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The Case of Smallholder Dairying in Eastern Africa

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ABSTRACT

Agriculture plays a crucial role in the economy of sub-Saharan Africa. A feature of particular significance about the region is that the majority of households are heavily dependent on agriculture as their major source of livelihood. Smallholder agriculture is the principal producer of staple foods and cash crops, accounting for very large shares of national production and marketed output. For the respective countries, therefore, the performance of smallholder agriculture has crucial implications for the overall economic development process including the alleviation of rural poverty. The demands created by steadily increasing populations, and the pressing need to increase agricultural productivity means that these countries must continuously adopt methods to intensify agricultural production.

Livestock production is an important consideration in the agricultural development of the region. Livestock, and especially cattle, have historically played multiple roles both in economic life and in socio-cultural traditions of African people. Cattle have been valued not simply as a source of food (milk, blood and meat) and hide but also as a visible form of wealth and a source of social prestige. In certain parts of the region, cattle still provide a valuable source of draft and traction power both for the plough and for transportation carts whereas in Arid and semi-arid lands (ASAL), cattle still provide a valuable security against famine. Traditionally, cattle were a valuable item in the payment of bride price while beef was a valued food item in ceremonies. Moreover, cattle manure is still valued as a fire-fuel and building material in ASAL whilst in arable areas it is valued as a fertilizer. In brief, cattle have retained their multiple roles among the African people. The relative importance of each role, however, varies with production and ecosystems (Freeland 1998; Fitzhugh 1998).

In the high potential areas, the economic importance of the cow has increasingly shifted to commercial milk production while at the same time retaining the complementary role of sustaining soil fertility for sustainable agricultural production. In such area, increasing population pressure interacting with the need to sustain soil fertility has driven the change in production structure with dairying becoming an important component of agricultural production. .

Eastern Africa is Africa's most promising region for dairy production. The region is predominantly rural, with over 80 per cent of its inhabitants deriving its livelihood heavily from agriculture. It holds over 40 percent of Africa's cattle resource of about 222 million (FAOSTAT).

This study looks at the development of dairy industry in two east African countries— Kenya and Uganda (Figure 1). From the early 1910s, Kenya has developed a dairy industry that ranks among the largest in sub-Saharan Africa. The industry is especially noted for its smallholder base. Uganda, on the other hand, has a large unexploited potential for dairying. In order to highlight special aspects of the respective country's industry, the study looks at the countries in turns. The study seeks to take a historical look at the respective dairy industries with a view to identifying major turning points in their respective developments. We then apply the DE-A-R framework in analyzing the circumstances surrounding

respective turning points, including the socio-political forces that influenced the specific forms of change. Our purpose is to identify the forces, and key actors, that have driven changes in the systems, and to understand the impact these changes have had on the overall production, on smallholder incomes and on the environment by comparing across countries. We hope to identify key ingredients necessary for achieving successful smallholder dairy growth elsewhere.

Figure 1--Location of Study area

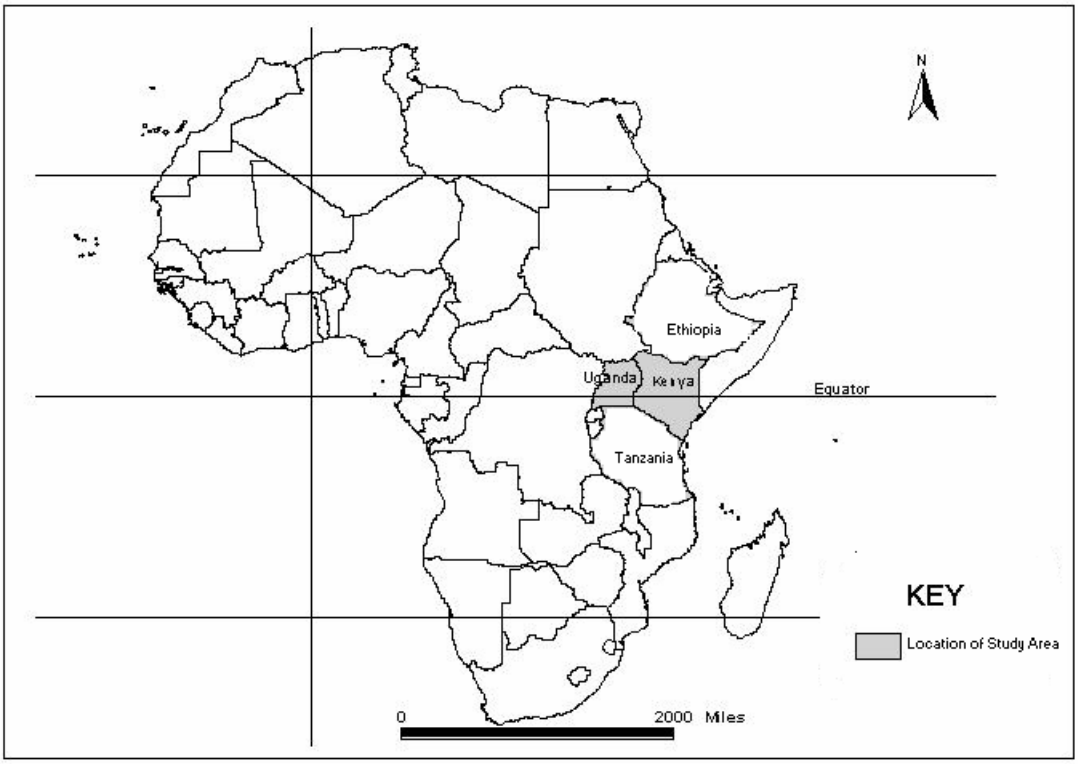

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TABLE OF CONTENTS

THE CASE OF SMALLHOLDER DAIRYING IN EASTERN AFRICA

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1. SMALLHOLDER DAIRY DEVELOPMENT IN KENYA

OVERVIEW

This section traces the development of Kenya's dairy industry since the introduction of commercial dairying in the country at the beginning of the 20th century. History shows that the country's dairy industry has evolved through a sequence of four distinct phases. The first, running from about 1900 to about 1953, coincided with the early integration of Kenya, through colonialism, into an expanding world capitalism, with Kenya as a peripheral economy. The second extended from about 1954 to about 1962 and coincided with the introduction of import-substitution industrialization (ISI) in the colony and the consequent need to develop large and growing local markets to support the industrialization. The third extended from the country's attainment of political independence in 1963 to the late 1980s, and corresponded to a period of greater shifts from large-scale to smallholder dairying and with incremental modifications of dairy marketing policy from a farmer-controlled dairy industry to one tightly controlled by the government. These three phases provide a chronology of events that lead to the fourth phase, which runs from 1992 to the present time.

Before exploring the forces driving change during each of these periods, it is necessary to examine some key features of the Kenyan environment which have made the

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rapid recent growth in smallholder dairy possible. Kenya is located in the eastern part of Africa astride the equator. It has a land area of about 57.6 million hectares of which, only about 9.4 million hectares (16 percent) is of high and medium agricultural potential (HMPL). Of the HMPL, 60 percent is under arable and livestock farming, 35 percent is set apart for game and forestry reserves while the balance is taken up by urban developments and infrastructure (ROK 1995). Estimates indicate that the country has human population of over 29.3. Population density on HMPL thus, has reached three persons per hectare. About 66 percent of the total population is rural-based and the economy is predominantly based on agriculture. The share of agriculture in the country's GDP averaged 26 percent in the last five years (RoK 2001). It is estimated that agriculture employs 59.8 per cent of the country's labor force (CBS, K-Rep, and ICEG 1999). A major feature of the country's agriculture is its domination by smallholder farmers. It is estimated that the country has over 3 million smallholder farm holdings averaging about 1.2 hectares, which account for about 66 per cent of the total area under crops.

With almost all of the high and medium potential lands already being utilized, the scope for increasing agricultural production through horizontal expansions is limited to marginal and semi-arid lands. Therefore, as the country's population pressure on land increases, growth in agricultural production must substantially come from enhanced productivity of land already under cultivation, and from capital investments in transforming marginal lands to zones of high-value agricultural production. Improved smallholder dairying has long been identified as one obvious route towards enhancement of the country's agricultural production. As already mentioned, the country has since the

early 1910s, developed a dairy industry that ranks among the largest in sub-Saharan Africa. The industry is particularly noted for its smallholder base. It is estimated that the dairy engages about 400,000 or about 20 percent of the country's total smallholder households estimated at 2 million (MoALD&M 1997). The share of smallholder dairying in national production and marketed milk is estimated at 75 and 80 percent, respectively (MoALD&M 1997). In addition, the industry employs a host of non-farm workers who transport, process and market dairy products as well as supplying dairy inputs. The industry is primarily based on cow's milk, which comprises about 84 percent of total marketed milk. Camel, goat, and sheep milk is also produced with camel milk constituting the major milk in arid areas of the country.

PHASE 1. THE ORIGINS OF KENYA'S DAIRY MARKETING INSTITUTIONS: 1900-1953

The late 1800s and early 1900s were years of high tides of change in Africa. Virtually the entire continent was put under new governments in the process dubbed 'the partition of Africa'. Accompanying the political changes were major socio-economic structural transformations, which charted new developmental courses for the emerging countries. With respect to the region's agricultural development, the colonial era is accredited with the introduction of a number of economically important crop and animal species as well as a variety of improved farming methods and marketing institutions, which not only revolutionized the region's agriculture, but also shaped the course of subsequent agricultural development.

Among the most notable agricultural changes was the introduction in Kenya of the artificial insemination (AI) reproductive technology, which made possible the

improvement of milk yields by crossing low-yielding but essentially more disease resistant local breeds (*Bos indicus)* with exotic breeds (*Bos Taurus)*. This was accompanied with the introduction of attendant dairy production management practices including the use of acaricides in dips to control tick-borne diseases. The colonial era also saw the institution of a dairy marketing policy upon which the country's post-independent dairy policy has been fashioned. Although these developmental efforts were introduced for the benefits of the imperial country rather than the indigenous people, they nonetheless formed the basis upon which the dairy industry now observed in the country was built. Therefore, any account of the development of Kenya's dairy industry would be incomplete without a review of the formation of colonial dairy farming and its related challenges.

Kenya was declared a British protectorate in 1885 and in 1901, a railway, financed with loans from the imperial government, from the coastal seaport, Mombasa, to the neighboring country, Uganda, was completed. This opened the interior of the country and ushered in a significant turning point for the country's agricultural development. The turn began with the commissioning of the colonial administration by the imperial government to ensure that the railway was profitable as one way of underwriting the colonial administrative costs (Pandit and Thurkur 1961; Leys 1975; Bates 1989). To facilitate this task, the administration advocated for white settlement on the vast land along the railway (Zwanenberg 1975; Leys 1975; Bates 1989); settler agriculture could give freight for the railway as output and inputs were shipped to and from the coastal seaport by rail. This, in turn, could generate the revenue needed both to underwrite the administrative costs and to finance the expansion of basic infrastructure.

White settlement, however, need not have been the only way to raise rail cargo. It is likely that, given the chance, the indigenous people could have exploited the trade prospects opened by the railway. Indeed, Hill (1956), Leys (1975), and Bates (1989) have reported that a thriving internal trade in agricultural products including cereals, legumes, and livestock products already existed among the indigenous people. Nor is there reason to suppose that the administration's need to make the railway profitable, by itself, could have attracted white settler agriculture. A more plausible explanation appeals to economic realism and suggests that basic individual self-interest must have been at the core of the turn of events; it is obviously the economic prospects of the settlement that was the primary motivation. According to Boahen (1987), demands of an expanding industrial revolution then under way in Western Europe provided the impetus for the settlement. The significant features of this argument are: first, it underscores an important fact—namely that market opportunities can play an important role in stimulating agricultural expansion; and secondly, it makes explicit recognition that basic transportation infrastructure has a central role in linking production and marketing.

Before recounting the formation and development of colonial dairy farming, it is useful to first focus on a few issues that had remarkably wide consequences in shaping the basic structure of agriculture and especially with respect to influencing and determining the participation of the indigenous people in the emerging commercial agriculture. We start by acknowledging the change with respect to the actors in the agricultural scene. Zwanenberg (1975) notes that the new scene was characterized by dominance and dependence relationships between: (i) the imperial and colonial government; (ii) the settlers and colonial government; and (iii) the settlers and the local

indigenous people. It is reasonable to suppose that the success of colonial administration in raising effective rail cargo was essentially tied to the success of settler agriculture; the pursuit of commercial agriculture by the settler-farmers yielded joint returns for both the settlers and the administration. It is, therefore, arguable that this reciprocity in gains engendered in the settler-farmers a capacity to influence the design and implementation of policies relating to the profitability of commercial agriculture in the colony. Their influence, as will become clear shortly, led to the establishment of a production structure that greatly subordinated indigenous agriculture by permitting the settlers to appropriate vast tracts of land as well as African labor. The colonial agricultural policies will also illustrate a point observed by Trebilcock (1981) regarding the role of the state in economic growth. He observes that the "state is not a wholly autonomous force in economic affairs but rather a reflector of other forces, of group interest within society". It will also illustrate the close links between economic power and political influence.

From the outset, Colonial agricultural development policies were largely determined by the constraints and opportunities faced by the settler-farmers. As Zwanenberg (1975), Leys (1975), and Bates (1989) have noted, the settlers alienated large tracts of land from the indigenous people and designated it "Scheduled Areas or the White Highlands". However, the critical developmental stage of settler agriculture was beset by two inhibiting factors. First, most of the settlers lacked farming knowledge; Zwanenberg (1975) and Leys (1975) report that initially the settlers were by no means better skilled-farmers than the indigenous people. Second, and most important, the majority of settlers suffered inadequate capital supplies they desperately needed to bring the land into productive use. This was exacerbated by the fact that rather than base loan

repayment capacity on productive capacity of the land, banks instead required the farmers to pledge land as collateral. Hence, the low valuation of cheaply acquired lands proved unable to provide adequate securities (Zwanwnberg 1975).

The constraints imposed by these problems threatened to hamper the settlers' capacity to develop the acquired lands. In an attempt to forestall this, the settlers sought to extract labor cheaply from the indigenous people in order to substitute labor for capital. However, the prevailing African's attitude about wage labor made it exceedingly unlikely that the settlers could substantially attract labor even at attractive wages (Hills 1956). Thus, additional devices were required to compel the indigenous people to work on settler farms. As might be expected, the task of designing and implementing such devices was left to the administration, as the agency with authority to impose policy solutions. The outcome was the institution of measures to confine Africans to "African Reserves (AR) or Non-scheduled areas" in combination with the imposition of "hut" and "poll" taxes payable in cash. The measures were explicitly designed to restrict the indigenous people from fully participating in the commercial agricultural process and to force mature African men into a captive wage labor force providing cheap labor to the settler farmers. In addition, the administration derived revenue to fund the infrastructure required to support the settler economy (Leys 1975; Zwanenberg 1975).

The result of these drastic approaches to the labor and capital problems was the development of a dual economy. On one hand the settlers owned large tracts of lands that were barely utilized while on the other, the AR were areas of high and fast growing population density. This pattern of land distribution gave rise to an interdependent squatter relationships, albeit asymmetric (Zwanenberg 1975), in which the settler farmers

offered part of their unused land as grazing and cropping land to landless indigenous in exchange for labor.

During these initial days, settler agriculture was largely monoculture. However, concerns about sustainability of soil fertility soon emerged, with expert advice warning that the farmers could not long sustain soil productivity if they did not integrate livestock into the farming (Hill 1956; Zwanenberg 1975). However, low milk-production potential of local cattle breeds was a limiting factor to the establishment of the commercial dairy industry aspired by the settlers. On the other hand, exotic breeds were highly susceptible to endemic cattle diseases to which the local breeds had over the years, acquired a fair degree of natural immunity. The challenge, therefore, was to produce breeds that combined high yield advantages of exotic breeds with adaptive attributes of the local breeds. The first formal breeding work started in 1903 with the establishment of a government dairy experimental farm at Naivasha, Nakuru District— presently, the Naivasha National Husbandry Research Centre, one of Kenya's leading animal research stations under the country's national agricultural institute, the Kenya Agricultural Research Institute (KARI). The prospective work necessitated trials with numerous breeds including Friesians, Guernsey, Ayrshire, and jersey. Nevertheless, significant progress was made and by 1909, a starter herd with moderate disease resistance was ready for release to settler farmers through sales.

However, the raising of upgraded stock alongside local livestock breeds was perceived, by settler dairy farmers, to be fraught with great risks. Since local breeds reared by indigenous people had built strong immunities, over the years, against endemic diseases, they could harbor the disease-causing organisms without suffering serous

clinical ills. For this reason, they were considered a hazardous reservoir of the diseases-causing organisms (Zwanenberg 1975). Further, as Bates (1989) has noted, the control of tick-borne diseases is characterized by network externalities stemming from the fact that the larger the number of contiguous farms adopting control programs, the greater the effectiveness. Yet, due to the substantial immunity of the local herd, the indigenous people had little incentives to abide by any tick-control programs. The presence of the local herd on the "white" highlands was therefore seen as a serous source of negative externalities for the settler herd. The inevitable pressure to create a less vulnerable environment for settler dairy herd resulted in a number of policy developments. The colonial administration responded by enacting the Fencing Ordinance and the Cattle Cleansing Ordinance in 1928 and 1937, respectively. The former was aimed, through provision of favorable terms, at encouraging settler dairy farmers to erect perimeter fences around their farms while the latter mandated farmers to dip or spray their animals weekly (Hill 1956; Zwanenberg 1975; Conelley 1998) with acaricides as a measure to control tick-born diseases. In addition, the government itself erected fences across various pastoralist's livestock paths to control the movement of African herds. Together with these measures, the settler dairy farmers successfully lobbied for the imposition of quarantine against African stock (Bates 1989; Zwanenberg 1975).

The quarantine, which entailed constraining the African herds of livestock within the AR, had far-reaching consequences for the indigenous people. It increased the already intense pressure on AR's natural resource base with the undesirable consequences of serious overgrazing. The ensuing environmental degradation, in turn, convinced the colonial administration that the AR areas could no longer be neglected in

terms of public investment. In response, the African Land Development (ALDEV) program was initiated in 1945. This however, consisted of specific reactive steps designed to curb land degradation. It in no way addressed the principal problems faced by the indigenous people, which included limited opportunities for improvement for their living conditions (Ruthenberg 1966).

Other significant livestock developments of the time included the setting up of a veterinary laboratory, in 1910 at Kabete near Nairobi, which has grown into the country's National Veterinary Laboratories; the introduction of AI services in 1935 which saw Kenya boasting one of the best AI systems, by mid-1950s, only comparable to that of Russia (Conelley 1998). The introduction of AI was the private initiative of a few settler dairy farmers directed at curbing the spread of venereal transmitted diseases. The practice soon caught up among other settler farmers and in no time, they started organizing themselves into Cattle Breeders' Associations. With time, the major application of AI shifted to principally become that of introducing high milk-yielding traits from exotic breeds to local breeds at relatively lower costs. At the same time, the need to centralize the production and distribution of bull semen became apparent. In accordance with the then prevailing development perspective that regarded state control of economic activities as crucial for economic development, the government assumed the centralization task leading to the establishment of the Central Artificial Insemination Centre (CAIS), which to date remains a parastatal. With this development, semen production became the responsibility of the government while farmers, through their Cattle Breeders' Organisations, were left with the responsibility of organizing and financing field insemination services.

With the technological constraints to commercial milk production well in the way of being addressed, the producer's attention was shifted, in the early 1910s, to the issue of marketing. This resulted in the establishment of organized milk marketing initially starting in 1912 when settler-dairy farmers around Lumbwa area —presently, Kipkelion in Kericho District—joined to form the Lumbwa Co-operative Society in emulation of dairy farmers in Australia and New Zealand (Kenya 1965). The society was charged with the collection of members' milk for collective processing and marketing. The system was further adopted by settler dairy farmers around Naivasha area in 1925 to form the Kenya Co-operative Creamery and latter in 1928 by farmers around Nanyuki area to form the Nanyuki Co-operative Creamery.

The three co-operative creameries operated independently of each other and were export-oriented. This however changed following the economic downturn of the Great Depression of the 1930s. The collapse of international markets for dairy products forced the three creameries to turn their attention to the domestic market. However, the effective domestic market was very small, with limitation imposed by the measures taken to secure a supply of cheap labor for settler agriculture. The measures inhibited the development of an adequate cash economy among the indigenous people and in effect held the purchasing power of the largest segment of the population at very low levels. The collapse of international markets in these circumstances gave rise to distributional conflicts among the three creameries regarding market share allocation. This is explicitly identified in *The Commission of Inquiry Report 1965*:

> "---competition developed as to who should supply the home market with better returns and who should be left with the lower returns from export."

The need to resolve this conflict was for the next three decades to increasingly shape the country's milk marketing institutions. Of particular significance to the development of the industry, the conflict compelled the three area-based cooperative creameries to merge forming the Kenya Co-operative Creameries Limited (KCC), an organization that would hold decisive impacts of the evolution of the country's dairy marketing institutions for the next three decades ending in 1992. Indeed, from 1931 to 1992, the story of Kenya's milk marketing policy became the story of the KCC. The role of the conflict in the merger is explicitly reported in Troup (1956):

> " --- competition between the creameries, for a small market, became intense. This led to an agreement between the parties to and eventually amalgamation took place in 1931 to form the Kenya Co-operative Creameries Ltd."

Analysis reveals that the merger was the inevitable result of the basic structure of the marketing problems faced by the three creameries in competing for a share of the small domestic market. The basic structure of distributional conflicts is a zero sum game, where no group can gain without loss to the others. The market-share distribution problem defines a situation where the competing dairy cooperative creameries exerted interdependent influences on domestic market shares and prices. In the situation, increases in the domestic market share of one cooperative creamery inevitably meant decreases in the share of the others. On the other hand, uncoordinated market supply meant increased market uncertainty for all. It can therefore be argued that the prevailing market situation forced the creameries to ponder the tradeoffs between retaining full autonomy and institutionalized cooperation. Evidently, the creameries agreed that cooperation was necessary and desirable. Hill (1956) reports that:

> "Aided by the circumstances of the times an agreement ----was soon reached by the boards of the three companies whereby the Lumbwa Co-operative Creamery and the Nanyuki Co-operative Creamery would go into voluntary liquidation and the Kenya Co-operative Creamery would purchase the assets of each company. -----the directors resolved to change the name to Kenya Co-operative Creameries Ltd, a change to the plural----"

The merger was effected in February 1931 and it appears to have enhanced the bargaining status of the farmers. This is evidenced by the fact that the KCC (as the agency of the member-farmers) was able to mount a lobby for statutory control (Troup 1956). This, however, was met with little success (Troup 1956). Instead, the government enacted the Butter Levy Ordinance of 1931 requiring all non-KCC members supplying butter to the local market to pay a levy (Hills 1956).

> " the proceeds of which levy was distributed among exporters in order to bring the export realisation nearer to the internal price" (Kenya 1965).

When seen in this right, it becomes clear that the merger of the creameries was a strategic structural change that, by introducing a hierarchy between the primary societies and an apex processing creamery, made possible the inter-organization of the societies to allow decision at a single leadership level. The apex organization also provided scope for representing farmer's problems to the administrative authority.

The World War II provided the settler farmers with a unique opportunity to further press for statutory control of prices. Faced with the need for large food supplies to feed its fighting forces, the British Government directed the colonial state to contribute in provisioning forces positioned in North Africa and Middle East (Bates 1989). This translated into pressure on the white settlers to increase agricultural production to meet the state's needs. The resulting change in the balance of bargaining power for statutory

control provide a clear illustration of the argument by Eggertsson (1998) and North (1995) that, forces exogenous to a system may function to upset the balance of bargaining power between actors and trigger a wave of reactions culminating in policy changes. The bargaining power shifted in favor of the farmers, with successful demands for the government to insure them against price risks at least for the period of the war. Consequently, the voluntary levy adopted in the early 1930s was rendered redundant and was withdrawn.

The wartime demand coupled with controlled higher prices and corresponding reductions in price uncertainties served as major stimuli to the industry resulting in large expansions in primary production and in processing capacity (Troup 1956). After the war, therefore, and with the withdrawal of the government as a major buyer, the contentious issue of how to share the domestic market appear to have re-emerged with greater intensity. This is clearly evidenced by the fact that the KCC found it necessary to alter its contract with its farmer-members. Thus, rather than resume the pre-war levy, a more complex institutional arrangement of quota-based contracts was designed and adopted in 1954. The change probably suggests that the distributional conflict had intensified far too high to be addressed by the levy. The overall objective of the quota pricing system was to safeguard the KCC capacity utilization. The quota-based contractual arrangement was designed to use conditional payments to create producer incentives as well as reduce costs borne by producers in sustaining supplies during off-peak seasons. This was implemented through a three-tier quota that allowed the payment to depend upon the costs of production. Producers contracting for a year-round quota — i.e. guaranteeing off-season supplies — received the highest price. Those contracting for

a high-season quota received the next best price while those who could not guarantee any quota received the lowest price (Kenya 1965).

Viewed from an institutional perspective, the quota-based contractual arrangement emerges as a strategic formulation of choices designed to induce self-selection among the farmers into three groups of producers "justly deserving" the respective price levels. Such strategies are, as explained by Rothschild and Stiglitz (1976), common in markets where individuals or commodities are not easily or costlessly distinguishable. In the case discussed here, the market quotas were designed in such a way as to induce producers to distinguish themselves according to abilities to sustain continual supplies of milk to KCC. By emphasizing the differentials in production costs, the problem was, in effect, transformed from one of market choice to one of choice of production system. This left the choice to the individual farmer, which was easy, given the fact that the farmers were, obviously, already differentiated into different production groups by differentials in their resource endowments. The design and implementation of the new contractual arrangements also serves to illustrate the potentials of changes in economic conditions in originating institutional changes.

PHASE 2: PRE-INDEPENDENT EFFORTS AT INTEGRATING SMALLHOLDER DAIRY PRODUCERS [1954-1962]

The analysis this far demonstrates that the settler dairy farmers were committed to the reduction of market uncertainty and were willing to forge voluntary cooperation to do so. They were as well willing to engage in direct negotiations to define marketing coordinating contracts. However, the ability of a group to organize to forge such

cooperation or to hold direct negotiations depends on its structural variables, including size of group, size distribution of their production firms, and heterogeneity of participants (Bates 1981; Ostrom 1998). The commercial dairy farmers comprised a homogenous group of white settlers operating large farms. This, however, changed with the implementation of the Swynnerton plan of 1954, which advocated for intensification of agricultural production of the indigenous people.

To understand what brought this intentional change about advancing and promoting the economic status of the indigenous people it is worth considering the circumstances that prevailed at the time. Two influences are particularly notable. First, the colonial government was, since the late 1940s, facing insurgency from the indigenous people culmination in the declaration of a state of emergency in 1952. The insurgency was intrinsically tied to the poor economic conditions in the AR. Tension had been growing over time owing to the alienation of land coupled with unfavorable labor conditions. The tension was further intensified by events following the introduction of commercial dairying on the "white highlands". Adoption of commercial dairying by settler-farmers was accompanied with the pushing of many squatters back to the AR where the population was already high. This worsened African's access to land. Furthermore, the developments on the "white" highlands had enhanced the property value of land as well as sensitizing the indigenous people on the benefits accruable from exclusivity in land ownership, which until then had been held communally or by clans. As a result, the evacuation of squatters from the "white" highlands created many displaced landless people. Combined, these factors served to deepen the deprivation of the indigenous people relative to the colonial settlers. This certainly increasingly

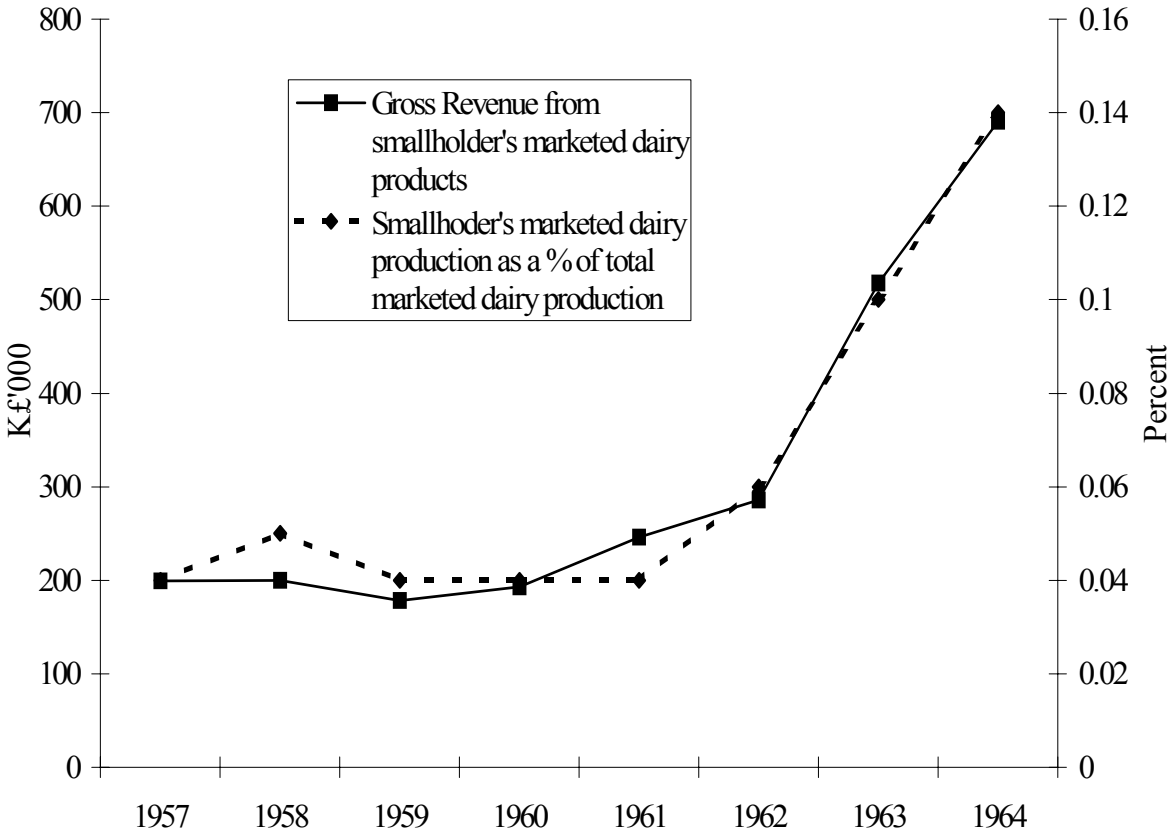
sensitized the indigenous people to the contrast between the 'reserves' and the 'white highlands'. In time, this prompted the indigenous people to exert sufficient political pressure to draw the attention of the colonial administration to their plight.

Secondly, it had since the early 1930s become increasingly clear that the domestic market could not adequately compensate for lack of export markets. Up till then, imperial governments regarded their colonies merely as sources of raw materials to feed expanding industrialization in the imperial countries (Boahen 1987; Lwanga-Lunyiigo 1989). The decline in world trade caused by the Great Depression was however, temporarily offset in mid-1940s by the demands related to World War II. The end of the war therefore, brought back the problem forcing the imperial government to consider the development of market opportunities, for their manufactured products, in the colonies. This led to the introduction of import-substitution industrialization (ISI) in the colonies. In the case of Kenya, ISI was introduced in the early 1950s with consequent need for a large and growing local market. Accordingly, a case was successfully advanced for intensification of agricultural production of African smallholders (Swynnerton Plan 1954) and as one of the Plan's recommendations, commercial dairy production was opened-up to the indigenous people.

This was followed with a specific government program to train smallholders on better methods of animal husbandry and to introduce exotic stock and AI schemes in AR areas. Smallholder herds in medium potential areas were upgraded with the Indian Sahiwal while European breeds were used in high potential areas. In 1960, the reservation of the "white Highlands" was ended (Hangwitz and Throwert 1967). As a result of these changes, smallholder marketed milk rose significantly. As show in Figure

1, the gross dairy products revenue from smallholder increased at an average annual rate of 14.5 per cent, from K£199000 in 1957 to K£691000 in 1964. By 1964, smallholders accounted for 14 per cent of total marketed dairy products up from 4 per cent in 1957, further splintering the small domestic market.

Figure 1--Growth in smallholder milk production: Kenya, 1954-1964



Source: Author's compiled based data present in Ruthenberg, (1966).

Not surprisingly, the KCC reacted to these changes with demands for a more interventionist approach that would serve their interest. Arguably, the integration of smallholder dairy farmers into the market posed a challenge to the KCC's efforts of maintaining distributional balance in sharing out the local dairy market. More

alarmingly, it increased the susceptibility of the asset-specific[2]milk processing plants operated by the KCC to market uncertainties. Further, the heterogeneity introduced may also have made it difficulty to enforce rules informally. Consequently, it may have introduced potentials for opportunistic behavior among settler dairy farmers. It is conceivable that uncontrolled marketing by the indigenous people could have created conditions conducive for self-interested settler farmers to divert sales from the KCC to sell to raw milk markets through their African farm hands. Indeed, Troup (1956) reports that such markets thrived in urban areas.

The above diagnosis depicts underlying distributional conflicts between the settler dairy farmers and the African smallholder dairy farmers. It can also be deduced that unlike the distributional conflicts discussed earlier, which involved a more homogenous group of farmers, this one involved a more differentiated actors. The structural variability introduced by the opening-up of commercial dairying to the indigenous people may have weakened the ability to coordinate the dairy products markets through direct negotiation and voluntary cooperation of farmers. The resultant dairy products market environment may, thus, have been typified by a non-conciliatory state of affairs, thus, increasing the need for a legitimate authority to formulate the rules of the market and to monitor, sanction, enforce compliance and facilitate problem-resolutions. This may explain why the settler-dairy farmers resumed, in 1956, their demand for statutory control of the industry. It is also worth noting that the marketing structure that the settlers wished to establish was greatly informed by the structure in their mother country. This is

[2] Asset specificity refers to inflexibility and difficulties of transferring the use of asset, in this case dairy processing machinery, from one production process to another.

reflected in the fact that in 1956 the KCC invited the Secretary to the Milk Marketing Board of England and Wales to review the industry and give recommendations.

Following from the 1956 review, the KCC successfully lobbied the colonial government to institute statutory measures in the interest of maintaining its dominance in the market. The outcome was enactment of the Kenya Dairy Industry Act— Chapter 336 of the Laws of Kenya — in 1958. As is to be expected, the Act accorded substantial protective powers to the KCC; in a word, the KCC was able to use its primacy to influence the formation of rules and regulations that would henceforth shape the industry. Under the Act, the Kenya Dairy Board (KDB) was instituted as the state agent in regulating the industry. Further, the Act zoned the country into "scheduled" and "unscheduled" areas and, most significantly, the Board appointed the KCC it prescribed agent in milk processing, packaging and sale in the scheduled areas, which tended to correspond closely to urban areas. The Act also established regulations (the Dairy Industry Regulations, Chapter 336 of the laws of Kenya) expressly keeping raw milk out of the scheduled areas; consumers in scheduled areas were to be served with pasteurized milk through the formal marketing channel

In summary, the period of colonization had the following significance for the country's dairy industry:

- Introduction of high-yielding breeds of cattle effectively laying the foundation for an agricultural activity that has grown to be a major source of livelihood to the majority of smallholder farmers in the country;
- Emergence of formalized institutional and organizational frameworks for milk marketing, and, for production and delivery of curative and preventive services including AI and tick-control service.

PHASE 3: CHANGES FOLLOWING POLITICAL INDEPENDENCE [1963-LATE 1980S]

Implementation of the Swynnerton plan of 1954 slowly began an agricultural transformation that gradually increased the role of smallholder agriculture in the country's economy. The transformation grew more rapidly after the country's attainment of political independence in 1963. Acquisition of the "white highlands" farms by the indigenous people was a key element in the negotiations for political independence from the British Government. The aim was to prevent a "cut and run" dilapidation of the farms and consequent slumps in the country's employment and commercial activities. The negotiations were concluded in a decision to avail funds to the in-coming government, which it would on-lend to landless Africans to purchase the farms from the White settlers (, Hangwitz & Thorwart 1967; Ley 1975). Mortgaged ownership was the principal mechanism through which the "highlands" were acquired by the majority of landless Africans. A group of prospective buyers would form a "Land-buying Company", identify a farm on disposal, and arrange a mortgaged purchase with a bond not to subdivide the land until full repayment of the mortgage. The company would then issue equity shares to prospective members-buyers and continued operating the farm as a limited company until the mortgage was fully repaid. Mortgage repayment usually extended over a number of years, this however, made it feasible for low-income landless people to acquire land by making small payments over the extended period.

The land transfers brought remarkable changes in the structure of the country's agriculture. By 1990, the changes had produced a situation where smallholder agriculture dominated both in the share of cultivated land and of national production and marketed production. Presently, the country's agriculture consists principally of farm holdings of

less than 2 hectares. The share of smallholder agriculture in national production and marketed surplus is estimated to be over than 75 and 50 percent, respectively. The share of smallholder agriculture in national production is especially high in maize, coffee, tea, milk, beef and meat, and pyrethrum where it is estimated to account for 70, 65, 50, 80, 70 and 100 percent, respectively (ROK 1995).

With special reference to smallholder dairying, the new government recognized that in addition to the structural change in land ownership, a combination of factors were crucial for building a sustainable basis for increased milk production. These are the (i) enhancement of milk production traits of smallholder dairy herd; (ii) optimization of smallholder farm conditions for maximum realization of the yield advantages of improved dairy cattle; and (iii) improved milk market access. These factors were based on the recognition that the yield advantage of grade cattle is realizable only when combined with the appropriate dairy production management and secondly, that the potential for increased productivity of smallholder dairy can be realized only in conjunction with an efficient marketing system. This section presents efforts made by the government to achieve these objectives.

Artificial Insemination services

Provision of efficient and affordable reproductive services has been a major dairy policy strategy in the country. The strategy has particularly been identified as being central to the development of the smallholder herd and, over the years, has taken the form of heavy public investment in A.I services. As already discussed, a government parastatal, CAIS, was already in place at the time of independence. However, it mainly operated as a bull-semen producing agent for Cattle Breeders' Associations, which were mainly patronized by large-scale dairy farmers. The need to broaden CAIS clientele to

cover smallholder dairy farmers was only addressed after independence. To address the need, the Kenya Government, with assistance from the Swedish International Development Agency (SIDA), established the Kenya National Artificial Insemination (KAIS) in 1966 (FAO 1991, MoALDM 1997) to be the government organization designated to perform and coordinate actual field inseminations.

The CAIS is still entrusted with the responsibilities of recruiting Kenya-bred pedigree bulls, collection, preservation, and distribution of the semen. The recruitment relies on supportive services of a number of organizations including the Kenya Stud Book (KSB), the Dairy recording Services of Kenya (DRSK), and the Livestock Recording Centre (LRC). Both KSB and DRSK are sub-committees of the Agricultural Society of Kenya (ASK) financed mainly through government grants and service charges. Both[3] are responsible for identifying and registering pedigree animals (mainly cattle, goats, sheep, and pigs) from farmers voluntarily seeking, willing, and able to pay to have their animals registered. The KSB is specifically charged with the responsibility of recruiting animals into an up-grading scheme, monitoring the scheme as the progeny upgrades from foundation through to pedigree, and maintaining a pedigree herd register. On its part, the DRSK is responsibility for monitoring the milk performance of animals in KSB register that are in milk, subject to farmer's voluntary participation. The third organization, LRC, is responsible for progeny testing, which involves evaluation of milk performance of daughters of pedigree bull using the DRSK milk performance monitoring data.

[3] Plans are underway to combine the two organisations to form the Kenya Livestock Breeders' Organisation

Procurement of pedigree bulls by CAIS operates through a contract-mating program which functions as follows: First, the dams to sire quality bulls are identified through KSB and DRSK records. The dams are then inseminated with quality semen. The farmer receives a few for any sired bull calves while he retains heifer calves.

Up to 1987, the provision of AI services was heavily subsidized (Table 1) with farmers meeting less than 20 percent of the cost of AI services.

Table 1--Trends in Producer AI Charges

	1980-81	1984-85	1986-87	1988-89	1989-90
Producer charges	1.00	1.00	1.20	10.20	14.80
Actual cost	5.20	8.40	12.80	14.20	14.80

Source: Author's computation from data presented in FAO, (1991).

The aim was to encourage widespread upgrading of the country's dairy herds. The minimal demand of an individual farm seems to have influenced the logistical form to be taken in distributing AI services to the smallholders. This demanded the establishment of a routine geared at maximizing the number of farms households that could easily access the services per a given workday. KNAIS determined that to be efficient, the adopted procedure needed to be strong on its ability to aggregate service-needs, per workday, over a large number of households in order to realize some economies of scale. Based on these aims, KNAIS designed a distribution system comprising of AI sub-centers. The centers were equipped with AI equipment funded by the government with the help of donors and had the responsibility of receiving and maintaining a stock of supplies (semen and liquid nitrogen) from CAIS, and to provide the services to farmers. Provision of services operated along a system of designated service-routes comprising several delivery points (road-side crushes). Farmers drove

their animals to the roadside crushes for services. Inseminators on motorized vehicles circuited the routes daily servicing the cows delivered to the crushes. The heavily dependence on motorized transport, however, meant high vulnerability to vehicle breakdowns (FAO 1991, MoALD&M 1987). Furthermore, the system placed heavy demands on government expenditure and as a consequence, provision of the services was heavily reliant on donor projects.

Tick Control

According to Hill (1956), the practice of cattle dipping in Kenya started in 1912 when the first dips were constructed. However, tick control formally became a national concern with the enactment of the Cattle Cleansing Ordinance in 1937 and in the past decades, in the past decades been held in that regard. Perhaps because of the network externalities characterizing tick control programs, the approach used among smallholders was to develop communal dips managed by dairy farmers' collective groups. The management was however not very efficient and in 1977, the government took over the management to enhance the effectiveness of the control. By 1987, there were 6041 dips in the country. However, Pegram et al. (1990) have questioned the basic assumption underlying the national intensive tick control program. They argue that the assumption that the indigenous cattle require as intensive a control regime as the exotic breed is not necessarily correct. They also argue that undue concern with the protection of a small herd of exotic breeds may have cost the country the loss of valuable tick resistance as well as loss of enzootic stability. They recommend that a more efficient program should vary with breed, type of cattle and ecological conditions.

Clinical services

Clinical services were started in 1974 when the first clinical centre was opened to cater for smallholders and by 1978, 18 clinical centre were in operation. This had expanded to about 284 by 1995. Up to 1988, the services operated with strong state support, including government-employed veterinarians and nominal charges for drugs. In 1988, the government started a gradual increase in the rate of cost recovery as well as encouraging the establishment of private veterinarians. The policy is for the government to retain the surveillance and prevention notifiable disease, which according to the Animal Disease Act of 1965 and Animal Disease Rules of 1968, include anthrax, contagious bovine pleural-pneumonia, east cost fever, foot and mouth disease, heart water, lumpy skin disease, rinderpest, are notifiable.

Extension Service

Improvement in cattle genetic has been coupled with efforts of enhancing the smallholder's capacity to realize the potential of high-yielding breeds of dairy cattle. The Government, through the national extension program, has put much effort to extending better dairy husbandry. Efforts have also been through training at university level, diploma, and certificate colleges. Donor agencies have also contributed greatly in enhancing the efficiency of extension service. Notable among these is the contribution made by the Dutch government. In 1980, the National Dairy Development Project (NDDP), a bilateral Kenya-Dutch collaborative effort, was launched. The project was mainly aimed at extending to farmers research findings of the Dairy Cattle Research Project (DCRP) conducted at the NAHRS since the late 1960s as part of Dutch assistance to Kenya's livestock sector (MoALD&M 1997). The project's major activity was the promotion of intensive smallholder dairying in high potential area by promoting, for

farmer's adoption, a zero grazing package comprising better napier grass management coupled with better cattle feeding practices (de Jong 1996). Latter the projected incorporated an activity to introduce and promote the production of leguminous fodder trees by the farmers for use as animal feed supplement (Kaitho et al. 1993; Murethi et al. 1995). The overall goal of the project was to increase national milk production through enhancement smallholder farm's dairy cattle carrying capacity and smallholder's capacity to realize dairy cattle production potential by use of high-yielding fodder. In addition, the project aimed at intensifying the internal dependence between dairy and crop production through of better utilization of urine and manure.

Milk Marketing

Immediately following independence, the dismal market participation by smallholders, became an issue of political concern. The problem was however primarily interpreted as a conflict between the large and small-scale producers over the patronage of KCC (Bates 1989; Leys 1975). The possibility that the problem may not have been with smallholder's limited access to KCC, but with the absence of an appreciable alternative market outlet was not admitted. Instead, government saw its task as redressing the inherited inequalities in producer prices and market opportunities between the large and small-scale dairy producers. This is clearly reflected in the terms of reference of a commission of inquiry constituted under the authority of Gazette Notice No. 31 of July 1964 to define appropriate institutions to resolve the issue. The terms included *inter alia*, "to ensure that equitable price structure is established taking into account the interest of all dairy farmers"(Kenya 1965).

The inquiry judged that the existing institutional arrangements were very complex and that they favored large-scale producers over SDF. Although the three-tier

pricing system used by KCC since 1954 was justified as a way of minimising supply and price fluctuations, it implied price discrimination against SDF by restricting their access to urban markets. This is because the SDF could not achieve the quantity guarantees required to qualify for the premium price. Furthermore, since it was increasingly becoming difficult to qualify for a quota, the system conferred relatives' benefits on those already awarded quotas through creation of a goodwill value in the transference of quotas from one farmer to another

To reduce the large-scale bias in access to urban markets, the inquiry recommended a statutory control of prices. However, the pricing structure was not changed until 1970. In that year, the quota pricing system was abolished and in 1971, a uniform pricing (pan-seasonal and pan-territorial) was introduced. This was part of broad instruments designed and implemented for most agricultural commodities regard as being key the country agricultural development— including maize, wheat, and beef —to ensure both seasonal price stability and spatial egalitarianism. The KCC was identified as the vehicle[4] through which to implement the statutory controls of milk prices. At the same time, private dairies dealing in raw milk were shut down and bulk sale to institutions by producers were forbidden. In this respect, the KCC's virtual monopoly [5]rights, which had been nominally in force since the enactment of the Kenya Dairy Industry Act, in 1958, were reaffirmed. In order to guarantee market outlet to all dairy farmers, the KCC was mandated to accept all milk delivered to its plants subject to minimum specification

[4] This probably reflects the proximate-role played by institutions and organisation inherited from the colonial administration; if there already existed a formalized organisation/institution, it made economic sense (both in term of time and resources) to adopt and adapt it for the advancement of the objectives of the new government.

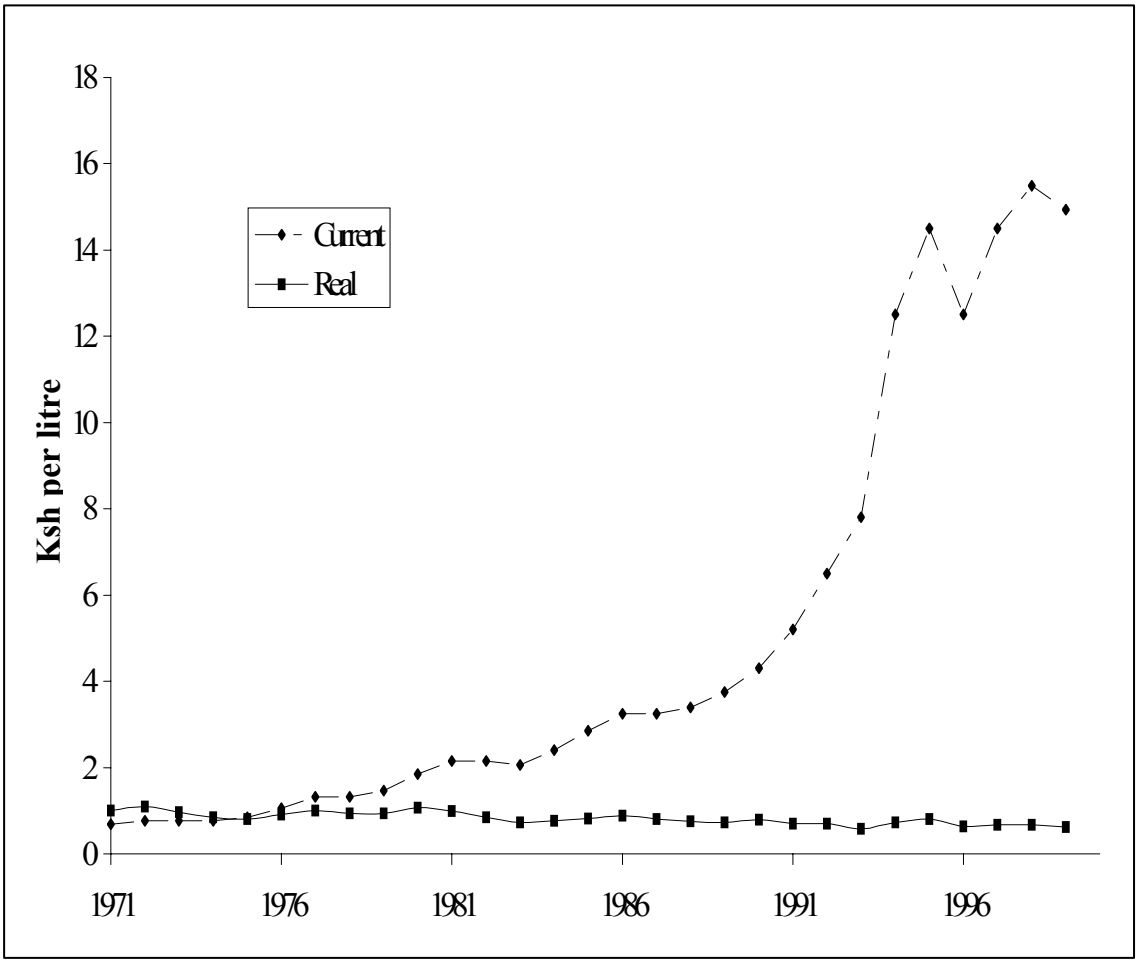
[5] These measure were opposed by a government working party set by the government to review the status of the country's agriculture on the grounds loss of competition was not consistent with the desire to enhance market efficiency (Hopcraft and Ruigu 1976).

of quality delivery schedules. Accordingly, the KCC expanded its capacity to achieve the national network commensurate with its new role. By 1991, it had an installed capacity of 1.2 million liters per day comprising 11 milk chilling centers spread all over the main dairy districts and 11 processing-plants processing and packing a wide variety of dairy products including low and high fat fresh milk, condensed milk, ultra heat treated long-life milk, milk powder, butter, ghee, cheese, and fermented milk. In this capacity, the KCC provided a reliable outlet for all dairy farmers.

The above changes had some apparent benefits for the SDF, which are best understood if viewed from a transaction costs perspective. Institutionalization has the advantage of widening the time-horizons of actions and of stabilizing the rational expectations of individuals (Czada 1998), as well as fostering regularity and order in the solution of frequently recurring problems (Pesaran 1987). These are desirable features in smallholder dairy production and marketing, given that the high perishability of milk and the pattern of flow of the output require that market be secured for full lactation periods. Furthermore, the arrangements had the merit of allowing the establishment of a routine operating procedure, a crucial feature given the highly repetitive task of milk sales activities, and the consequent need for regularity. This was, as will be explained shortly, designed and implemented through a network of primary dairy farmer cooperatives societies (DFCS) with well-defined network of milk bulking for pooled transportation to KCC processing and cooling plants. The other obvious benefit was that by cushioning the farmer from price fluctuations associated with free market force, the system offered a stable marketing system. Figure 2 depicts the trend in official producer prices. Analysis of the prices for the period 1971-1992 indicates lower fluctuations in real price, with a

coefficient of variation of about 13.5, as compared to nominal prices with a coefficient of variation of 57.2. The analysis, however, reveals that in real terms, the producer prices declined at an average annual rate of 1.36 percent per year over the same period.

Figure 2--Official producer price trends, Kenya (1970-1999)



Note: Current prices are deflated using an average of Nairobi's lower and middle income-group CPI
Source: Statistical Abstract and Economic Survey, various issues

The merits of the system not notwithstanding, the implication for the economy as a whole, of the new dairy marketing structure, was a system centered on large-scale milk processing facilities and characterized by extensive transportation that could not be sustainable in the long-run. The implication for the KCC was that it was implicitly identified as a public organization charged with specific roles. In effect, the KCC entered

an implicit contract with dairy producers, committing it to pay for all accepted deliveries of milk promptly and regularly at month-end. Although the KCC was incorporated as a private sector organization to represent the interests of its members, the net effects of the institutional changes designed and implemented after independence as related here, was to transform it to a *de facto* parastatal─ with a growing state involvement. Other social roles entrusted to it included: (i) the maintenance of a strategic stock of milk, (ii) being a buyer of last resort, and, (iii) being an agent of the Ministry of Education in implementing a School Milk Program introduced in 1979. A further consequence of the changes was that any autonomy the shareholders had in running their organization was gradually eroded and taken over by government. This may however be attributed to the change in the organization's size and membership structure. As already noted, initially the KCC represented the interest of influential large-scale farmers. However, its size membership and composition changed remarkable with the increased access by smallholder farmers. Such changed as Bates (1989) has explained tend to give the benefits sought by the affected organization a public goods character.

The funds required by the KDB in discharging its responsibility were to be contributed by the recipient of its services. Accordingly, the Act empowered the KDB to levy cess on all milk handled commercially. To effect the collection of the cess, the KDB delegated its agent —the KCC — to collect the cess from those supplying its plants. However, by 1972 the KCC was already experiencing trading losses to which the government responded by allowing it to retain 50 per cent of the cess collection. Later, in 1984 it was allowed to retain the total cess collection. Earlier (in 1982), the KDB had lost its Dairy Development section to the Ministry of Agriculture and the nutrition section

to the KCC. Thus began a series of concessions that gradually limited KDB's ability to regulate the industry while simultaneously increasing the KCC's privileges and monopoly rights. These included direct participation in determining entry through its representation on the KDB's Licensing Committee (DANIDA/MALD 1990) through which it exerted restrictive control over the issuance of licenses to potential entrants and limitations on the quantity of raw milk supplies that a licensed processor had access to (Coughlin 1992). The control over raw milk supply operated as follows: All other licensed milk processors (see text box 1) were denied the right to procure raw milk supplies directly from farmers. Instead, they were required to place an application with the KCC, which then made arrangements for a number of farmers to deliver *a specified* amount of milk to the applicant. The KCC then invoiced the processor for a price that left a margin for the "services" rendered the processor. The effect of all this was that other processors were at considerable competitive disadvantages when compared to KCC. Further, KDB was gradually weakened financially and its role in the industry significantly reduced.

Text Box 1--Effect of restrictive control on dairy processing activities in Kenya

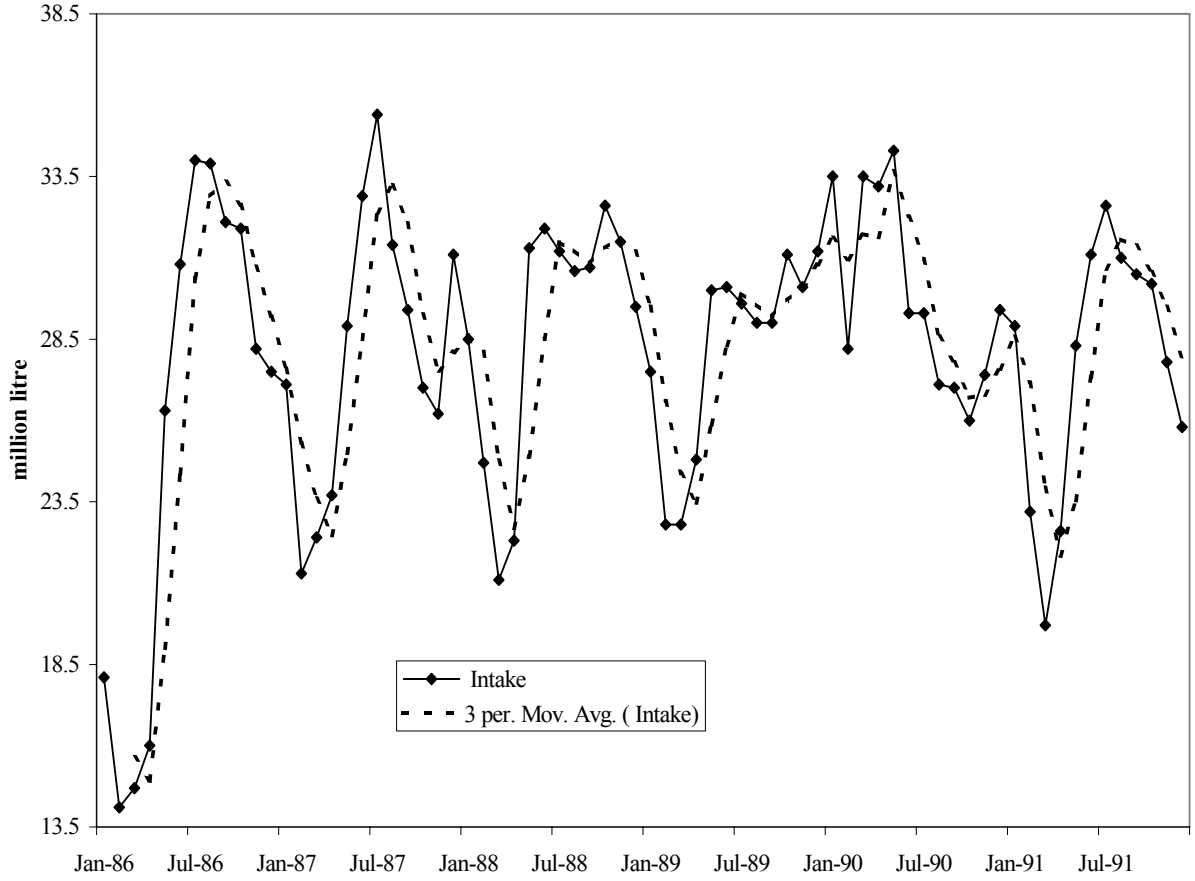
Restrictive statutory controls pursued before 1992 constrained the development dairy processing in the country mainly to one firm, the Kenyan Co-operative Creameries (KCC).

Attempts to upgrade primary dairy co-operatives from being mere bulking agents of the KCC to engaging in processing were made in the early 1980. This was done through collaborative efforts between the government of Kenya and a donor agency. However, the efforts did not go beyond the pilot stage, which only installed small processing capacities in two co-operative —Kitinda Dairy and Meru Dairy in Western and Eastern Kenya, respectively. The combined milk intakes by the two co-operative, however, averaged a mere 2% of all milk marketed through the formal channel (DANIDA/MoLD 1991).

Private entrepreneur were restricted to specialty products (mainly cheese, yoghurt and ice-creams) and niche marketing. However, as FAO (1991) notes, there is virtually no statistics on capacities and volume of manufacture by the firms.

Performance of social roles by the KCC inevitably meant that some of its operations were inconsistent with cost minimization strategies and that it to some extent shouldered the risks of milk supply fluctuations. For instance, operation of a national network of large-scale facilities meant a low overall operating capacity averaging. Analysis of the firm's milk intake for 72 pre-liberalization months running from January 1986 to December 1991 show that capacity utilization averaged about 0.92 million liters per day, or about 77 percent of the firm's installed capacity of 1.2 million liters per day. This low capacity utilization mainly stemmed from the fact that the country's dairy production is predominantly based on rain-fed natural and planted pastures. Thus, domestic milk supply corresponds closely with the rainfall pattern. Figure 3 shows the behavior of milk supplies to KCC as computed from a three-months moving average of the period of 72 months running from the year 1986 to 1991. The figure depicts a clear seasonal pattern with a trough in the months of March and peaks in the months of July and October. This bears much relationship to the country's bimodal rainfall pattern —the country receives two rainfall seasons, the first (the "long rains") running from about mid-march to July and the other (the "short rains") from September to November.

Figure 3--Milk supply pattern, Kenya (1986-1991)



Source: Statistical Abstract, various issues

Figure 3 also depicts the occasional break with pattern; 1990 was not a normal year. Yet, as DANIDA/MALD (1990) noted, although plants were under-utilized during the low supply periods, labor was mainly on permanent terms and, therefore, could not be flexibly managed to cut losses. Further, and not unlike many other public institutions, there was a problem of inappropriate staffing levels coupled with disproportionate employment of labor with a heavy salary burden going to non-essential staff. As well, DANIDA/MALD (1990) noted that during wet seasons, long queues of milk-trucks at processing plants' offloading-bays were a common sight, causing heavy congestions that,

in effect lengthened the time between milking and delivery. The congestion often resulted in high rates of milk spoilage, the cost of which was passed to producers through rejected milk together with its transfer costs. High transportation costs were also incurred during heavy production period in extensive re-routing of milk. Receipt, by any plant, at higher than capacity meant that the milk had to be re-routed to other plants receiving below capacity— adding to the cost of milk (DANIDA/MALD 1990). In addition, the KCC often had to carry heavy inventories of processed products, which commanded lower pricing margins apart from the tied capital. For instance, by June 1993, the KCC held 123 million worth of storable milk products.

Given the high-cost nature of these operations, it was just a matter of time before the KCC would start experiencing severe performance and efficiency difficulties. The difficulties were mainly manifested in accumulation of indebtedness to both farmers and the government. FAO (1991) reports that the KCC's running costs were high and on the increase, increasing by 121 per cent between 1985 and 1989. The problems culminated in persistent breaches of promissory obligations to pay for milk deliveries promptly and the KCC started falling into arrears with farmers' payments.

Irregular and delayed payments were perhaps the most damaging consequences of the KCC 's operational inefficiencies and were the greatest source of pressure for deregulation of dairy products markets. Apart from forcing farmers into involuntary creditors of the KCC, the problem greatly undermined the solvency of DFCS and as a consequence contributed to erosion of DFCS capacities to extend services to members. Operation of milk transportation by DFCS, by far the most crucial and expensive, was adversely affected. That the viability of the DFCS was closely linked to that of the KCC

becomes evident when it is taken into account that the institutional settings in force constrained DFCS's marketing activities to intermediation between the KCC and dairy farmers. Essentially, DFCS provided the major organizational framework for the collection and transportation of milk to the KCC and for transmitting payments to members. In other words, the DFCS were not in the market as active participants but as passive agents of the KCC. To perform this agency role effectively, a specialized operating system was developed that functioned as summarized text Box 1

PHASE 4. POLICY REFORMS AND CHANGES IN THE INDUSTRY: 1987 TO PRESENT

From the foregoing section, it is clear that on attainment of political independence, the new Government of Kenya regarded state control of the dairy sub-sector as central for the sector's development. To place the statutory control of the sector in the right context, it is worth pointing out that the developmental perspective prevalent at the time regarded state control of economic activities as crucial for counties social and economic development. For the emerging state, this had great influence on the design of economic policies. In particular, direct government interventions (through marketing boards and parastatals) coupled with statutory control of production and marketing was considered the policy option most consistent with broad national goals including improving income distribution and spatial egalitarianism (Hewitt de Alca′ntara 1993). Accordingly, the government chose, for the agricultural sector, to control the production and marketing of commodities considered strategic for the country's development and political stability, including the cereal and dairy sub-sectors. However, the strategy, while justifiable during the transition period when the country was undergoing structural

reform to increase economic participation of indigenous Kenyans, it was clearly not sustainable in the long-run.

The un-sustainability of the strategy started showing in the late 1970s coinciding with severe socio-economic crisis precipitated by the oil crisis. Severe drought in the early 1980s further worsened the socio-economic situation (RoK 1986). At the same time the perspective regarding the appropriate extent of government control of economic activities was undergoing a global change as advocated in the World Bank and IMF backed structural programmes (SAPs). Within this context, Kenya embarked, from the mid-1980s, on broad-based economic reforms aimed at reducing the role of the state while stimulating the growth of a more competitive and productive private sector (GoK 1986). In the dairy industry, reforms begun in 1987 with a launching of a process to divest the government from the provision of breeding services followed in 1988 with initiation of a process to divest it from the provision of clinical services. In 1989, the manufacture and sale of feeds was liberalized while in 1991, a process to divest the government the management of cattle dips was begun. The process was finally completed in 1992, with the liberalization of the marketing of milk. This section presents some of the changes that have occurred since this process to increase the participation of the private sector in the sub-sector begun.

Breeding and clinical services

Divestiture was the main policy choice taken to reform the provision of AI, and veterinary services. The choice of the approach, however, was basically influenced by the very fact that the services had been virtually totally in the hands of the government. The appropriate approach needed to ensure a smooth transition devoid of gaps in the provision of the services. Since private entrepreneurs would likely not form

instantaneously to fill gaps left by folding-up government services, the government in 1988 started to gradually increase the rate of cost recovery of services as well as encouraging the establishment of private veterinarians. The presumption was that the veterinarians already in government establishment would resign voluntarily and take-up private practice while those newly qualifying would join in the competition. Farmers' dairy co-operatives were also encouraged to compete in the provision of the services.

The more general result can be described as a market "skimming" where privatization has tended to flourish in areas that are considered easy to serve. In such areas, veterinarians venturing into practice have tended to set up integrated enterprises engaged in feeds and drug retail, as well as offering on-call veterinary and AI service. Although there are no clear statistics, there are indications that the majority of the participants are veterinarians in government establishment, which is Paradoxical since there quasi-private status confers them a competitive advantage over participants not affiliated to the government. This may in turn hamper the development of a fully-fledged private practice. The fact that veterinarians in government establishment can maintain a quasi-private status means that there is no incentive for them to leaving the establishment and become fully-fledged private practitioners. More significantly, non-affiliated veterinarians are obviously reluctant to put heavy invests so long as the status quo maintains.

Milk Marketing

To help describe changes in marketing system, it is help full to make a distinction between formal and informal marketing channels. In its current common usage in Kenya's dairy marketing, formal milk-marketing channels refer to milk-marketing channels that both process and move processed milk product to final consumers.

Conversely, informal milk marketing channels refers to channel moving raw milk to final consumers. Liberalization has resulted in partial decriminalization of milk sales activities that move raw milk to consumers in urban areas (formally scheduled areas). As a result, the KDB has licensed a number of participants to conduct the activity. Therefore, the terms formal and informal have no connotation of legal recognition; they are simply used to distinguish between channels moving processed dairy products from those moving unprocessed milk to final consumers. It should be noted that unlike the case of Ethiopia where informal channels also handle homemade processed products, in Kenya, fluid milk is the major product handled through the channels.

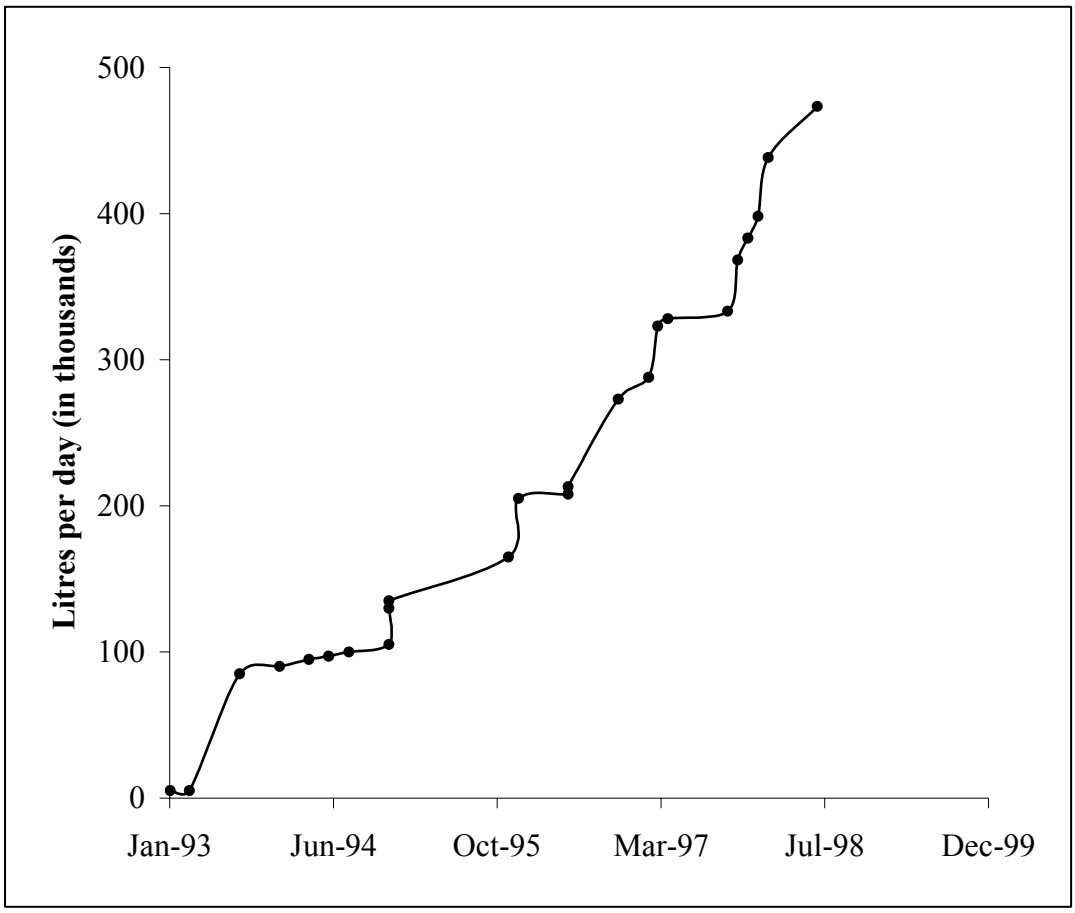
Private Processing

Since 1992, appreciable progress has been made in the development of private and co-operative milk-processing plants have emerged. Their development first started on large-scale dairy farms (including Brookside, Illara, and Delamere Dairies), which afforded a head start through foundational supplies from own herds. These progressed fast into taper integration— sourcing some fraction of raw milk input from their own vertically integrated dairy farms and the balance from market supply from farmers. The number of processors has also increased over the years now stands at about 45 and they all depend heavily on market supply from farmers. As shown in Figure 3, the processing capacity installed by the emerging processors had by 1999 reach about 500 thousand liters per day. This amounts to about 47 percent of KCC's average daily milk intakes for six year before the liberalization.

Initially, the private processors favored at-factory-gate deliveries of raw milk supplies. However, increases in individual and combined capacity, and the attendant

competition for supplies, placed a challenge for an increased ability by individual processors to guard against under-utilization of installed capacity. Individual processors are thus faced with the pressure to actively cultivate procurement arrangements favorable to creating steady milk supply relations with farmers. This may well lead to invariable linkages between milk procurement and inputs and services delivery systems as processors act under the stimulus of the desire to create a competitive position. Already, processors are contracting formal arrangements with collective farmers groups. Investigations show that although the trade has also attracted traders who buy raw milk from the farmers to resell to processors, the processors prefer procuring supplies from farmers through DFCS and other forms of collective milk marketing because they are more dependable when compared to middlemen, who seek trade relationships only during times of high milk supplies.

Figure 3--Installed non-KCC processing capacity, 1992-1999



Source: Adapted from Ngigi 2000

Sale of Raw Milk in Urban Areas

The issue of whether sale of raw milk in urban areas should be legalized and encouraged, as part of enhancing dairy market competition and hence dairy marketing-efficiency, has figured prominently in the country's public debates. To place the debate in proper perspectives, it should be recognized, as already discussed, that even before the liberalization of the industry in 1992, sale of raw milk was a legal activity in the "unscheduled" areas as defined in the Dairy Industry Act. Producers have always sold milk directly to milk deficit households and institutions in the neighborhood of the producing households. Similarly, DFCS could resell raw milk to households, institutions,

hotels, and restaurants in their respective "area of operation" (see text Box 2). However, sale of raw milk in the "scheduled" areas, which corresponded closely with the urban areas, was illegal and KDB was mandated with the responsibility of monitoring the areas to ensure compliance.

However, although assumed away and thus not reflected in milk marketing statistics, raw milk marketing activities have always been a thriving activity in all urban areas. The Dairy Industry Regulations (Cap, 336) and their enforcement actions were not very successfully in controlling their development. Moreover, with the growing inefficiencies in the single-channel formal system coupled with KDB's weakening financial position, the activities continued to thrive and by the early 1990s KBD's dwindling capacity could hardly cope.

Sale of raw milk in urban areas is thus not a development of dairy market liberalization but a long-established practice, which has always operated parallel to the official milk-marketing channel. Estimates made just before the liberalization of the market show that the official channel (i.e., milk-marketing channels that both processed and moved processed milk product to final consumers) accounted for only about 38 percent of the nation's total marketed milk production (DANIDA/MoA 1995), a share quite disproportional with official efforts to develop the channel

Common to other agricultural output and input markets, the liberalization of the industry in 1992 occurred in a legal vacuum in that it was not preceded by a review of the Dairy Industry Act. The change was communicated as an official directive, which, though explicit in encouraging potential processors to enter the market to open-up the KCC to competition, it was not as explicit on the question of sale of raw milk in the

"scheduled areas". However, the directive was understood as a move to generally free the private sector's participation in the dairy market. In light of the legal vacuum, and given the competitiveness (as discussed shortly) of raw milk trade, the response was a visible activity of raw-milk traders in urban areas. Sights like the one shown on Figure 7 are now a common sight in major urban centers. However, it is not easy, based on available data, to make an assessment of the "with" and "without" situation. Beyond an informal versus formal reference, available pre-liberalization data does not indicate how the volume of raw milk sales was shared between rural and urban markets.

In principle, sale of raw milk in rural areas is still legally acceptable; it is reasonable and acceptable for a milk-deficit household to procure milk from its milk-surplus neighboring households or from a collective milk-marketing group. Such "over-the–fence" raw milk sales are not considered to pose much public hazard. However, the legal position of sale of raw milk in urban areas, under the liberalized milk marketing policy, is yet to be clarified. As Ngigi (2000) has noted, the KDB's position with respect to the activity has been characterized by *ad hoc* and reactive regulatory measures, which generally have involved impromptu confiscation of milk supplies from raw-milk traders. Estimates however show that formal processing channels still occupy a small share of the country's milk market (Figure 4).

Three major channels are involved in the distribution and sale of raw milk to end-consumer as follows:

- Direct sales by producers: This is by far, is the most important sales channel accounting for more than half of smallholder's marketed milk. As Figure 4 shows, surveys have shown that apart from farm-gate sales to deficit households in the producer's neighborhood, smallholder dairy households are also active participants in supplying urban raw-milk markets.

- Rural-to-urban sales through informal traders: These procure supplies mainly from the rural areas, either directly at farm-gates or from Farmer's Collective Groups, or from other traders. Three categories of rural-to-urban raw-milk traders are identifiable. One category, referred here as small-scale milk hawker, deals in small quantities of milk ranging from 5 to 30 liters per day and commonly transports milk on bicycles (see Figure 7) and other public means of transport. The other category, large-scale milk hawker, deals in large quantities and use small trucks for transportation. The third category retails milk from milk shop commonly referred at as milk bars. Milk bars vary in terms of milk handling facilities with some equipped with freezers. Some milk bars also produce yoghurt and flavored milk using local --

- Rural-to-urban sales through Farmers' Collective Groups selling: Before the liberalization of the industry, direct sale of raw milk by co-operatives was confined to their milk supply cashment areas (see Text Box 2). With liberalization, and partial decriminalization of sale of raw milk in urban areas, the spatial range over which co-operative can sell raw milk to end-consumers has expanded into urban areas. This has been especially so with co-operatives in Kiambu district (the district neighboring the city of Nairobi). Although quantitative information on market share allocation between the rural and urban markets is not accurately known, it is estimated that raw-milk sales accounts for up to 70 percent of co-operative's total milk intakes.

A major factor in understanding why raw-milk trade bears a competitive edge over processed milk relates to the fact that, in its common form of consumption (mainly in tea and coffee, or as a food snack) milk does not necessarily require any processing. Pasteurization and packaging are mainly focused at hygiene and safety in order to protect consumers from milk-borne public health hazards, improve shelf life, and enhance ease and convenience in handling. Yet, surveys have shown that Kenyans habitually boils all fresh milk before use (Omore et al. 2001). Furthermore, the cost of processing and packaging mean that, raw-milk traders can operate competitively and profitably within processor's prices margin. In other words, raw-milk traders can procure milk from farmers at prices higher than those offered by processors and resell, for a profit, at a price lower than that of packaged-pasteurized fluid milk. An analysis of data from surveys

conducted by Smallholder Dairy Project[6], between 1999 and 2000, clearly illustrate this. The survey data showed that on average producer, and consumer prices in the formal channel was about Ksh 15.94/litre and Ksh 50/litre, respectively. Yet, as shown in Table 2 raw-milk traders in two major urban areas (Nakuru and Nairobi) operated competitively within this price margin. Furthermore, the trader's incomes raging from about Ksh 5,096 to 9,660 per month (assuming a 28 workday per month) were higher than the gazetted minimum wage for the agricultural industry, which stood at Ksh 1,676 per month (see also Ngigi 1995).

Table 2--Costs and profits of trade in raw milk

Variable	*NAKURU TOWN*		*NAIROBI*	
	Milk-bar	Hawker	Milk-bar	Hawker
Resale Price per liter	24.40	25.00	31.40	26.80
Purchase Price per liter	18.80	16.10	24.70	20.55
Fixed Costs per liter	0.43	0.15	0.40	0.04
Labor per liter	1.37	0.00	2.47	0.00
Transport [1] per liter	0.00	0.00	0.00	2.33
Intermediate Costs per liter	1.01	0.42	1.98	0.25
Statutory Costs [2] per liter	0.14	0.00	0.24	0.30
Contingency [3] per liter	0.00	0.00	0.00	0.30
Total Costs per liter	2.95	0.57	5.09	3.22
Purchase Price as a % of resale Price	77.05	63.89	78.66	76.68
% Share in Resale Price Retained by Participant	22.95	36.11	23.57	23.32
% Share in Resale Price Incurred as Cost	12.09	2.26	16.21	12.01
% Share in Resale Price Retained as Net income	10.86	33.85	5.13	11.31
Average volume handled per day	130.00	35.00	150.00	60.00
Average Total income per day	345.00	299.00	242.00	182.00

Source: Author's computed from survey data of the Smallholder Dairy (R&D) Project: Assessment of Informal Milk Market Performance and Associated Public Health Risks in Kenya

Notes:

- In Nakuru, hawker commonly procured milk at farm-gate and transportation was by bicycle. Transportation cost is thus inbuilt into fixed and intermediate cost (i.e. the capital recover & maintenance cost of the bicycle).
- In Nairobi, hawkers commonly bought at DFCS's bulking points and transported on public service vehicles. Transportation included –----and personal fare.
- In both areas, milk bars commonly bought at their "business gate" from hawkers and producers. Therefore, they did not commonly perform any transportation function.

[6] (a collaborative effort between the International Livestock Research Institute (ILRI), the Ministry of Agriculture, and Livestock Development (MoALD), and the Kenya Research institute (KARI)

Despite the competitive advantage of raw-milk trade, critics have pointed out that raw milk sales activity is characterized with the moral hazard of adulteration. There is also the concern that handling containers commonly used by majority of raw-milk traders are difficulty to sterilize. Another concern is that hawker may only have a short-term view of business and may thus be merely interested in skimming easily-accessible supply and re-sale markets rather than in product and market development. Thus, the critics argue that raw-milk sales activities are associated great sanitation and safety risks and pose a public health hazard yet it may not possess a significant role for long-term development of the industry. On the other hand, advocates of raw milk trade feel that its continued dominance despite official prejudice against it implies official misallocation of efforts to develop a western-model milk processing and distribution channel. They argue that giving legitimacy to raw milk trade activity would give it a long-term view thus giving the traders confidence to scale-up their business and engage in product and market development. Consumer education may also help in alleviating the moral hazard problem.

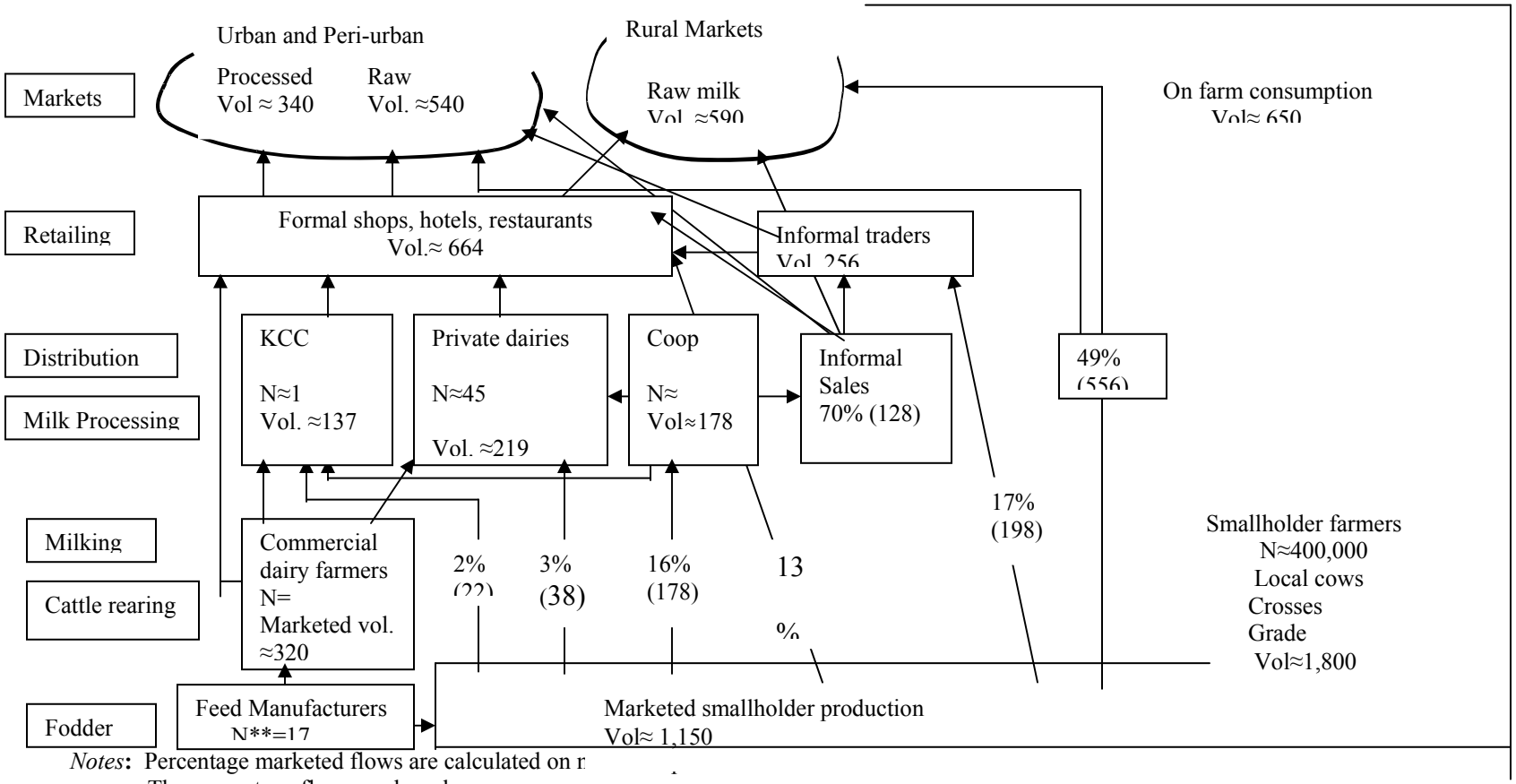
Inherent informational problems regarding the handling of raw milk mean that moral hazard of milk adulteration is potentially present in all channel levels handling raw milk. A study by Omore et al. (2001) provides sufficient evidence to indicate that adulteration of milk with water coupled flour and margarine to increase volume of sale, while maintaining the specific gravity and butter fat content, is a real moral hazard in the channel especially during periods of low supplies. Indeed, DFCS include in their by-laws a stipulation against deliveries of adulterated milk, with specifications of heavy penalties for non-compliance (Ngigi 1995 2002). However, even for them, adulteration poses a

difficult supplies-screening challenge given the structure of production and the associated need of large membership for viable operations. Potential for adulteration is enhanced by the fact milk may change hands a number of times before reaching the final consumer (e.g., farmer →large-scale hawker →milk bar →consumer, or farmer →large-scale hawker →small-scale hawker → consumer). Furthermore, supplies may be bulked form several suppliers.

The persistence of raw milk sales activities, however, may be an indication that participants, to a large extent, may have devised ways of countering the problems. Further, the highly perishable nature of raw fresh milk may itself partly mitigate the problem. The perishable nature demands high standards of cleanliness to minimize spoilage losses. Repeat seller-buyer informal relationships, which are common in informal milk market channels, may contribute in enhance monitoring and built-up of social capital both of which may go a long way in mitigating moral hazard problems.

Small-scale rural-to-urban resellers commonly handled milk in plastic containers stack in a plastic crate. However, although cheaper and lighter than aluminum milk-cans, plastic cans have raised concerns over their difficulties in sterilizing. Some organizations including ILRI are currently addressing the problem of the cans and are popularizing the use of light small aluminum like the ones shown in panel (c)

Figure 4--Kenya milk marketing channels, 2002 (million Liters)



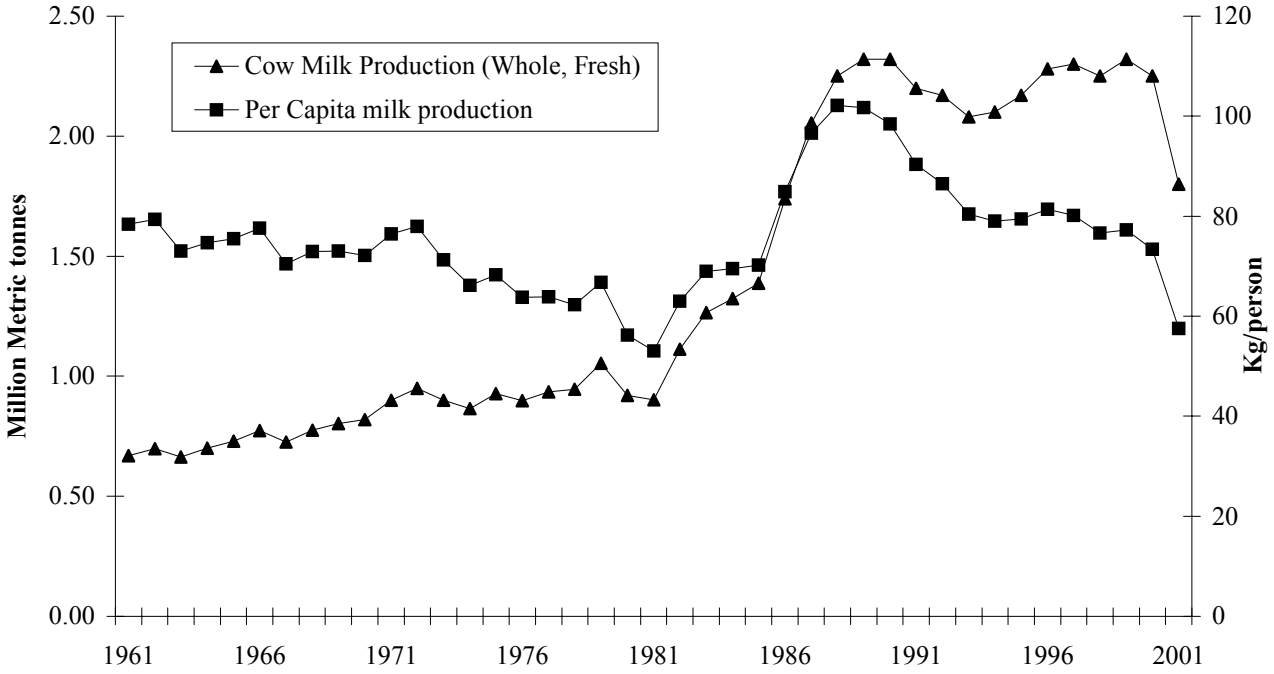
Notes: Percentage marketed flows are calculated on r
The percentage flows are based on
*** this only includes large to medium processors

PERFORMANCE OVER TIME

Aggregate performance.

Figure summarizes the trend in the country's milk production. Between 1961 and 1981, production grew at an average annual rate of 1.69 percent rising from 0.67 million metric tons in 1961 to 0.90 million metric tons in 1981. However, since human population grew at a higher annual rate of 4 per cent, the per capita milk production in the period declined at an average annual rate of 2 per cent from 78.35 Kg to 53.05. The most striking growth occurred in the next decade when production grew at an average annual growth rate of 10 percent to rise from about 0.90 metric tons in 1981 to about 2.20 metric tons in 1991. Over the same period, per capita production rose to 90.38. In the last decade, production has recorded mixed performance averaging a declining growth rate of 1.9 percent resulting in a decline in per capita production to 57.52 in 2001. However, a recent study by Staal et al. (2002) suggests that these official figures represent a gross underestimation of the country's production.

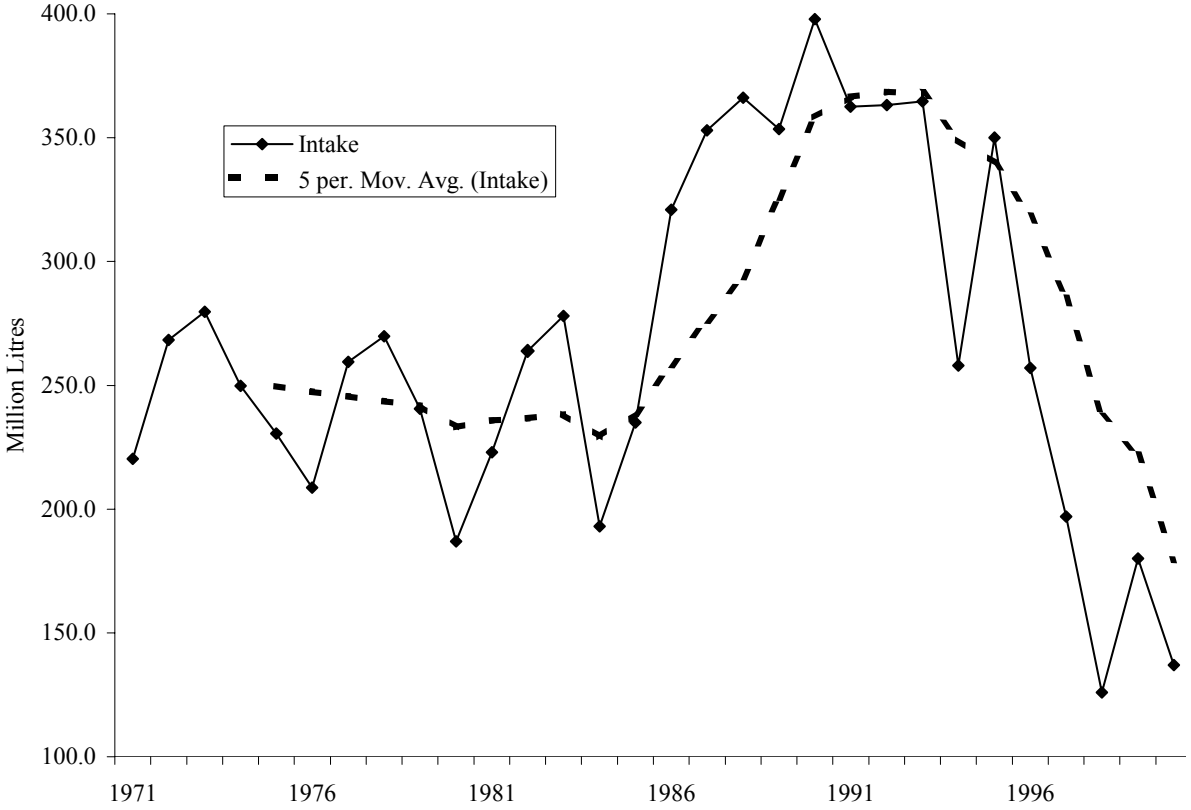
Figure 6--Trend in milk production



Sources: Author's compilation based on FAO stats

As already discussed, the KCC was the major milk-processing firm up to the mid 1990s. Therefore, the firm's milk intakes provide a good indication of the country's performance of milk processing activities up to the mid 1990s. Figure summarizes the trend of the firm's milk intakes for the period 1971 to year 2000. Analysis of the data shows that between 1971 and 1984, the firm's milk intakes decreased at an average annual rate of 0.19 percent.

Figure 7--Trend in KCC milk intake, 1971-2000



Source: Author's compilation based on Statistical Abstract, various issues
Notes: FAO climatic records suggest that Kenya experiences a drought every 5 to 7 years. Accordingly, and since as already discussed Kenya's dairy production is mainly base on rain-fed natural and planted pastures, milk intake data has been depersonalised using a 5-year moving average.

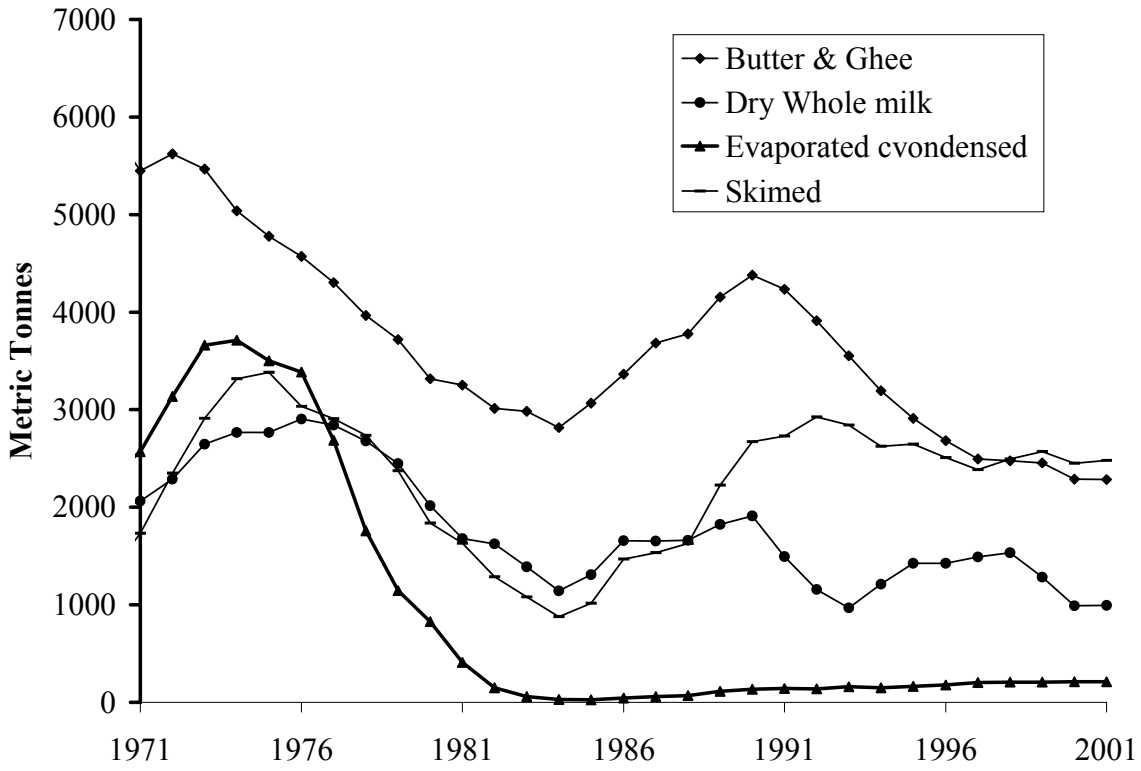
In the next decade, intake grew at an average annual rate of 4.45 to reach its peak in 1993. Since then, the firm's participation in the industry has been decreasing at an average annual rate of 10.30 percent and only amounted to about 137 million liters in the year 2000 (or about 0.37 million liters per day). During this time, the unused capacity has been idle.

There are indications that the market share lost by the KCC has almost been fully taken over by emerging private processors. Estimates from KDB's records show that in the year 2000,

the emerging dairy firms processed about 0.6 million liters per day. This, combined with KCC's production of about 0.37 million liters per day in that year, brings the country's average daily milk processed in the year to about 0.97 million liters per day. This compares well with the country's pre-liberalization processed milk production, which as has already been mentioned averages about 0.92 million liters per day. These figures suggest that, in absolute terms, there has not been much change in the country's level of processed milk production. Rather, what has happened is that KCC's installed capacity has continuously fallen idle just as that of other private entrepreneurs has increased.

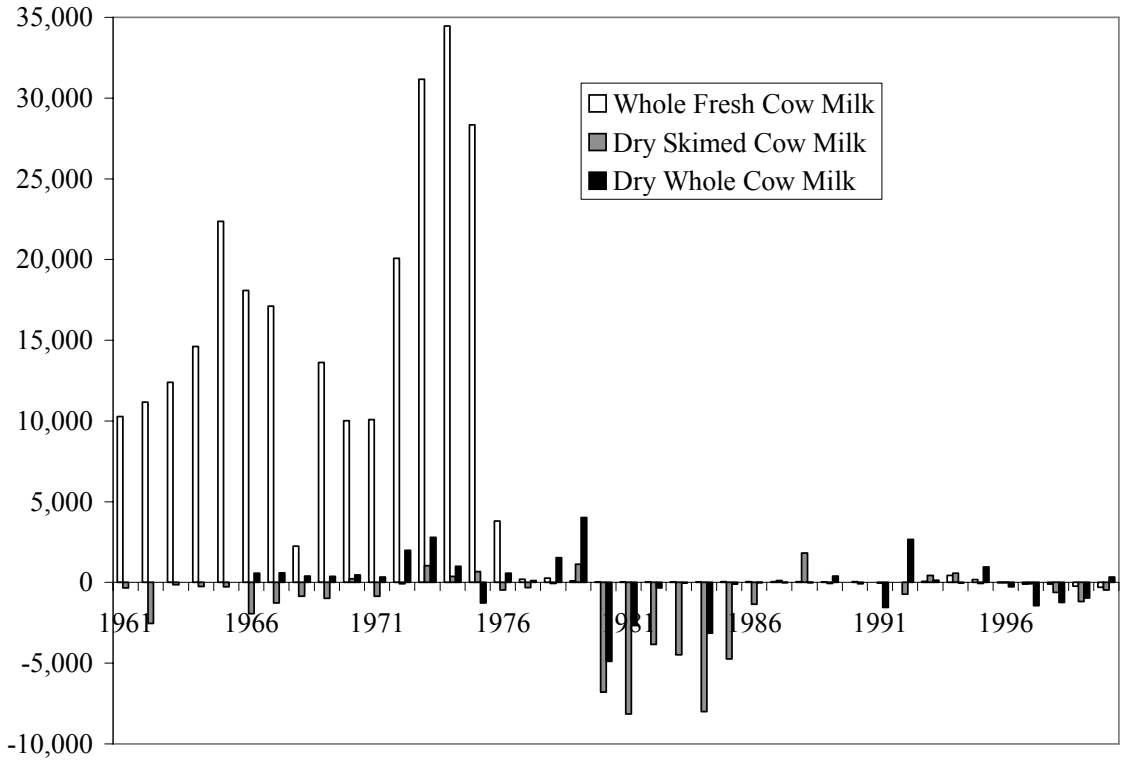
Figure 8 and Figure 9 show the trends in the country's processing of specific products and long-term trend of the country's dairy development. The figures show a close correlation between milk intakes (Figure) and production of the processed products. Figure suggests that the country has become a net importer.

Figure 8--Trend in KCC milk processing (5-year moving averages)



Source: Author's compilation based on FAOSTAT

Figure 9--Trend in net export for major dairy products



Source: Author's compilation based on FAOSTAT

Table 3--Long-term trend in Kenya dairy

	1980	*1990*	*2000*
Milk Production (10^6 Mt)			
Raw	0.73	1.92	1.91
Processed [a]	0.19	0.40	0.34***
Total [b]	0.92	2.32	2.25***
Per capita consumption (Kg) [c]			
Raw	44.8	81.5	62.3
Processed	11.4	16.9	11.1
Total	56.2	98.4	73.4
National herd [d]			
Total Cattle (million head)	10	13.8	13.8
% Grade and crosses	15.3	23.6	21.7
% Local	84.7	76.4	78.2
Productivity by Grazing system [e]			
%Stall feeding (zero grazing)		32	29
%Semi-zero grazing		29	28
%Open grazing		39	23

Source: [a] Author's compilation based on various issues of the Kenya Bureau of Statistics (KBS) Economic Survey and KDB records
[b] FAOSTAT
[c] Author's computation based on the milk production figures and national population statistics
[d] Various Animal Production Reports
[e] Staal et al. 2002
*** Corrected for the amount processed by private processors (The KBS has not adjusted its recording to include this amount)

IMPACTS OF LIBERALIZATION.

A major objective of the policy reforms implemented under the SAPs was to remove distortion caused by government intervention policies, and to consequently improve the efficiency of production and marketing. One method of assessing the extent of policy distortion is provided by PAM (Monke and Pearson 1989). The underlying principle of the PAM is the recognition that in an efficient system, resources are valued at their opportunity costs while the prices of consumer goods and services are determined by the willingness to pay. Price policy distortions, however, cause the observed market prices to differ from social accounting prices, or shadow prices. This in turn implies divergences between private and social profits. The PAM is used in assessing this divergence.

In the absence of distortions, private prices equal social prices and, therefore, the ratio of private to social prices, i.e., the nominal protection coefficient (NPC), is unity. A NPC greater than one indicates policy protection while an NPC less than one indicates policy taxation. Staal et al. (2002) results, using the method, show that contrary to the common belief that dairy farmers enjoyed a subsidy in the pre-liberalized industry, they were in effect taxed (Table 4). The effective taxation has however decreased with liberation from a NPC of 0.35 to 0.9. The greater impact has however been at the post-farm level where policy the effective policy has translated from a taxation to a protection with the NPC moving form o.59 to 1.79

Table 4--Comparative analysis of the effects of liberalization on Kenya's dairy industry

		Post-Liberalisation 1992-2000		Pre-Liberalisation 1985-1991	
Variable	Units	Farm level	Post-Farm level	Farm level	Post-Farm level
Private Price	$/1000 l	48	216	15	61
Social Prices	$/1000 l	70	25	87	132
Effect of divergence	$/1000 l	-22	190	-72	-71
Nominal Protection Coefficient		0.9	1.79	0.35	0.59

Source: Adapted from S.staal et al. (2002)

CHARACTERISTICS OF SMALLHOLDER DAIRY FARMERS.

Milk production by smallholders has expanded substantially and now constitutes the major source of marketed milk. By 1975, smallholder dairy production accounted for only 35 percent of recorded milk sales (Minae 1981). Since then, large-scale dairying has been increasing surpassed in importance by smallholder primary dairy production which has climbed to 80 percent of national milk production and 75 percent of marketed milk. Lekasi et al. (1998) have shown that smallholder dairying is an inevitable result of tendencies to maximize land use, with cattle making significant contribution to nutrient cycling (. It is estimated that over 80 percent of the country's dairy cattle population is reared on mixed crop-livestock farms (Gitau et

al. 1994; ROK 1995). Dairy farming forms part of a complex animal-crop interaction in the smallholder systems with strong internal interdependencies between crop and dairy enterprise. Draft power and manure from the livestock benefits plant production while crop by-products such maize stover, peelings of various crops, stubble left on the farm after harvesting are important sources of animal feed. Moreover, the sale milk provides the farmer with a more regular supply of cash. Under the system, animals and crops reinforce each other in a way that increases or helps sustain farm productivity.

To bring out a picture of the current smallholder dairy farming system in the country, we will use two household survey data sets one conducted by the Smallholder Dairy Project (SDP), a collaborative effort between the International Livestock Research Institute (ILRI), the Ministry of Agriculture, and Livestock Development (MoALD), and the Kenya Research institute (KARI). The other was conducted TAMPA, a policy research collaborative effort between Tegemeo Institute of Egerton University, Kenya and Michigan State University. Both studies used self-weighting stratified random sampling. In TAMPA's case, over 1400 smallholder farmers have been involved in a survey consists of a series of annual interviews, with each sample household, beginning in 1997. This analysis, however, uses data from the 1999 and 2000 surveys. In ILRI's case, a cross-section survey covering over 1300 representative smallholder households was followed by a longitudinal survey covering 43 representative smallholder dairy farm-households in three districts. Whole farm activities of the 43 households were monitored for a 13 months period, with a recall period of 2 to 3 days. In both cases, the questionnaires were designed to paint a complete picture of each household's whole farm activities. Each incorporated an account of the households purchase and use of farm inputs, harvest and allocation of farm outputs between home consumption and the market, dairy herd dynamics,

demographic and allocation of family labor as well as information on hired labor, and households incomes (both farm and off-farm).

As depicted in Table 5, results from the two surveys show that a large proportion of the sample households were involved in dairy farming. This suggests that, for a large proportion of rural farm-households in the country's high and medium potential areas, dairying is an important component of smallholder farm activities. It also reinforces the importance of dairying as an integral component of smallholder farming system.

Table 5--Proportion of sample households engaged in dairying

	SDP		*TAMPA*	
	No	% Of total	No.	% Of total
Total farm households in sample	1382	100	1482	100
Number operating a dairy enterprise	1036	74.96	1081	72.94

Demographic and Socio-Economic Characteristic of Smallholder farmers

Demographic and socio-economic characteristics of the sample dairy households are shown in Table 6.

Table 6--Selected household characteristics [mean and (standard error)]

Variable	
Land size (in hectare)*	2.61(4.6)
Number of years since farm was established*	22.28 (11.64)
Household size and structure ***	
Children below 8 yrs	1.23 (1.56)
Children 8-14 yrs	1.17 (1.33)
Members 15-21 yrs	1.08 (1.46)
Members 22-65 yrs	2.41(1.64)
Members >65 yrs	0.26 (0.58)
Total	6.15(3.28)
Age of head of household**	50.60 (14.10)
Average years of schooling completed by the head of household**	7.89(4.07)
Year of experience in dairy production**	17.87(12.63)
Proportion of households headed by women**	25%
*Size and structure of dairy herd (head)**	
Bulls	0.23(0.67)
Cows	1.86(2.82)
Heifers	0.96(1.75)
Male calves	0.22(0.66)
Heifer calves	0.30(0.75)
Total	3.58(4.96)
Milk harvest lts/day*	8.83 (5.30)
Milk consumption lts/day*	1.84 (1.30)
Milk marketed lts/day*	6.61 (3.60)
Average Livestock holding (head) ***	
Goats	1.14(5.22)
Sheep	1.64 (5.16
Donkey	0.12(0.6)
Poultry	5.09(8.05)
Pig	0.25(3.05)
*Main herd type by proportion of household****	
Exclusively grade cattle	19.04
Exclusively cross breeds	38.28
Exclusively local	38.09
Mixed herd	4.59
*Age at first curving (in number of months)**	
Friesian	31.4
Ayrshire	31.2
Sahiwal	43.2
Jersey	29.9
Guernsey	32.4
Boran	37.4
Zebu	43.9

Source: ** Egerton/Tegemeo/MSU Rural Household Survey 2000 * SDP survey data

On Average, the households comprised a family of six members. About 25 percent of the total households were headed by women. The mean age of the head of the household was 50 year. On average, the farmers had been farming for 22 year, implying that the majority started farming in their late twenties. Farmers' experience in dairy farming averaged 17 years, implying that most started dairying 5 year after engaging in agriculture. This lag may be explained by the fact the farmer has to raise capital either through farming or through off-farm activities to start a dairy enterprise. Education level averaged 8 years, implying that the majority of the farmers had a primary level education, which in Kenya takes 8 years.

The average size of land holding per household was 2.61 hectares. Private ownership was the major right to land with about 80 percent of the sample households reporting that they held private ownership to at least one of the plots they farmed. On average, the households had 3 heads of cattle. The dairy heads mainly comprised crossbreeds and indigenous breeds. The result shows that the proportion of households rearing exclusively cross breed cattle and that rearing exclusively local breeds was distributed fairly equally. Households rearing exclusively pure exotic breed were proportionately low (20 percent). This suggests that there is a considerable scope for use of AI services to replace local breeds with high yielding breeds and thus facilitate more farmers to raise their milk output. On average, the households produced 9 liter of milk daily of which about 2 liter were consumed by the household while about 7 were sold. In addition, the household had on average a goat, 2 sheep, and a flock of 5 poultry.

Household Labor Allocation

It is evident from Table 6 that smallholder farm labor consists of many diversified tasks and a lack of a clear pattern of division of labor; each worker performs multiple tasks. The results suggest that the family is the principal source of farm labor contributing over 77 percent

of total farm labor. The results further suggest that the tasks are allocated among different labor categories in different proportions with some degree of specialization in certain tasks. In particular, the analysis suggests that the proportion of total labor accounted for by women was relatively high in planting, weeding, harvesting, and drawing water while the proportion accounted for by men was higher in milking, spraying (with acaricides) and feeding the animal. Children contributed substantial labor in sale of milk. Casual labor is mainly hired to ease seasonal labor demands for land preparation, planting, weeding and harvesting. Long-term labor is employed for more-regular tasks including herding, milking, and delivery of milk to bulking/sales centers. Table 7, however, suggest that overall women contribute proportionately more farm labor than men.

Table 7--Farm labor allocation

	Family labor			*Hired labor*		*Family as a % of total*
Variable	Female	Male	Child	Permanent	Casual	
Land preparation	30.61	30.92	4.22	20.07	14.17	65.75
Planting	48.16	18.32	8.83	14.35	10.34	75.30
Weeding	40.75	18.24	6.37	16.10	18.54	65.35
Manuring	37.23	25.98	7.74	14.78	14.25	70.96
Fertilizing (inorganic)	63.48	20.68	2.31	3.35	5.19	91.46
Collecting "cut & Carry" fodder/grass/stover	30.79	36.54	6.84	22.72	3.09	74.18
Harvesting + transporting/heaping	58.06	11.77	15.64	5.54	8.98	85.46
Milking	26.19	49.82	3.08	20.84	0.08	79.90
Processing	41.79	2.98	52.99	1.49	0.74	97.76
Animal feeding	30.46	43.19	5.85	19.94	0.55	79.50
Herding/grazing	18.19	27.49	25.90	22.96	5.47	71.59
Barn cleaning	8.43	52.50	8.97	28.45	1.65	69.90
Spraying	12.78	60.26	4.98	19.53	2.45	78.02
Purchase of agricultural inputs	24.00	63.73	5.66	5.97	0.63	93.40
Selling/transporting milk/dairy products	11.93	37.98	21.62	26.50	1.97	71.52
Sale of manure	0.00	37.50	25.00	12.56	25.00	62.56
Purchase of feed	15.56	62.53	9.02	11.60	1.28	87.11
Drawing water	45.30	28.51	18.55	6.39	1.23	92.38
Others	34.48	25.52	6.08	11.76	22.16	66.08

[a] Adult male equivalent is used as a reflection of cost of labor. The survey revealed women were paid 0.8% of male wage rate, children were paid 50

Source: SDP survey data

Table 8--Share in farm labour

Female	*22%*
Male	31%
Children	9%
Casual labour	14%
Long-term labour	22%

Source: SDP survey data

Spatial Variation in herd size and composition

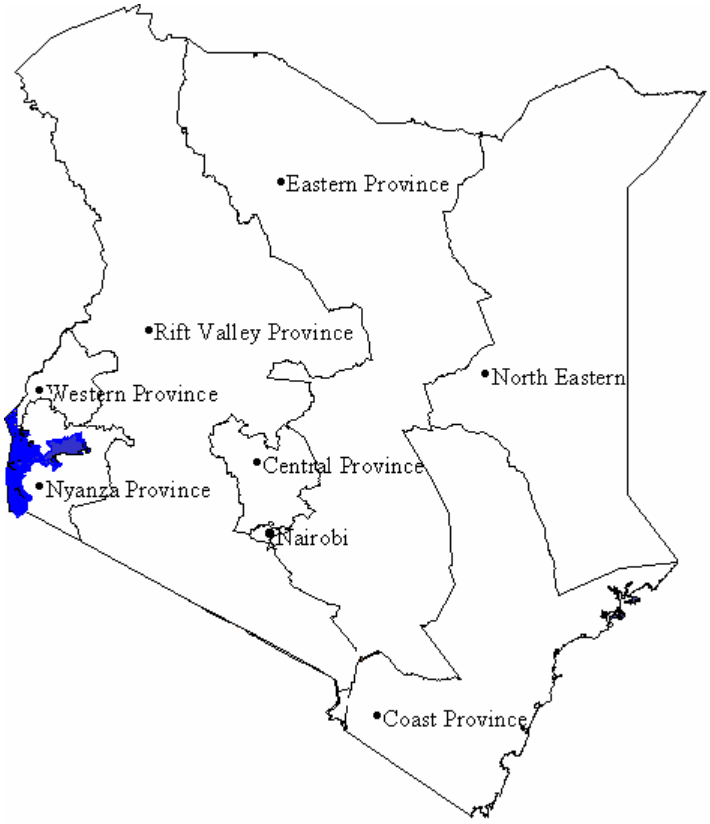
Table 9 gives an indication of regional variation in size and composition of dairy herds. Analysis of the cow composition suggest that the milking herds in North-rift mainly comprise of cross cows, averaging about half the cow herd size of about 2.84 cows. Those in the Western region mainly comprise local cow, averaging about two-thirds the cow herd size of about 3.03 cows. Those in Eastern/Central/Coast region are fairly balanced among grade, cross and local cows.

Table 9--Size and composition of dairy herds, by region

Variable	*East/Central/Coast*	*North-Rift*	*Western*	*All*
Grade Cow	0.48 (0.94)	0.52 (1.66)	0.09 (0.48)	0.36 (1.16)
Cross Cow	0.33 (0.69)	1.47 (2.48)	0.40 (1.42)	0.75 (1.80)
Local Cow	0.40 (1.83)	0.85 (3.61)	1.03 (1.42)	0.77 (2.57)
Grade-bull	0.04 (0.36)	0.04 (0.21)	0.01 (0.10)	0.03 (0.24)
Cross-bull	0.03 (0.18)	0.16 (0.52)	0.11 (0.66)	0.10 (0.51)
Local-bull	0.23 (1.140	0.50 (4.61)	0.53 (1.26)	0.43 (2.87)
Grade-calve	0.23 (0.63)	0.34 (1.27)	0.04 (0.29)	0.20 (0.85)
Cross-calve	0.21 (0.53)	0.91 (2.35)	0.27 (1.07)	0.47 (1.57)
Local-calves	0.20 (0.93)	0.50 (2.06)	0.55 (1.08)	0.42 (1.47)
Average herd-size (head)	**2.16 (3.71)**	**5.31 (9.53)**	**3.03 (4.18)**	**3.54 (6.57)**

Source: ** Egerton/Tegemeo/MSU Rural Household Survey 2000 * SDP survey data

Figure 10--Map of Kenya showing the Administrative Provinces



Income Levels, Size and composition

The results presented in Table 10 show that about a half of the smallholder farm households had an annual income of less than Ksh 75,000 (≈ US$ 950). For 22 percent of the farm households, dairy ranked the highest in terms of income earning, while earnings from non-dairy agriculture ranked highest for 24 percent of the households. The proportions of households earning the highest incomes from formal and informal employment were distributed equally at 30 percent.

Table 10--distribution of households by level of annual income (total from all sources)

Household income categories	*Percentage of total household in the income category*
≤25, 000	19.90
25,001 - 50,000	18.92
50,001 - 75,000	12.35
75,001 - 100,000	14.12
100,001 - 125,000	8.63
125,001- 150,000	5.59
>150,000	20.49

Source: Egerton/Tegemeo/MSU Rural Household Survey 2000

The average income by source for the sample households is given in Table 11 farm income is computed as the net income after deducting variable costs. Cash and non-cash incomes are considered. Change in the value of livestock was also taken into account. The table underscores the important role played by agricultural production in generating incomes for smallholder farmers. The table as well clearly demonstrates the relative importance of dairy production in total smallholder income, but the relative importance varies with region (table 10).

Table 11--Composition of income by source

Source	*Share in household as a pe centage of total*
Crop	37.62
Dairy	33.41
Other livestock	10.90
Off-farm	18.06

Source: Egerton/Tegemeo/MSU Rural Household Survey 2000

Table 12--Value of dairy production as a percentage of total household income, by region

Region	*Mean*
East/Central/Coast	33.13
North-Rift	25.00
Western	24.90
All	31.28

Table 13 suggests that dairying is merely a supplement to income for half the population of dairy households but a significant enterprise for the other half. For about 45 percent of the

farmers, dairying comprise only up to 20 percent of household incomes. However, for about 28 percent of the farmers, dairying contributes more than a half of household's income. For another 26 percent dairying comprise between 20-50 percent of household income

Table 13--Distribution of farm households by relative importance of dairy enterprise

Value of dairy as a percentage of total household income	*Percentage number of household*
≤ 0	20.78
0.01- 10.00	12.16
10.01- 20.00	12.94
20.01 – 30.00	10.98
30.01 - 40.00	8.53
40.01 – 50.00	6.86
50.01 – 60.00	6.08
60.01 – 70.00	5.20
70.01 – 8.0.00	3.43
More	13.04

Source: Egerton/Tegemeo/MSU Rural Household Survey 2000

As shown in Table 14 both the relative economic importance dairying in terms of contribution to household income and in terms of share of value of milk and non-milk cash incomes varies across income groups. For high-income households, dairy cash incomes are more likely to accrue from milk sales. Conversely, for low-income households, dairy cash-income is more likely to accrue from sales of animals. This suggests that low-income households keep dairy animal either as a source of consumption smoothing or as a form of security against lumpy cash needs.

Table 14--Relative importance of dairying by income category

Income category	Value of dairy as a percentage of total household income	Value of milk sales as a percentage of total household dairy cash income
1st quintile	47.5	31.9
2nd quintile	27.9	43.7
3rd quintile	28.5	55.8
4th quintile	35.9	59.0
5th quintile	27.9	70.6

Source: Egerton/Tegemeo/MSU Rural Household Survey 2000

Feed Management Regimes and Aspects

Smallholder dairy is operated under different feeding regimes of varying labor and land intensification. The survey distinguished three types: free grazing, semi zero grazing and zero grazing. Table 15 shows that the proportion of households using zero and semi-zero grazing was distributed fairly equally. Proportionately fewer farmers (25 percent) used free grazing system. Zero grazing releases land for production of crops. Furthermore, since the animals are constrained in a comparatively small area, relatively more manure is collected. It also improves the carrying capacity of the land. It has therefore been promoted in high potential areas where human population is high and land holding small.

Table 15--Main Dairy Production System by Proportion of Household

Feed Management System	Proportion as percentage of
Free grazing	25%
Semi-zero	38%
Zero	37%

Source: Author's computation from SDP survey data

As is to be expected, the choice among the three systems was strongly influenced by market access. As already discussed, intensive dairy production systems has, since the early 1980s, been promoted in high potential areas as a package aimed at enhancing smallholder

farm's dairy cattle carrying capacity as well as smallholder's capacity to realize dairy cattle production potential by use of high-yielding fodder. The system is both labor and capital-intensive as compared to free grazing, and therefore only where there is an ensured market will the farmer take the extra risk of investing heavily in the higher milk production. A multinomial model to assess the factors influencing the choice of feed-management system (Table 15) suggests that, all other things being equal, the probability of using zero- and semi-zero grazing system as compared to free grazing decreases significantly the farther away the farm is from urban area. The probability also significantly decreases the farther away the farm is from a milk collection point. Apart from market access, the relationship between proximity to urban areas and the choice of milk production technology may be explained by land value since it is expected that the opportunity cost of land increase with proximity to urban areas.

Table 16--Factors influencing the choice of dairy feed management

Variable	*Coef.*	*Std. Err.*	*z*	*P>|z*
Zero-grazing Feed Management System				
Size of land holding	-0.02	0.02	-1.08	0.28
Travel distance (in tens of Km) to Nairobi	-0.04	0.02	-1.71	0.09
Travel distance (in KM) to urban* market	-0.01	0.01	-1.77	0.08
Travel distance (in Km) to the nearest milk collection center	-0.04	0.01	-4.22	0.00
Head size (head)	-0.16	0.09	-1.76	0.08
Breed (1 if grade or cross, 0 if local)	1.31	0.24	5.49	0.00
Age of head of household	0.01	0.01	1.15	0.25
Sex of head of household (1 if male; 0 if female)	-0.16	0.27	-0.58	0.56
Number of years of school completed by head of household	0.05	0.03	1.42	0.15
Constant	0.80	0.84	0.95	0.34
Semi-zero Grazing Feed Management System				
Size of land holding	-0.25	0.06	-4.31	0.00
Travel distance (in tens of Km) to Nairobi	-0.22	0.03	-7.01	0.00
Travel distance (in KM) to urban* market	-0.04	0.01	-3.73	0.00
Travel distance (in Km) to the nearest milk collection center	-0.02	0.01	-1.97	0.05
Head size (head)	-0.46	0.14	-3.22	0.00
Breed (1 if grade or cross, 0 if local)	1.55	0.28	5.59	0.00
Age of head of household	0.02	0.01	1.54	0.12
Sex of head of household (1 if male; 0 if female)	-0.03	0.30	-0.09	0.93
Number of years of school completed by head of household	0.10	0.04	2.52	0.01
Constant	3.26	1.00	3.27	0.00

Notes: n=661 smallholder dairy farm households, Outcome free grazing is the comparison category, LR chi2=331.42, prob>chi2=0.00, Log likelihood=-551.09, Pseudo R^2 =0.23
Source: Author's computation from SDP data

COST AND RETURNS OF DAIRY PRODUCTION

Because of the strong internal interdependencies between crop and dairy enterprise coupled with social values attached to cattle, it is difficult to quantify all the costs and benefits associated with milk production. Therefore, what is presented here is only indicative and comprise of assessment of easily quantifiable costs and benefits. The analysis is based on data collected in the longitudinal survey consisting 43 representative smallholder dairy farm-households, 21 in Kiambu district and 22 in Nyandarua and Nakuru districts. Although complete data sets for the other dairy production areas were not available, the choice of the two districts conforms to the criteria for choice of feed management regime as evaluated in Table 16.

Kiambu district borders the city of Nairobi and thus has a relatively better market access. However, household's farm holdings in the district are relatively smaller with very limited access to communal grazing lands as compared to the other two districts. Production the district is predominantly by zero-grazing system while open grazing predominates in the other two districts. Table 17 presents the differentials between production systems in the two areas.

Table 17--Characteristics of dairy production, by feed management regime

	Kiambu	*Nyandarua/Nakuru*
Predominant feed management regime	Zero-grazing with limited or no access to communal grazing	Open grazing with access to communal grazing land
Average land holding*	1.2 (1.1)	3.6(5.6)
Average milking herd per dairy household (head)	1.47	2.60
Annual herd milk production (liters)	3256	4247

Studies have clearly established that both milk yields per cow and the cost of production per liter differ by the feed management regime (Sellen D et al. 1990) due to the differentials in input use. In areas where households have relatively larger land holdings coupled with access to communal land, milking herds are larger. Nevertheless, substitutability between land and capital mean that households with relatively smaller land holdings and limited access to grazing land can substitute capital for land to produce as much or even higher milk. However, as shown in Table 18, such substitution often raises the per-unit cost of milk. The substitution is therefore, only justifiable if the associated productivity or differential in milk market prices, or the combination of the two is large enough to offset the cost increases. Therefore, the choice among the regime is dependent on the opportunity cost of land and market prices of milk.

For the analysis, labor was valued at the prevailing average casual-workers' hiring rate, regardless of whether it is family or hired. This was based on the argument that the allocation of family labor to dairy production reduces the amount of family labor available to other farm

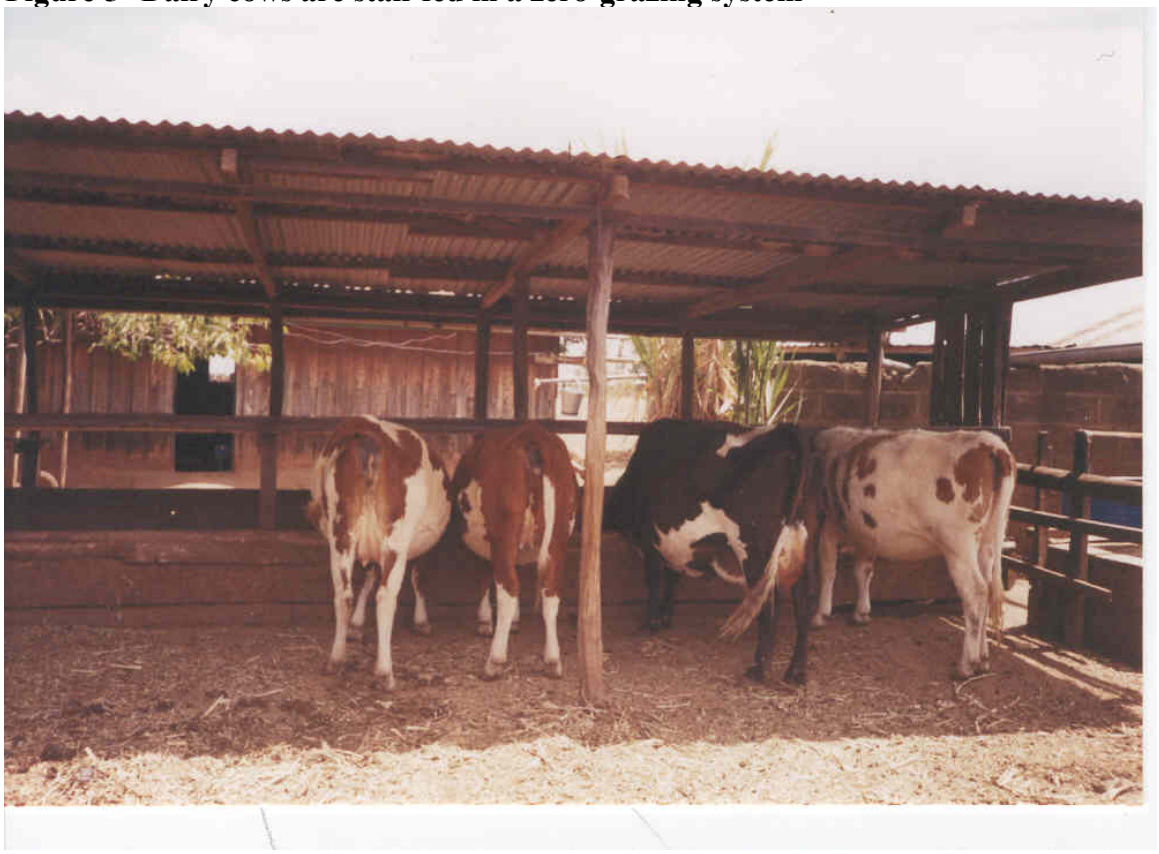
enterprises. This in turn imposes an opportunity cost to the family labor, which can be estimated by the amount of money the labor would earn if it were hired out to other farmers in the same production area. Table 18 shows that the cost of production per liter (see Annex 2 and Annex 3 for detailed budgets) is much higher for the zero grazing system. However, the cost differential is more than offset by higher price milk market prices and the associated increase in productivity.

Table 18--Average milk production cost per cow, by feed management regime (in 1999)

	Kiambu	*Nyandarua/Nakuru*
	Zero-grazing system	*Open grazing system*
Annual average yield per cow (liters)	2214.97	1633.46
Average farm-gate price per liter	17.75	13.11
Milk sales (Ksh)	32614.2	16379.13
Home consumption (Ksh)	11483.2	5037.67
Sale of animals	3842.68	3305.6
Gross revenue	**47940.26**	**24721.97**
Labor	15969.52	3203.58
Intermediate cost	13357.14	5587.69
Total Cost	**29326.66**	**8791.27**
Gross Margin	18613.6	15930.7

Notes: ** Excludes cost of land

Figure 5--Dairy cows are stall-fed in a zero-grazing system



Note: Stall-feeding optimizes on manure collection which in turn promote crop intensification.

FARM-LEVEL CASE STUDIES

Case 1: Retiree turns to commercial dairy production

Mr. Wainaina retired from salaried employment in 1982 and used his benefits to buy a three acres piece of land on which he started rain-fed horticulture mainly producing tomatoes, onion and French beans. In 1983, he bought a dairy cow from the proceeds of the horticultural enterprise. By 1991, his dairy herd had expanded to four cows but he had to gradually sell all to pay his children's school fees. In 1994, he received an in-calf heifer at a subsidized price of Ksh 2800 credit from the Farming Systems Project, a church-based NGO with major objectives of helping poor households in high and medium areas of the country to start dairy enterprises. The

organization operates a scheme that lends a "starter" in-calf heifer to an identified household. But first, the organization offers training in dairy management to the identified households in a bid to enhance their capacities to manage a dairy enterprise. On top of the subsidized monetary price, recipient households repay in-kind through the first in-calf heifer, which the organization lends on to another farmer.

By the time of this interview the cow, a Jersey breed, had calved eight time getting twins twice. The offspring have been Jersey-Friesian crosses. The farmer has maintained his herd at two milking cows. The farmer also serves as a milk-bulking commission agent for a milk trader. The task's basic function is to facilitate the principle trader to secure milk more efficiently. This entails assembling milk from neighboring farms to a maximum amount of the quantity required by the principle trader, screening each individual's milk for adulteration and making entries in the individuals' milk record card keeping records of each suppliers accepted deliveries; and transmitting payments to the suppliers. As an effective way of doing this, Mr. Wainaina has designated his farm a milk bulking point.

In addition to milk production, Mr. Wainaina grows horticultural crops, mainly tomatoes, onions, French beans, sweet corn, kale, and oranges, under rain-fed conditions. He rates his dairy enterprise highest in term of income earnings.

Case 2: Farmer finds a "tree that bears fruits every day" in milk

Mr. Ruto, 70 years old, started his adult life working as a tractor driver on a white settler farm in Central Province. In 1968, he registered with a Land-Buying Company, which bought off a white settler's farm in Nakuru, Rift Valley Province. The land was shared off to the shareholders in 1979 in according to each member's share contribution; Mr. Ruto received an eight acres piece. On top of the land share, the shareholders received dairy cow each from the

farm's dairy herd. In addition to the one cow, Mr. Ruto had also paid for cows from the farm's herd. Therefore, at the time the land was shared out, he already owned four dairy cows. The four cows, all Friesian-Sahiwal crosses, comprised Mr. Ruto's foundational herd. Mr. Ruto maintained his herd at four cows through sales to pay for his children's school fees. In 1984, he allowed the herd to grow to six cows. In 1986, he gave two cows as dowry for his son's wife.

He sold his milk to the KCC up to 1997 when he sought other market outlets and settled hotels and restaurant in a shopping centre 2 Km away from his farm. In the last three years, he has been in an informal sales agreement with one of the hotels. He sells all his morning milk output and retains evening milk for his family consumption. His only regret about the liberalized market is that it has meant diminished opportunities for monthly contracts. As it is now, he sells his milk on a cash-on-spot basis.

In addition to milk production, Mr. Ruto grows food crops mainly maize, beans, and millet for his family consumption and sales. However, he rates his dairy enterprise highest in term of income earnings. He describes dairy as a "tree that bears fruits every day" unlike maize where the family has to wait for six month before harvest. Last season he only harvested 15 bags (i.e., 1.35 tonnes) of maize from a 2-acre maize-bean intercrop. At the time of the interview, the farm-gate price of maize stood at Ksh 450 per bag. The gross value of his entire maize harvest was therefore stood at Ksh 6,570. In comparison, he explained that his milk output averaged at 20 kg per day. Therefore, at the price of Ksh 19.60 per kg, his dairy milk value stood at Ksh 392 per day or 143,080 per year.

His dairy rank is well reflected in his land use. Currently he reserves 6 acre for the dairy enterprise 4 of which is planted with Rhode grass and 2 with napier and fodder sorghum. In addition, he has planted leguminous trees along the farm line dividing the different farm patch.

He explained that the leguminous trees were promoted by an agro-forestry project implanted by Kenya Forestry Research Institute (KEFRI) in collaboration with (JICA).

Case 3: Farmer finds a source of livelihood in milk

Mr. Wanyoike, 70 started his adult life working as a houseboy for a white settler farmer in Rift Valley Province. As soon as the indigenous people were allowed to grow tea, in the late 1950s, he left the employment to return to his ancestral land in Kiambu to establish a tea crop on a section of his parent's land. In the early 1960s, he took a loan from the Agricultural Finance Corporation (AFC) to establish a dairy enterprise. In 1985, he bought a 10-acre farm in Nakuru from the proceeds of the dairy enterprise, and moved his family from his parent's land. With time, he has bought more land and now owns a total of 20 acres. He is a member of *Jirani Mwema* (literally "good neighbors") Farmers' self-help Group, which coordinates the collection of members' milk for transportation to a processing plant 50 km away. He also sells some milk to milk-deficit household in his neighborhood. The self-help group is only 3 years old. Before then, he was a member of a dairy farmers' co-operative.

In addition to milk production, Mr. Wanyoike's other cash enterprises are a plot of 150 rain-fed orange trees and a one acre rain-fed tomato plot. He rates his dairy enterprise highest in term of income earnings. His orange enterprise comes second. He explains that rain-fed tomato growing does not offer a reliable source of incomes. Currently he has reserved 14.5 acres of his land to fodder crops, which includes 1.5 acre of Napier and 13 acres of Rhode grass.

2. DAIRY DEVELOPMENT IN UGANDA

Uganda is noted for its soil fertility and a favorable climate endowing it with one of the best potentials for agricultural production. It has a land area of about 24 million hectares of

which about 16.8 million hectares is good cultivable land. Of the total cultivable land, only about 40 percent (about 6.7 million hectare) is currently being utilized (MPED 1996). The country's human population is estimated at 6.3 million. Agriculture is the dominant sector of the economy. It contributes about 42 percent of the country's gross domestic product (GDP), account for over 80 percent of all employment and provides basic livelihood to over 85 percent of the country's population (Okwenye 1994). Livestock production forms a substantial proportion of the country's Agricultural Gross Domestic Production economic role accounting for about 30 percent of agriculture's gross domestic production (AGDP).

That it has an exceptionally favorable agro-ecological environment for dairy production has been a well-recognized fact since the publishing of the findings of a livestock survey conducted in East Africa by FAO in 1967. Yet, despite sharing a common colonial experience with Kenya, commercial milk production was not introduced in Uganda until the late 1950s. The explanation for this difference probably lies in the differentials between the successes of settler agriculture between the two countries. While in Kenya white-settle agriculture was the main feature of commercial agriculture before the mid-1950s, this was not the case in Uganda. As Mamdani (1976) and Southall (1988) have explained, in the case of Uganda white-settler agriculture did not recover appreciably from the adverse conditions of World War 1; instead, primary production was left to the indigenous people while the European and Asians concentrated more on secondary production. Yet, it was during this period that settler farmers in neighboring Kenya were experimenting with primary commercial Dairy production. Experimentation with high-yielding exotic and crossbred cattle did not happen in Uganda until 1928 (Amann 1973)—but these initial efforts soon had to be abandoned when the entire experimental herd was wiped out by diseases.

Explanations for the quick abandonment of the attempts probably go beyond the frustrations by the diseases. In any case, attempts in neighboring Kenya in the early 1910 had faced similar problems but persisted in the struggle leading to appreciable successes by the 1930s. Moreover, Uganda, starting later should have benefited from the Kenyan experience avoiding any mistakes made there and should thus have faired better. A more credible explanation probably lies in the economic circumstances prevailing at the time. The timing of these early attempts to introduce commercial dairying in Uganda was inadvertently ill timed. The attempts came head-on with the collapse of international commodity prices of the great depression. Settler dairy farmers in neighboring Kenya, where dairy production had by then made appreciable success, were forced to rely on an extremely limited domestic market. There was therefore not much incentive for their counterparts in Uganda to continue with their efforts

Further attempts to develop commercial dairying in Uganda were not made until the late 1950s. The beginnings and progress of these latter attempts are detailed in Nsubuga (1973) and (Amann 1973). What is presented here is a summary of the salient points. Obstacles similar to those faced in the introduction of dairying in Kenya in the early 1910s had to be overcome. These included dealing with the challenges posed by tick-borne diseases and the need to build a dairy herd with high milk production traits. Fortunately, major advances in these two areas had been made by then. Furthermore, high-yielding breeds could be imported across the border from Kenya where dairy industry development had by then achieved an appreciable level. Experiences with the introduction of exotic and crossbred cattle in Kenya suggested that tick-control was the starting point. Accordingly, prospective commercial dairy farmers were advised that in order to prepare their farms for introduction of exotic and crossbred cattle, they needed to create a less vulnerable environment for the survival of the breeds. To achieve this, they were

instructed to use indigenous cattle as tick-bait with an intense six-month tick control-regime using acaricides. This practice proved quite successful and the technological constraint was well in the way of being overcome.

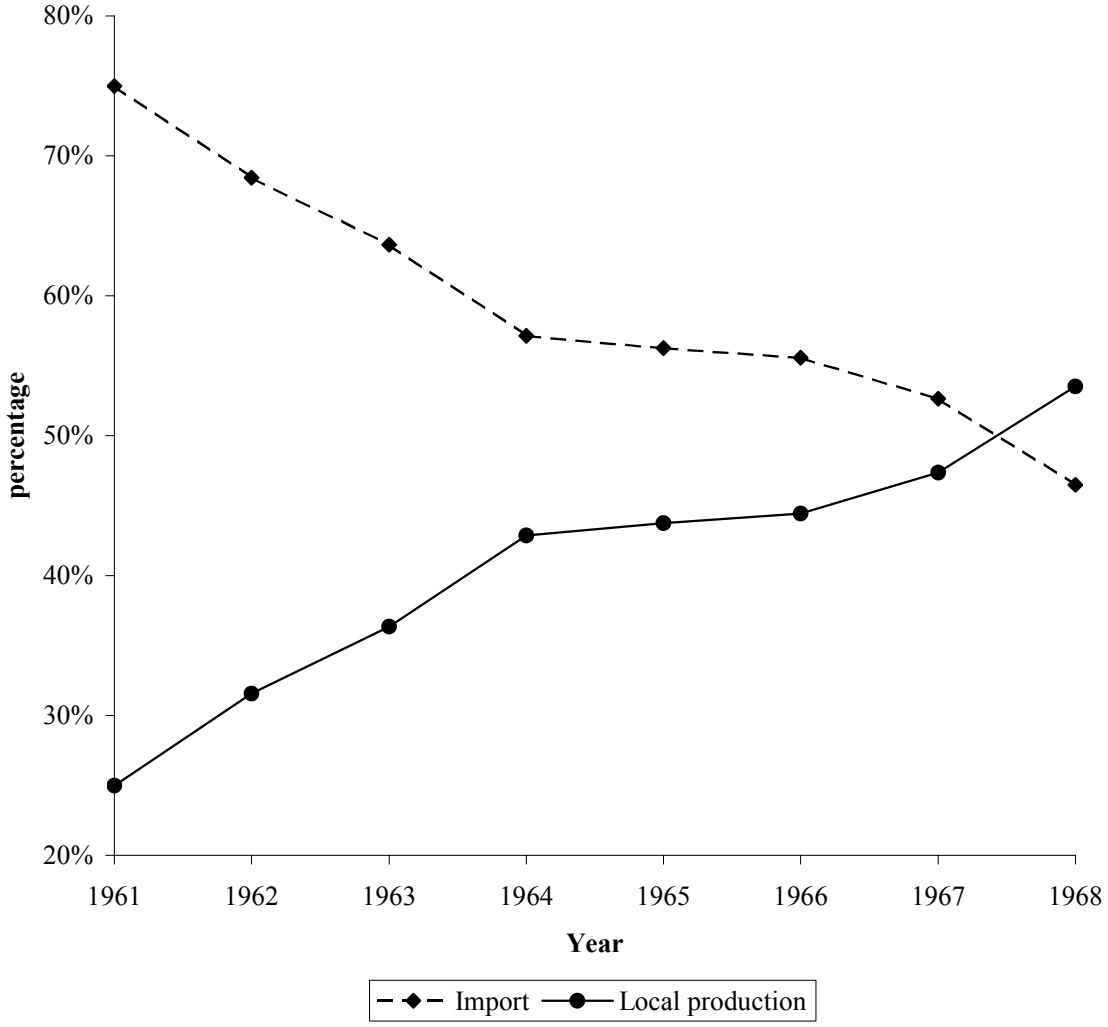
Success with introduction of the breeds on the farms was followed by a growing recognition that dairy presented a promising opportunity to diversify the country's agriculture. Furthermore, increase in domestic production could lead to reduction of milk imports from Kenya with valuable savings in foreign exchange. As a result, the government started in the 1960s, to pursue a policy of attaining self-sufficiency in milk. Farmers in high potential areas were encouraged to integrate dairy into crop production to benefit from the valuable complementarities especially from sustenance of soil fertility by cattle manure. A two-part strategy was taken to expand production: expanding the herd of high-yielding cattle and enhancing dairy farmers' ability to realize the breeds' potentials. Efforts to expand the high-yielding herd included: (i) importation of the high-yielding breed mainly from Kenya and latter when supply from Kenya could not meet demand, from U.K., Netherlands, U.S.A, Denmark, and Canada; and (ii) crossing to build diseases resistance. To realize the potential of exotic and crossbred cattle smallholder farmers required to adopt new management practices.

The efforts proved quite fruitful. National milk production increased at an average annual rate of 0.3 from 208,950 metric tons in 1961 to 212 metric in 1968 (FAOSTAT). Local production soon began to meet a significant proportion of the country's major consumption markets. Figure 8 depicts the change in the share of domestic production in the supply to Kampala city and its environs. The figure shows that imports fell steadily and by 1967, Uganda had made major reduction in milk imports —milk imports from Kenya were on a steady declined from 1961 when imports supplied 75 percent of the total milk consumed in the country's major

consumption market. With this growing success in local milk production, the government shifted its focus to the operations of milk marketing. The country already had an organized milk collection and distribution developed by a private company, the Uganda Milk Processing Limited, which imported fresh milk from Kenya for distribution in Kampala. However, the developmental perspective guiding not only Uganda, but also many other countries at the time regarded state control of economic activities as crucial for social and economic development. Accordingly, the government of Uganda sought, in 1967, to foster the development of the industry, which had by then attained a position of relative importance to the economy, through a system of legal monopoly of the kind utilized in fostering the development of other commodities of such importance to the country. Hence, a parastatal, the Dairy Corporation was established by an Act of parliament.

The Act charged the corporation with the responsibilities comparable to those vested with the KCC in the neighboring Kenya. These included, the regulation of production, marketing, pricing, as well as processing, manufacturing and distributing finished dairy products. By 1971, the corporation had installed eight milk-chilling centers spread in major producing areas.

Figure 13—Change in the milk supply for Kampala (litres) 1961-1968



Source: Adapted from Nsubuga 1973
Source: Computed from FAOSTAT

From the foregoing, Uganda's Dairy development was by 1967 showing good prospects. These prospects were however dashed by a severe collapse in public security resulting from the civil crisis that ravaged the country between 1971 and 1986 with devastating effects. Moreover, the crisis coincided with the oil crises of the early 1970s and the collapse of the East African Community in 1977 both of which simply compounded the economic crisis experienced in the country. The economic collapse resulting from this combination of devastating conditions had

severe effects on agricultural production. In Particular, dairy production suffered from rustling, decline in veterinary disease control (as a consequence of disruptions in public services), and a resurgence of animal trypanosomiasis (Belshaw 1988). Research and extension also collapsed. Furthermore, because of disruption of the marketing system, productivity declined as farmers retreated to subsistence farming.

When Amin's military regime fell in 1979, the country appeared set to regain some composure. This led to the launching of a short-term recovery program to address the issues of economic and social recovery (WB 1982). The program recognized the importance of agriculture to economic recovery and was set to lay heavy emphasis on the sector as the engine for revival of the entire economy. However, these efforts were beset by a number of problems. First, because of political uncertainty and consequent loss of confidence about the future, the country had lost most of its skilled labor. Secondly, as a result of industries confiscated from non-indigenous entrepreneur, especially the Asian community (in what came to be dubbed "economic war"), the civil service had been greatly bloated. Nonetheless, the expectations were that through prudent programs, these trends could have been reversed within a reasonable timeframe. These expectations were however thwarted when the country plunged into another wave political instability. The recovery efforts were abandoned.

CURRENT POTENTIAL FOR DAIRY DEVELOPMENT

The civil crisis suffered by Uganda resulted in severe declines in the country's economic activities. When the current government took over in 1986, it faced the challenges of designing a much-needed recovery program. Realizing the essential role of agricultural performance to the recovery of the country's economy, the government's economic recovery measures identified agriculture as a priority sector. The design and implementation of recovery programs has been

taking place under a development thought different from that which guided the country in the pre-crisis period. The global perspective regarding the appropriate extent of government control of and intervention in production and marketing processes has changed from one that regards state control of economic activities as crucial for social and economic development. The potential for significant contribution by the private sector is now recognized. Accordingly, Uganda's public policy supports a recovery programme based on the involvement of the private sector in rebuilding the country's economy.

The country still holds a large potential for dairy production and marketing. A collaborative study conducted in 1996 involving the International Livestock Research Institute (ILRI), and Uganda's Ministry of Agriculture, Animal industry and Fisheries (MAAIF), National Agricultural Research Organization (NARO), and Makerere University, noted several factors that offer significant potential for expansion of dairying in Uganda:

To begin with, land per se is not yet a crucial limiting factor to expansion of agricultural production, as indicated by a comparatively higher hectare per capita of high agricultural-potential land, which stand at about 2 hectares per person as compared to Kenya's less than 0.4 hectares per person. However, appropriate land utilization is constrained by an inappropriate land tenure system where land fragmentation coexists with large tracts of under-utilized and unutilized land. Secondly, the country has a large cattle resource base, which however predominantly comprise of low-yielding indigenous breeds. Of a total 4.2 million cattle, only 3.4 per cent is of improved breeds (Okwenye 1994). Milk productivity of the indigenous breeds is estimated to averages 600 liters per lactation period compared to that of exotic breeds, which is estimated to average about 2800 per lactation. Combined, these two facts suggest that improvement of the genetic productivity of the country's dairy herd offers one of the most

significant means of raising its milk output and productivity. Thirdly, milk production is predominantly based on natural pastures. Milk production is thus highly correlated with the rainfall variability. Improving the country's feed resources, therefore hold great potential for increased milk production.

Market assessment, by the same study demonstrated substantial potential for the utilization of the production potentials identified above. The survey reports that, although the country has a large potential for expansion of dairy production, it experiences a milk shortfall estimated at 100 to 200 million liters of milk per annum. Furthermore, the per capita consumption of milk is estimated at 22 liters per person, which is well below the FAO's recommendation of 200 liters per person. Moreover, the country has a high rate of urbanization averaging 10 per annum. This promises a growing milk marketing opportunity in the sense that urbanization invariably generates demand for food, and given the fact that milk has a high-income elasticity of demand, urbanization hold great potential for the expansion of the country's dairying. Another element, also noted in the report, is the potential high milk demands from other countries in the region, including Rwanda and Burundi.

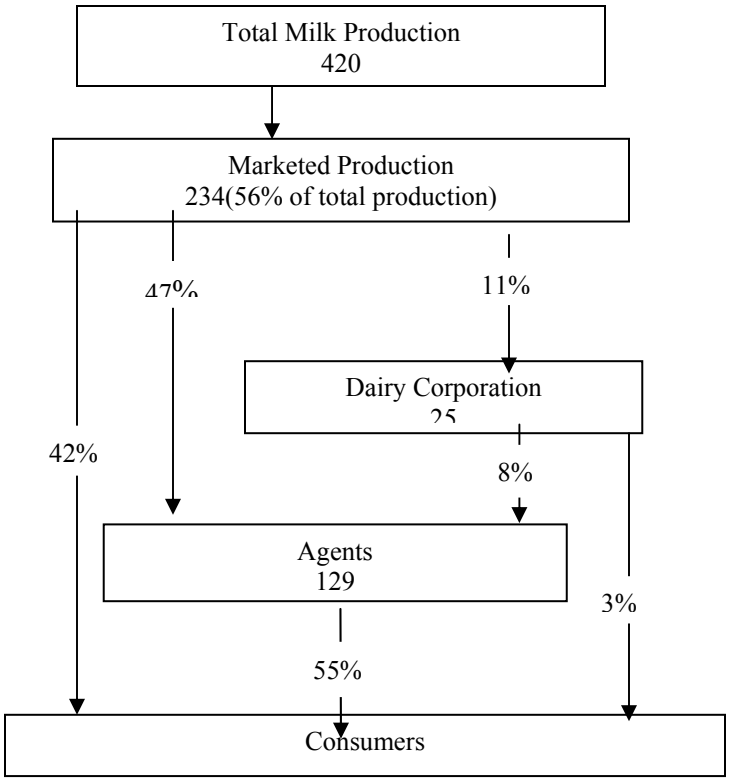
The evidence above suggests that major potential for milk increases indeed exist in Uganda. The evidence also underscores the potential that improvement of dairy production and marketing has for generating incomes for smallholder farmers in Uganda as well as the potential for generating income opportunities for the majority who would be indirectly employed in market distribution of dairy products and production inputs and services. The challenge appears to lie in the design and implementation of initiatives that would enhance dairy farmers' capacity to exploit the potential. Priorities clearly lie in measures to improve pastures and pasture management, improvement of dairy breeds and breeding programmes with the aim of gradually

upgrading the indigenous cattle, and development of smallholder dairy technologies for milk processing and sale. In addressing these challenges, recognition should be taken, as Fitzhugh (1998) has pointed out, of the fact that the relevant technologies for improved production may already exist. What may be needed is an effective screening and promotion mechanisms to enhance transfer and adoption of appropriate technologies.

Improved farm productivity is, however, heavily dependent on the efficiency of the marketing system. The producer must efficiently procure production inputs as well as dispose the output to the market efficiently. In other words, the foundation for the producers to truly exploit the existing dairy production potential must be the consideration of efficient marketing as a necessary condition. In order to meet the unmet domestic requirement and to be able to tap the market potential offered in the region, better breeding methods and sustainable feed management technology must be coupled with efficient marketing. As already mentioned, Uganda is moving away from bureaucratic co-ordination of agricultural markets towards allowing market co-ordination to play an increasingly larger role.

Figure 9 depicts Uganda's milk-marketing channel. The channels can be distinguished between formal and informal marketing. The figure shows that informal milk marketing comprises the dominant mode of distributing milk to consumers. Formal marketing through the Dairy Corporation accounts for only 11 per cent of total

Table 19--Uganda's milk marketing channels



Source: adapted from ILRI, MAAIF, NARO & Makerere University
Notes: Percentage marketed flows are calculated on marketed production

3. CONCLUSIONS

The foregoing country-specific profiles of dairy development in the two countries─ Kenya, and Uganda─ have provided a broad background for identifying forces underlying dairy development in East Africa. Although important differentials in domestic circumstances and in general patterns of development have resulted in some differences in the levels of dairy development between the two countries, it is nevertheless possible to generalize the constraints and opportunities facing the dairy sector. It is also possible to highlight the main factors that

have the potentials of stimulating the sector's development towards better exploitation of the vast potential, for dairy development, held by the region.

The production and marketing systems of the two countries are fairly similar. In both, smallholder dairying dominates production. An essential feature of smallholder dairying, and one that is central to understanding its constraints and opportunities, is the small sizes of an individual farmer's production. Increasing population pressure interacting with the need to sustain soil fertility and to intensify agricultural production has been at the core of making dairying an important component of the region's smallholder agriculture. Under mixed farming, animals and crops reinforce each other in ways that can lead to substantial increase in per hectare productivity. However, the production system, in both countries, is predominantly based on natural pastures. Due to the latter fact, milk production in both countries is highly correlated to their respective rainfall patterns.

Similarly, milk-marketing systems of both countries are characterized by a co-existence of formal and informal channels with a heavier presence of the latter. This is in spite of the fact that, over the year, dairy marketing policies in both countries have discouraged informal milking marketing. Yet, smallholders would benefit through processing milk into products of comparatively higher value. This lack of product innovation by farmers is probably attributable to a dairy development policy that has over-emphasized large-scale milk processing while suppressing private creativity through imposition of single channel formal outlet. Urban areas are the major market outlets for value added products. Yet, for year, these areas have been the preserve of large legal monopolists. For both countries significant amounts of marketed output is sold through informal channels mainly in the raw form. However, as raw-milk sales activities expand in the urban areas, it raises the issue of public health hazard that needs to be addresses.

The issues is, however, a complicated one since the informal channels offers relatively higher producer prices while at the same time offering relatively lower prices to consumers. Smallholder milk marketing is also faced by the critical problem of quantity constraint in marketable surpluses. Although the farmer can sell milk to deficit households with his neighborhood, his geographical marketing scope may be greatly limited by quantity constraints. Sale of small quantities of milk entails relatively high transactions costs. Transaction costs are further compounded by the high perishability of raw milk coupled with the pattern of flow of milk output, which is continuous, at least, within a lactation period.

Because of the positive impact that market-oriented dairying has on alleviation of rural poverty, effective market participation by smallholder dairy farmers has been a major goal pursued by public policy in both countries. Compared Kenya has a relatively the larger herd of improved dairy cattle. Kenya has a total cattle herd of about 12.5 million of which, 23 percent comprise grade and cross dairy cattle. By contrast, only about 4 percent of Uganda's 5.9 million cattle are of improved breed. The primary reason for this difference in herd structures between the two countries is, to a significant extent, attributable to a relatively higher availability of exotic breed dairy cattle in Kenya in the earlier years of the country's dairy development (Mohamed et al. 2003).

The cases demonstrate a strong case for public action to promote smallholder dairying. The predominance of smallholder agriculture in the region and the demonstrated complementarities between crop production and dairying means that promotion of market-oriented dairying which raises household incomes would have a profound impact in poverty reduction. And when incomes from market-oriented dairying results in intensification of crop production─ from use of purchased higher-yielding inputs coupled with use of cattle manure

—this results in freeing of land for dairying on which the farmer can grow fodder for even higher dairy productivity. The cases clearly demonstrate that, the short-term priority in promoting market-oriented dairying is to improve smallholder market access. Reducing the travel time to milk sale point is one way of doing this. The immediate effect of this is to release time, allowing the household to give more time to other farmer activities. In the longer term, the challenge must be to enhance the productivity of smallholder dairy herd. This entails a three-part strategy: (i) enhancing the dairy herd's milk production traits (ii) enhancing the smallholder's ability to realize the breed's potential through advice and training on better herd management practices (iii) optimizing on the herds potential through feeding adequate feed in terms of both quality and quantity.

In addressing these challenges, recognition should be taken of the fact that relevant technologies for improved dairy technologies already exist. The transfer of the technologies, however, needs to be done using an appropriate methodology. One important requirement is that farmer be involved in the in the choice. Therefore, the challenge is to design better modes involving the farmer in the choice to enhance the appropriateness and adoption rates. This entails better exploitation farmer participatory methods. The ILRI has started a few dairy farmers field school on a pilot basis. Through the school, farmers are encouraged to participate in screening available technologies, to identify those relevant and to make any necessary adaptation. Another issue in improving smallholders' ability to realize the breeds' potential is the effectiveness of the delivery of services. Given the quantity constraint of production and therefore of input demand, delivery of services may be highly dependent on local institutions and capabilities. Involvement of the farmers, through the emerging CBO is one promising way of building effective service delivery channels.

REFERENCES

Amann, V.F. 1973. Experience in smallholder dairy production in Uganda as a basis for setting production policy objectives. In *Agricultural policy issues in East Africa,* ed. V.F. Amann. Kampala, Uganda: Makerere University.

Bates, R.H.1989. *Beyond the miracle of the market*. Cambridge: University Press.

Bonoti, C.W. Summary policy recommendation for eastern and southern Africa: Mbanbane, Swaziland. *British Society of Animal Science Occasional Publication* July 28 to August 1, 1997: 19-25.

Conelly, T.W. 1998. Colonial era livestock development policy. *World Development* 26:1733-1748.

Coughlin, P. 1992. Development policy and inappropriate product technology: The Kenyan case. In: *Industrialization in Kenya: in search of a strategy*, ed. Coughlin, P. and G.K. Ikiara. London: East African Education Publishers LTD.

Czada, R.M. 1998. Interest groups, self-interest and the institutionalization of political action. In: *Institutions and political choice: On the limits of rationality,* ed Heritier, A. and H. Keman. Amsterdam: VU press.

DANIDA and Ministry of Livestock Development 1990). *Kenya dairy master plan.* (UnPub)

FAO. 2002. FAO statistical database. http://apps.fao.org/.

Fitzhugh, H.A. 1998. Global agenda for livestock research. *British Society of Animal Science Occasional Publication* 11-17.

Hewitt de Alca'ntara, C. 1993. Introduction: Marketing in principles and practice. In *Real markets: Social and political issues of food policy reforms,* ed. C. Hewitt de Alca'ntara. Geneva: Frank Cass & Co. Ltd.

Hills, M.F. 1956. *Cream country: The story of the Kenya co-operative creameries limited*. Nairobi: KCC.

Freeland, G. 1998. Setting donor research agenda. *British Society of Animal Science Occasional Publication*.5-10.

Isrealsson R. and Oscarsson G. 1994. Kenya National Artificial Insemination Services (KNAIS): Review of Plan 1993/94. KNAIS report. Nairobi.

Jaffee, S. 1995. Perishable profits: Private sector dairy processing and marketing in Kenya. In *Marketing Africa's high-value foods: Comparative experience of an emergent private sector.* ed. Jaffee, S. and J. Morton. Dubuque, Iowa: Kendal/Hunt Publishing Company.

Kenya. 1965. The Dairy commission of inquiry report. Government of Kenya. DAIRY/INQ/A/64. Nairobi: Ministry of Agriculture

Leys, C. 1975. *Underdevelopment in Kenya: The political economy of neo-colonialism.* Berkeley and Los Angeles: University of California Press.

Mamdani, M. 1976. *Politics and class formation in Uganda.* London: Monthly Review PR

Ministry of Agriculture, Livestock Development, and Marketing (MoALDM). 1997. National dairy development project-pilot privatization project: Foundation Knowledge on Community Based Private AI Service. Nairobi: MoALDM.

Muriuki, H.G. and Thorpe, W. 2001. Smallholder dairy production and marketing in Eastern and Southern Africa. In the Proceedings of the South – South Workshop on Smallholder Dairy Production and Marketing – Constraints and Opportunities. March 12 - 16 2001, Annand, India.

Muthee A.M. 1995. *The adjustment gap. MRAS Technical Paper No. Draft.* (UnPub)

Ngigi, M. W. 1995. Liberalization and dairy industry. 66-95.

Nsubuga, H.S.K. 1973. Dairy developpment in Uganda: Policy and institution matters. In *Agricultural policy issues in East Africa,* ed. V.F. Amann. Kampala, Uganda: Makere University.

Okwenye.A. 1994. Rehabilitation of the dairy industry in Uganda. *World Animal Review,* 2-7.

Omore, A., S.Arimi, E.Kange'the, J McDermott, S.Staal, E.Ouma, J.Odhiambo, A.Mwangi, G.Aboge, E.Koroti, and R.Koech. 2001. *Assessing and managing milk-borne health risks for the benefit of consumers in Kenya*. (UnPub)

Owango, M., S. Staal, M. Kenyanjui, B. Lukuyu, and W. Thorpe. 1996. *Liberalization in the livestock industry: Evidence of impact from dairy co-operative societies in central province, Kenya*. (UnPub)

Pandit, S., & Thukur, N.S. 1961. *A Brief history of the development of Indian Settlement in Eastern Africa.* Nairobi: Panco Publications.

RoK. Agricultural Sector Review. 1995. MoALDM; ASIP Secretariat

RoK. Economic Survey, Various issues, Central Bureau of Statistics, Ministry of Finance and Planning.

RoK. Statistical Abstract, various issues, Central Bureau of Statistics, Ministry of Finance and Planning

Staal, S. J. 1995. Peri urban dairying and public policies in Ethiopia and Kenya: A comparative economic and institutional analysis. Ph.D Dissertation, Dept of Food and Resource Economics, Univ. of Florida, Gainesville, Florida.

Staal, S. J.and B.I.Shapiro. 1996. The economic impact of public policy on smallholder Periuran dairy producers in and around Addis Ababa. Ethiopian Society of Animal Production (ESAP). Publication No.2, Addis Ababa, Ethiopia: Ethiopian Society of Animal Production (ESAP).

Rothschild, M. and J.Stiglitz. 1976. Equilibrium in competitive insurance markets: An essay on the economics of imperfect information. *Quarterly Journal of Economics* 90: 629-650.

Ruigu, G.M. 1976. *Stallholder milk production and marketing: Opportunities and problems*. (UnPub)

Staal, S. and G.R. Mullins. 1996. *Dairy consumption and its determinants in coastal Kenya*. (UnPub)

Staal, S.J., Waithaka, G. A., Owour, G. A, and Herrero. 2002. Demand and supply

changes in the livestock sector and their impact on smallholders: The case of dairy

in Kenya: a summary.

Sellen, D., Kodhek, G., Chomba, A., Karin, F., Mukumbu, J.M., Mutua, M., Nyambu, M., Okumu, G., Pagiola, S., Rop, I. K., Nelson,.A.W. 1990. Dairy in Kenya: Issues in Agricultural Policy. Policy Analysis for Rural Development. Working Paper Series No. 8, Egerton University

Southall, A. 1988. The recent political economy of Uganda. In Hansen.H.B & Twaddle.M (Eds.), (pp. 54-69). Nairobi: Heinemann Kenya.

Swynnerton, R.J.M. 1954. *A Plan to intensify the development of African agriculture in Kenya.* Nairobi: Government Printer.

Trebilcock C. 1981. *The industrialization of the continental powers 1780-1914*. London and New York: Longman.

Troup, L. G. 1956). A Report of the Committee of Inquiry into the Dairy Industry. Nairobi: Government Printer.

Zwanenberg, R.M.A. 1975). *Colonial capitalism and labor in Kenya 1919-1939*. Kampala, Nairobi, Dar es Salaam: East African Literature Bureau.

Annex 1--Cattle Population in a selected Countries, 1997-2001

Cattle Stocks (Head)	1997	1998	1999	2000	2001
Eastern Africa	94,292,450	97,032,005	97,355,198	98,654,715	96,513,500
Burundi	311,000	346,000	329,000	320,000	315,000
Comoros	48,200	49,500	50,000	51,000	52,000
Djibouti	267,000	268,000	269,000	269,000	269,000
Eritrea	1,927,800	2,026,200	2,100,000	2,150,000	2,200,000
Ethiopia	32,612,350	35,371,768	35,095,232	35,480,000	34,500,000
Kenya	13,413,600	13,002,000	13,392,000	13,794,000	12,500,000
Madagascar	10,331,000	10,342,000	10,353,000	10,364,000	10,300,000
Malawi	750,000	740,000	711,675	750,000	750,000
Mauritius	20,500	22,000	25,000	27,000	28,000
Mozambique	1,290,000	1,300,000	1,310,000	1,320,000	1,320,000
Rwanda	570,000	657,137	748,976	732,123	800,000
Réunion	26,700	27,000	26,915	27,692	28,000
Seychelles	1,300	1,400	1,400	1,400	1,500
Somalia	5,600,000	5,300,000	5,000,000	5,100,000	5,200,000
Tanzania, United Rep of	14,163,000	14,302,000	14,350,000	14,380,000	14,400,000
Uganda	5,460,000	5,651,000	5,820,000	5,965,500	5,900,000
Zambia	2,100,000	2,176,000	2,273,000	2,373,000	2,400,000
Zimbabwe	5,400,000	5,450,000	5,500,000	5,550,000	5,550,000

Source: FAOSTAT

Annex 2--Dairy production for Kiambu zero grazing system

Average milking herd per dairy household= 1.47
Annual average milk production per dairy household=3652 liters.

	OUTPUT				
ITEM	UNIT	QTY	PRICE	TOTAL/YR	Per cow
Milk sales to cooperative	Liter	1,377.51	16.36	22,536.06	
Milk sales to local neighborhood market	Liter	999.37	18.65	18,638.25	
Milk sales to rural-to-urban traders	Liter	324.12	18.21	5,902.23	
TOTAL MILK REVENUE				**47,076.54**	32024.86
Home consumption	Liter	951.00	18.65	17,736.15	12065.41
Cull cows	Head	0.04	18000	720.00	
Heifer	Head	0.08	20,000	1,600.00	
Female calf	Head	0.2	11,000	2,200.00	
Male calf	Head	0.32	3000	960.00	
Immature male	Head	0.02	8000	160.00	
TOTAL ANIMAL SALES REVENUE				**5,640.00**	3836.73
GROSS REVENUE					
Livestock (1.45 cows, head)	35,702.00	0	8	9193.61	
Buildings	60,000.00	0	25	11895.55	
Spray pump	6,800.00	0	10	1599.98	
Cans	800	0	5	265.15	
Buckets (5 kg)	400	0	5	132.58	
TOTAL FIXED COST				23086.87	15705.36
	MANDAYS	RATE			
Family labor	205.78		80	16,462.40	
Hired labor	87.66		80	7,012.80	
TOTAL LABOUR				**23,475.20**	15969.52
	INTERMEDIATE COST				
Drug cost				1,128.70	
A.I &Veterinary Service cost				2,129.96	
Feed cost				16,062.76	
TOTAL INTERMEDIATE COST				**313.58**	13357.14
TOTAL PRODUCTION COST				96,635.00	
TOTAL COST LESS SALES				**66197.08**	
COST PRICE PER LIRE OF MILK				**15.5**	

Notes: CRF=20% Exchange rate of Ksh 75/US$
Source: Author's computation

Annex 3--Dairy production budget for Nyandarua open grazing system

Average milking herd per dairy household= 2.60
Annual milk production=4247 liters

ITEM	UNIT	QTY	PRICE	TOTAL/YR	Per cow
Milk sales through Co-operative/self-help group	Liter	877.00	14.46	12,681.42	
Milk sales to local neighborhood markets	Liter	942.00	12.21	11,501.82	
Milk to processor	Liter	779.64	15.14	11,803.75	
Milk to raw milk traders	Liter	649.70	11.55	7,504.04	
TOTAL MILK SALES REVENUE				**43,491.02**	**16,727.32**
Home Consumption	liter	999.00	12.21	12,197.79	4,691.46
Cull cows	Head	0.40	13555.00	5,435.56	
Heifer	Head	0.23	7400.00	1,702.00	
Female calf	Head	0.05	600.00	30.00	
Male calf	Head	0.36	1950.00	702.00	
Immature male	Head	0.05	5500.00	275.00	
Steer	Head	0.05	9000.00	450.00	
TOTAL ANIMAL SALES REVENUE				**8,594.56**	**3305.60**
GROSS REVENUE				**64,283.37**	**24724.37**

Livestock (2.6 cows)	35,705.00	13555	8	1.0	8,483.50	
Calf Pen	10,000.00	0	15	1.0	2,138.82	
Buckets (5kg)	1,780.00	0	5	1.0	595.20	
parlour	20,000.00	0	25	1.0	4,042.37	
Fencing	60,000.00	0	15	1.0	12,832.93	
Cans	13,500.00	0	10	1.0	3,220.06	
Spray Pump	6,800.00	0	10	1.0	1,621.95	
TOTAL FIXED COST					**32,934.83**	12667

LABOUR INPUTS	MANDAYS	RATE				
Wage	10	70			700.00	
Family labor	109	70			7,630.00	
TOTAL LABOUR					**8,330.00**	3203.8
		INERMIDIATE INPUT				
Drug cost					1,125.00	
Service cost					3,302.00	
Feed cost					10,101.00	
TOTAL INTERMIDIATE COST					**14,528.00**	5587.7
TOTAL COST						55,792.83
TOTAL PRODUCTION COST LESS ANIMAL SALES						47,198.27
COST PRICE PER LITRE OF MILK						11.11

Notes: CRF=20% Exchange rate of Ksh 75/US$
Source: Author's computation

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