THE KENYAN DAIRY SUB-SECTOR

A Rapid Appraisal

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MOA/KARI/ILRI

Smallholder Dairy (Research & Development) Project Report

Funded by

British Department for International Development (DFID)

January, 1999

This publication includes preliminary results of market-oriented smallholder dairy research conducted by the collaborative MoA/KARI/ILRI Smallholder Dairy (R&D) Project in Kenya. The results are published informally to enable early dissemination of research outputs. It has not been prepared in accordance with the formal publication procedure of any of the collaborating institutions. Comments are welcome.

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Acronyms and Abbreviations

ACZ	Agro-Climatic Zone
ADC	Agricultural Development Corporation
AI	Artificial Insemination
approx.	Approximately
CAIS	Central Artificial Insemination Station
Coop.	Co-operative
DANIDA	Danish International Development Agency
DFID	Department for International Development, United Kingdom
ECF	East Coast fever
EU	European Union
FAO	Food and Agriculture Organisation
FMD	Foot and Mouth Disease
FWM	Fresh Whole Milk
GDP	Gross Domestic Production
GM	Gross Margin
GNP	Gross National Product
GTZ	German Technical Co-operation
ha.	hectare
HIT	Heifer-In-Trust
CBPP	Contagious Bovine Pleuro-Pneumonia
HPI	Heifer Project International
IFAD	International Fund for Agricultural Development
ILRI	International Livestock Research Institute
JICA	Japanese International Co-operation Agency
KARI	Kenya Agricultural Research Institute
KCC	Kenya Co-operative Creameries
KDB	Kenya Dairy Board
kg	Kilogram
km	Kilometre
LME	Liquid milk equivalent
MALA	("*maziwa lala or mgando*") Soured Milk
MALD	Ministry of Agriculture and Livestock Development
MALDM	Ministry of Agriculture Livestock Development and Marketing
MLD	Ministry of Livestock Development
MoA	Ministry of Agriculture
MT	Metric Tonnes
Mt.	Mount
NAFCO	National Agricultural and Food Corporation
NEP	National Extension Project
NGO	Non Governmental Organisation
RRP	Regional Research Programmes
ODA	Overseas Development Administration
RA	Rapid Appraisal

Comment [C1]:

SDP	Smallholder Dairy (Research & Development) Project
SIDA	Swedish International Development Agency
SMP	Skimmed milk powder
SNV	Netherlands Volunteer Services
TBD	Tick Borne Diseases
KNAIS	Kenya National Artificial Insemination Services.
LDP	Livestock Development Project
NDDP	National Dairy Development Project
TOR	Terms of Reference
KSh.	Kenya Shilling
EAZ	East African Zebu
UHT	Ultra Heat Treated milk
US$	United States Dollar

Executive Summary

The Rapid Appraisal (RA) report presents the results of a study of Kenya's dairy systems carried out by the MoA/KARI/ILRI Smallholder Dairy Project (SDP). Interdisciplinary teams from SDP examined Dairy Production Systems, carried out Economic and Structural Analysis of dairying, and addressed Policy and Institutional Issues related to dairy development in Kenya. The methodology used in the appraisal is a refinement of that used by ILRI and its national collaborators in Uganda and Tanzania. The RA is an indicative analysis of the dairy systems within the following milk sheds and consumption centres: Lake Basin; Central and South Rift Valley; Central Province; Eastern Province; Greater Nairobi; and, Coast Province.

A brief history of the dairy industry in Kenya is presented that may partly explain its uniqueness in the East African region. The report highlights the increasing opportunities which smallholder dairying represents for income generation and agricultural development, including the opportunities for increasing production and marketed output; the important interaction between access to the market and levels of milk sales and prices; the lack of accurate estimates of demand patterns; the importance of informal milk marketing and concerns over associated public health hazards; the lack of accurate livestock census reports to allow accurate impact assessments; and, the potential for large increases in the productivity and profitability of dairying stimulated by the liberalisation of milk processing, marketing and input services.

Milk Marketing and Consumption

Based on MoA cattle population statistics and research reports, it is estimated that approximately 3,078 m. litres of milk are produced annually[1], 81% of which originates from approx. 3 m. dairy cattle[2] (2.5 m. of which are in smallholdings), and the rest from the indigenous herd. Almost all marketed milk comes from the dairy herd and a high proportion (about 70%) originates from the smallholder dairy herd. From the annual smallholder dairy herd production of 1,720 m. litres, about 626 m. litres (36%) are consumed on-farm (456 m. litres consumed by household and 170 m. litres offered to calves), and 1,092 m. litres (64%)

[1] This estimate is about 20% higher than MoA (1997) estimates and is based on reviews by Peeler and Omore (1997) and recent findings from SDP characterisation surveys (see discussion under demographic over-view in Section 2)

[2] Dairy cattle refers to specialised dairy *Bos taurus* cattle and their crosses with *Bos indicus* (EAZ) breeds

are offered as marketed surplus. This marketed surplus is sold through: (i) direct sales to consumers, either individual or institutional, which account for 600 m. litres (55% of marketed milk); (ii) co-operatives, self-help groups and traders, who market milk in local and urban markets, handle some 414 m. litres (38%), out of which 44 m. litres is sold to KCC; and (iii) sales to the private processors, either directly or through coops, totalling about 164 m. litres. Important market outlets for large scale producers are the few large private dairy processing plants and Kenya Co-operative Creameries. Marketing infrastructure is most advanced in Central Province, especially in Kiambu District, where dairy co-operatives play a major role, while direct sales from producers to consumers are common in Coast, Southern Rift Valley and Western Kenya. Sales of processed milk by KCC and private dairies comprise only 19% of marketed milk, most of which is sold in Nairobi.

Following liberalisation of milk marketing in 1992, an increasing number of private sector participants are getting involved in transporting, processing and distribution of milk, most of which is sold raw, reflecting consumer preference for lower price and high butter-fat. Hawking plays an important role, particularly by increasing consumer convenience and providing employment. Milk traders operate mostly in high population density peri-urban areas, particularly in Kiambu and Murang'a districts, where the competition they provide threatens the survival of some dairy co-operatives. Estimates of marketing margins indicate strong returns for most informal market agents, especially small milk traders whose returns range from 8 - 20% depending on the region. Farm gate prices for raw milk are lowest in milk surplus areas such as Nyandarua and Murang'a districts and highest at the coast, where milk deficits are acute. The prices range from KSh 11/litre (approx. US$ 0.18) in Nyandarua to KSh. 35/litre (approx. US$ 0.6) in Mombasa, reflecting extremes in milk surplus and deficit areas. Though sufficient information to assess general consumption and preference patterns is lacking, indications are that most consumers prefer and consume (boiled) raw milk, especially in tea.

Dairy Production Systems

Demographic statistics show the importance of the smallholder dairy cattle herd; it comprises 20% of the cattle population and produces an estimated 56% of the milk from cattle. About 60% (approx. 1,900 MT) of the milk produced in Kenya comes from less than 10% of the country's landmass in the fertile central districts of the Rift-Valley and Central Provinces where 80% of exotic and cross-bred dairy cattle, mostly kept by smallholders, are found. Other areas with significant dairy production include Western Province, Embu, Kisii and Meru Districts. Extensive cattle production with the Small East African Zebu (EAZ), is concentrated in agro-pastoral systems in the Rift-Valley, Eastern and North-Eastern, and in sedentary systems in Coast and Nyanza Provinces. Western and Eastern Provinces also

contribute a small proportion of their milk offtake to local rural markets, including through direct sales to neighbours.

The major cattle production systems are, broadly, comprised of two large scale and two small scale systems. The large scale systems are: (i) intensive and semi-intensive dairy production with *Bos taurus* cattle that is entirely market-oriented. This system is estimated to have 500,000 cattle found mostly in private dairy farms in central Rift Valley; and, (ii) extensive dairy-meat or pastoralism with *Bos indicus* (EAZ) cattle. This system has about 4.5 m. cattle mostly concentrated in the north and central Rift Valley, Eastern and Coast Provinces. The small scale systems are: (i) intensive rural dairy-manure production with *Bos taurus* and crossbred dairy cattle that is mostly market-oriented. This system has the majority of dairy cattle (approx. 2.5 m.) and the highest concentration is found in the Central and Rift Valley Provinces; and, (ii) semi-intensive dairy-meat-draught-manure production with *Bos indicus* and few crossbred dairy cattle that is mostly subsistence oriented. This system has about 5.3 m. cattle mainly in Nyanza, Western, Coast, Eastern and Rift Valley Provinces. It was concluded that the potential for increased marketed milk production is through increasing individual animal productivity in the small scale intensive rural dairy-manure production system.

Institutional and Policy Issues

The lack of infrastructure, especially roads, water supply, input services and access to markets were cited by producers, market agents and extension staff as the most important constraints in many areas. The liberalisation of milk marketing in 1992 was accompanied by policy changes that led to considerable change in institutional aspects of the dairy sub-sector, including increased private sector participation and government divestiture. Increased private sector participation has, as yet, not filled the gaps in the provision of support services and the supply of inputs, including breeding, veterinary clinical and credit services. Though farmers' organisations, including co-operatives, are already beginning to respond to these needs, many areas outside Central Province do not have these organisations. An increase in public investment in maintenance of roads would increase milk offtake in dairy producing areas. Innovative ways to encourage community participation in working out modalities for solving widespread problems (e.g., lack of maintenance of access roads) are needed to supplement any government efforts.

Primary Constraints

The primary constraints under **milk marketing and consumption** include: (i) poorly understood structure and performance of the informal private sector; (ii) lack of reliable

information on demand patterns, including product differentiation and changes in dairy consumption habits with urbanisation; (iii) limited market information on input (e.g., feed) and output markets; and, (iv) concerns over public health hazards of marketed raw milk, associated with increased informal milk marketing, particularly brucellosis, zoonotic tuberculosis and low standards of milk hygiene. An understanding of these factors can enable the design and promotion of more efficient market mechanisms, and the formulation of informed policies.

The primary constraints to increasing productivity in **intensive and semi-intensive smallholder dairy production systems** include: (i) under-nutrition and seasonal fluctuations in quantity and quality of feed resources and the low rate of adoption of available technologies to address them; (ii) the important disease challenge in extensive areas, especially TBDs and trypanosomosis; (iii) unreliable access to inputs, particularly credit, breeding and veterinary services, especially in areas with poor marketing infrastructure. Underlying all these constraints is the lack of accurate data, including livestock census data, to enable the accurate *ex-ante* impact assessments of potential interventions in specific production systems.

Primary constraints under **policy and institutional aspects** are: (i) poor infrastructure particularly roads, to allow improved access to output markets; (ii) poor rural water supply; (iii) mismanagement in farmers' organisations due to low level of farmer control; (iv) slow changes in the policy environment and the enactment of regulations to back up policy changes; and, (v) poor linkages between input and output markets by farmers' organisations.

1. Introduction

Dairy farming in Kenya is dominated by smallholders who are estimated to contribute approx. 56% and 70% of total and marketed milk production, respectively (Peeler and Omore, 1997). These are farmers who, besides growing crops for subsistence and for sale, mostly keep 2 to 3 cows with their followers on land sizes typically of about 1 ha. in the intensively farmed areas and about 2.5 ha. in the extensively farmed areas (Staal et al., 1998; MoA/KARI/ILRI, 1998). The estimated total population of 2.5 million of dairy cattle in approx. 625,000 smallholdings (MoA, 1996; Peeler and Omore, 1997) suggests that this sub-sector employs many Kenyans who derive a regular source of cash income and balanced nutrition.

Although smallholder dairy production accounts for most of the total milk production in Kenya, individual cow productivity is low (Omore *et al*., 1996a; Staal *et al*, 1998), but the potential for increased productivity per animal is considered to be high. Since most Kenyans live in smallholdings and are resource-poor with 47% of rural households living below the poverty line (CBS, 1998), there is consensus that research and development efforts within the agricultural sector are best targeted to the smallholder dairy sector. This is mainly because dairying represents a promising avenue for improving the welfare of resource-poor rural communities. Other reasons cited in favour of focusing research and development efforts on smallholder dairies include: the potential for increasing demand for milk due to growing urbanisation and potentially higher incomes against projected shortfalls in supply; the high income elasticity of demand for milk; the predominance of smallholdings in the most suitable dairy production zones; the central role that livestock play in nutrient cycling in mixed farms; and, increased income generation opportunities.

The opportunities for increased productivity and improved welfare continue to be enhanced through increasing private sector participation and reduced government involvement in both milk marketing and livestock services in producing areas. There is increasing private sector activity through various actors, including small traders, private dairy processors and farmer groups, each innovating mechanisms for collecting and retailing milk and for providing inputs and animal reproduction and health services. The changes have also shifted the patterns of incentives in the dairy sub-sector. This Rapid Appraisal (RA) provides stakeholders in the sub-sector with an overview of the current situation and insights into the main issues that require urgent attention to further enhance the benefits of smallholder dairying. Successful alleviation of those constraints which may currently impair the performance of the dairy sub-

sector and further development, can enhance those benefits in addition to matching projected demand through increased productivity. The central emphasis of this appraisal was to identify those constraints, whether technical, economic, or institutional in nature.

The appraisal is an output under the DFID sponsored MoA/KARI/ILRI Smallholder Dairy Project (SDP) whose purpose is to identify required actions for the creation of a supportive operational environment for market-oriented smallholder dairying. This study, which has been conducted using, as a guideline, ILRI's Conceptual Framework for Dairy Research (Rey et al., 1993), has highlighted the potential that smallholder dairying represents for income generation and agricultural development within the context of current activities. These include: the important interaction between access to the market, agro-ecology (and hence production potential), levels of milk sales and prices; the lack of accurate estimates of demand patterns; the importance of informal milk marketing and concerns over associated public health hazards; and, the potential for large increases in the technical efficiency, expansion and profitability of dairy production stimulated by the liberalisation of milk processing, marketing and of input services.

This report is a summary of individual team reports. The report provides a brief historical and demographic overview and presents the analysis under three themes namely: marketing and consumption aspects; dairy production systems; and, policy and institutional issues. The main issues under each of these themes are summarised at the end of each section.

2. Historical and Demographic Overview

Major Events in the History and Development of the Dairy Industry in Kenya

Market-oriented dairy farming with exotic cattle in Kenya started almost a century ago when European settlers introduced dairy cattle breeds from their native countries. Most of these settlers occupied the most agriculturally productive highland areas in central parts of Rift Valley and Central Provinces. Cross-bred cattle dairy production by Africans started after 1954 when a colonial policy paper, the Swynnerton Plan of 1954, allowed them to engage in commercial agriculture. By 1963, when Kenya attained independence, the dairy herd had expanded to about 400,000 exotic cattle and their crosses with the local East African zebu.

To support the expanding and export oriented dairy production by European settlers, key livestock support and marketing services were initiated. The Veterinary Research Laboratories in Kabete and the Animal Husbandry Research Station in Naivasha were

started in 1903 to assist in controlling livestock diseases and provide animal husbandry research services, respectively. The Kenya Co-operative Creameries (KCC) was founded in 1925 to process and market dairy products (mainly butter and cheese) locally and abroad. The need to control reproductive diseases and improve genotype quality of dairy stock led to the establishment of the Central Artificial Insemination Station (CAIS) in 1946 in Kabete. In 1958 the Kenya Dairy Board (KDB) was established through an Act of Parliament to regulate dairy marketing.

After independence in 1963, many foreign settlers who opted to leave the country sold their farms to Africans or to the government. Many of these farms were rapidly sold to African smallholders resulting in a decline of dairy cattle population in large-scale farms from 400,000 to 250,000 heads by 1965 and a rapidly expanding smallholder herd. To encourage dairy production, the government effected a number of changes in the provision of livestock production and marketing services. By 1966, free or cheap and efficient livestock services were introduced including clinical and daily runs to provide artificial insemination services. In 1971, the government abolished the contract and quota system of dairy marketing to KCC. The system had effectively excluded most smallholder producers from selling milk to KCC.

The relatively efficient provision of livestock services continued until the early 1980's when the efficient delivery of the services became impossible due to government budgetary constraints. The serious decline in their provision prompted the government to seriously think about restructuring the industry with a view to increasing the role of the private sector. These changes are contained in various policy documents including: the National Livestock Development Policy (1980); National Food Policy (No. 4 of 1981 and No. 2 of 1994); Sessional Papers (1986; 1994) on renewed economic growth and recovery; and, policy framework papers on economic reforms published between 1996 and 1998.

For the dairy sub-sector, the major policy change was the liberalisation of milk marketing in 1992 (Dairy Development Policy, 1993), which followed recommendations contained in the Dairy Master Plan (1991). This policy change effectively ended KCC's monopoly in milk marketing in urban areas. Its major impact has been a rapid growth of the formal and informal private sector which provides input and output services, and a redistribution and increase of the overall social and economic benefits of market-oriented dairying to smallholder producers, market agents and consumers in Kenya. Changes in the legal framework to support the stated policy revisions have however lagged behind the policy statements.

Demographic Overview

Kenya has a total area of 581,787 km^2. Of this, only approx. 20% is suitable for arable agriculture and supports over 70% of the population. Population density in many parts of the arable land is estimated at about 500 persons per km^2. The current (1998) population is estimated at 29 million given the estimated population of 21 million in 1989 and an annual growth rate of 3.3% (CBS, 1994). The population of Nairobi, the biggest outlet for marketed milk, is currently (1998) estimated at 2,000,000 persons comprising approx. 41% of urbanised Kenyans (CBS, 1995)[3]. Per capita GNP has been declining gradually since 1980 when it peaked at over US$300, to only US$260 presently.

Table 1. Ruminant livestock[a] populations and annual milk production in Kenya

Province	Indigenous cattle		Dairy cattle		Small Ruminants		Milk Prod.	Milk per Capita	Milk per Km^2
	Pop ('000)	%	Pop ('000)	%	Pop. ('000)	%	('000 MT)		MT
Central	78	<1	810	27	690	4	699	165	52.8
Coast	1,074	11	45	1	1,308	8	100	40	1.2
Eastern	1,498	15	273	9	3,010	17	325	63	2.1
North Eastern	809	8	<1	<1	1,268	7	47	93	<1
Nyanza	2,089	21	149	5	1,612	9	230	48	18.4
Rift Valley	3,358	34	1,666	55	9,258	53	1,571	231	8.6
Western	925	10	102	3	328	2	126	36	15.2
Total	9,831	100	3,045	100	17,474	100	3,098	106[b]	5.3

[a]Source: MoA Annual Reports and Peeler and Omore (1997). Figures exclude milk production from camels, which is significant in parts of Eastern and North Eastern provinces.
[b]The overall milk per capita takes into consideration the population of Nairobi

The agricultural sector is estimated to contribute about 27% of GDP and is the most important sector of the economy, generating about 65% of export earnings (CBS, 1995). Livestock contribute approx. 30% and 10% of agricultural GDP and overall GDP, respectively. Ruminant livestock populations are currently estimated at around 10 million EAZ and 3 million exotic dairy or their crosses, 10 million goats and 7 million sheep (MoA, 1996). No livestock census has been conducted recently to establish the actual livestock numbers, their growth rate and number of households keeping them. Most exotic dairy breeds are found in the central highlands, while most EAZ cattle are kept under pastoral systems in non-arable and low-rainfall rangeland areas in Eastern, North-Eastern Provinces

[3] The World Bank (1989) estimated a higher proportion of 57%

and in northern and southern parts of the Rift Valley Province (Table 1 Figure 1). About 2.5 million of the 3 million dairy cattle (83% of the dairy herd) are estimated to be in smallholdings.

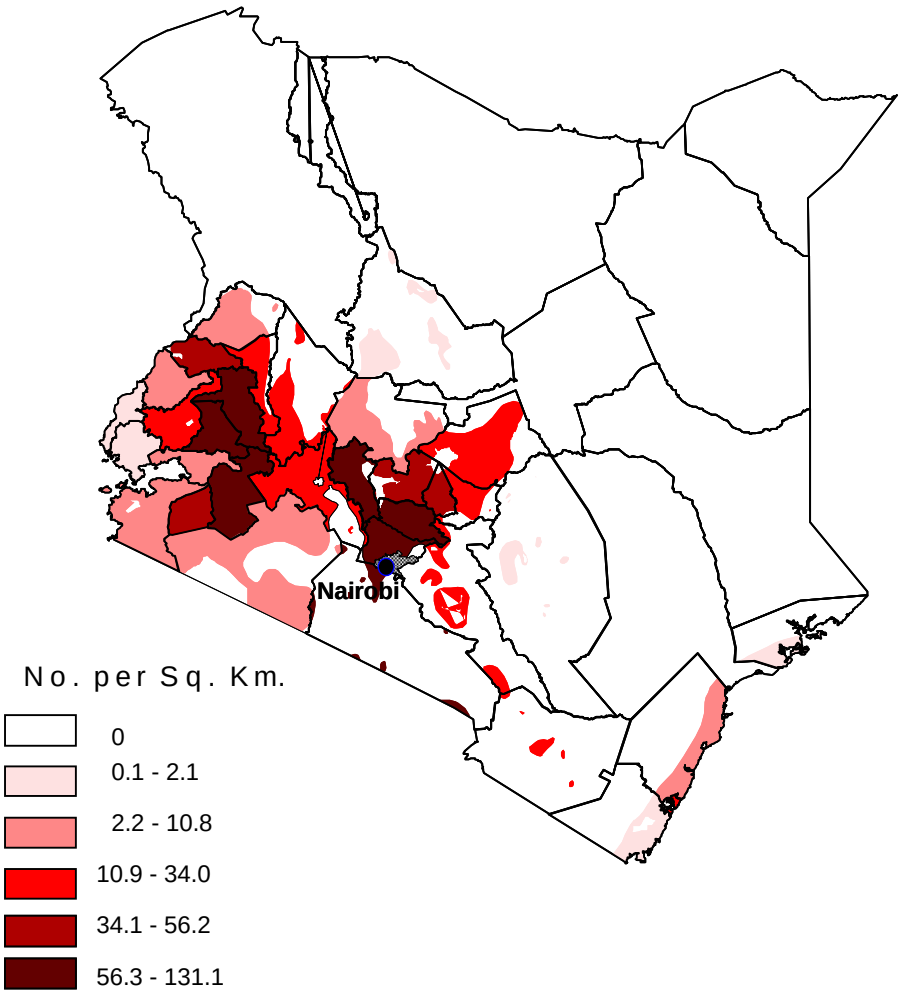


Figure 1. Dairy herd density

Total milk production is estimated at 3 million MT from both the local and the dairy herd, equivalent to KSh 43 billion (US$ 717 million)[4] in 1997, which constitutes approximately 50% of total value all livestock products (Peeler and Omore, 1997). Though accounting for

[4] 1US$ was equivalent to approx. KShs. 60 in 1998

only 23% of the cattle population, the dairy herd contributes approx. 80% of the total production (2.5 million MT). More detailed district-level analysis of milk production, based on the MoA livestock population figures and research reports on production, have been recently published by Peeler and Omore, (1997).

Trends in milk production published by MoA from 1981 to 1997 are presented in Figure 2. The Figure suggests that MoA milk production estimates have stagnated at about 2.5 million MT since 1989. This seems unlikely since the observed production parameters suggest a positive herd growth rate for all cattle production systems, especially the dairy herd (Peeler and Omore, 1997). A likely underlying reason for the apparent stagnation in dairy production according to MoA is the lack of census reports on which to base cattle population and growth rate, hence more or less the same estimates of cattle population figures have been used over the period.

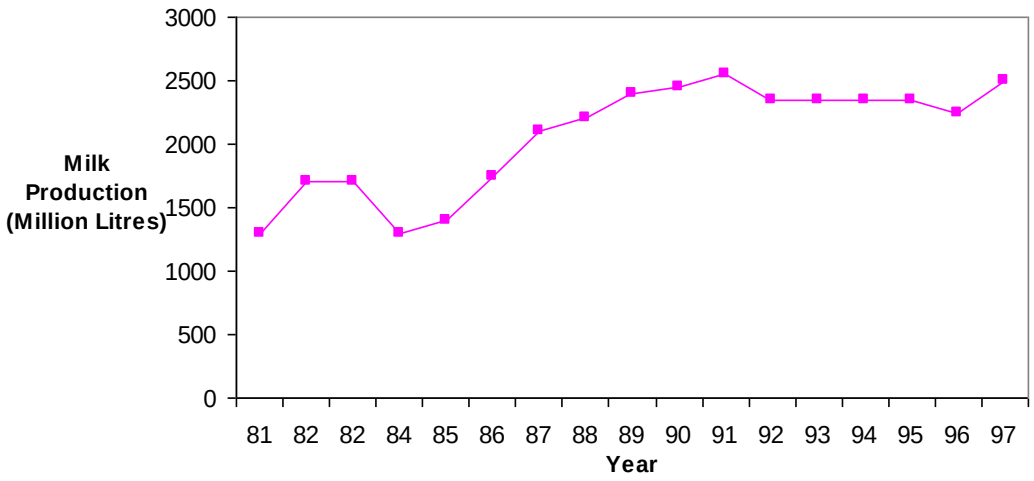


Figure 2. Trend in milk production: 1981-1997

Source: Ministry of Agriculture Annual Reports.

The milk production estimates by Peeler and Omore (1997) are about 20% higher than those by MoA which estimated total annual milk production at 2.5 million MT in 1997 (MoA, 1997) (Figure 1). The major difference is in the estimation of annual production per dairy cow. The MoA estimates milk production at 1,300kg/cow/yr for lactating cows across all dairy production systems, while Peeler and Omore (1997), after reviewing various research reports, estimated higher production of 1750kg/cow/yr and 4000kg/cow/yr for lactating cows

in small- and large-scale dairy production systems, respectively. Milk production estimates for dairy cattle recorded during recent SDP characterisation surveys were 7.2kg/cow/day and 5.0kg/cow/day in Kiambu and the rest of the Nairobi milk shed[5], respectively. These figures correspond to annual production indices of 2628kg/cow/yr for Kiambu and 1825 kg/cow/yr for the rest of the Nairobi milk shed (actual milk yields per cow per year would be lower depending on the number of days cows are dried off). These figures are similar to those from reports on smallholder dairy production previously reviewed by Peeler and Omore (1997) but significantly higher than MoA production estimates. The total cattle milk production estimate by Peeler and Omore (1997) give an annual per capita milk availability estimate of approx. 106kg, compared to 90kg and 80kg estimated from the MoA production figures and FAO (1996), respectively.

[5] The seven districts in the Nairobi milk shed selected for the SDP characterisation surveys were: Kirinyaga, Machakos, Nakuru, Narok, Nyandarua, Murang'a and Nairobi.

3. Dairy Marketing and Consumption

This section describes the major findings of the RA regarding recent changes and the current major features of milk marketing in Kenya, particularly milk marketing channels, the actors involved and the amounts of milk passing through them. The role of the emerging milk channels is discussed.

3.1 Projections of Demand and Supply of Dairy Products

Accurate projections in demand and supply of dairy products to determine the production gaps are difficult to make in the absence of reliable data on their key determinants such as cattle population (including its growth rate), and income elasticity of demand for milk products. A previous demand projection contained in the Dairy Master Plan (1991) only considered formally and informally traded milk. Notwithstanding the lack of accurate data, some projections of supply and demand have been made, based on rough estimates of the determinants of supply and demand for traded and non-traded milk.

The demand for milk, like other consumer goods, is a function of population size, income levels and the elasticity of demand for milk, retail price, and to a lesser extent, taste and preference over other products. The supply of milk is mainly influenced by producer prices, access to support services, the size of the national dairy herd and estimated milk yields. The demand and supply of milk can be forecasted based on assumptions about trends in these variables, and the expected rise in dairy demand over time. Indicative estimates of supply and demand based on assumptions about growth rates of population and incomes until 2010 show a continuing widening of the gap between demand and supply. Most of the demand for marketed milk is in urban areas where approx. 15% of the population currently lives (CBS, 1989; 1995)[6] and where average incomes and population growth rate are higher than in the rural areas. Two scenarios in supply and three scenarios in demand have been compared.

Projections in Supply

The first scenario for projection in supply assumes the current annual milk production growth rate of 4.3% (1.1% for the traditional herd and 5% for the dairy herd[7]), and the second

[6] The Word Bank (1989) gives a higher proportion of urban population of 32%

[7] The Kenyan dairy herd grew at over 10% annually from an estimated 400,000 heads in 1963 to at least 2.5 million in the late eighties. The growth rate is considered to have dropped remarkably since the collapse of government supported AI services in the early 1980's.

scenario assumes an annual production increase of 3% over and above the current dairy production (Table 3). This increase could be achieved through incentives and modest improvements in services and technologies necessary to increase productivity in intensive production systems. In both supply scenarios, a decrease in herd growth rate of 0.1% is assumed (this will result in the dairy herd growing at a modest 1.6% per annum by 2010). Under these assumptions in supply, the total offtake would rise by 69% and 145% for scenarios one and two, respectively, by 2010. During the same period, the dairy herd production would increase from 83%, to 88% and 92% of total production for scenarios one and two, respectively.

Table 2. Projected dairy supply[a] without (Scenario 1) and with (Scenario 2) intervention to improve dairy herd productivity

Supply variable	1998	2005		2010	
		Scenario 1	Scenario 2	Scenario 1	Scenario 2
Traditional herd population ('000)	10,221	11,034	11,034	11,655	11,655
Dairy herd population ('000)	3,173	4,458	4,458	5,372	5,372
Traditional herd prod. (m. litres)	511	552	552	583	583
Dairy herd prod. (m. litres)	2,805	3,715	4,847	4,477	6,771
Total prod. (m. litres)	3,156	4,267	5,399	5,059	7,354

[a]Projections are based on cattle population estimates of MoA (1996) and on a rough estimate of traditional herd growth rate of 1.1%, dairy herd growth rate of 5%, and a decrease in both growth rates of 0.1% per annum. Dairy production growth rate is estimated at 4.3%. Scenario 2 is calculated from a 3% increase in annual dairy productivity.

Projections in demand

Estimated annual human population growth rates of 3.3% (3% for rural and 5% for urban populations) (CBS, 1989; 1995), and annual per-capita consumption for 1996 of 101 and 156 litres for rural and urban populations, respectively, are assumed for estimates of demand (Table 3). Each (rural and urban) population's growth rate is assumed to be decreasing annually at 0.05%, resulting in a decreased overall population growth rate to 2.7% by 2010. These rates of growth will result in about 19% of Kenyans living in urban areas by 2010. Annual per-capita real GDP growth rates of 1.0% and 2.0% are assumed for the first and second scenarios, respectively. Income elasticity of demand for milk is estimated at 0.8.

Though Kenya has up to now been considered to be self sufficient in dairy production, projections under these modest assumptions in supply and consumer demand indicate

future shortfalls in production. The demand for dairy products would rise to about 5.8 million MT by 2010, 15% higher than the expected production if there is no intervention. The projected demand and production gap is due to Kenya's high rate of population growth rate of 3.3% per annum and a reduced dairy herd growth rate. Most of the projected increases in demand for marketed milk are going to be in urban areas, where average incomes and the population growth rate are higher than in the rural areas.

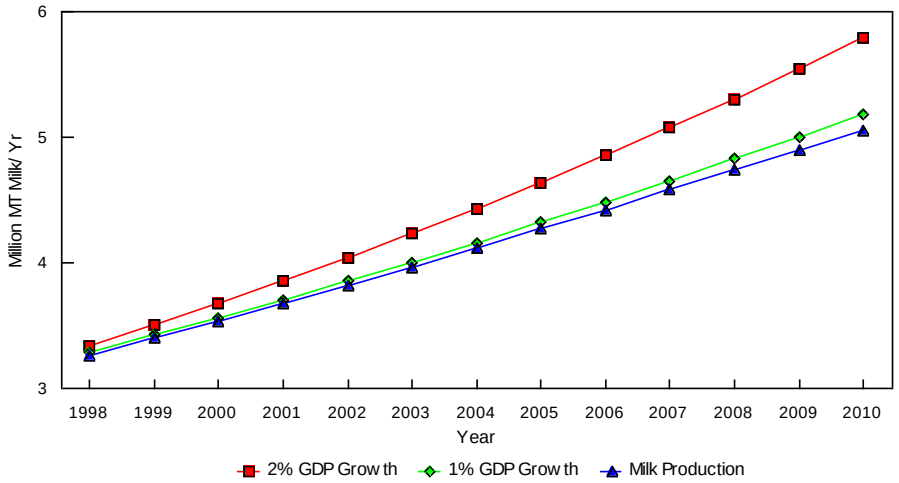
Table 3. Projected dairy demand[a]

Demand variable		1998	2005	2010
Rural population (million)		25.2	30.3	34.2
Urban population (million)[8]		4.6	6.4	7.9
Overall population growth rate (%/yr)		3.3	2.9	2.7
Scenario 1: 1.0% real annual GDP growth rate	Rural per-capita consumption (litres)	102	108	113
	Urban per-capita consumption (litres)	153	162	169
	Average per-capita consumption (litres)	110	118	138
	Demand (million litres)	3,288	4,320	5,185
	Production gap without intervention (million litres)	29	53	126
	Production gap with intervention (million litres)	29	-1079	-2169
Scenario 2: 2.0% real annual GDP growth rate	Rural per-capita consumption (litres)	104	116	126
	Urban per-capita consumption (litres)	156	174	189
	Average per-capita consumption (litres)	112	126	138
	Demand (million litres)	3,341	4,639	5,792
	Production gap without intervention (million litres)	82	372	733
	Production gap with intervention (million litres)	82	-760	-1562

[a]Calculations based on 1996 production estimates and current rural and urban population annual growth rates of 3% and 5%, respectively, with an overall annual decrease in population growth rate of 0.05%; urban/rural consumption ratio of 1.5; and income elasticity of demand for milk of 0.8.

The predictions confirm the projected shortfalls in marketed milk supply contained in the Dairy Master Plan (1991). Assuming real GDP per capita grows at over 2%, closing the production gaps will require that government, NGOs, bilateral and multilateral donors support on-going (and planned) dairy development programmes to reduce the expected increase in overall deficit. Table 3 shows Kenya could become a net exporter of dairy products in the next 5-10 years with a modest improvement (3% increase) in the productivity of the dairy herd. That modest increase in productivity and supply can be realised because there is presently good opportunities for improvement due to the increasing stimulus for

private sector involvement in dairy production, with good opportunities for smallholders to meet shortfalls in local supply. Low per-capita milk availability in neighbouring countries (e.g.



Tanzania; MOAC/SUA/ILRI, 1998) also provides opportunities for exports.

Figure 3. Projections in dairy demand and supply at 1% and 2% GDP growth rate

3.2 Present Milk Marketing Channels

It is estimated that of the annual production of 2.5 million MT from the dairy herd, 1.72 million MT (69%) are produced by the smallholder dairy herd (Peeler and Omore, 1997). Of this smallholder production, on-farm consumption or non-marketed milk accounts for 626 million litres (36%)[9] and the remaining 1,092 million litres (64%) is marketed[10]. About 20% of marketed milk flows through KCC and private processors. The remainder of the marketed milk is sold as non-processed milk. The non-processed milk market channels include: (i) direct milk sales to consumers by farm households (35%)[11]; and (ii) milk collected by dairy co-operative

[8] An urban population proportion of 15% (CBS, 1995) has been used for these calculations. This is lower than the approx. 32% given by World Bank (1989). The higher urban population proportion implies higher demand

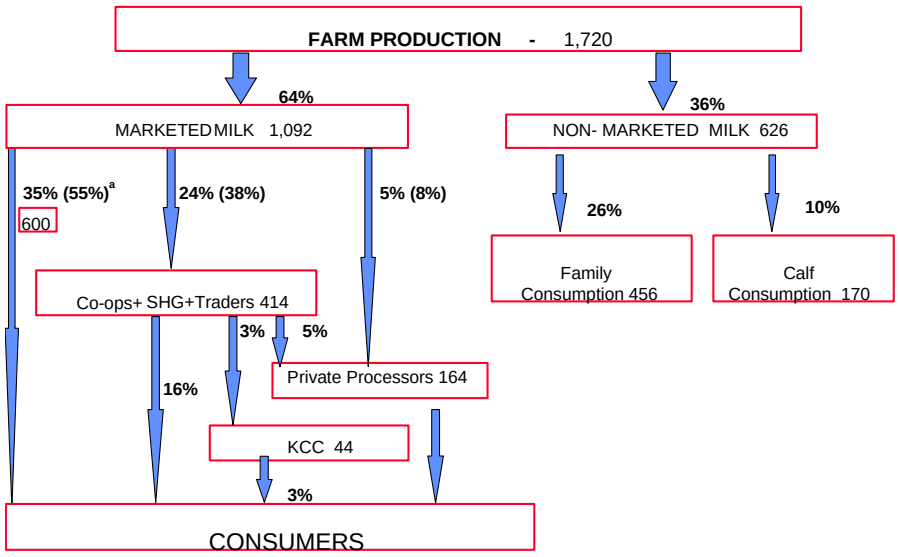
[9] Farm consumption comprises calf and family consumption. Calf consumption is based on 3 litres per day per calf for 90 days for a calving rate of 70% and pre-weaning mortality of 20%. Family consumption is an estimated 2 litres per day for each of the estimated 625000 dairy farm households.

[10] These figures have been adapted from Peeler and Omore (1997).

[11] Estimated from total marketed production less the estimates of flows through informal traders, co-operatives and processors. The flows through each of these channels were established through estimates of their numbers and average amounts handled by each market participant as follows: About 4,000 informal traders each handling about 100 litres/day; about 250 coops and SHGs each handling about 2,000 litres/day; and, about 45 processors each handling about 5000 litres/day

societies, SHGs and individual milk traders who sell either directly to consumers[12] (16%), private processors (5%) or KCC (3%).

There are however large regional differences in the milk marketing channels. In areas with high production, low consumer concentration or few alternative market outlets, such as Nyeri, Nyandarua, Koibatek, Trans-Nzoia and Nandi districts, marketing through KCC still dominates, with over 50% of marketed milk passing through their factories. The rest of the districts have most of their milk passing through other private processors; self-help groups (e.g., Kirinyaga, Nakuru); individual traders or co-operatives (e.g., Kiambu, Murang'a, Meru); or, local sales from producer to consumer (e.g., Coast). Nairobi, Coast Province, Machakos, Narok, Kisumu, Siaya and parts of Western Province are milk deficit areas that receive milk from high production areas delivered by KCC, small milk traders and private processors.



[a]Proportions of marketed milk in brackets

Figure 4. Milk marketing channels from smallholder dairy cattle production and estimates of amounts (million litres) and proportions of milk flows through each major channel

3.3 Non-Processed Milk Marketing Channels

The flow chart (Figure 4) reflects the predominance of raw milk sales, which account for approx. 884 million litres or about 80% of marketed milk, and the increasing role of private processors as an alternative market channel for milk from smallholders.

[12] Consumers include individuals, hotels, institutions, factories and restaurants etc.

Direct Producer to Consumer Milk Sales

About 600 million litres or over half (55%) of marketed milk is through direct sales from smallholder producers to consumers (Figure 4). This marketing channel is common in areas of low production relative to the number of consumers, particularly in the Coast, Nyanza and Western Provinces, and Narok District. Nearly all milk sales from small-scale zebu cattle milk producers in the rural areas are sold in this way.

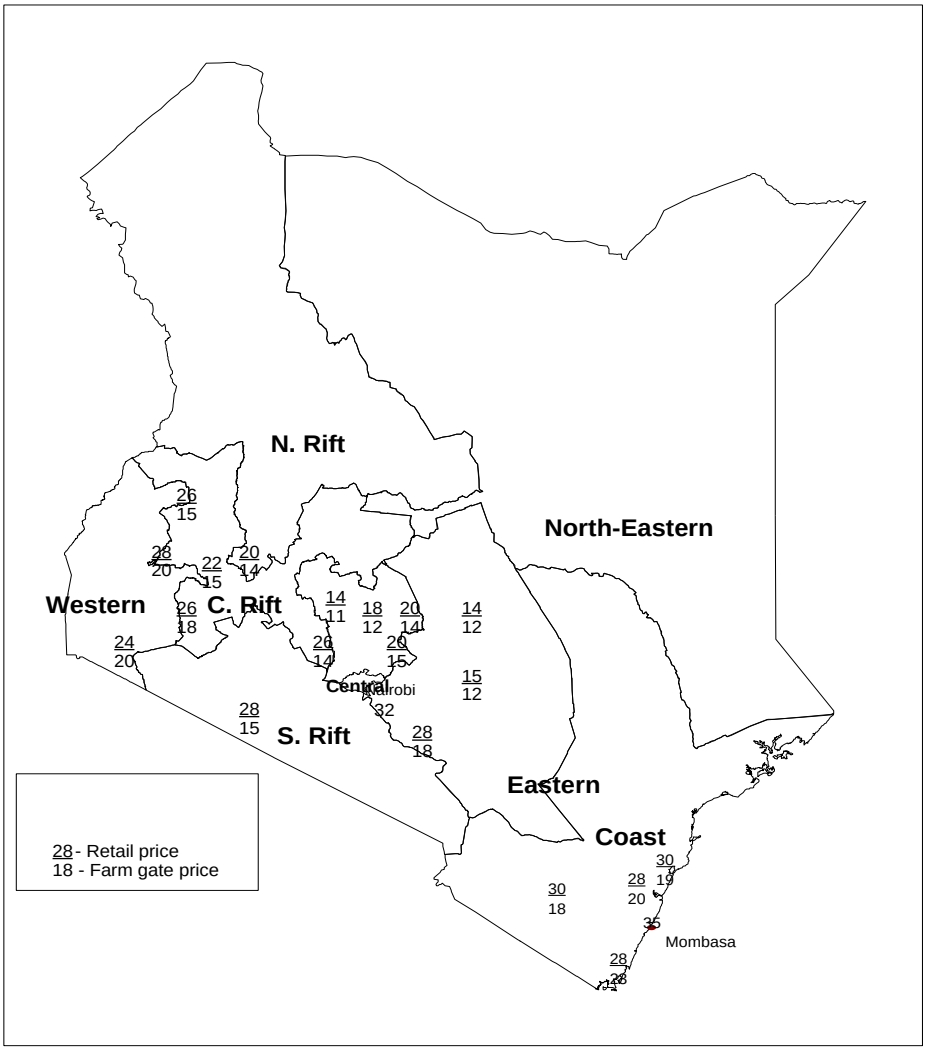


Figure 5. Producer and retail prices for fresh raw milk (KSh/L.)

Informal Milk Traders

The dramatic increase in the number of informal milk traders[13] in milk marketing is a recent phenomenon prompted by the liberalisation of milk marketing. For example, in Murang'a District, 70% of milk sales were through KCC in 1995 (Owango *et al*, 1996) but reduced to only about 5% in 1997 (Survey, 1997). Kiambu and Murang'a Districts have the highest concentration of milk traders. In some cases, especially in Murang'a, traders are viewed as competitors to dairy co-operatives because they act as alternative channels and provide a better price for milk from producers. In Kiambu, traders play a major complementary role to co-operatives by providing outlets for milk collected by the co-operatives. This may be due to the value members attach to additional input services (veterinary clinical, AI, credit etc) provided by co-operatives in Kiambu, unlike those in Murang'a.

Large differences in producer and retail prices exist from region to region. Farm-gate and retail prices ranged from KSh. 11 (US$ 0.18) and KSh. 14 (US$ 0.22) per litre, respectively, in Nyandarua, to KSh. 20 (US$ 0.33) and KSh 35 (US$ 0.58) per litre, respectively, at the coast (Figure 5)[14]. The figures reflect a general rise in real farm-gate prices since milk market liberalisation (Owango *et al*., 1996) and higher margins in areas of relative milk deficit.

While most informal traders take milk to the nearest urban centres, some were found to cover long distances to reach markets that offer higher retail prices. For example a few individual traders travelled over 100km on public transport to deliver milk all the way from Murang'a to Athi-River where retail prices, at KSh 32/litre, were almost double those in Murang'a. The traders mostly use bicycles or public transport to move around farms to collect milk and the same means to deliver the milk to markets, including restaurants and individual households. They handle daily between 60 – 250 litres each and sell to hotels, restaurants and individual customers, and earn gross margins and net market margins ranging from KSh. 1.50 - 5 per litre and 8 - 19%, respectively (Table 4). The net market margins mainly reflect returns to labour given the low operating costs and almost negligible capital costs. They are generally lower than those calculated for small milk traders in Tanzania where they range from 18-32% (MOAC/SUA/ILRI, 1998), reflecting, perhaps, the higher availability of milk in Kenya compared to Tanzania.

Some traders (observed mainly in the Rift Valley) boil then cool the milk before sale, mainly to lengthen shelf life because of the long distances and time that the milk takes to reach

[13] These refer to traders who transport milk on bicycles, pick-ups or public transport and milk kiosks/bars

[14] 1US$ was approx. KShs 60

consumers. Many milk bars and kiosks were found in all urban centres, some of which are operated by dairy coops. They mostly sell raw milk that they buy directly from farmers, which they transport to their premises using public transport, bicycles or pick-up trucks. Some milk bars process the milk into yoghurt or ferment it to make *mala*. Records at KDB show only about 250 traders, including milk bar/kiosk operators are licensed, meaning that many more operate without a licence.

Table 4. Milk prices and margins for small milk traders

Region	Murang'a	Athi	Nairobi	Nakuru	Kitale	Kisumu	Mombasa
Costs							
Buying Price KSh. (P_1)	15	20	25	14	14	20	30
Operating/Transport costs	0.5	1	3	2.50	3	3	3
Total Variable Cost	15.5	21	28	16.5	17	23	33
Revenues							
Selling Price KSh. (P_2)	18	26	32	18	20	26	40
Gross Margin (GM)	2.5	5	4	1.5	3	3	7
Net Market Margin (GM/P_2), %	14	19	13	8	15	12	17

Source: Survey (1997)

Dairy Co-operatives and Self-Help Groups

It is estimated that over 200 dairy co-ops and self-help groups are currently engaged in active milk marketing in Kenya. Most farmer groups are concentrated in central Kenya. Most farmer groups collect mainly morning milk, and sell it fresh. Amounts that cannot be sold fresh are often sold to private milk traders and KCC or processed into *mala*. A few (e.g., Limuru and Meru Central Union) pasteurise the milk, besides making butter and yoghurt.

Dairy co-op membership ranges from 60 - 12,000 per coop and their milk intake/day ranges from 20 - 20,000 litres, with approx. 75% of them handling less than 1,800 litres per day. More than double these figures are handled during seasonal flush periods. They sell as much raw milk as they can locally and take the rest to KCC or to other big private processors such as Brookside Dairy. A couple of co-ops at Athi-River/Kitengela and Ngong received milk from traditional Maasai herds. Generally, only about 50% of co-op members are active, i.e., delivering milk at any given time. More coop members (e.g., about 50% of active members in Limuru Coop) in Kiambu use the feeds on credit facility as compared to coop members in other districts. This perhaps reflects that credit is not a very important constraint

to smallholder dairy producers. Some dairy co-ops have a strong capital base with assets in excess of KSh. 10 million (US$ 167,000) (e.g., Limuru and Molo). SHGs, in contrast, are often much smaller with membership ranging from 12 - 1,200 and record milk intakes of less than 500 litres/day. They also have a much lower capital base. In many cases, members of SHGs seem to have a greater sense of owner-ship and "belonging" than coop members.

3.4 Processed Milk Marketing Channels

Private and Co-operative Dairy Processors

Until the early 1990's, milk processing in Kenya was almost entirely undertaken by KCC. Current records kept by the KDB indicate that last year (1997), there were some 45 registered private milk processors with a capacity to process about 400,000 litres/day. Most are small scale enterprises processing between 1,000 - 10,000 litres/day. Many small scale entrepreneurs operating private processing outfits visited during this survey were previously employees of KCC. A small number (e.g., Brookside Dairy) process over 50,000 litres per day. A cursory look at the records of most private processors show that their daily milk intakes are on an upward trend. Already, the upcoming processors provide stiff competition to KCC and dairy co-operatives for milk collection in many areas.

Table 5. Milk Prices and Margins for some Private Milk Processors and Co-operatives (KSh./Litre)

Cost Parameter	Milk processors/Co-operatives				
	Jufred Processor (Kirinyaga)	Boyo Coop (Muranga)	Molo Coop (Molo)	Kilifi Plantations Processor (Kilifi)	Wakulima SHG (Nyeri)
Full capacity (litres/day)	2300	10,000	50,000	12,000	5,000
Capacity utilized, %	70-80	5-10	5-10	60-80	70-80
Cost of raw milk (P_1)	15	15	12	19	13
Operating costs	2.0	1.00	1.67	3.87	0.53
Transport to market	0.60	0.50	0.86	0	0.67
Total variable costs	17.6	16.5	14.5	22.9	14.2
Selling prices (P_2)	20	16	15	36	16
Gross margin (GM)	2.40	-0.50	0.47	13.10	1.80
Net marketing Margin (GM/P_2), %	12	-3	3	36	11

Source: Survey (1997)

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.

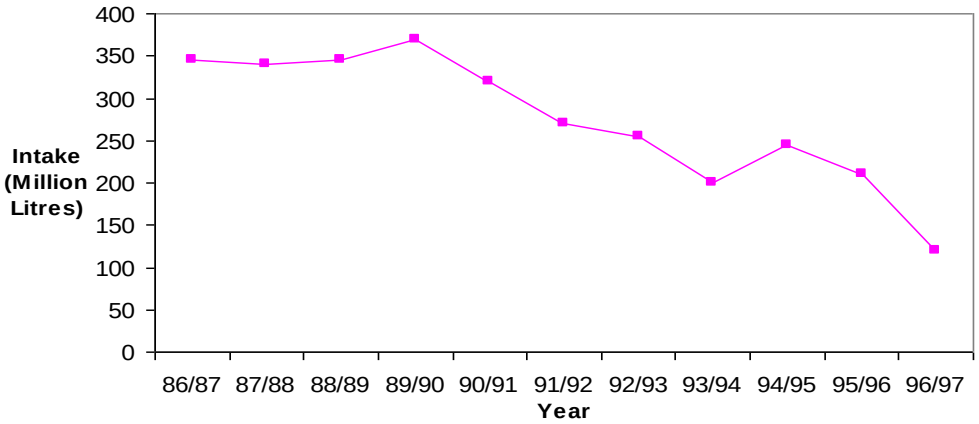


Figure 6. Milk intake by Kenya Co-operative Creameries.
Source: KCC Annual reports

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

experimentally vaccinated in the early 1990's and about 1,000 in the highlands also experimentally vaccinated in 1995/96. Apparent success in reducing morbidity and mortality rates by ECFiM was reported at the coast and similar benefits may be expected in other areas of high ECF risk.

Intensification has been known world-wide to be associated with production limiting diseases such as mastitis and lameness. However, investigations under local intensifying dairy production systems indicate that they are currently not a priority. Clinical mastitis incidence is low at only 13.3 per 100 cow-years at risk and there is only modest association between sub-clinical mastitis and milk yield (Omore *et al*., 1996a). Similarly, though cattle are predisposed to lameness and foot lesions due to confinement in the zero-grazing housing conditions, the incidence of lameness is less than 2% per month (Gitau, 1995). The occurrence of these diseases of intensification show that they are not a big constraint currently, although they can be expected to become a big problem once milk yields increase.

4.6 Main Issues in Production Systems

1. The lack of a livestock census to allow accurate production estimates. Random household surveys in Kiambu and Kilifi have shown that present estimates may be higher or lower than MoA estimates by as much as 50% or more.
2. The severe constraint of the scarcity of quality feed resources especially in the dry season. This constraint is expected to become even more severe with continuing land sub-division, unless efficient fodder markets emerge to fill the gap. Though many technologies on feedings strategies to improve production have not been tested on-farm, there is poor delivery of technical information on the efficient use of available feed resources.
3. The important disease challenge in many extensive areas especially TBDs and trypanosomiasis in Coast and central Rift Valley Provinces. The real and perceived risk of these diseases also inhibits adoption of dairying in some areas, especially in western and Nyanza Provinces.
4. Smallholder farmers do not have access to suitable replacements due to limited availability of good breeding stock and declining breeding services.
5. The low adoption of smallholder dairying in some apparently suitable areas that would also benefit from improved soil fertility with cattle manure application e.g., parts of western Kenya.

5. Policy and Institutional Issues

This section summarises the major issues on how policy and institutional aspects have affected present dairy outcomes, especially since the beginning of liberalisation of the economy, and how policy reforms at the national and local level can make better use of the technical and economic potential for smallholder dairy development. This includes analysis of the effects of liberalisation on the dairy sector -- and the competitiveness of smallholders therein -- of public policy and institutional arrangements, and of government and donor activities and investment.

5.1. Regulatory Environment

Relevant Acts of Parliament

Official regulations for the dairy industry in Kenya are contained in the Dairy Industry Act (CAP 336 of the Laws of Kenya) which was first enacted in 1958 and established the Kenya Dairy Board (KDB) to regulate the dairy industry. The act has been revised several times in the past (1962, 1972 and 1984) to improve the dairy. The KDB has mostly concentrated on its policing role at the expense of its other functions including: promotion of market research in dairy produce; improvement of quality of dairy produce; and, promotion of private enterprise in the production, processing and sale of dairy produce. Another major weakness of the Dairy Industry Act has been the concentration of authority in the hands of the government minister in charge of agriculture. For example, the appointment of officials to run KDB, and the nomination of KCC in the past as the sole agent for KDB never worked well for the industry. The latest revision, which is intended to bring the act into line with the liberalised dairy industry, is about to be enacted into law at the time of this write-up. The revision includes the establishment of a restructured KDB with enhanced functions and capacity to improve its role.

The other important regulation is the Co-operative Development Act, under which all dairy marketing co-operatives fall. Again, this act has in the past not allowed sufficient farmer-control of dairy co-operatives, thereby contributing to a high incidence of mismanagement. The act has been revised recently (1997) but its impacts on the ground are yet to be realised.

Taxes

Producers pay cess levy at 2 cents per litre to KDB. The cess is only paid from milk sales through processors and coops other than KCC, who are exempted from paying it. This denies KDB an important source of income. Large scale farmers would normally pay income tax but most small scale producers do not. Sales of processed milk products from established enterprises are subject to value added tax (VAT) at (16%). Imported milk and milk products are subject to import duties and other levies.

Land tenure

The land tenure policy in Kenya (Agriculture Act, CAP 318 of the Laws of Kenya) that allows private land ownership is considered to be one of the key factors that has spurred growth of dairy production. The policy has over the years had the positive effect of allowing producers to access credit by taking advantage of the collateral value of land, though this advantage has lately been greatly curtailed by expensive credit from the formal banking sector. The policy sought to prevent uneconomical sub-divisions of agricultural land by stipulating minimum land sizes in various areas but this is rarely implemented.

Major impacts of dairy market liberalisation

The immediate impact of the dairy market liberalisation has been increased participation in milk marketing by formal and informal market agents. This has had the effect of re-distributing the benefits of dairying including increased employment opportunities, increased milk availability and an increase in real farm-gate milk prices thereby increasing producer earnings. There is also a positive shift in the concerns of farmers from difficulties with milk marketing to investigating options for increasing production. The other major impact has been the changes in relative prices in various regions that now reflect market access (Owango *et al*., 1996). However, as already noted, the legal framework to increase the benefits of market liberalisation has lagged behind the policy change. For example, though KDB now issues licences to traders of raw milk, the regulations that were there before liberalisation (that disallowed trading in non-processed or non-pasteurised milk products) are still in place. The KDB is also in a dilemma on how to institute new regulations in the absence of information on actual risks faced by consumers of raw milk.

With more accurate information[22] on the risks to humans from informally marketed milk, the present regulations will need to be revised. The trade-offs from implementation of some

[22] A study, on "Public health hazards of informal milk marketing in Kenya" is underway by SDP and the Dept of Veterinary Public Health, University of Nairobi in collaboration with various stakeholders including KDB and Kenya Medical Research Institute (KEMRI).

hygiene and quality regulations are substantial. They are favourable in that, aside from helping to ensure the standard of formally marketed milk, they assist in boosting the image of milk generally as a healthy product and thus may have a promotional effect on milk consumption. Importantly, however, the strict implementation of regulations creates strong incentives for markets to avoid them due to the costs of compliance, and the consequent higher sale prices of dairy products. In a market where purchasing power of the customers is low, this clearly weakens the competitiveness of the formal sector. The policy question that needs to be answered is thus: is it preferable to maintain strict milk standards which result in higher costs and thereby free most marketed milk into informal channels, or is the public better off by standards that are relaxed but capture more of the informal market? If standards were relaxed to officially allow raw milk marketing, yet regulations regarding handling, permissible time to retailing, and adulteration are maintained with some incentives to milk traders to comply[23], then a much larger proportion of the milk market may fall under regulatory control, improving the average standards of milk in the market.

5.2 Farmer Organisations

Dairy marketing farmer organisations mainly comprise dairy co-operative societies and SHGs. Dairy co-ops are organisations registered with the Ministry of Co-operative Development, while SHGs are registered with the Ministry of Culture and Social Services. Functionally, there are no differences between dairy co-ops and SHGs engaged in milk marketing. In comparison to other East African countries, farmer organisations and co-operatives in Kenya have played a critical role in assisting the participation of smallholder dairy producers in the market. Combining the roles of milk collection and service provision permits farmer groups to maintain an advantage over other actors in the milk market, principally because they offer producers the advantage of accessing distant markets at lower marketing costs per litre of milk due to bulk purchases and sales.

Dairy co-operative membership has generally been on an upward trend since 1963 when there were only 2,300 members to over 100,000 members currently (MOCD Annual Reports). Karlen (1995) established that dairy co-ops account for 34% of all co-operative societies in Kenya, and that they are mostly concentrated in the central highlands. It was observed during this study that SHGs were more popular in some areas (e.g., Kirinyaga) than co-ops because of the history of mismanagement in coops. As a result, some co-ops have become dormant. Both co-ops and SHGs offer producers in high milk production areas

[23] Some examples of incentives could include basic training in milk handling and hygiene, or an official stamp of approval, which they could use to promote their milk to customers.

the advantage of accessing distant markets at lower marketing costs per litre of milk due to bulk purchases and sales.

Kiambu District has the most well established milk marketing infrastructure through some 14 dairy co-ops with memberships ranging from a few hundreds to several thousands, some of which were established in the early 1960's (e.g., Limuru Dairy Co-op Society, established in 1962 and with a current membership of 7,000). Beyond milk marketing (which is mostly of raw milk), most of the dairy co-ops in Kiambu provide some or all of the following additional services: credit; the bulk supply of feed, drugs and other dairy inputs; and AI and veterinary services. In terms of provision of services, larger co-operatives (with many members) are best placed (Ombui *et al*., 1995, Owango *et al*., 1996). To enjoy the same services at a cheaper cost, smaller co-operatives have began to pool resources, to be able to provide more services, including AI, at a cheaper cost. Dairy co-ops are also reasonably well established in Murang'a and Nyandarua Districts, but they offer few services beyond milk marketing.

Other areas of the country do not have a high concentration of co-ops either because they are relatively low milk production areas (hence most sales are direct from producer to neighbour), KCC still plays a dominant role, or other private milk processing dairies provide adequate service. For example, in Kirinyaga District there is only one active co-op, the Kirinyaga Dairy Co-operative Society, which is currently handling about 4,000 litres of milk per day. The co-operative sells raw, pasteurised and fermented milk. Private processors in the district handle in total an equivalent amount of milk to dairy co-ops and are beginning to provide some of the input services that co-ops provide. The central Rift Valley, though being a high dairy production zone, has relatively fewer co-ops than Central Province. Only a few co-ops were found in Machakos and Kitui Districts.

There are breed societies with origins in the colonial era when they were formed to serve the interests of large scale European settler farmers. The societies still mainly serve the interests of large-scale dairy producers. These societies exist for the following breeds: Friesian, Ayrshire, Guernsey, Jersey, Sahiwal and Boran. All breed societies maintain records of pedigree animals through the Kenya Stud Book (KSB). There are moves to integrate all the breeders' societies into one strong group.

5.3 Livestock Support Services

Research

The reorganisation of agricultural research activities in Kenya resulted in the creation of the parastatal Kenya Agricultural Research Institute (KARI) in 1989 with a national mandate to carry out both crops and livestock research. KARI has several research centres spread throughout the country with either national and/or regional research mandates. National mandates include strategic and basic research activities whereas regional mandates emphasise adaptive farming systems research. Research centres with both national and regional mandates for dairy research are situated at Naivasha and Muguga. Centres with regional mandates are situated at Kitale, Kakamega, Muguga, Kisii, Embu, Katumani and Mtwapa. This deliberate focus on adaptive farming systems research approach is commendable. The institute has recently completed its second priority setting exercise to enable it better focus its research activities; it considers dairy as one of the most important commodities for research. Current priorities under dairy research (KARI, 1996) fall under the following thrusts: i) socio-economics; ii) feed resources and utilisation; iii) animal health; and iv) animal breeding/genetic improvement. Under the socio-economics thrust, the institute identified research on policy environment as a priority. The main priorities identified under feed resources and utilization were: improving cow and heifer diets; forage/food crop inter-cropping; and, on-farm testing of forage technologies. Improvements in cow fertility and on-farm ECF control were identified as needing urgent attention under the animal health thrust. KARI has started to actively encourage the private sector to get involved in addressing priority research issues, including financing of research activities that benefit them. Besides KARI, useful research directly or indirectly related to dairy has been and continue to be carried out at agricultural faculties at the University of Nairobi and at Egerton University, Kenya Trypanosomiasis Research Institute (KETRI) and the Kenya Forestry Research Institute (KEFRI).

National dairy research to date has contributed to the identification of useful production technologies (especially feeding strategies), besides identifying and attempting to resolve social and economic constraints to the development, adoption and productivity of smallholder dairy systems. However, the translation of a number of these technologies into adoptable interventions by farmers still remains a major challenge.

The International Livestock Research Institute (ILRI) has been an active collaborator in a number of national dairy research activities. Notable examples include: the KARI/ILRI collaborative research activities on smallholder dairy in the coastal lowlands which was

concluded in 1994; KARI/ILRI/MoA collaborative smallholder research and development activities currently being carried out in the highlands; and, field testing of animal health technologies. The International Centre for Research in Agroforestry (ICRAF) is also involved in research aimed at improving natural resource management through the introduction of trees, including cattle fodder trees.

Input supply

Successful delivery of AI services country-wide since 1966 through the Kenya National Artificial Insemination Services (KNAIS) has been a major contributor to the growth of dairying in Kenya. These services continued to improve until 1979 when the peak of about 542,000 inseminations were performed, out of which 9% were carried out on zebu animals. This figure dropped dramatically by 1992 to 195,000 inseminations with only 1% being conducted in zebu cows (KNAIS, 1994). The number of inseminations by KNAIS has continued to drop with only about 85,000 and 60,000 inseminations in 1996 and 1997, respectively. In contrast, the number of inseminations by private AI providers (including coops and private veterinarians) has been rising steadily, surpassing those provided by KNAIS in 1995 when about 97,000 inseminations were conducted. This figure rose to about 113,000 inseminations in 1996, excluding those inseminations by informal service providers and individuals on their own farms. The dramatic decline in the number of inseminations provided by KNAIS since 1981 has greatly affected the growth and genetic quality of the dairy cattle population, but the private sector is evidently rising to the challenge of filling the gap left by the declining services by KNAIS. The Livestock Recording Centre, started in 1974, has been a useful programme for progeny testing and making available quality bulls for CAIS and private large scale farms.

Though increasing participation through the private sector (e.g., dairy co-ops, private veterinarians and companies such as American Breeders Service Ltd and World Wide Sires Ltd) may have improved the situation somewhat, many smallholder farmers were still found to solely rely on private, communal or NGO provided bulls for breeding. The government currently provides bulls through the FINNIDA supported Livestock Development Project (LDP) to individual farmers for use by local communities at a fee. The LDP, which is basically an extension project started in 1991, operates in the Lake Basin (Nyanza and Western Provinces) and Rift Valley. By 1995 the LDP had established 335 bull schemes providing services at KSh. 100 per bull service. In the absence of efficient AI services and with the high price of more than KSh. 25,000 (US$ 400) for average quality heifers, upgrading through bull services provide a useful alternative for those wishing to increase

dairy genes of their animals. The obvious disadvantage of spread of reproductive diseases however remains.

Access to credit, for the purchase of services and inputs, is considered essential in solving the financial constraints at the farm level. As already stated, many dairy co-operatives are increasingly linking their marketing activities to the provision of input services. But access to credit inputs through coops mainly occurs in Central Province, especially Kiambu. In other areas, dairy co-operatives have not taken off or are still in their infancy. Formal credit institutions such as banks, charge relatively high interest rates beyond that which most smallholders can afford.

Extension and veterinary services

The effectiveness of government extension, including the provision of clinical and preventive health services, has been declining for some time as a result of government budgetary constraints and the transition to privatised services. Present evidence shows low extension staff to farmer ratios, which continue to decline, as a result of stoppage of further staff recruitment by the government. The extension staff to farmer ratios range from 1:500 in Central Province to about 1:1,230 in Western Kenya. These ratios will continue to decline unless the private sector (e.g., private processors) begins to provide similar services. A recent study in Kiambu shows that fewer than 50% of farmers receive livestock extension advice (Staal *et al*., 1998).

The MoA has defined those goods whose delivery it considers public, private or shared; but the privatisation of the provision of those services that are considered private goods is happening quite slowly, despite the continued reduction in public budgetary allocations to these services. As a result, privatisation is happening by default but this is not adequate to fill the gap created by the continuing divestiture of government services.

As already stated, farmer groups are increasingly playing an important role in providing some veterinary services (e.g., clinical and AI) to smallholders that are linked to their milk marketing services especially in Kiambu District. This institutional linkage provides an opportunity to reduce costs of service provision and ease payment recovery, thereby improving the long-term viability of both the collection and service functions. A major gap however remains in the provision of technical information to improve productivity.

Presently about 200 veterinarians are in formal private practice, and many more practice informally, especially since the stoppage of automatic government employment of veterinary graduates in 1990. Most clients of private veterinarians are the better resource-endowed farmers who can afford their services (Wamukoya *et al*., 1995). Where farmer groups are present, most smallholder farmers prefer the cheaper farmer-group provided veterinary services that they can also obtain on credit. The EU supported Kenya Veterinary Association Privatisation Scheme has boosted the number of formally registered private vets, which has attracted 41 successful loanees since its inception in 1995. Many more have not been successful due to lack of collateral. A "subsidised" private service is provided by government veterinarians and para-veterinarians who use public facilities at no cost and so can afford to charge low rates for their services. As the possibilities for such activity decline with continued reforms, and as private services respond to demand, it is anticipated that the privatisation of veterinary clinical services and liberalisation of input supply and AI will improve efficiency in the dairy farming community. There remains considerable uncertainty, however, as to the level of service that the private sector will be willing to provide in areas where dairying is less market-oriented.

Agricultural training

Private and publicly provided formal training for the agricultural sector is available at several levels from farmer training centres, to certificate, diploma and degree colleges. Certificate-level training in animal husbandry takes place at several Animal Health and Industry Training Institutes situated at Kabete, Ndomba, Bukura and Nyahururu; certificate and diploma-level training in dairy technology is provided at the Dairy Training Institute-Naivasha; and, degree-level training is provided at Egerton University, University of Nairobi, Moi University and Baraton University, which is privately funded.

5.4 Access Roads and Water Supply

Most dairy production areas have good seasonally passable road networks but which are rarely maintained. The lack of maintenance is major limiting factor for milk collection and transportation to markets, particularly in Nyandarua and Kericho Districts. Instances of milk wastage, especially during the rains are common in these areas. An estimated 30% of milk production from these districts is lost annually due to the poor state of roads (MoA, 1996). Poor access to water is also of great concern in many areas including those with relatively good market and roads infrastructure such as Kiambu District.

5.5 Donor Participation in the Dairy sub-Sector

Many bilateral and multi-lateral donors and NGOs have assisted dairy development in Kenya over the years. The major bilateral donors that are presently involved are: the Netherlands Government presently supports the Dairy Programme at KARI; Finnish Government supports the Livestock Development Project; Danish International Development Agency (DANIDA) recently suported the develoment of the Dairy Master Plan and the revision of both the dairy policy and the Dairy Industry Act (Cap 336); GTZ supports smallholder dairy goat development in Central Province; Swedish International Development Agency (SIDA) supports dairying related community water development projects; IDRC supports an agroecosystem health project based at the University of Nairobi; and, the Department for International Development (DFID) of Britain supports KARI's second National Agricultural Research Programme (NARP II)[24] and the MoA/KARI/ILRI Smallholder Dairy Project. Multilateral agencies that are involved are the World Bank which supports the National Extension Project (NEP) and KARI's Regional Research Programmes (RRP), Food and Agricultural Organisation (FAO) supports training in dairy processing and European Union (EU) supports the animal health services privatisation priogramme. NGOs that are involved are Heifer Project International (HPI), Farm Africa, and the Dutch Volunteer Services (SNV).

5.6 Institutional Linkages

Good linkages to improve the efficient delivery of livestock services, coordination and sharing of information for dairy development among national institutions exist between MoA and KARI. However further improvement in linkages with other related institutions is required to foster this effort. Other national stakeholders with whom linkages need to be strengthened include the national universities, farmer groups (e.g., cooperatives), NGOs, the private sector and donors. Strengthening of linkages between these institutions can enhance the capacity to undertake more integrated, inter-disciplinary dairy system research and development, by better utilizing available knowledge, institutional and human resource capacities. Improving linkages between KARI, MoA and the national universities should be a priority, particularly Egerton and Nairobi Universities which have well established agricultural faculties. Both universities possess a large pool of trained manpower whose skills can be tapped to contribute more to the national agricultural research agenda, besides present mechanisms such as KARI's Agricultural Research Fund which mostly serves independent research activities. Collaborative research activities currently being initiated between the University of Nairobi and the MoA/KARI/ILRI Smallholder Dairy Project to assess the public

[24] DFID's support to KARI's NARP II is scheduled to end in April, 1999

health hazards of informal milk marketing should serve as a model for similar collaborative arrangements in the future.

5.7 Main Issues in Policy and Institutions.

1. Underdeveloped infrastructure, especially access roads which are impassable during rains, and poor water supply in many dairy producing areas.
2. Uncertainty of appropriate policy guidelines for informal milk market agents whose role has increased tremendously in recent years. There is a lack of information on which to base those guidelines.
3. The difficulty farmers face in accessing input services including feed, veterinary and AI and the failure of the privately delivered input service provision to fill the gap left by the withdrawal of government services.
4. Unfair competition to private service providers from those still on government payroll.
5. Role of KDB needs to be redefined to reflect the wishes of all stakeholders
6. There is the need for decentralised feed quality testing centres. Currently, these services are only available centrally at KARI-NARL and KBS in Nairobi. Many farmers suspect that the lack of response by cows to feeding is partly caused by poor quality feeds.
7. The need for marketing institutions that link milk collection/marketing and livestock service provision in some areas, including provision of suitable credit. There is a near absence of farmer groups in some areas to facilitate input and output service linkage. Where present, many farmer groups do not provide input services (Farmer groups in Kiambu are a notable exception). The formal banking sector offers unaffordable credit due to high interest rates and the performance of the specialised agricultural banking institution - the Agricultural Finance Corporation - has greatly diminished in recent years.
8. Low impact of government extension services with less than 50% of smallholder dairy farmers accessing the services.
9. Uncertainty of the impacts of liberalisation on input supply and extension services.
10. Inefficient management and lack of effective farmer control in farmer groups particularly coops.
11. Uncontrolled livestock movement leading to resurgence of diseases in some areas where they had previously been effectively controlled.

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Appendix 1: Research Teams and Terms of Reference

Research teams

The collection and analysis of data were conducted jointly by three teams drawn from the three institutions represented in SDP The three teams were:

Analysis of the Dairy Production Systems:
Dr. M. Owango - Animal Nutritionist, Head of Animal Production Programme NARC, Muguga, KARI ; Assistant Manager - SDP
Mr. B. Lukuyu - Senior Technical Officer – NARC, Muguga, KARI
Mr. F. Musembi - Agricultural Economist - NARC, Muguga, KARI

Analysis of Economic and Structural Aspects:
Dr. M. Kenyanjui - Veterinarian, Senior Field Research Technologist, Market-oriented Smallholder Dairy, ILRI
Dr. A. Omore - Veterinary Epidemiologist, Research Officer – KARI/ILRI.

Analysis of Policy and Institutional Issues:
Mr. H. Muriuki - Assistant Director, Animal Production , Ministry of Agriculture, Headquarters; Manager - SDP
Mr. G. Gichungu - Animal Production Scientist, Ministry of Agriculture, Headquarters.

Report-Editing:
Dr. A. Omore - Veterinary Epidemiologist, Research Officer – KARI/ILRI.
Dr. S. Staal - Agricultural Economist, Market-oriented Smallholder Dairy - ILRI

Terms of Reference for the Rapid Appraisal

The terms of reference (TOR) for each thematic research team were:

TOR for Economic and Structural Analysis Team

1. Identify the physical and geographical distribution of dairy production, processing, markets and consumption. This includes quantification of flows through alternative market channels and illustrated by diagrams of quantities and percentages for national market and smaller market components.
2. Assess the historical trends in output supply and demand, and project the changes in demand over the next 20 years.
3. Assess issues related to input supply and demand patterns, including for heifers and feeds.
4. Measure the economic viability of all market components of the sub-sector.
5. Quantify the effects of macro-economic and regional/world market factors on competitiveness of domestic dairy production and processing.

TOR for Production Systems Analysis Team

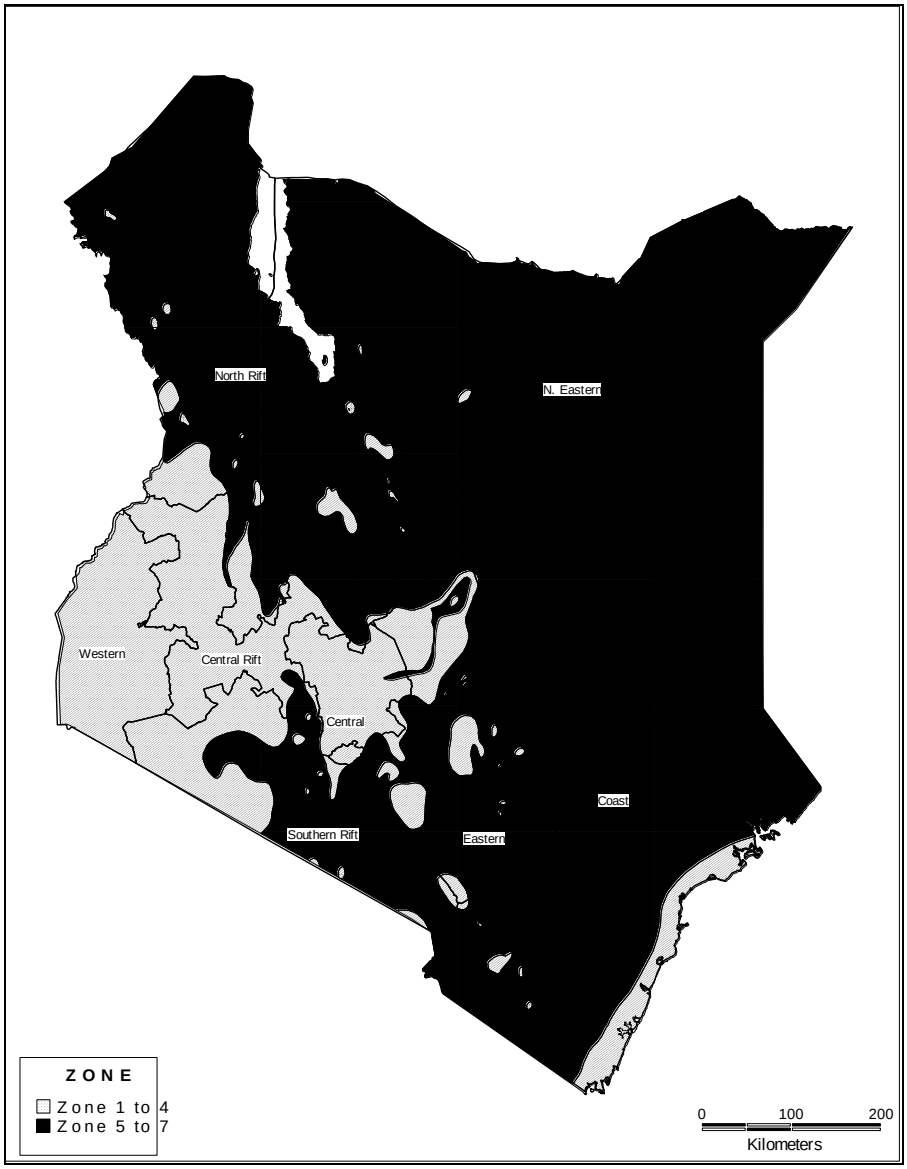
1. Identify the current principal milk sheds and their major consumption centres, and the areas with potential as milk sheds to serve milk deficit areas now and in the next 20 years.
2. Describe briefly the history of dairy development in each milk shed.
3. For each milk shed, document in as quantitative terms as possible, the current production systems (livestock species and breeds; herd/flock sizes and structures; milking and calf management; breeding practises; feeding resources and systems; disease risks and health management practises); and, their output and input market linkages (including quantities of milk consumed by progeny and by the producer household, and how much is marketed in what form). Put these descriptions into the context of the farm and land use systems of the milk shed.
4. For each major production system in each milk shed, identify the current major constraints and opportunities (bio-physical, technical, social, institutional and policy issues), and those expected in five, 10 and 20 years.
5. Highlight the factors driving changes in the production systems, their likely consequences and the resultant research and development challenges.

TOR for Policy and Institutional Analysis Team

1. Describe the evolution of dairy development nationally, including: changes in stated and effective public policy towards dairy production and marketing, and consumption, central and local government, donor and NGO activities in the dairy sector, and the evolution of institutions in the dairy sub-sector dealing with policy-making and investment, extension, training/education, disease control and animal health, reproductive services, input supply and feed, processing and marketing, and credit.
2. Describe the current and planned policy interventions, institutional re-organisation and donor activities.
3. Assess what is known about how policy at the central and local government levels has impacted on smallholder dairy development since 1960, and priority knowledge gaps for effective action to promote greater smallholder involvement, especially from the poorer groups.

Appendix 2 : Agro-climatic Zones

Agro-climatic zones classification[25]



[25] ACZ 1-4 represent areas with humid to semi-humid zones with Rainfall/evaporative potential greater than 40% and are suitable for arable agriculture. ACZ 5-7 represent semi-arid to very arid zones with Rainfall/evaporative potential less than 40% and are suitable for rangeland cattle keeping only