A few private and coop milk processing plants have a strong capital base and have attained high industrial standards (e.g., Limuru, Brookside, Meru Central Union) but a majority use simple equipment such as *jikos* and firewood to heat the milk in water jackets. Most small scale private processors sell as much liquid raw milk as they can and only process the remainder.

Table 5 shows the wide variation in margins realised between processors and coops in the highlands and at the coast. Boyo Coop in Kangema Division of Murang'a District had a negative margin due to a low retail price and high competition from small milk traders who collect milk from the same area to sell in Murang'a Town and other distant urban centres at a better margin of 20% (Table 4). The two tables illustrate the competitiveness of private enterprises (private processors and small milk traders) compared to coops. When capital and other overhead costs of the coops are considered, their net margins would be even lower compared to private enterprises especially small milk traders.

KCC

KCC has 11 plants countrywide. These plants are located at Naivasha, Nyahururu, Eldoret, Nakuru, Kitale, Nairobi, Kiganjo, Sotik, Miritini (Mombasa) and Dandora (Nairobi); 11 cooling/collection centres located at Kapsabet, Lessos, Ainabkoi, Iten, Githumu, Kangema, Nanyuki, Runyenjes, Molo, Kilgoris and Eldama Ravine; and, 26 sales depots and sub-depots located at Nairobi, Dandora, Mombasa, Nakuru, Kisumu, Eldoret, Kitale, Nanyuku, Thika, Naivasha, Machakos, Kericho, Kiganjo, Bungoma, Meru, Kisii, Nyahururu, Embu, Busia, Kabarnet, Sotik, Taveta, Kibwezi, Kitui, Makueni and Malindi. Their total capacity is about one million litres/day or approx. 365,000 MT/year. Most plants currently operate at below 30% (the KCC Dandora plant, which is the biggest with half of KCC's total capacity, was operating at less than 10% of its capacity in mid 1998). It is estimated that up to 60% of the KCC sales are in Nairobi.

Milk intake by KCC over the last 10 years has declined from a peak of about 350,000 MT/year in the late 1980's and early 1990's to only about 120,000 MT in 1996/97 (Figure 6) (KCC, 1997). This translates into only about 330,000 litres per day, compared to over 400,000 litres per day that were reported to be privately processed during this survey. The beginning of the decline corresponds to the end of milk marketing monopoly by KCC and the emergence of private sector participants following milk market liberalisation and hence, can be partly attributed to direct competition. This was quite evident in areas where milk hawking has increased remarkably such as in Murang'a District, where intake at the local KCC Plant at Kangema declined from a peak of 48,000 litres/day (its total capacity) to only

2,000 litres/day in 1997. However, KCC continues to play a major role in reducing the milk deficit in Coast Province and as buyer of last resort in many areas. When KCC has excess milk, it is turned into powder for later reconstitution and sale in milk deficit areas and during periods of low liquid milk supply. In 1996/97, the KCC Miritini Plant in Mombasa reconstituted about 27 million litres of milk powder, similar to the figure reported by Staal and Mullins (1996) for 1990, when KCC also transferred an additional 20.5 million litres of liquid milk from Nairobi to supplement the reconstituted milk. This liquid milk transfer from the highlands is currently non-existent. The poor record of delayed payments of up to six months that started in 1995 and limited farmer control are widely considered as the major reasons that have contributed to the decline in milk intake by KCC.

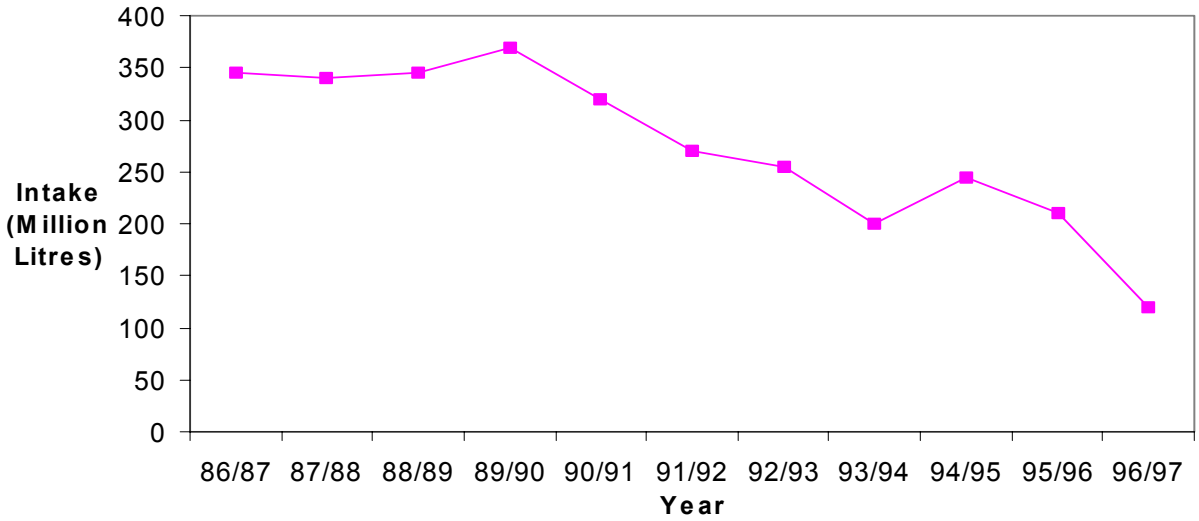

Figure 6. Milk intake by Kenya Co-operative Creameries.
Source: KCC Annual reports

3.5 Milk Consumption and Preference Patterns

Sufficient information to assess milk consumption and preference patterns is generally lacking. One study based on a household survey at the coast found a near 100% preference for raw milk over pasteurised, fermented, powdered or UHT milk (Staal and Mullins, 1996). They found that none of the existing market mechanisms (both formal and informal) were adequate in meeting consumer preferences and overall market demand that increases with higher income and urbanisation. However, in a recent small urban survey of milk traders in Nakuru District, retailers indicated the frequency of sales for pasteurised milk, UHT milk and *maziwa lala* to be 36%, 23%, and 32%, respectively, compared to 36% for raw milk (Kurwijila et al., 1997). These apparent wide differences in preferences between the

Coast Province and Nakuru District may be a reflection of the different methodologies used or a wide variation in milk consumption and preference patterns.
The consumption study by Staal and Mullins (1996) at the Kenyan coast showed milk deficits of up to 60%; MoA estimates show that milk deficits of between 30-40% also occur in western Kenya and in Narok.

3.6 Public Health Concerns Over Informal Milk Marketing

The increasing role of informal non-processed milk market pathways in urban areas has raised concerns by consumers and policy makers. The concerns are over public health hazards that are believed to be associated with informal milk marketing, especially zoonoses of brucellosis and to some extent, zoonotic tuberculosis (caused by *M. bovis*). Previous government policy of only promoting pasteurised milk sales (reflected in the many years of protection of KCC as the only legal milk marketing agent) and prohibition of raw milk trade was geared towards minimising these risks. The changed policy scenario means that alternative mechanisms must be found to protect public health, if indeed those risks are real. Appropriate mechanisms for protecting public health however cannot be formulated in the absence of accurate information. These concerns are the subject of a study that has commenced under the MoA/KARI/ILRI Smallholder Dairy Project, which will investigate the risks at the farm- market- and consumer-levels, and produce accurate information for policy makers. During this appraisal, these concerns over milk-borne diseases were particularly raised in Nakuru, Uasin-Gishu, Nandi and Narok districts.

Indications are that these concerns over brucellosis, a contagious disease, may be more real in extensively grazed herds than in smallholder intensive farming systems. Muriuki *et al*., (1994) reported an overall proportional morbidity of 5.5% among all hospital cases and 14% among those with flu-like symptoms in a study among Maasai pastoralists in Narok District. In contrast, one localised study conducted on intensive dairy farms in Kiambu District found a 2% apparent prevalence (Kadohira *et al*., 1997), indicating that brucellosis is unlikely to be important in local smallholder dairy herds.

Unlike all other neighbouring countries, there has never been a report of *M. bovis* infection in either bovine or human populations in Kenya.

3.7 Main Issues in Consumption and Marketing

1. The good opportunities for continued growth in smallholder dairying given projected local demand (at least 70% increase over the next 12 years) and supply projections. With modest improvements in milk supply of at least 3%, substantial amounts of dairy products would be available and could be exported. Potential markets for export exist in neighbouring countries (e.g., Tanzania with a very large gap between demand and supply of dairy products).

2. The increasing role of the informal private sector in milk marketing and concern by the formal private sector (including coops) about unfair competition regarding taxation, which informal operators do not pay; and the cost of observing quality standards, which does not apply to informal operators

3. Increasing concern by consumers and policy makers over milk-borne public health hazards, and the lack of information to quantify the actual risks.

4. Seasonality in milk supply and the lack of sufficient mechanisms by the informal and formal milk markets to level off its impacts. The current dry season premiums paid by some processors have not had the effect of stabilising supplies because the level of incentives and the market share for processed milk are small.

5. Lack of reliable information on milk demand patterns, including product differentiation and the changes in dairy consumption habits with urbanisation.

6. Limited market information on input (e.g. feed) and output markets, and the suitability of alternative market mechanisms

7. Farmers' preference for reliable marketing channels that pay promptly and offer additional services, over the price offered *per-se.*

4. Dairy Production Systems

This section summarises the major findings of the RA on the dairy production systems. The characteristics of the principal milk sheds and production systems within them are described.

4.1 Milk Sheds

About 60% (approx. 1,900 MT) of total milk production in Kenya takes place in less than 10% of the country's landmass in the central districts of the Rift-Valley and Central Provinces, where 80% of exotic and cross-bred dairy cattle are found. All these districts fall within agro-climatic zones (ACZ) 1-4,[15] and have fertile volcanic soils in most areas. Other areas with significant dairy production include Western Province, and Kisii and Meru Districts. Extensive cattle production from the East African Zebu (particularly in agro-pastoral areas in the Rift-Valley, Eastern and North-Eastern and in sedentary areas in Coast, Nyanza, Western and Eastern Provinces) also contribute a small proportion of their milk offtake to local rural markets including direct sales to neighbours.

Table 6. Livestock numbers[a] and milk offtake by species and regions[16]

Province	Indigenous cattle		Dairy cattle		Goats	
	Population ('000)	Milk offtake ('000 MT.)	Population ('000)	Milk offtake ('000 MT.)	Population ('000)	Milk offtake ('000 MT.)
Central	78	5	810	694	13	0.1
Coast	1,074	62	45	35	711	2.4
Eastern[b]	1,498	86	273	235	1,400	4.9
N. Eastern[b]	809	44	<1	<1	814	2.7
Nyanza	2,089	128	149	101	44	0.6
Rift Valley	3,358	193	1,666	1,367	3,200	11.2
Western	925	57	102	69	8	0.1
Total	9,831	575	3,045	2,502	6,190	22
Proportion%	76	19	24	81	-	-

[a]Source: MoA (1996) and Peeler and Omore (1997)

[b]There is significant but unquantified camel milk production from these provinces

[15] Details on Agro-climatic zones (ACZ) are in Appendix 2. They were first described as climatic agroecological zones (AEZ) by FAO (1978) and are roughly parallel with Braun's climatic zones of the Precipitation/ Evaporative (P/PE) Index. They have been widely used to show *agro-ecological mosaics* in Kenya (Kenya Soil Survey, 1982)

[16] Estimates of livestock numbers in some areas may be higher or lower than MoA official statistics by as much as 50% as recently shown by figures from random household surveys in Kiambu (Staal *et al*., 1996) and Kilifi (Nicholson *et al*., 1998).

Total milk offtake from indigenous and improved dairy cattle is estimated at 575,000 MT (19%) and 2,502,000 MT (81%), respectively (Table 6). Production from local and a few (<4,000) dairy goats contribute an insignificant proportion (<1%) (Table 6). The distribution of various cattle breeds and offtake in different regions is mainly a function of market access and agro-climate. In addition, the influence of historical exposure to dairy cattle keeping, colonial era livestock development policy that targeted specific areas for the introduction of dairy cattle (Conelly, 1998) and ethnic differences cannot be ignored as key factors that determine the current distribution of dairy cattle.

4.2 Classification of Production Systems

Dairy production in Kenya is mostly with cattle. Besides some production from local goats, there is a small (a few thousands) but steadily growing dairy and improved dual-purpose (dairy-meat) goat population being promoted in central and Western Kenya. There is yet no record that their milk production makes a significant contribution to total marketed milk.

Cattle production systems

Cattle production systems in Kenya and production parameters within them have been extensively described by various authors and summarised by Peeler and Omore (1997).

The dairy and indigenous cattle production systems can be divided into four broad classes (two large- and two small-scale systems) reflecting the genotype, the major product(s) or objectives of production and the physical (climate), biological (flora and fauna) and socio-economic (market orientation and management input[17]) environments. Cattle population, number of households and major production regions are shown in Table 7.

The systems that occur in ACZ 1-4 are associated with arable farming; the systems in ACZ 5-7 are mostly pastoralist. The estimated median of frequency distributions of herd size for each region has been used to divide the scale of production, within each broad system, into small and large. The classification defines impact zones that may be used, in conjunction with market factors, to carry out *ex-ante* impact assessment of interventions, and setting of priorities.[18]

The classification (Table 7) shows the dominance of small scale production, particularly where exotic cattle and their crosses are adopted. Marketed dairy production is

[17] Management input (classified as intensive, semi-intensive and extensive) describes the degree of external purchased inputs and labour

[18] District level dis-aggregation of these classes are contained in Peeler and Omore (1997).

concentrated near consumers (e.g. Nairobi) and in the highland areas with a suitable agro-climate and high human population density. This is similar to recent findings in Tanzania (MOAC/SUA/ILRI, 1998) and confirms the presumption that market-oriented dairying is primarily a function of market accessibility, agro-climate and good infrastructure. Production parameters for selected production systems are summarised in Table 8.

Large scale cattle production systems

(i) Large scale dairy intensive and semi-intensive dairy cattle production systems

Large scale dairy production systems consist of large farms owned by individuals, private firms and public institutions such as the Agricultural Development Corporation (ADC). It is estimated that there are approx. 500,000 heads (about 17% of the total population of exotic and cross bred dairy cattle) (MoA, 1996) in large scale dairy systems. The herd sizes are skewed with a few farms having over 100 heads, though any farm with more than 20 head is classified as large scale. Friesian is the dominant breed, but Ayrshire, Guernsey and Jersey are also found. Some farms in the drier areas cross Sahiwal with the local EAZ breed. Management in these farms varies greatly from very low input, low milk output, semi-intensive to mechanised intensive production based on irrigated legume production and machine milking. The farms are a source of breeding heifers for many smallholdings and for buyers from neighbouring countries, particularly Tanzania. In-calf heifer prices in well-managed farms are over KSh 50,000 per head. The lack of a regular livestock census makes it impossible to determine whether the number of farms and cattle in this system continues to decline, as was the case in the 1960's and 70's, or whether they are stable. Indications from recent SDP characterisation surveys in the Nairobi milk shed suggest that the number of cattle in this system may not be as many as previously assumed.

(ii) Large scale extensive dairy-meat cattle production system

This system is mostly pastoral and agro-pastoral with EAZ cattle (and some small ruminants) in the low rainfall areas (ACZ 5-7). It is found in the northern and southern regions of the Rift Valley, Coast and Eastern Provinces. In some areas, improved Boran and Sahiwal bulls have been introduced (Roderick, 1995). The numbers of cattle in pastoralist herds are also very skewed with a minority of pastoralists owning herd sizes of over 150 heads, though any farmer with over 30 cattle falls in this category. They have access to considerable grazing land. Production in some areas (e.g., south Rift Valley and Coast) is constrained by tsetse challenge and by feed shortages during the long dry seasons.

Table 7. Dairy and indigenous cattle production systems in Kenya

Production System	Geno-type	Major Product(s)	Agro-Climate/ Farming System	Purpose	Manage-ment	Cattle Population[a] '000	%	Milk Prod ('000 MT)	No. of Households[b] '000	%	Major Production Regions
Large Scale											
1. a) Intensive dairy	Exotic	dairy	humid to semi-humid/ (ACZ 1-3) crops-livestock	entirely market-oriented	intensive	500	4	782	5	<1	Central Rift valley
b) Semi-intensive dairy	Exotic/ crosses	dairy	humid to semi-humid/ (ACZ 1-3) crops-livestock	entirely market-oriented	Semi-intensive						
2. Extensive dairy-meat	Zebu	dairy-meat	semi-arid to arid/ (ACZ 5-7) livestock only	mostly pastoralism	extensive	4,500	35	246	45	3	North and South Rift Valley, Eastern and Coast
Small Scale											
1. a) Intensive dairy-manure	Exotic/ crosses	dairy-manure	humid to semi-humid/ (ACZ 1-3) crops-livestock	mostly market-oriented	Mostly intensive	2,500	20	1719	625	47	Central Province, Central Rift Valley, Coast.
b) Semi-intensive dairy-manure	Exotic/ crosses	dairy-manure	humid to semi-humid/ (ACZ 1-3) crops-livestock	mostly market-oriented	Semi-intensive						
2. Semi-intensive dairy-meat-draught-manure	Zebu/ few crosses	dairy-meat-draught-manure	humid to semi-arid (ACZ 1-5) crops-livestock	mostly subsistence	semi-intensive	5,300	41	328	660	50	Nyanza, Western, Coast, Eastern, Rift Valley

[a]Source: MoA (1996); Peeler and Omore (1997)
[b]These are only rough estimates based on research findings. No recent census reports are available

Small scale cattle production systems

(i) Small scale intensive and semi-intensive dairy-manure cattle production systems

About 80% of dairy cattle are found in this production system, which is common in the highland areas of central Rift Valley and Central Provinces. The farms are small and the farmers produce cash and food crops besides milk. In the intensive systems within these highland areas, farmers own about 4 cattle on approx. 1 ha. of land cropped with any combination of coffee, tea, maize, edible horticultural crops and some fodder, depending on agro-climate and terrain elevation (Jaetzold and Schmidt, 1983; Gitau *et al*., 1994a; Staal *et al*., 1998). A high proportion of farmers stall-feed their cattle. The system is common in Kiambu and Murang'a Districts. In Kiambu District, this system is practised by about 70% of households (Staal *et al*., 1998). In the semi-intensive production systems, the number of cattle and the land area per household are slightly larger than those in the intensive systems. Most farmers free-graze or paddock-feed their cattle. The system is common in the Rift Valley and in Kirinyaga, Embu, Meru and Nyandarua districts.

Milking is twice a day in most areas and is done by hand in almost all farms. Some of the milk is bucket fed to calves up to 3 months of age (about 3kg/calf/day). A few farms, with good market access (e.g., in Nairobi and Machakos) were observed to milk thrice a day. Housing recommendations promoted by the National Dairy Development Project (NDDP) that include roofing and concrete floors, have been adopted by only a few farmers. Most cow sheds are built of cheap locally available materials and have earthen floors. In Kiambu District, only 50 and 28% of cow sheds are roofed and have concrete floors, respectively (Omore *et al*., 1996a).

In-calf heifer prices in this system range from approx. KSh. 15,000 in the semi-intensive systems to about KSh. 30,000 in the intensive system[19]. Productive performance is low with long calving intervals of about 600 days (Odima *et al*., 1994); high calf mortality rate of about 20% and low milk yields, mostly between 5-8kg/day; the result of under-nutrition (Omore *et al.*, 1996b; Staal *et al*., 1998).

[19] In-calf heifer and cow prices generally reflect the total value of milk that a cow is expected to produce in a year

Table 8. Production Parameters across selected Cattle Production Systems

Production Parameter	Production System			
	Large scale Extensive (Zebu)	Small scale semi-intensive (zebu)	Small scale Semi-intensive (exotic/ crosses)	Small scale Intensive (exotic/ crosses)
Herd size	>30	1-30	1-20	4 (1-10)
Farm size (ha)	Communal	30	10	4
Breeding management	Bull	Bull	Bull/AI	Bull/AI
Grazing management	Free (pastoral)	Free (agro-pastoral)	Semi-zero	Zero
Cultivated land (ha)	0	1-5	4	3
Natural pasture (ha)	communal	20-25	5	0
Proportion breeding cows (%.)	35	35	40	40
Planted pasture (ha)	0	0	<1	1
Age at first calving (years)	4	3.5	3	3
Calving rate (%/yr)[a]	60	60	70	70
Pre-weaning calf mortality (%/yr)	20	20	15	20
Age at weaning (days)	>200	>200	90	90
Adult mortality (%/yr)	6	6	5	5
Price of in-calf heifers (KSh)	8,000	8,000	20,000	25-30,000
Lactation length (days)	>200	>200	450	450
Milk offtake (litres/cow/yr)	200	250	1555	2000
Milk for calf rearing (litres/cow)	suckling	suckling	270 (bucket)	270 (bucket)
On-farm consumption (litres/cow/yr)	150	240	650	650
Marketed milk production (litres/cow/yr)	0	10	905	1350
Average gross margin (KSh/cow/yr)	7,000	9,000	20,000	25,000

[a]Rates are presented as true rates.

Sources: Stotz (1983); Moll *et al*., (1984); de Leeuw and Wilson, (1988); Bekure *et al*., (1991); Odima *et al*., (1994); Gitau *et al*; (1994a,b); Maloo *et al*., (1994); Roderick (1995); Latif *et al*., (1995); Semenye (1987); Omore (1997); Peeler and Omore, (1997).

Though limited access to breeding services may be a major cause of long calving intervals, many farmers voluntarily wait for long periods of up to 200 days after calving before getting their cows served or inseminated again (Odima *et al*., 1994). Indications are that smallholder farmers may not be interested in reducing the long calving intervals until they realise higher milk yields with peaking lactation curves because the extra benefits of reduced calving intervals under current production are minimal (Tanner *et al*., 1997).

Many farmers use manure to fertilise their food and fodder crops, either in the form of compost (which may include poultry waste), slurry or fresh dung. However, little is known

about the efficiency of nutrient flows and details of manure management practices, to optimise crop and livestock production in the areas where manure use is common. Indications are that manure is not used optimally due to lack of knowledge about how to extract maximum benefits from them (Lekasi, personal communication).

Low calf growth rate (mean weight gain only 0.24 kg/day) up to 5 months of age and high annual calf (up to one year of life) morbidity and mortality (mostly due to diarrhoea) of 27 and 22%, respectively, have been reported in intensive systems (Gitau *et al.*, 1994b). The poor growth rates result in late age at first calving averaging 41 months (Odima *et al.*, 1994). The low dam milk production is also an important constraint to optimal calf growth.

(ii) Small scale semi-intensive dairy-meat-draught-manure cattle production system

Many farmers, who are mostly subsistence oriented, practice small scale semi-intensive production with predominantly EAZ herds and a few crosses in the same agro-climate as intensive producers above (ACZ 1-3), and in the drier areas (ACZ 4-5). Farmers practising this production system own between 1 and 15 ha. depending on geographic region and ACZ and up to 30 cattle that are mostly grazed. These farmers not only have the objective of producing milk but also frequently sell surplus animals for meat and in some instances also use bulls or steers for draught power, especially in Western and Nyanza provinces. Cattle are paddocked, tethered on the farm or taken to graze in communal areas. Cows are usually milked once a day for approx. five months of lactation. Calves are allowed to suckle their dam after milking and left to suckle freely after the period of extracting milk for human consumption. Crops grown include cotton and tobacco (mostly in Western and Nyanza), maize, sorghum, millet, rice, cassava and sweet potatoes. Crop by-products are fed to cattle and in many areas manure is used to fertilise crops.

4.3 Breeding Management

Private provision of reproduction services by individuals or farmer groups is slowly emerging to replace the reduced public support for such services. The large-scale dairy cattle production systems depend mainly on private AI services. However, small-scale dairy producers depend partly on public (government provided) or farmer-group provided AI/bull services as well as private AI services. Prices paid are mostly between KSh. 200 - 400 (approx. US$ 4 - 8) per insemination, depending on whether transport is included, or the service is provided at home or at the roadside. Some dairy co-ops have pooled efforts to provide the services at a reduced cost per insemination (e.g., Nderi, Kikuyu and Kabete dairy coops in Kiambu). Most private AI providers are concentrated in areas with high dairy

cattle density indicating that market concentration (scale and size) is critical to the efficient provision of private AI and other livestock services.

The high reproductive wastage due to high calf mortality stated elsewhere in the text has implications for the ability of farmers to select female replacements. Most calves that survive are selected for survival rather than growth.

4.4 Feeding Management

In all milk sheds dairy production is influenced by seasonality in feed availability and quality. Stall-feeding of crop residues, natural (mostly Kikuyu, Star and Rhodes grass) and planted fodder (mostly Napier grass), is common and increasing in importance, particularly in peri-urban dairy keeping households and districts with high human population density (Table 9).

Table 9: Area of natural and planted fodders in some districts.

Province/ District	Natural pasture ('000 ha)	Improved pasture ('000 ha)	Napier + other fodder ('000 ha)	Fodder Trees ('000)	Legumes (ha)
Rift Valley					
Nakuru	261	32	5	-	170
Trans Nzoia	64	10	2	<1	-
Uasin Gishu	91	14	5	1	-
Nandi	88	<1	1	<1	-
Central					
Kiambu	-	4	14	-	-
Nyeri	18	3	5	<1	154
Muranga	7	-	11	-	-
Kirinyaga	<1	<1	2	-	
Nyandarua	110	58	<1	-	1,025
Other areas					
Machakos	114	4	<1	<1	-
Kakamega	-	-	3	41	-
Vihiga	<1	<1	1	64	23
Kisumu	-	<1	1	37	3

Source MoA (1996) district annual reports

The figures suggest a widespread adoption of planted fodder and that land pressure and high dairy cattle density are important factors in adoption of planted fodder (e.g. Murang'a).

Common crop residues are maize stover, wheat straw and horticultural crop residues. Purchase of fodder (Napier grass or hay), some of which originates from roadsides, is commonly practised by farmers in the most intensive farming areas such as Kiambu District (Staal *et al*., 1998). Prices range from KSh. 70-120 per bale of hay or backload of Napier grass around Nairobi.

Planted fodder may, in few circumstances on smallholder farms, include sweet potato vines and various kinds of legumes such as vetch and desmodium or fodder trees such as Calliandra (mainly in Embu) and Leucaena. Farmers also feed purchased grain concentrates and milling by-products such as brans, wheat pollard and some dairy meal. Many farmers complained about the high cost of dairy meal (KSh. 700-850 per 70kg bag) and opt instead for the cereal by-products (KSh. 550-600 per 70kg bag)[20]. Variable amounts of concentrates are usually fed to cows at milking time with many smallholders feeding a flat rate of about two kg per day throughout lactation

The inadequate availability of quality feed resources and low dry matter intakes by the majority of dairy cattle is the major cause of low milk yields and collapsing logarithmic-function lactation curves (Omore *et al*., 1996b, Staal *et al*., 1998). An experiment, that has just been concluded, on re-allocation of concentrate feeding to early lactation in order to change the shape of the lactation curves by allowing milk production to peak, shows tangible benefits (Biwott, personal communication). The translation of these lactation curves from logarithmic- to peaking gamma-function shapes in early lactation may also provide farmers with an additional incentive to shorten calving intervals and improve productivity (Tanner *et al*., 1997).

4.5 Animal Health Management

The major diseases cited by most extension personnel as adversely affecting dairy production are tick borne diseases (TBDs), especially East Coast fever (ECF). The impact of TBDs is through high mortality rates and high cost of control through the use of acaricides (mostly hand sprayed) and therapy. The actual incidence and impact of these diseases has been ascertained through field studies in some areas in the coastal lowlands and in the highlands of central Kenya. Evidence from these studies show that TBDs are especially a problem in the more extensive free grazed and semi-intensive paddocked herds in lowland areas (Table 10).

[20] Prices at the time of this survey (end-1997).

Whereas the risk of ECF in such areas have been shown to be as high at 30% per year and account for over half of all clinical cases (Maloo *et al*., 1994), the risks in the highlands (ACZ1-2) especially in stall-fed dairies, are less than 3% per annum (Omore et al., 1996b; Gitau et al., 1997). Additional information on the incidence of these diseases in other areas are expected from studies in western Kenya by KARI's National Veterinary Research Centre-Muguga and characterisation surveys recently conducted in eight districts under SDP. However, based of the information already available, it is clear that the economic merits of TBD control, using either acaricide or vaccination, will vary by region and by farm within regions.

Table 10. Impact of East Coast fever on smallholder dairy production in Kenya

ECF Impact Indicator[a]	ACZ 1-2		ACZ 3-5			
	Central Highlands		Central Highlands		Coastal Lowlands	
	Zero grazing	Free grazing	Zero grazing	Free grazing	Zero grazing	Open grazing
Annual Incidence	Very low	Low	Low	High	High	Very high
Proportional morbidity	High	Very high	Very high	Very high	Very high	Very high
Proportional mortality	Very High	Very high	Very high	Very high	Very high	Very high
Case-fatality	High	High	High	Very high	Very high	Very high
Antibody prevalence	High	High	Very high	Very high	Very high	Very high

[a]Very high =>50% High=20-49%; Low= 5-19%; Very low=<5%

Sources: Deem *et al*., (1993); Maloo *et al*., (1994); Omore *et al*., (1996b); Gitau, G.K., (1998)

For a long time, farmers depended on government managed dips to control ticks and TBDs. However, most smallholder farmers now use hand spraying of acaricide. Following the collapse of government run dip services, the dips were handed over to local communities who were supposed to run them under community management committees[21]. The success of this arrangement has been mixed, with some reverting back to government supervision, but with no improvement in service provision. At the time of this survey (end of 1997), less than 50% of the communal dips were reported to be operational in most areas.

Prevention of ECF by vaccination using the infection and treatment method (ECFiM) has not been widespread beyond the Coast Province where an estimated 4500 cattle were

[21] There are about 3,000 mostly non-functional dips throughout the country