire and Zebu with unknown blood levels of each breed.

The lactation length ranged between 6 - 12 months with an average of 9.72 ± 2.34 months and a coefficient of variation of 24 %. The low coefficient of variation indicates that lactation length in the studied herds did not vary by a big magnitude.

Table 4.4 : Grazing pattern of the study herds

Grazing pattern	No. of herds	Average time for: Departure	Return	Cummulative outside kraal (h)	Trekking (h)	Grazing (h)
Continuous for the day	39	8.30 am	5.45 pm	8.66	1.28	7.38
Resting during the day	11	8.00 am	12.40 pm	4.50	0.55	3.95[1]
		2.50 pm	5.55 pm	3.03	0.50	2.53[2]

[1] = Row for morning grazing session

[2] = Row for afternoon grazing session

NB: Total grazing hours for the herds that rest during the afternoon is equal to 6.48 h

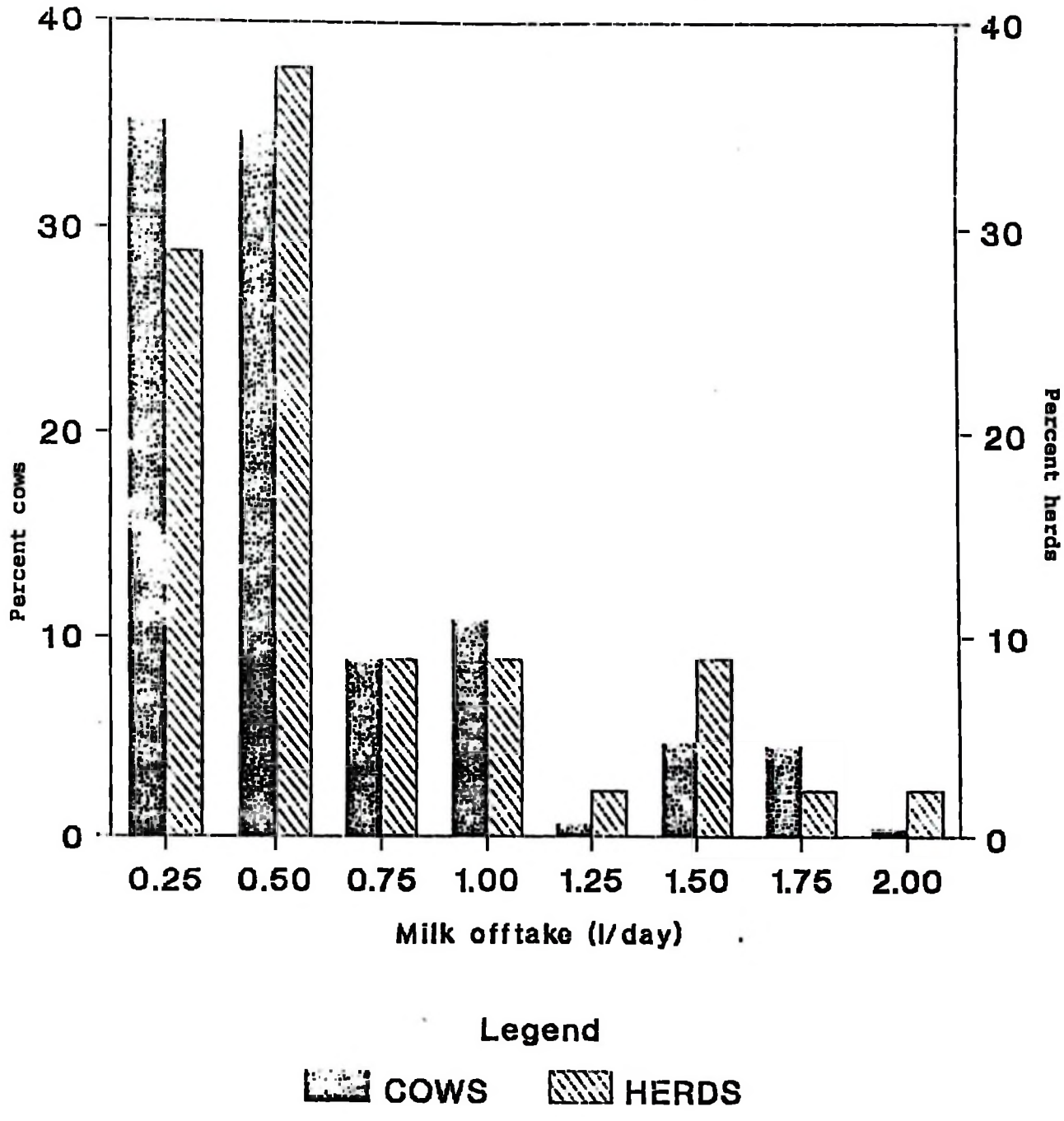


Fig. 4 : Average daily milk offtake for cows in sample households

4.4 Reproduction

Farmers were also requested to report on the different reproduction parameters of their herds as they know them. The parameters were the age at which heifers and young bulls start to mate, the age at first calving, calving rates and average length of dry period. The results for these responses are summarized in Table 4.5.

The results show that bulls started to mate at an earlier age compared to heifers. Herd average length of dry period averaged to over one year and calving rates were less than 50 % on average.

4.5 Mortality rates

Mortality rates were considered for calves and adults separately. The period that was investigated was between January to December 1990.

4.5.1 Calf mortality

This was considered to be the percentage of calves that died for the year 1990 to that of the total births for the same year. Sex differences were not considered because most farmers could not recall well about the sexes of the dead calves.

Table 4.5 : Reproductive performance of cattle in sample households

Parameter	Unit	Range	Mean	SD
Mating age	Mo			
Heifers		18 - 54	46.89	2.56
Bulls		24 - 48	39.00	0.63
Age at first calving	Mo	27 - 69	44.86	12.99
Average length of dry period	Mo	7 - 33	12.77	8.39
Calving rates	%	35 - 100	49.71	24.49

Note Mo = Months

Results have shown that calf mortality rate for the reported year averaged 17.6 %.

4.5.2 Adult cattle mortality

The number of adult cattle was taken to constitute all those cattle that were one or more years old. This was generalized so as not to confuse the farmers with many age groups. The results revealed the mortality rate in adult cattle to be 3.58 %.

4.6 Milk utilization options

The study identified three major options for the utilization of milk for the producer households. These options were; household consumption, household processing and sales to other people. Non-producer households indicated only one option for utilization, that is, consumption.

4.6.1 Milk utilization by producer households

Table 4.6 summarizes the production, consumption, sales and household processing of milk by producer households.

Table 4.6 : Family size in relation to milk output, consumption, sales and processing

Family size	Households No.	Households %	Milk output/day (l)	Household utilization options % Consumption (Fresh or sour)	Sales	Household processing
4 - 6	13	26	75.75	39.60	48.50	11.90
7 - 9	11	22	33.03	22.74	14.30	64.36
10 - 12	10	20	79.75	40.23	8.46	50.63
13 - 15	5	10	32.25	37.21	20.93	40.31
16 and above	11	22	185.63	26.42	21.62	50.09
Average			81.28	32.15	23.41	43.46

The results show that milk output per household was highest in the households with a big number of family members. For the other family size groups the trend was not very clear. On average, more milk was retained for household processing (43.46 %) and for consumption (32.15 %). Only 23.41 % was sold to others.

Family size influenced amount of milk consumed per person per day as shown in Table 4.7. Families with more family members showed low consumption levels per person per day except for the category of 7 - 9 family size households who had the lowest consumption level. Sales and processing levels also showed a similar trend where the households with the smallest family size sold and processed more milk per head per day than other family size groups.

A regression model was used to determine the contribution of the factors affecting the amount of milk sold per household. The results are presented in Table 4.8.

Four variables (production per day, milk consumed per day - fresh or sour and milk allocated for processing) were statistically significant ($P<0.001$). As expected, production per day showed a positive relationship with

Table 4.7 : Average amounts of milk consumed, sold or processed per household member per day (ml)

Family size	Consumption	Sales	Household processing
4 - 6	90	120	50
7 - 9	9	9	30
10 - 12	30	6	40
13 - 15	10	2	20
16 and above	10	9	20

Table 4.8 : Linear regression coefficients for factors influencing the amount of milk sold per producer household

Factor	Reg. coef.	SE	P > F
Production per day	0.9845	0.0125	0.0001**
Milk consumed fresh	- 0.9698	0.0619	0.0001**
Milk consumed sour	- 0.9950	0.0203	0.0001**
Milk for processing	- 0.9861	0.0165	0.0001**
Age of household head	- 0.0008	0.0034	0.8084 NS
Education level of household head	0.0183	0.0893	0.8385 NS
Family size	- 0.0161	0.0107	0.1398 NS
Number of observations	50		
R^2 (for all factors) =	0.9963		

** Significant (P < 0.001)

NS - Non significant (P > 0.05)

the amount of milk sold, while the other variables showed negative relationships. Age of the household head and family size showed negative relationships, while education level of household head showed a positive relationship with amount of milk sold. However, these last three variables were not statistically different from zero ($P > 0.05$). Together the variables mentioned in the analysis explained 99.63 % of the variations in the amount of milk sold.

The relationship between herd size and some selected variables is shown in Table 4.9 for simple correlation. Average milk output per day, family size and amount of milk processed were all positively correlated to herd size and were statistically significant ($P<0.05$). Sales and consumption of fresh or sour milk were not statistically significant ($P > 0.05$) though they showed a positive relationship with herd size.

4.6.2 Milk utilization by non-producing households

Cross-tabulation and correlation were used to study the influence of family size, distance from source, income category and price of milk on the frequency of consumption of milk. Frequency tables were constructed to show the relative distribution of the consumers and the average

Table 4.9 : Simple correlation for factors determining milk utilization options at the producer household level

Independent variable	Dependent variable	r
Family size	Herd size	0.69*
Herd size	Average milk output/day	0.66*
	Processing	0.66*
	Sales	0.27NS
	Consumption	0.26NS

* Significant ($P < 0.05$)

NS = Non significant ($P > 0.05$)

amount of milk consumed as affected by the mentioned factors.

4.6.2.1 Influence of source of milk on the consumption patterns

The results for this parameter are shown in Table 4.10. The study has shown that most consumers (49.2 %) obtained their milk directly from the producers (farmers). The next major source was from bicycle boys or hawkers who sold milk at the door steps of the consumers. This source supplied milk to 29.5 % of the consumer households. Consumers who bought milk from kiosks accounted for only 8.2 % of the consumers while 13.0 % of the consumers obtained their milk from different sources.

The results further showed that, consumers who obtained their milk from shops and kiosks had the highest consumption levels (2 l/week/head) followed by those who obtained their milk from various sources (0.83 l/week/head). For those consumers who obtained their milk from bicycle boys or hawkers and farmers had average consumption levels of 0.70 and 0.58 l/week/household respectively.

Table 4.10 : Milk consumption (l/week) per non-producing household and per head in relation to source of product

Category	Description	n	%	Weekly consumption levels: Family Mean	Family SD	Head Mean	Head SD
1	Established farm	0	0	-	-	-	-
2	Farmer	30	49.18	3.905	2.973	0.55	0
3	Market	0	0	-	-	-	-
4	Shop/kiosk	5	8.20	1.650	1.357	2.00	1.75
5	Bicycle boy/hawker	18	29.51	2.528	2.239	0.70	0.57
6	Super market	0	0	-	-	-	-
7	Combination of several sources	8	13.11	4.667	2.021	0.53	0.47

Note - = Not applicable

4.6.2.2 Milk consumption levels as affected by distance from supply source

The results of the effect of distance between the source of the milk and the consumer are shown in Table 4.11.

The results show that, except for category 2 and 3, the number of consuming households and amount of milk consumed was decreasing as distance from the source to the consumer increased. Also, except for category 2 and 4 the amount of milk consumed per person showed a similar trend.

The results also show that 57.4 % of the households obtained milk from within the village or location while families that obtained their milk from sources more than 10 km constituted only 14.8 % of the consuming households.

The price trend at the producer household level showed an inverse relationship with respect to distance between the producer and the Municipal centre (Fig.5). Consumers far away from the Municipal centre paid less for a litre of milk consumed compared to those nearby. A contrast to this relationship was shown in Mkonze village which had the lowest price per litre of milk consumed although it was the nearest to the Municipal centre.

Table 4.11 : Milk consumption (l/week) per household and per head in relation to distance from source

Category	Description	n	%	Weekly consumption levels: Family Mean	Family SD	Head Mean	Head SD
1	Within village/location	35	57.38	3.879	2.853	0.90	0.79
2	Less than 2 km	0	0	-	-	-	-
3	2 - 5 km	2	3.28	5.250	3.182	1.13	0.53
4	5 - 10 km	15	24.59	2.183	1.882	0.77	1.05
5	More than 10 km	9	14.75	2.000	2.000	0.5	0.5

Note - = Not applicable

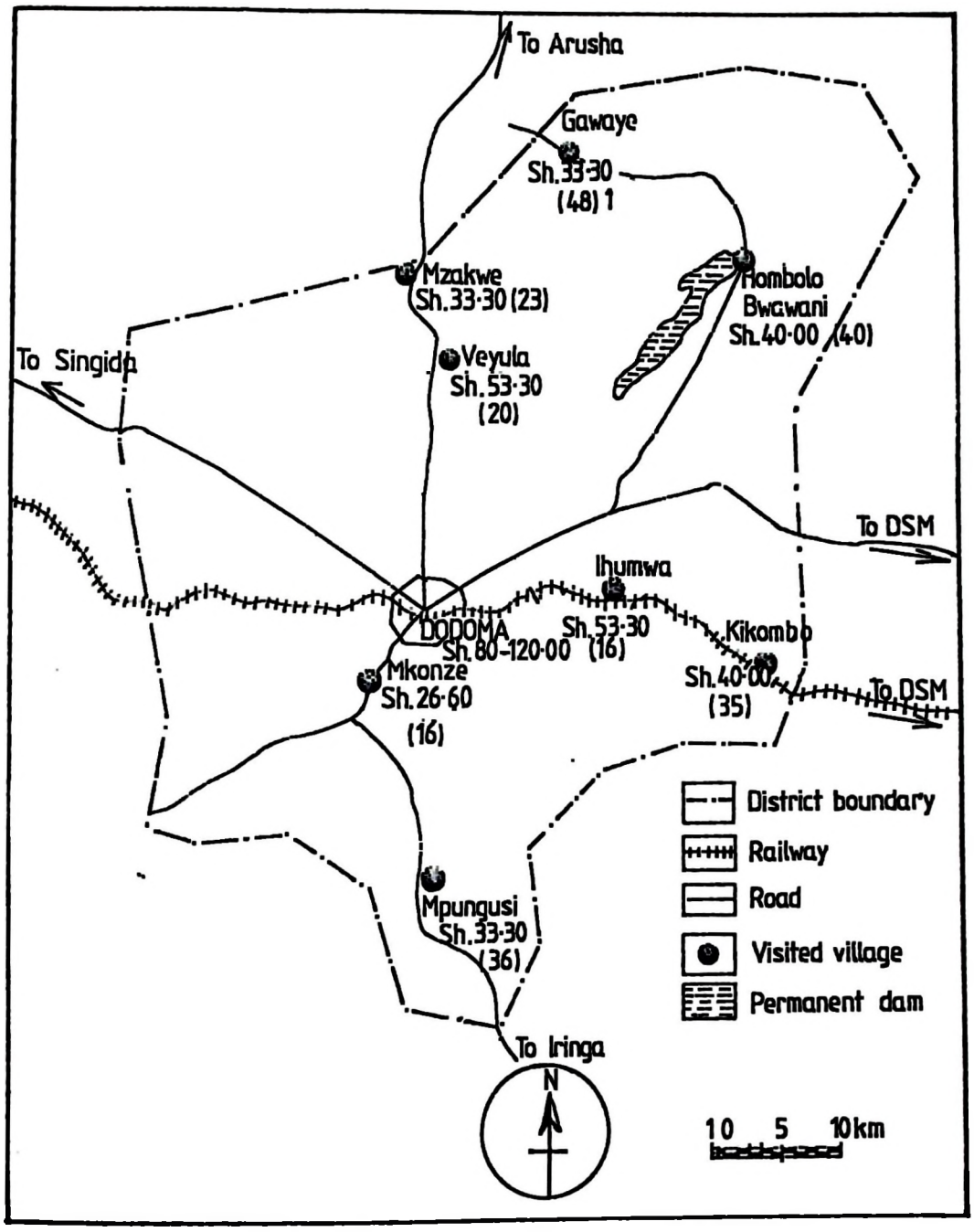


Fig. 5. Average prices of milk (Sh/litre) in relation to distance from Dodoma Municipal centre.

Note: 1 Figures in bracket indicate distance (km).

The above relationship was not expected, however, this could be attributed to the fact that most farmers in this village sold milk directly to the town centre to get better prices, and for those who sold within the village did so to close relatives for social reasons rather than for money gains.

4.6.2.3 Effect of income level on consumption patterns

The results as shown in Table 4.12 indicate that, though the family mean for weekly milk consumption was higher in the first two income categories than the others, weekly consumption per head was the same in the low and medium income levels and was higher than in the high income level. The poor income category had the lowest consumption levels in both per family or per head per week.

4.6.2.4 Consumption frequency

Table 4.13 shows that only 29.5 % of the studied households consumed milk daily and the rest consumed less frequently. As expected, average amounts of milk consumed per week also decreased with decreasing frequency of consumption.

Table 4.12 : Milk consumption per household and per head (l/week) in relation to income level

Category	Description	Household		Weekly consumption levels			
		No.	%	Family		Head	
				Mean	SD	Mean	SD
1	High	10	16.39	3.23	3.15	0.66	0.68
2	Medium	29	47.54	3.66	2.80	0.94	0.79
3	Low	15	24.59	2.75	2.42	0.94	0.96
4	Poor	7	11.48	0.75	1.06	0.18	0.24

Table 4.13 : Milk consumption (l/week) per household and per head in relation to frequency of consumption

Category	Description	n	%	Consumption per week			
				Family		Head	
				Mean	SD	Mean	SD
1	Daily	16	29.51	5.333	2.111	1.43	1.11
2	At least once a week	19	31.15	3.934	2.295	0.70	0.25
3	At least once a month	1	1.64	0.750	-	0.03	0.06
4	Rarely	17	27.86	0.794	1.163	0.22	0.33
5	Not at all	6	9.54	-	-	-	-

Note - = Consumption figures not available

The reasons influencing the frequency and amount of dairy products consumed per household are summarized in Table 4.14.

Correlation coefficients were determined for some variables influencing milk consumption in households. The results are presented in Table 4.15. Consumption frequency was positively correlated to family size and income category, while it was negatively correlated to distance from source of product and milk price. However, these correlations were not significant ($P>0.05$). Milk price was positively correlated to distance from source ($r = .68$) and was highly significant ($P<0.001$).

4.7 Household milk processing

The study has shown that the range of products at the household level is very narrow. The common products include sour milk, butter and ghee. Of these, butter was found to be a transition product to the making of ghee as the use of it was very limited. Another product which was found to be known among the older people was traditionally known as *behema* which was made from butter milk by allowing it to develop a high degree of acidity and is used to prepare a special kind of porridge which has a bitter taste.

Table 4.14 : Major influencing factors on the frequency of dairy products consumed per household (n = 61)

Factor	Number of times mentioned	%[1]
Price	46	52.30
Irregualr supply	18	20.45
Distance from source	7	8.00
Product quality	6	6.80
Family size	3	3.40
Not familiar	3	3.40
Product type	2	2.30
Storage conditions	1	1.14
Habit	1	1.14
Feeding infant	1	1.14

Note 1 = Percentages may not add up to 100 because of rounding

Table 4.15 : Correlation coefficients of some factors influencing consumption frequency and consumer price of milk

Dependent variable	Independent variable	r
Consumption frequency	Family size	0.0941 NS
	Distance from source	- 0.1240 NS
	Income category	0.2399 NS
	Milk price	- 0.2587 NS
Unit price	Distance from source	0.6800**

** Significant (P < 0.05)
NS Non significant (P > 0.05)

4.7.1 Factors influencing churning efficiency

Five factors were presumed to be influencing churning efficiency, that is, the recovery of butter fat from milk as butter. Table 4.16 shows the ranges, means and standard deviations of the factors.

In order to asses and rank the contribution of each factor to the final churning efficiency of the milk, a General Linear Model was fitted to estimate Regression Coefficients for the factors. The results as presented in Table 4.17 show that the presumed factors accounted for only 26.0 % of the variations in butter recovery from churning sour milk. (see also Appendices 4 to 8 for scatter diagrams and regression lines)

4.7.2 Churning efficiency coefficients

The features of the churning process are summarized in Appendix 2.

Correlation analysis for the factors influencing fat recovery indicated the relationships shown in Table 4.18. The results show that the extent of fill improved fat recovery. Time spent was positively correlated to the amount filled and extent of fill while it was negatively correlated to the acidity of the milk. The overall average churning efficiency was 71.6 %.

Table 4.16: Levels of the factors influencing fat recovery in traditionally churned milk

Parameter	Unit	Range*	Mean	SD
Capacity of churn	litres	4.45-28.0	13.44	6.28
Extent of fill	%	6.8 -62.5	31.21	16.29
Milk acidity	pH	3.0 - 5.0	3.85	0.66
Milk temperature	^{0}C	21.0-36.0	26.10	4.06
Churning time	Min	10 - 50	28.75	12.03

* Range of the factors is between milk samples

Table 4.17 : Regression coefficients of factors determining the efficiency of fat recovery for traditionally churned milk

Factor	Parameter estimate	SE	P > F
Capacity of churn	- 0.14	0.29	0.644 NS
Extent of fill	- 0.09	0.35	0.244 NS
Milk acidity	- 1.40	2.82	0.626 NS
Milk temperature	0.34	0.48	0.497 NS
Churning time	0.03	0.19	0.856 NS
Constant	65.2		
Number of observations	20		
R^2 (for all factors)	0.26		

NS = Non significant (P > 0.05)

Table 4.18 : Simple correlation for factors influencing fat recovery and churning time

Dependent variable	Independent variable	r
% Fat recovery	Capacity of churn	- 0.10
	Churning time	0.29
	Extent of fill	0.39
Churning time	Amount filled	0.61
	Extent of fill	0.41
	Milk pH	- 0.10

4.7.3. Composition of milk and milk products

Samples of whole milk, buttermilk, butter and ghee collected in the field were analysed for the composition of moisture content, butter fat and non-fat-solids. The results are summarized in Table 4.19. Whole milk had a mean of 86.12 % moisture content while the value for buttermilk was 91.51 %. Moisture content was on average 18.82 % and 0.33 % for butter and ghee respectively. The percent fat content for whole milk averaged 5.06 %, that for buttermilk was 1.35 %. Fat content of butter was found to be 78.57 % and that for ghee was 99.45 %. Whole milk had a non-fat-solids content of 8.87 % and buttermilk showed a value of 7.14 % for the component. Butter and ghee had a content of 2.64 % and 0.22 % of non-fat-solids respectively.

Table 4.19 : Composition of major components in whole milk, buttermilk, butter and ghee

Product	No. of samples	% MC		% Fat		% Non fat solids	
		Mean	SD	Mean	SD	Mean	SD
Whole milk	20	86.12	2.98	5.06	0.65	8.87	2.71
Buttermilk	20	91.51	1.31	1.35	0.31	7.14	1.45
Butter	20	18.82	5.88	78.57	6.04	2.64	1.51
Ghee	20	0.33	0.08	99.45	0.15	0.22	0.14

5. DISCUSSION

5.1 Cattle production systems

5.1.1 Cattle population and ownership

Cattle population and ownership patterns in this study are of a similar trend as those reported by Chikaka and Foote (1978) for traditional herds in Mara region, Tanzania and Okanta (1991) in the plains of Accra in Ghana. Cattle ownership was entirely by small holders with herd sizes ranging from 3 to 157 heads of cattle. The results are also in agreement with findings elsewhere as far as male to female ratios are concerned. The male: female ratio of 1: 2 to 1: 3 in this study is similar to that found by Chikaka and Foote (1978) of 1: 3 to 1: 5. The ratio is however, narrow when compared to the ratio of 1: 15 and 1: 30 suggested by Diggins (1984) and Minish and Fox (1982) respectively. The reason that could be given for this difference could be that of differences in sex preferences for the different cattle keepers when it comes to livestock disposals. Herd composition in this study (Table 4.2) was similar to that reported in other studies (Wilson 1986; Wilson and Clarke 1976) where the proportion of cows and heifers is higher than that of other sex groups. The relationship of age of owner and herd size found in this study is in conformity to that reported in another study (Chikaka and Foote 1978) where herd sizes were increasing with the age of the owner.

5.1.2 Cattle management

5.1.2.1 Grazing management

The study showed on average that cattle graze for 6.5 to 7.4 h per day. This grazing time is higher than that reported by Mgheni and Petersen (1986) but slightly lower than that reported by Agarwal and Sharma (1986). The variation in grazing hours among herds was mainly determined by the location of the household in the village as this influenced trekking time to the grazing fields. Similar relationships were reported by Chikaka and Foote (1978). Like in other traditional grazing systems night grazing was not practiced in the study area.

5.1.2.2 Provision of water

Water sources for cattle in this study were dams, wells and seasonal rivers. The watering frequency was found to be mainly once per day except for only 6 % of the herds which watered their cattle twice per day. This watering frequency was higher compared to that reported by Oba and Lusigi (1987) who reported frequencies of once in every three or four days. Other reported watering frequencies include those by Baudelaire (1972) who suggested a daily supply of water for cattle kept under intensive system or once every two days for extensive ranching system. Castle and Watkins (1984) proposed an ample supply of water to cattle throughout the grazing

period. From these other findings, it can be noted that the frequency of provision of drinking water in this study is within the expected levels under traditionally managed herds and may not be considered to impose any deleterious stress to the animals though it influences level of milk production.

5.1.2.3 Milking practice

All households were milking their cows twice every day; in the morning before the cattle are let out for grazing and in the evening after returning from the grazing. This pattern of milking is similar to that reported by Mgheni and Petersen (1986) and Majubwa (1987). The milking system in this study is different from that of the White Fulani tribe in Nigeria (Diallo *et al*.1981) who milk their animals once only in the evening and leave the calves to remain with their dams throughout the night. This is probably due to the fact that societies which take milk production as a primary and important output in the cattle production system milk their cattle more frequently while societies which consider herd expansion as the main objective of keeping cattle allow the calves to suckle more milk and thus they milk their cattle less frequently (Okanta 1991).

5.2 Cattle production and reproduction

Cattle performance was considered in terms of the age when heifers and young bulls start to mate, age at first calving, average length of lactation length, calving interval and average daily milk yields. Another consideration was on the calving rates and survival rates of calves and adult cattle.

5.2.1 Mating age

It is generally agreed that *Bos indicus* cattle under traditional systems reach puberty later than *Bos taurus* or grade cattle kept in improved environment. The reasons advanced to account for this phenomenon among others, are nutrition, disease and temperature (Gordon 1983). The age at which cattle start to mate in this study is within the range reported in other studies. Whereas the average age at which heifers and bulls start to mate is 46.9 and 39 months respectively in this study, Mukasa-Mugerwa (1989) has reported the age to range between 16 and 40 months in the tropics and sub-tropics due to different nutritional environments, disease incidences and genetic differences.

5.2.2 Age at first calving

The age at first calving in this study (Table 4.5) is almost similar to that reported by Machunda (1977) for zebu cattle. The results are however, lower than those

reported by Wilson (1986), N'diaye (1982) and Sang'are (1983) as cited by Wilson (1986). The results of this study on the other hand are higher than those reported by Akarro (1984) for zebu cattle in Mbeya. The reason for this variation could be due to the stress imposed to the cattle in the study area because of the low nutrition potential which retards growth rate and the animals mature late (Gordon 1983).

5.2.3 Milk yield and lactation length

The milk yield levels observed in this study are of a similar magnitude as those reported in the literature for shorthorn zebu. Milk production levels of between 0.25 - 0.5 l/day/cow is similar to that reported by Wilson (1986). The few herds that were producing above 1.5 l/day/cow were in conformity to the levels reported by Alberro and Haile-Mariam (1982). This difference in production levels between herds could be attributed to the presence of Ayrshire crosses in the high producing herds.

The lactation length in this study is within the range reported by many workers for zebu cattle. Among these are Nicholson (1984), Saeed, Ward and Light *et al.* (1987) and Gryseels and Anderson (1983). The average lactation length in this study was however, longer than that reported by Chikaka and Foote (1978) and MALD (1988).

The small coefficient of variation (24 %) for this parameter in the current study could be attributed to the uniformity of the breed and environment.

5.2.4 Calving rates

Calving rates in the traditional sector are considered to be low due to non-pathological and pathological factors (Asdell 1968; Ensminger 1968). Many workers have reported calving rates of between 50 - 75% (Clarke 1976; Hall 1973; ILCA 1983; Wilson 1982). The results from this study are moderate and are within the range that was reported by Hall (1973) and Wilson (1982). The moderate calving rate of about 50 % in this study could be attributed to both non-pathological and pathological factors such as under feeding, vitamin and mineral deficiencies and diseases.

5.2.5 Survival rates

Since total milk production is related to herd size, particularly on the number of cows being milked (Wilson 1986) and presence of the calf to stimulate milk let down in zebu cattle (Nicholson 1984; Mgheni and Petersen 1986; Majubwa 1987) the necessity of high survival rates of both calves and adult cattle cannot be overemphasized.

The calf mortality in this study was lower than that reported in other studies. The rate in this study averaged 17.6 % while that reported by Mutagwaba *et al.* (1991) was between 26.0 - 27.2 % and
that by Williamson and Payne (1978) was 50 % for calves under traditional management systems. This difference could be due to different calf rearing practices and exposure to disease risks.

The average adult cattle mortality in this study was higher than that reported by Wilkins *et al.* (1979) and ILCA (1978). The results are however, lower than those reported by Williamson and Payne (1978) for zebu in East Africa and those by Mgheni and Petersen (1986) for Tanzania Shorthorn Zebu, possibly due to differences in nutrition, health status and support services.

5.3 Milk utilization options

5.3.1 Milk utilization options by producer households

The milk utilization options at the producer level found in this study are similar to those shown by other workers (Prabahan and Sivaselvam 1986; Majubwa 1987), the major options being consumption at home, household processing and selling to other people.

5.3.1.1 Household milk production

In this study, herd size was significantly ($P<0.05$) correlated to family size and daily milk output ($r=0.69$ and 0.66 respectively). This implies that larger families owned bigger herds and produced more milk per day than smaller family groups. Reasons for large families owning bigger herds could be the use of livestock as a bank to cater for social and economic obligations in the traditional sector (Msechu 1988). This relationship is similar to that reported by Agarwal and Sharma (1986) and Prabahan and Sivaselvam (1986).

5.3.1.2 Household milk processing

The amount of milk retained for home processing was higher than that retained for direct consumption or sales for all family size groups except for the 4 - 6 family size group. These findings are similar to those reported by Prabahan and Sivaselvam (1986). This implies that the use of buttermilk was more popular than whole fresh or whole sour milk among households. The popularity of buttermilk could be due to the double advantage the farmers get from separating the milk to butter and buttermilk, all of which have different usefull roles in their diets.

5.3.1.3 Household consumption levels

Consumption levels per head in this study decreased as the number of family members increased, except for the 7 - 9 family size group. The consumption figures were lower than the average for Tanzania reported by Mpelumbe, Hedley and Scotland (1978) for all family size groups except for the 4 - 6 family size group which was higher by 30 ml per head per day. The consumption levels were also lower than those reported by Majubwa (1987) for the Maasai of Morogoro district. The disparity could be due to the different farming systems between the Wagogo and the Maasai as milk consumption in rural areas depends on the role of livestock in the various farming systems. If the daily averages for all family size groups are converted to annual figures the annual consumption average of 10.88 l is lower than that reported by Mpelumbe *et al.* (1978) of 33.4 l for rural people but similar to 11.0 l for urban people in Dodoma region. The figure is also lower than the national average reported by Kurwijila (1988) and MLD (1983) of about 22.4 l for rural consumers in Tanzania. It can be concluded from here that the consumption level in this area is still below the expected figures for both regional and national levels. It can further be stated that, due to the short nature of the study vis a vis the seasonality of milk production in traditional cattle populations, and that, as the study was carried during the

dry season the results are limited to that short period.

5.3.1.4 Milk sales

The amount of milk exposed for sale was the lowest among the three utilization options across family size groups except for the smallest family size group. The average for all family size groups was lower than for that retained for direct consumption and household processing. This trend was expected as traditional milk producers tend to retain most of the milk for home use (direct consumption or processing). Similar observations were made by Rodriguez (1987) in Zimbabwe where sales were higher in the smallest families. The findings by Agarwal and Sharma (1986) show that largest families exposed more milk for sale than smaller families. This increase was perhaps due to the big obligations by bigger families for making purchases to meet other family demands. The results of this study are however in conformity to those reported by Prabahan and Sivaselvam (1986).

Regression analysis for factors influencing the amount of milk sold per household showed that four variables (production per day, milk consumed per day - sour or fresh and milk reserved for processing) were statistically significant ($P < 0.001$) with the expected relationships. Other factors remaining constant, a 1 %

increase in the amount of milk produced would result in a 0.98 % increase in the amount of milk sold. On the other hand , a 1 % increase in the amount of of milk consumed or reserved for processing would result in a 0.96 - 0.99 % decrease in the amount of milk sold.

5.3.2 Milk utilization by non-producing households

The consumption pattern of milk for non-producing households was found to be influenced by the type of source, the distance from the source of the milk to the consumer, the income of the consuming family and price of the milk.

5.3.2.1 Influence of the source of the product

The findings of Ashimogo and Kurwijila (1990) that most of the traditional dairy products are marketed through interhousehold sales and exchange was verified in this study. From the study it was shown that about 50 % of the non-producing consuming households obtained their milk directly from neighbouring farmers.

5.3.2.2 Effect of the distance from the source

The results of this study on the influence of distance from the source of the product to the consumer (Table 4.11) are in agreement with those reported by Kurwijila and Mdoe (1989) and Coppock, Holden and Mulugeta

(1990). From the literature it was shown that the frequency of farmers sending their milk to distant places decreased to about twice per week or once per week for distances beyond 10 km and 20 km respectively. The low frequencies were attributed to lack of transport whereby farmers had to transport their milk by head loads on foot or by bicycles. This study has shown similar trends in that less than 15 % households located more than 10 km from the source were consuming milk. There were more consumers residing within the milk producing villages or locations accounting for more than 57 % of all consumers. Category 3 showed a low number of consuming households because many villages stretched for more than 2 km as such most respondents were grouped in category 1.

5.3.2.3 Effect of income level

This study has shown a peculiar trend on the consumption of milk when income level was considered. The results show that the medium and low income categories had higher milk consumption levels than the high income levels. This trend was shown also by Seyoum (1989) who showed that expenditure on milk actually falls as income rises, suggesting that there are other food items preferred by the consumers. This suggestion is supported by the study of Mrema (1984) on the influence of income on the consumption of meat and fish which showed that as the

income of consumers increased, consumption of meat and fish increased as well thus reducing the amount of milk consumed.

5.3.2.4 Influence of price of milk on consumption frequency

Correlation analysis has indicated that in this study consumption of milk was negatively correlated to the price of milk. Also distance from the source was significantly ($P<0.05$) negatively correlated to the price. These two facts lead to the suggestion that consumers living far away from the producers paid more for a unit of product sold than those living nearby and so had a lower consumption frequency as shown under section 5.3.2.3 of this thesis.

5.4 Milk processing

Milk processing techniques and the range of milk products made at the producer household level in this study are not very different from those reported in the literature.

While O'Mahony and Bekele (1985) and O'Mahony (1988) report the use of earthenware jars and bottle gourds for churning milk, in this study all households were using bottle gourds hung from the main post of the house.

The range of products made from milk in this study are similar to those reported by Larrat and Veisseyre (1989) and Ryoba and Kurwijila (1991). This trend could be due to tastes and preferences by the farmers that have evolved over the years and lack of exposure to other products. To this effect, there may be a need to introduce to the farmers some other products like cottage cheeses.

5.4.1 Butter making

The average amount of milk churned per batch in this study was lower than that reported by O'Mahony and Bekele (1985), that is 3.6 l against 9.7 l. Time of churning in the current study is shorter than that reported by O'Mahony and Bekele (1985). However the time is similar to that reported by Okanta (1991). The relatively shorter time in this study could be attributed to the smaller amount of milk churned per batch as churning time was found to be positively correlated ($r = 0.61$) to the amount filled. Another reason to this effect could be due to the high churning temperature (21 - 36 $^{\circ}$C) in this study since low temperature increase churning time (O'Mahony 1988).

5.4.2 Churning efficiency

Percent fat recovery in this study was similar to that reported by O'Mahony and Bekele (1985) for traditionally churned milk.

Regression analysis on the factors affecting fat recovery showed that none of the factors significantly ($P > 0.05$) influenced churning efficiency and the coefficient of determination ($R^2 = 0.26$) was too low. This could be attributed to the small sample size. The parameter estimates (Table 4.17) showed that milk temperature and churning time had positive relationships to fat recovery while capacity of churn, extent of fill and milk acidity showed negative relationships. The results are as would be expected because low temperatures and acidity allow the fat to crystallize to butter grains and long churning time give higher chances of fat grains to coalesce. Furthermore the capacity of churn and extent of fill affects the level of agitation. Effective agitation is achieved at around 50 % fill (O'Mahony 1988). As most batches were underfilled (Appendix 2), the result of fat recovery showed a negative relationship. Except for milk acidity which showed an unexpected negative relationship probably due to being confounded by other factors, according to O'Mahony and Bekele (1985) and O'Mahony and Peters (1987), these relationships were expected.

5.4.3 Quality of the products

The quality of the products in terms of moisture content, fat content and solids not fat was not in much disagreement from those reported in other studies except for levels suggested by standard organizations (AOAC 1990, IDF 1961 and TBS 1985). While the moisture content and fat content of buttermilk in this study (Table 4.19) were similar to those reported by O'Mahony and Peters (1987) the level of solids not fat in the current study were higher. This disparity could be due to the genotype, environment, the milking practices and lack of straining of the milk hence incorporating some extraneous materials in the milk.

The moisture content in butter of the current study was higher than that recommended by the Tanzania Bureau of Standards - TBS (1985) and that reported by O'Mahony and Peters (1987). Fat content and solids not fat were on the other hand lower than those reported by the two mentioned authorities. This implies that butter produced in this study had a potentially lower storage time than can he expected as the storage time of butter decreases with an increase in moisture content (Bekele and Kasaye 1987; Berg 1988). Hence there is need to improve processing technique.

Fat content in ghee as determined in this study was similar to that reported by the IDF (1969). The study by O'Mahony and Peters (1987) showed higher values in respect to this parameter. The moisture content and non-fat solids in this study were higher than those found by O'Mahony and Peters (1987). The high value of moisture content and the non-fat solids in this study could be attributed to poor processing and the incorporation of non-milk components like dust as the milk or ghee was not filtered, this could account partly for the observed difference between this study and that of O'Mahony and Peters (1987) in fat content in the ghee.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The following conclusions can be drawn from this study:

(i) The milk production systems and milk production levels found in this study are similar to those reported in the literature for zebu cattle managed traditionally by agro-pastoralists elsewhere.

(ii) The results of the current study have shown that producer households retained most of the milk in the house for direct consumption or for processing to butter and ghee.

(iii) The traditional method used for milk churning is limited to small amounts of milk and is time consuming with a low fat recovery efficency.

(iv) The marketing channels in this study were relatively few. Mostly milk was purchased directly from the farmers for village consumers. Town centre consumers who obtained milk from bicycle-boys or hawkers and shops had one to two intermediaries in the chain for delivering milk from production areas to Dodoma Municipality.

6.2 Recommendations

(i) Based on the low milk production levels found in the traditional herds studied, there is need to carry out studies on the possibility of raising these levels. Management practices like a good grazing environment for improved nutrition and control of diseases such as tick borne diseases and programmed vaccinations are proposed in the short term. Long term plans for sustainable nutrition, health care, systematic selection within pure zebu cattle, limited upgrading of the selected zebu cattle through cross breeding with other breeds and establishing large herds of improved pure zebu cattle and determining optimum blood levels of the crosses under Dodoma conditions are important approaches to increased milk production and cattle productivity.

(ii) The small amount of milk exposed for sale by the producers is an indication of lack of outlets which offer prices conducive to the farmer. To this effect there is a need for the farmers to sell their milk through cooperative groups so as to have a control of the prices offered for their milk and improvement in infrastructure so that the groups can transport their milk to the municipal areas to fetch higher prices

which are currently enjoyed by the middle men. The possibility and profitability of establishing milk collection centres especially to buy excess milk during the peak periods can be studied and introduced in order to stabilize prices throughout the year.

(iii) The traditional processing method is not efficient enough to process large amounts of milk during peak periods. Improved cost effective technology like the churn fitted with an internal agitator can be tried in order to improve both fat recovery and reduce churning time.

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Appendix 1: Facilities for the support of livestock in the study villages

Name of village	Water sources		Veterinary centre	Cattle dip	Cattle market
	Type	Distance from village/km			
Gawage	Wells	< 2	-	-	-
Hombolo-Bwawani	Dam	< 2	1	1	1
	Weels	< 5			
Ihumba	Boreholes	< 2	.-	-	-
	Wells	< 2			
Kikombo	Wells	< 2	1	1	1
	Boreholes	< 2			
Mkonze	Wells	< 2	-	-	-
Mpunguzi	Wells	< 2	-	-	1
Mzakwe	Boreholes	< 2	-	1	1
	Wells	< 2			
Veyula	Boreholes	< 2	-	-	-
	Wells	< 2			

- Not available

Appendix 2 : Sample households: Characteristics of churning milk traditionally, Ihumwa village, 1991

Batch	Capacity churn (l)	Amount filled (l)	Extent of fill (%)	Milk acidity (pH)	Milk temperature (^{0}C)	Time spent (Min)	Percent recovery of fat
1	20.00	5.25	26.25	3.5	25	50	68.88
2	23.00	3.75	16.30	3.0	22	31	64.58
3	4.45	2.25	50.56	3.0	27	19	76.80
4	9.00	3.75	41.67	3.0	23	50	70.90
5	12.00	7.50	62.50	4.0	24	44	72.00
6	28.00	4.88	23.22	3.5	22	30	82.45
7	8.25	5.25	61.76	3.5	25	27	76.47
8	12.50	3.75	30.00	5.0	30	26	63.83
9	9.00	3.75	41.67	4.0	35	26	68.51
10	9.50	4.50	50.00	4.0	26	39	85.00
11	12.00	3.75	30.00	5.0	30	43	78.94
12	9.00	3.75	41.67	3.5	23	40	75.61
13	15.00	3.00	20.00	5.0	29	20	73.07
14	20.00	1.48	6.75	5.0	25	21	57.50
15	8.25	1.65	45.45	4.0	21	29	72.50
16	12.00	3.75	31.25	3.5	36	22	83.33
17	20.00	3.75	18.75	4.0	26	12	73.81
18	7.00	1.32	17.14	3.5	24	10	64.15
19	10.00	2.31	21.00	3.5	24	15	70.68
20	20.00	2.64	12.00	4.0	25	21	62.22

Appendix 3. QUESTIONNAIRE FORMAT

1. GENERAL INFORMATION ON VILLAGES

1.1 Name of village.....

1.2 Location of the village.....

1.3 Number of households in the village.....

1.4 Number of people in the village:
- a) Men.....
- b) Women.....
- c) Children above 10 years.....
- d) Children below 10 years.....

1.5 Livestock population
- a) Cattle.....
- b) Sheep.....
- c) Goats.....
- d) Others .....

1.6 Does the village have any extension officer living in the village? Y/N

1.7 What water sources are avilabile in the village
- a) Boreholes.....
- b) River.....
- c) Dams.....
- d) Wells.....

1.8 How far is the water source from the village?
- a) Less than 2 km from the village.....
- b) 2 5 km from the village.....
- c) 5 10 km from the village.....
- d) More than 10 km from the illage.....

1.9 How far is the village from the nearest following places
- a) District Head Quarters (Urban centre).....km
- b) Veterinary centre ..... km
- c) Cattle market ..... km
- d) Cattle dip..... km

2. PRODUCER HOUSEHOLD INFORMATION

2.1 Owner of the cattle

a) Name .....

b) Sex.....

c) Age.....

d) Marital status : Single/Married

If married

i) Number of wives.....

ii) Children : Sons.....Daughters.....

iii) Number of children less than school age .....

iv) Permanent dependants.....

e) Level of education.....

i) Did not attend school.....

ii) Primary.....

iii) Secondary.....

iv) Higher.....

2.2 Herd size (cattle numbers)

a) Cows..... b) Breeding bulls.....

c) Heifers (above 2 yr)..... d) Female calves.....

e) Male calves..... f) Young bulls.....

g) Steers.....

2.3 Management of the herd

a) Who does the following operations

i) Castration.....

ii) Mark animals .....

b) At what time are cattle normally taken out and returned from grazing

Wet season:

Out.....

Back.....

Dry season:

Out.....

Back.....

c) For how long was pasture considered to be available for your cattle in 1989 .....months,

1990 .....months

d) What do you do when pastures are not adequate
.....

e) How frequently do you water your animals : Per day.....
Per week.....

f) Have you had your animals vaccinated over the past year
Y/N.....
If Y: Did you request for vaccination? Y/N.....
If Y: Against what diseases were the animals vaccinated
.....
If N: Who initiated the vaccination.....
.....

g) How often do you dip your cattle Per week.....
Per month.....

h) At what age do you normally wean your calves
Female calves ..... months
Male calves ..... months

i) At what age do heifers and bulls start to mate
Heifers..... years
Bulls ..... years

j) How frequently do you milk your cows :
Once a day at.....
Twice a day at .....and at.....

k) When do you get the highest amount of milk
i) In the morning/evening.....
ii) During the wet season/dry
season.....

l) Who milks the cows
i) The household head.....
ii) The women.....
iii) The herdsboys.....
iv) The girls.....
v) Hired labourer.....

2.4 Hygiene at milking

a) Do you normally wash the udder befor milking
Y/N.....
b) How do you get the milking utensils cleaned
i) By cold water and soap.....
ii) By cold water and ash.....
iii) By hot water and soap.....
iv) By hot water and ash.....
v) Other (specify).....

c) Is milk strained Y/N
If Y, what method do you use
i) Sieve (mesh).....
ii) Cloth (cotton cloth).....

2 .5 Livestock production levels

a) How many cows did calve down over the last year (1990).....

b) How many calves died in 1990 .....

c) What is the current production level of milk on average from a cow/heifer per day:
Cow.....l,Heifer.....l

d) How much is the best cow giving per day currently.....l
How much was the best cow giving last year.....l

e) For how long do you milk your cows/heifers before drying off.....months.

f) How many cows calved over the last twomonths.....

g) How many of these had calved before.....

h) When was their last calving.....

i) How much milk do you get from your herd per day?
.....l/bottles

2.6 Marketing and consumption

a) How much milk did you get in the last one week
.....l/bottles.

b) How much was consumed at home.....l/bottles

c) How much was sold.....l/bottles

d) What was the price per unit sold.....sh/l/bottle

e) Do you consume fresh milk Y/N.....
If Y, drinkraw.....l/bottles
Drink after boiling.....l/bottles

f) Do you consume
   i) Sour milk Y/N.....
   If Y, with ugali.....l/bottles sour milk
   alone.....l/bottles

ii) Butter Y/N.....
   If Y, how.....

iii) Ghee Y/N.....
   If Y, how.....

g) Do you sell
   i) Sour milk Y/N.....
   If Y, how much.....l/bottles
   and how often.....week/month
   ii) Butter Y/N.....
   If Y, how much.....kg and
   how often.....week/month
   iii) Ghee Y/N.....
   If Y, how much.....l/bottles and
   how often.....week/month

h) Where do you normally sell your dairy products

   i) Village shop.....
   ii) Local market.....
   iii) Off-the road.....
   iv) Vendors.....
   v) Contracted individuals.....
   vi) Others (specify).....
   vii) What prices are offered for
   a) Freshmilk.....sh/l/bottle
   b) Sour milk.....sh/l/bottle
   c) Butter.....sh/l/kg
   d) Ghee.....sh/kg

   i) Where do you store your milk before you expose for sale
   i) In gourds.....
   ii) In milk cans.....
   iii) In buckets.....
   iv) In bottles.....

   j) How do you get this milk transported to the selling point
   i) By donkeys.....
   ii) Headloads.....
   iii) Bicycle.....
   iv) Sold at door step.....
   v) Others (specify).....

2.7 Farm problems

a) What do you consider to be your main problems

i).....
ii).....
iii).....
iv).....
v).....

b) Did you loose any of the following livestock classes in 1990 through death

i) Young calves : Number.....
ii) Heifers : Number.....
iii) Young bulls : Number.....
iv) Steers : Number.....
v) Adult cattle : Number.....

3 CONSUMER HOUSEHOLD INFORMATION

3.1 Name .....

3.2 Occupation.....

3.3 Place of domicile

a) Urban.....
b)Rural.....

3.4 Income category

a) High (more than 10,000/= per month)
b) Medium (5,000 to 10,000/= per month)
c) Low (2,000 to 5,000/= per month)
d) Poor (less than 2,000/= per month)

3.5 Family size

a) Babies 1-2 years.....
b) Infants 2-3 years.....
c) Children 3-15 years.....
d) Adults.....

3.6 How frequently do you consume fresh milk?

a) Daily.....
b) At least once a week.....
c) Monthly.....
d) Rarely.....
e) Not at all.....

3.7 From where do you get your fresh milk?

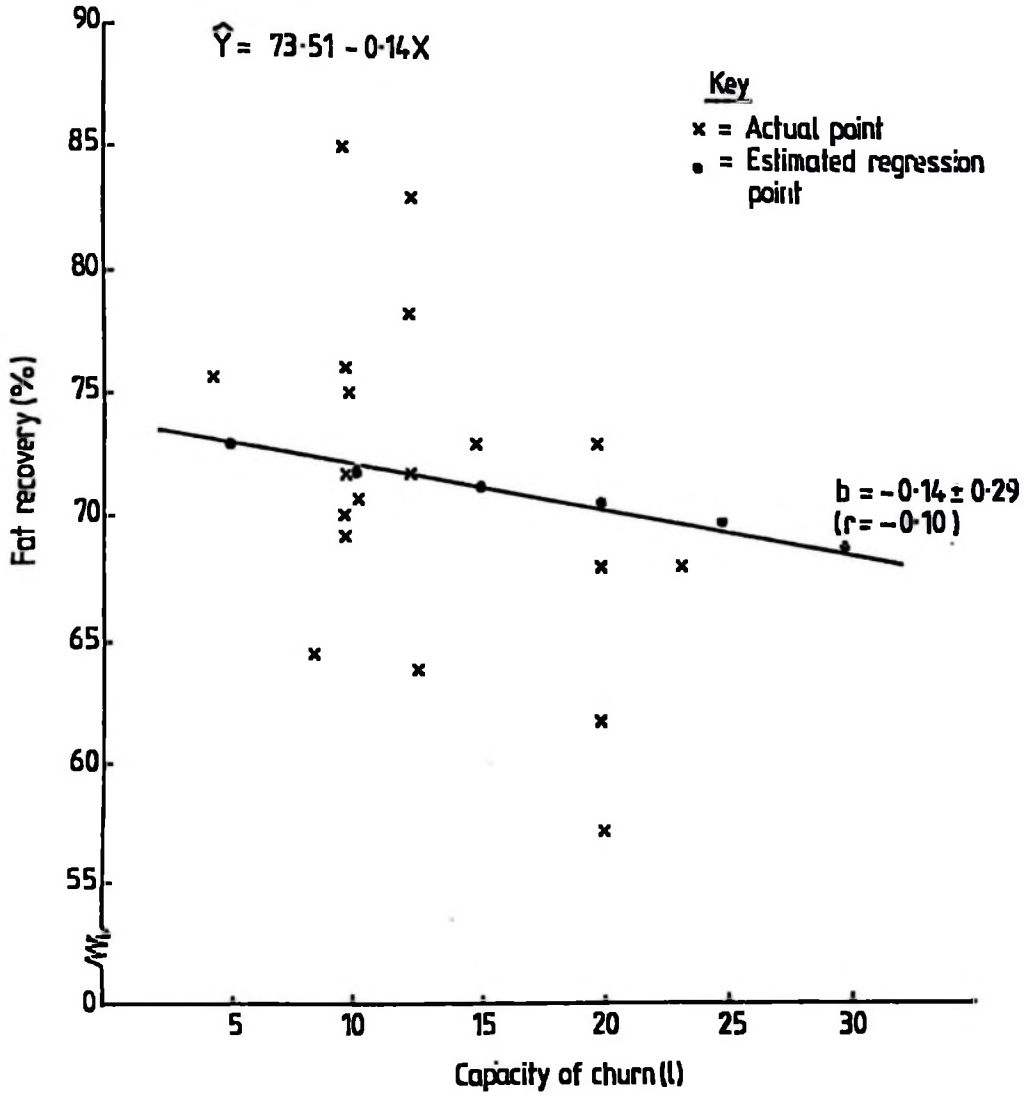
a) Farm.....
b) Farmer.....
c) In market.....
d) Bicycle boy/hawkers.....
e) Shop/kiosk.....
f) Others (specify).....

3.8 Distance from source
a) 0 - 2 km.....
b) 2 - 5km.....
c) 5 - 10km.....
d) More than 10km.....

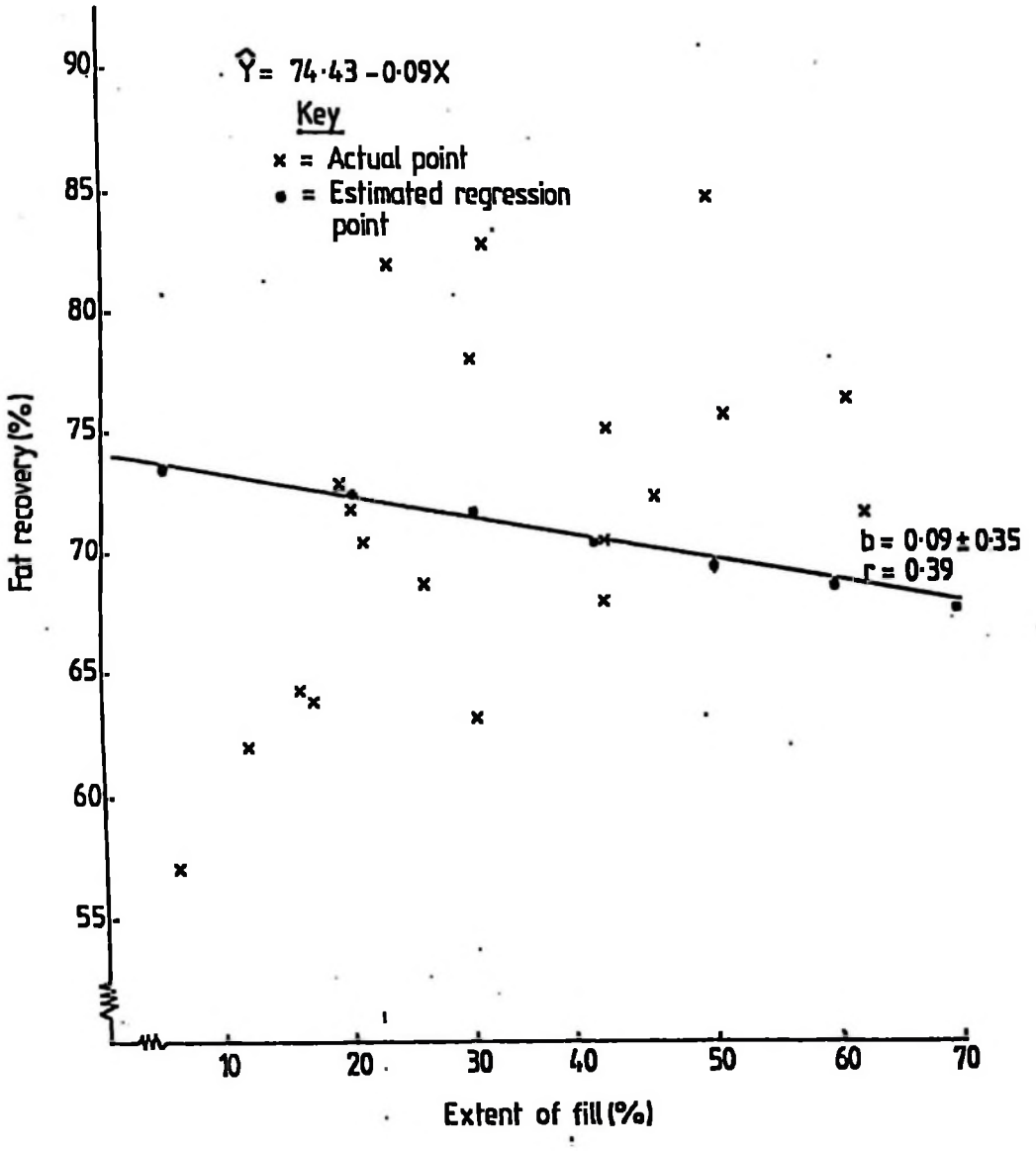
3.9 What processes do you perform after receiving fresh milk
a) Boiling .....
b) Separation into cream or butter.....
c) Leave to ferment.....
d) Add sugar.....
e) Add flavours or food colours.....
f) Others (specify).....

3.10 What factors influence the amount of the dairy products you consume
a) Product type .....
b) Product quality.....
c) Price.....
d) Storage conditions.....
e) Not familiar.....
f) Distance from the source.....
g) Others (Specify).....

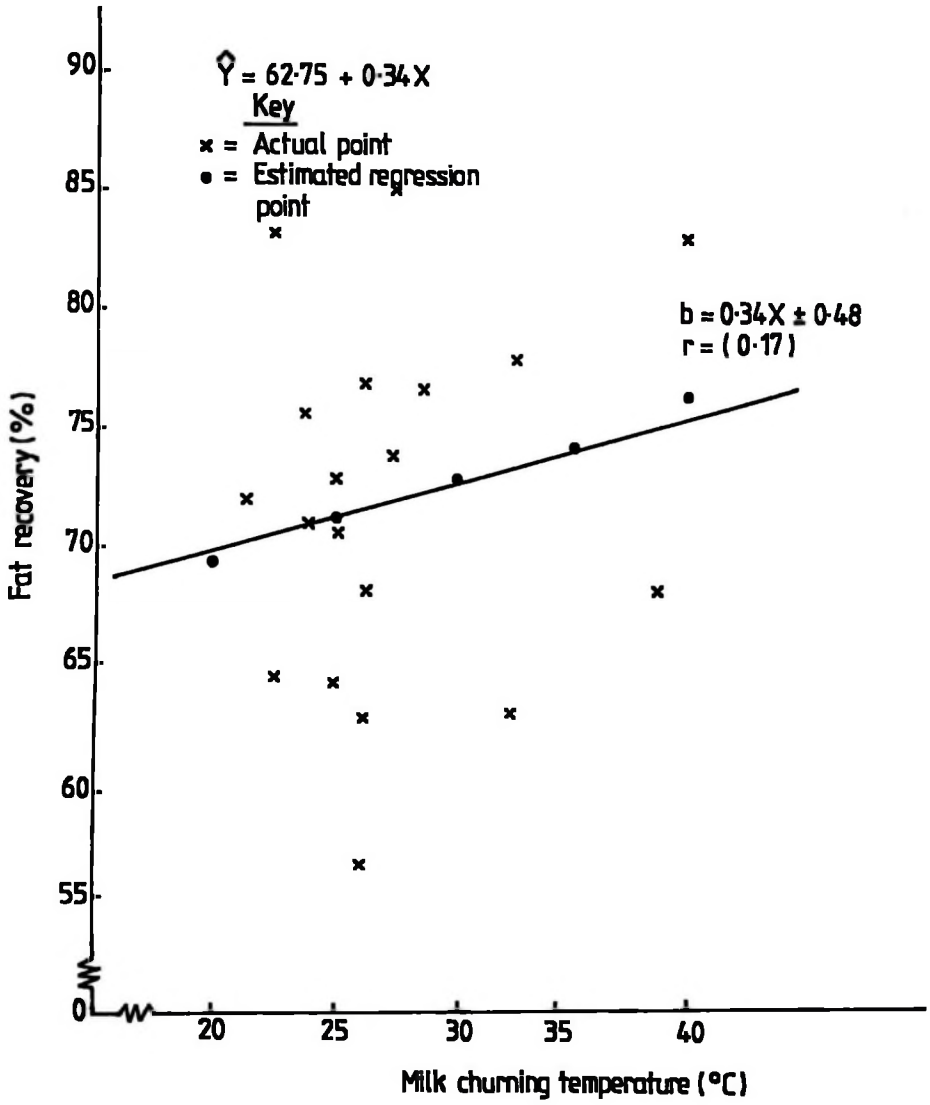
Appendix 4 . Regression of fat recovery on capacity of churn



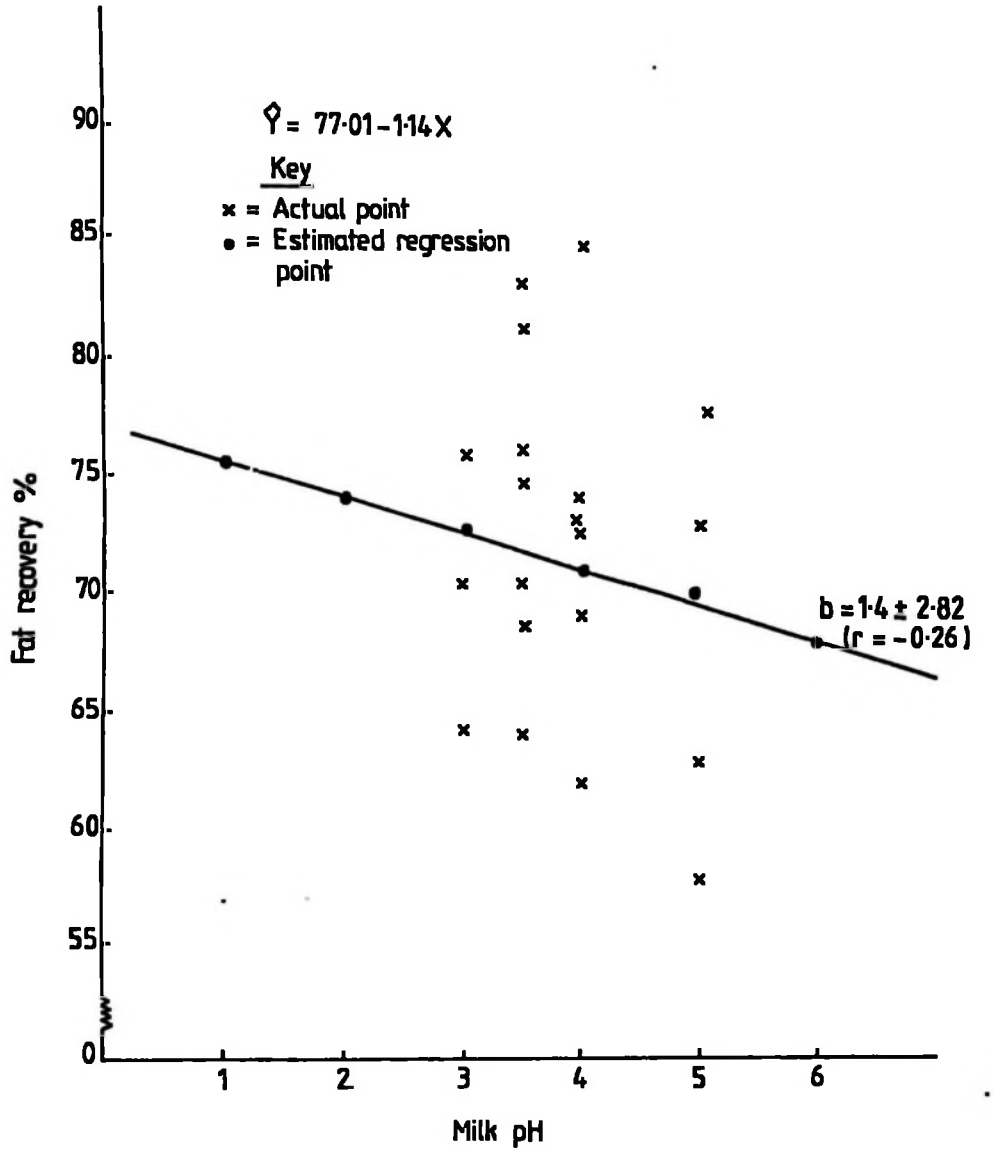
Appendix 5 . Regression of fat recovery on the extent of fill



Appendix 6. Reggression of fat recovery on milk temperature



Appendix 7 Regression of fat recovery on milk acidity



Appendix B. Regression of fat recovery on churning time