ILCA BULLETIN

No. 21–January 1985

Moisture availability, cropping period and famine in Ethiopia

Productivity and potential of pastoral systems

Dairy imports into sub-Saharan Africa

ISSN 0255–0008

The *ILCA Bulletin* is a quarterly publication of the International Livestock Centre for Africa. It provides an up-to-date account of aspects of the Centre's work. Contributions to the Bulletin are invited from other livestock researchers in Africa whose work is closely associated with that of ILCA. The *ILCA Bulletin* is distributed to 1500 researchers, policy makers, donors and extension agents throughout sub-Saharan Africa and elsewhere in the world.

ILCA is one of 13 international centres for agricultural research whose work is funded by the Consultative Group on International Agricultural Research (CGIAR). The 13 centres have been established by the CGIAR to provide long-term support for agricultural development in the Third World.

Table of Contents

Preface

This issue of the *ILCA Bulletin* includes papers on climate and drought in Ethiopia, the productivity of traditional pastoral systems, the role of government policies in regulating dairy imports and the possible impact of these imports on dairy development in sub-Saharan Africa.

The first article discusses the climatic events that have preceded drought and famine in Ethiopia. Using a computer model that provides an estimate of the moisture available for crop growth, the authors have been able to estimate the length of the crop growing period and the implications for crop production in a region. The preliminary results of an analysis that related seasonal rainfall to the recorded incidence of recent Ethiopian famines reveal that the onset of famine is not always due to crop failure in a single year; surpluses from previous good years are often available to meet any sudden shortfall. The authors show that the development of a famine is usually more complex: in famine-prone areas of Ethiopia, where a bimodal rainfall pattern is common, severe famine periods have followed a sequence of 2 or more years in which the short rains failed, and the main growing periods were either marginal or so short that crop failure was inevitable. By closely following these rainfall patterns it may be possible to give an early warning of the occurrence of famine within a region.

The second article presents an analysis of the productivity of a traditional pastoral system. Pastoralists have often been referred to as unproductive, and their rangelands are said to have great potential for improvement. However, ILCA's studies of the Borana pastoralists in southern Ethiopia have shown that traditional, subsistence-oriented pastoralists are much more productive in terms of energy per unit of land than commercial enterprises operating in similar environments. The major difference between the two forms of enterprise is that the Borana are more interested in milk than meat, since their main concern is the support of a relatively large number of people. They do this very successfully and, because of the high productivity of their system, the author suggests that the options for improvement are rather limited.

The third article considers dairy imports into sub-Saharan Africa. Over the last decade these imports, be they commercial or in the form of food aid, have increased dramatically. At present about 30% of the dairy products consumed in the continent are imported. The author discusses the factors that have contributed to this situation, and how government policies have influenced the level and nature of dairy imports. It is assumed that the high levels of imports have acted as disincentives to domestic milk production, but the paucity of data makes it difficult to reach any firm conclusion. More in-depth, individual country studies will be needed in order to determine the impact of government policies on dairy imports and on the development of the local industry.

Wayne Ralph, Richard Stewart, *Editors*
Inca Alipui, *Assistant Editor*
ILCA Bulletin,
Publications Section, ILCA,
P.O. Box 5689, Addis Ababa, Ethiopia.

Moisture availability, cropping period and the prospects for early warning of famine in Ethiopia

B.L. Henricksen and J.W. Durkin
Computer Unit, ILCA,
P.O. Box 5689, Addis Ababa, Ethiopia

Summary

DROUGHT AND FAMINE *occur regularly throughout sub-Saharan Africa, and their effects are particularly severe in heavily populated countries such as Ethiopia. Over the last 30 years, four major drought periods and associated famines of varying degrees of severity have been recorded in Ethiopia.*

Relatively simple models are available to predict the moisture available for plant growth using standard meteorological data. Since moisture availability is directly related to crop production, such models may make

it possible to give an early warning of crop shortfalls and the onset of famine.

In this paper, a moisture availability model developed by the Food and Agricultural Organization (FAO) of the United Nations is used to estimate the periods since 1953 when there has been sufficient moisture available for satisfactory crop growth at different locations in Ethiopia. The preliminary results of an analysis using existing meteorological data show that short length of growing periods correlate well with the recorded incidence of drought and famine in the country.

Across the drought- and famine-prone areas of northern and central Ethiopia there is a bimodal distribution of rainfall and cropping is usually restricted to the period of the main rains which occur during June to September. Although the short rains falling between February and May generally do not provide enough moisture to support a crop, they are important because it is during this period that much of the land preparation and cultivation takes place. If land preparation is largely completed during the short rains, the farmer can take full advantage of the main rains.

If the short rains fail, most land preparation can only begin after the start of the main rains, and this preparation time cuts into the period available for crop growth. Historically, severe famine periods have been associated with a sequence of 2 or more years in which the short rains failed and the resultant main-season growing periods were either marginal or so short that crop failure was inevitable.

Introduction

Plant growth and crop yield are closely related to the amount of moisture available during the growing season. Relatively simple models are available that can quantify this relationship and, when fed appropriate data, can be used not only to predict but also to partially explain past crop failures. The opportunity to analyse data on moisture availability, and to develop a predictive model for application in Ethiopia, arose in August 1984 through cooperation between ILCA, FAO and the Land Use Planning and Regulatory Department of the Ethiopian Ministry of Agriculture.

Methods

A computer program originally developed by FAO for an agro-ecological study of crop suitability in Africa (FAO, 1978) was installed on the Hewlett Packard 3000 computing system at ILCA headquarters in Addis Ababa. The FAO program estimates the moisture available for crop growth in individual months of the year, using data of the type described in Table 1. The length of growing period (LGP) is calculated through a simple water balance model that relates precipitation (P) and moisture stored in the soil (S) to the potential evapotranspiration (ETp) of the crop, the latter being assessed using the Penman formula (Penman, 1948). Crop production can then be estimated, at least qualitatively, in terms of the time during which plant growth can proceed without serious restriction due to moisture stress.

Table 1. *Parameters used in the calculation of LGPs*.

Abbreviation	Parameter
P	Monthly precipitation (mm)
T	Daily average temperature for the month (°C)
T_x	Average maximum temperature for the month (°C)
T_n	Average minimum temperature for the month (°C)
e	Average vapour pressure (mb)
RH	Relative humidity (%)
U	Average wind speed at 2 m above ground ($m.sec^{-1}$)
n	Monthly average number of sunshine hours per day
n/N	Percentage of possible sunshine hours
R_g	Total radiation ($cal.\ cm^{-2}\ day^{-1}$)
R_n	Net radiation ($cal.\ cm^{-2}\ day^{-1}$)
ET_p	Potential evapotranspiration ($mm.\ Month^{-1}$)
S	Stored soil moisture (mm)

Monthly ET_P varies little between years, and the LGP can be estimated with reasonable precision from rainfall data once the mean ET_p has been calculated from long-term records. Fortunately precipitation, and to a lesser extent temperature, are both widely recorded in Ethiopia. A number of other parameters required in the original calculation of ET_P were estimated from nearby locations (FAO, 1984).

For the purposes of the following analysis the LGP is defined as the period in days when moisture supply from precipitation exceeds half the potential evapotranspiration (from Penman, 1948), plus that period during which plants evapotranspire stored soil moisture resulting from excess precipitation (definition modified after FAO, 1978). The stored soil moisture assumed to be available can be varied in the computer program from 0 to 200 mm in intervals of 50 mm. This allows factors such as soil texture and depth to be taken into account. Any time interval when water is available but the temperature is too low for crop growth is excluded from the calculation of LGP.

A typical growing period includes a 'humid period' when P exceeds ET_P, enabling the soil profile to accumulate a moisture reserve and plant growth to proceed without restriction from moisture stress. Such a growing period is termed a 'normal growing period'. Growing periods where P remains between 0.5 and 1.0 ET_p are referred to as `intermediate'. No soil moisture reserve accumulates under these circumstances, since P remains less than ET_P. The choice of 0.5 ET_p as the threshold value for moisture availability is based on considerable experimental evidence that important physiological changes are induced in many crops below 0.5 ET_p (Doorenbos and Kassam, 1979). Germination also proceeds in most crops when P exceeds 0.5 ET_P.

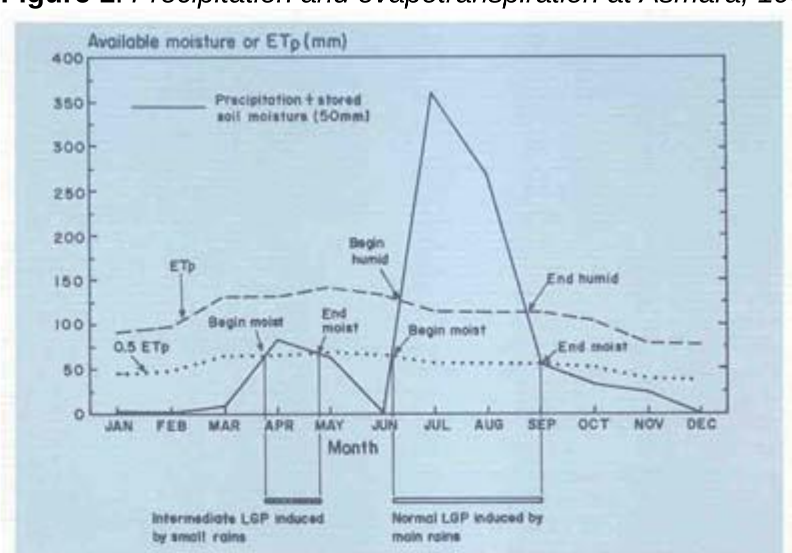
Results and discussion

Rainfall distribution patterns in central and northern Ethiopia

The annual rainfall distribution in the central and northern highlands of Ethiopia, including those areas periodically affected by drought, is generally bimodal (FAO, 1984). The first period of rainfall, usually in the months of February to May, provides a growing period of between 5 and 100 days, depending on the location. The longer growing periods during this short rainy season are more likely to occur along the northeastern escarpment running from southern Tigray through Wello to northern and central Shewa. The variability in the length and frequency of these rains is much greater than that of the main rains occurring from June/July to September.

Figure 1 gives a typical example of moisture availability during 1981 in areas surrounding the northern highlands town of Asmara. An intermediate growing period of approximately 30 days occurred around April, followed by a dry period of about 45 days, after which the onset of the main rainy season quickly raised soil moisture above 0.5 ET_p. In the example given the LGP from June to September was 85 days.

Figure 1. *Precipitation and evapotranspiration at Asmara, 1981.*



Generally, the short rains are insufficient for producing all but the most rapidly maturing crops; they may fail altogether or occasionally merge with the long rains. The dry period between the short rainy season and the onset of the main rains is usually too long to allow the planting of long-season crops before the start of the main rains. Highland sorghum may be planted during the short rains in areas where these are more reliable and substantial, but only at the risk of severe yield reduction or complete crop failure in a bad year.

The importance of soil depth in reducing moisture stress

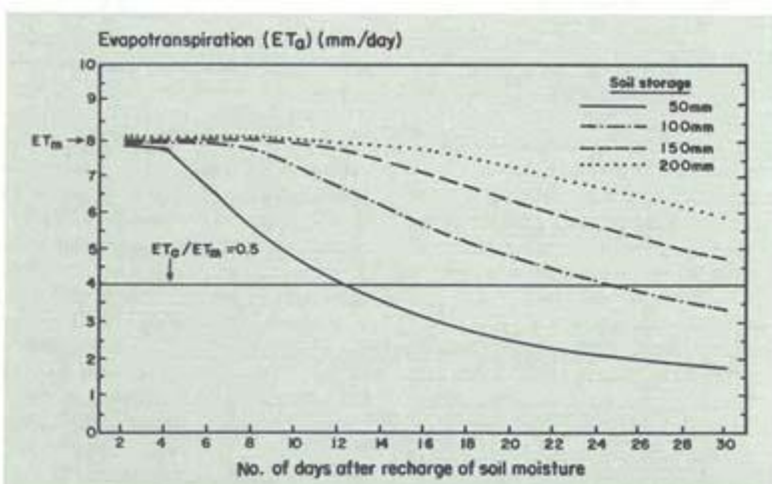
Stocking and Pain (1983) have examined in some detail the concept of available soil moisture and the minimum soil depth necessary for crop production. Assuming that a 50% yield reduction is tolerable, surprisingly shallow soils appear capable of supporting the production of crops such as sorghum.

Rainfall patterns in northern and central Ethiopia during the main rainy season are characterised by heavy monthly falls of between 150 and 350 mm in July and August. This rainy season begins and ends rather abruptly. The moisture index (P/ET_p) for July and August normally exceeds 1, and may in fact exceed 2 or 3 even in relatively dry years. However, little additional rain falls after the second week of September. Consequently crops must draw on stored soil moisture after only about 60 to 80 days, and considerably sooner if late land preparation delays planting.

The ability of soils to store water from the 2 previous wet months is thus a critical factor in the final crop yield. Much depends on the growing season requirements of the crop itself, but Stocking and Pain's assumption that soil moisture recharge occurs 10 times during the growing season is probably not applicable to Ethiopia, making minimum soil depth requirements somewhat greater if acceptable yields are to be achieved.

Figure 2, derived from Doorenbos and Kassam (1979), shows the reduction in actual evapotranspiration (ETa) over time from the point of last recharge, for four different soil storage capacities. Assuming that the maximum evapotranspiration of the crop (Et_m) is 8 mm/day, then for a soil storage capacity of 50 mm ETa/ET_m it is reduced below 0.5 after 12 days. Beyond this point yields are assumed to fall to less than 50% of their potential. For a storage capacity of 100 mm it is 24 days before the same degree of yield reduction occurs. This emphasises the importance of soil moisture storage after the rainy season has ended.

Figure 2. *Reduction in evapotranspiration over time.*



Because of the shallow soils that are found over much of the famine-prone areas of Ethiopia (FAO, 1984[x]), a substantial proportion of the precipitation falling during the heavy main rains is lost as runoff. For Asmara and Mekele the assumed storage capacity is 50 mm, since at both locations the medium-textured soils are generally less than 50 cm deep. Medium-textured soils are assumed to have available soil water capacities of about 140 mm/m (Doorenbos and Kassam, 1979), and this is consistent with a storage of about 50 mm in a soil less than 50 cm deep.

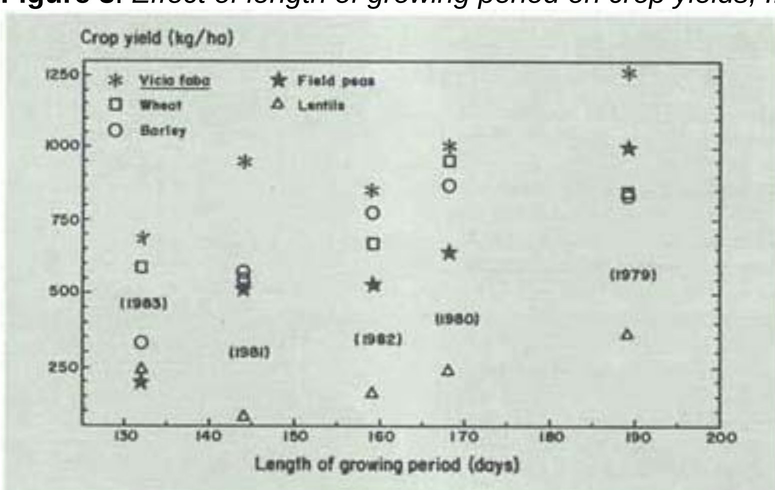
In Asmara, for example, P/ET_p in 1981 exceeded 3 in July and 2 in August (see Figure 1), yet the main-season LGP was still only 85 days because most of the rain would have run off the land. Despite an apparently favourable total rainfall, the LGP during 1981 extended only into September.

Annual variability of LGP in drought-prone areas of Ethiopia

The effect of moisture stress was investigated by estimating the LGP in cases where severe yield reductions or total crop failures are reported to have occurred in drought-prone areas of Ethiopia. The preceding climatic events and the moisture available from the short rains were also examined to gain a more complete understanding of the famine cycle.

Some empirical data on the effect of LGP on crop yield were obtained from research reports of the Ethiopian Institute of Agricultural Research (TAR). Unfortunately, the limited nature of the data meant that no firm conclusions could be reached. Data from ILCA's Debre Berhan research station were also examined for five different crops, for the years 1979 to 1983. The results of this analysis are shown in Figure 3 where each point represents the weighted mean yield from 42 cooperating farmers growing traditional crop cultivars.

Figure 3. *Effect of length of growing period on crop yields, ILCA, Debre Berhan, 1979–1983.*



Yields of all crops show a generally upward trend with increasing LGP, except those of wheat and barley at an LGP of 190 days when an excess of moisture may have influenced the results. However, for the purpose of studying the effects of serious moisture stress, Debre Berhan is not a suitable station, as the minimum LGP was more than 130 days in the years for which data are available. Further research into the effects of moisture availability on crop yields in Ethiopia is clearly needed before firm conclusions can be reached.

Figure 4 shows the year-to-year variation in the main-season LGP for three meteorological stations in traditional grain-producing areas of Ethiopia, spanning the period from 1953 to 1983. Table 2 gives the location and altitude of each station.

Figure 4. *Crop growing period at three Ethiopian sites, 1953–1983.*

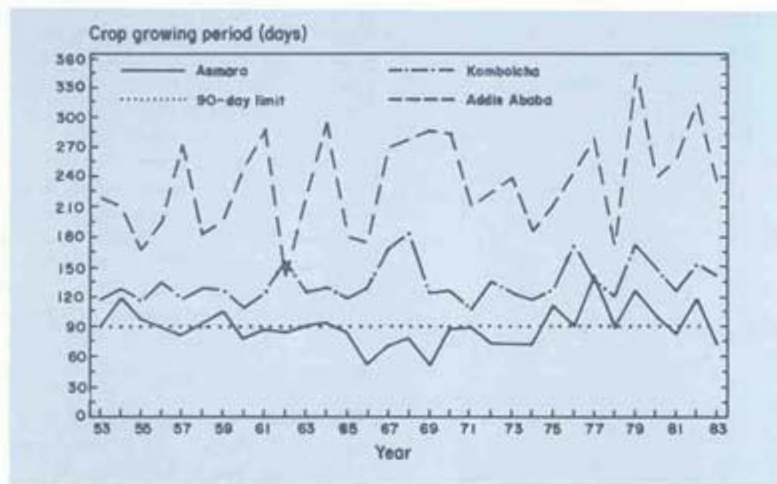


Table 2. *Variation in main-season LGP at three Ethiopian sites, 1953–1983*.

Site	Location	Altitude (m.a.s.l.)	Mean main-season LGP (days)	Standard deviation	Coefficient of variation (%)
Addis Ababa	9° 02'N, 38° 45'E	2408	235	50	21
Kombolcha	11° 05'N, 39° 45'E	1903	133	20	15
Asmara	15° 17'N, 38° 55'E	2355	89	20	22

Most crops grown in Ethiopia, with the exception of some pulses and very low-yielding varieties of teff and wheat, require a growing season of at least 90 days. This generalisation is of course dependent on temperature and, as altitude increases and temperatures fall, a crop requires a progressively longer LGP if it is to yield successfully. Above 2000 m a.s.l. in Ethiopia, highland varieties of sorghum and maize commonly require between 150 and 180 days to reach maturity; on the other hand, at lower altitudes these crops mature in only 90 to 120 days. Thus short growing periods in the highlands can be a serious problem for such crops.

The data for Asmara show that the longest LGPs over a 31-year period rarely exceeded 90 days, and particularly low values were recorded in the years 1966–69 and 1972–74, which were both famine periods in northern Ethiopia. While the identification of drought years is not quite as simple as estimating the LGP in a given year, it is worth noting that Asmara had rather short main-season LGPs in most years of the period under study. This in turn must have severely limited the range of suitable crops for the region since, at such a high altitude, the optimal growing period for barley, for example, probably exceeds 90 days.

Addis Ababa and Kombolcha both have much longer LGPs, but these varied substantially. Farmers planting late-maturing crops in the vicinity of Addis Ababa will undoubtedly have poor yields in some years. However, the shortest LGP recorded for the main growing season in both

Addis Ababa and Kombolcha still exceeded the maximum for Asmara. The average LGP for Kombolcha (133 days) is lower than that for Addis Ababa (235 days) but 120 days was exceeded in most years and, as will be noted later, rainfall in Kombolcha tends to be more bimodal in its distribution, from which crop production can benefit substantially.

Role of the short rains in crop production

There is a relationship between reported drought periods and the failure of the short rains in those years when the main-season LGP was less than 90 days. Crops can be grown successfully if the short rains are sufficiently prolonged, but for much of the highlands, including the drought-prone areas of Wello, Tigray and Eritrea, these rains are so unreliable that farmers cannot regularly take advantage of them for cropping. Unreliable as they are, the short rains are still very important because they facilitate land preparation prior to the main cropping season.

Land preparation in Ethiopia with the traditional ox-drawn plough is extremely difficult if the soil is either very dry or excessively wet. Thus, ideally, land preparation begins at the end of each harvest before soils dry out, and starts again during the short rains when the soil is easily worked. Such a practice enables farmers to plant early in the main rainy season and takes full advantage of the available LGP. If the short rains fail, however, land preparation can only begin after the onset of the main rains. Consequently, planting is delayed well beyond the start of the main growing season and crops may be subjected to moisture stress if the rains end early. At higher altitudes, generally above 2300 m a.s.l., the risk of frost damage to late-season crops must also be considered.

The total time needed for land preparation varies with the crop and the soil, but is generally between 10 and 30 days. If this time is subtracted from the main-season LGP in a year when little or no land preparation is possible because of the failure of the short rains, then the likelihood of crop failure is greatly increased.

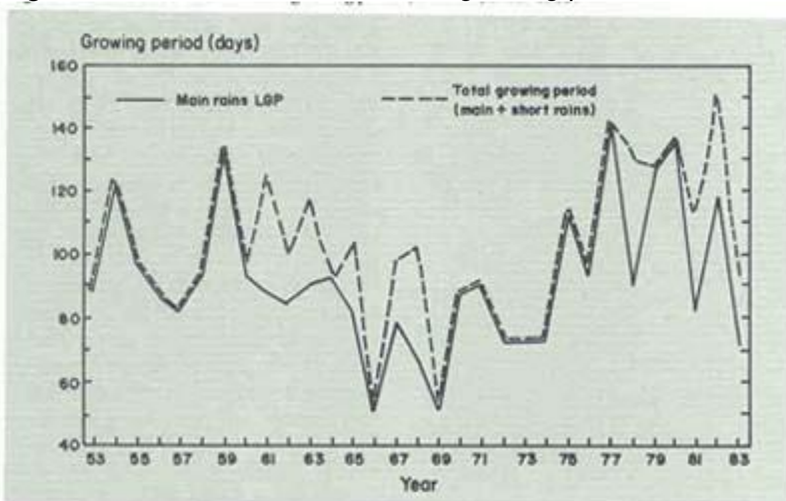
Case studies

Figures 5, 6 and 7 support the suggestion that the combination of a failure in the short rains and a shortened main-season LGP has, historically, coincided with serious drought and famine years in northern Ethiopia.

Asmara, 1953–1983

In Figure 5 the main-season LGP for Asmara from 1953 to 1983 is shown by a solid black line. The dotted line represents the total number of growing days in the same years, thus highlighting the contribution from the small rains. Between 1953 and 1960 the total LGP and the main-season LGP were the same, indicating that effectively no short rains fell in those years.

Figure 5. *Main rains LGP and total growing period, Asmara, 1953–1983.*



Growing periods of 95 days or less, with a minimum of 80 days in 1957, occurred between 1955 and 1958. Assuming that land preparation had to take place during the main cropping season, the total LGP probably varied between 50 and 85 days, indicating a substantial cumulative loss in both grain supplies and the seed available for planting. Draught animals and the human population in the Asmara area must have been in poor condition by 1957 and 1958, and substantial numbers of people died in Wello and Tigray during the period following the 1957/58 drought, although a locust infestation exacerbated the problems caused by the low rainfall (Tafesse Olkeba, 1984).

In 1966 a serious drought appears to have occurred around Asmara. The short rains failed totally and the main-season LGP fell to around 50 days, indicating that most crops probably failed. In the following 3 years the main-season LGP was less than 90 days, although in 1967 and 1968 the total number of days suitable for crop growth exceeded 100. Another serious failure occurred in 1969 with no short rains evident and an LGP of less than 60 days.

From 1969 to 1974 a period of extreme drought occurred in the Asmara area. In 1971 and 1972 some crops may have been successful, but a shortage of seed carried over from the preceding years probably limited plantings. Substantial crop failure is again indicated for Asmara from 1972 to 1974 with no short rains and an LGP of about 75 days in each of these years. This period coincides with the widely reported famine of 1971–74.

Although there were no short rains from 1969 to 1977, in 1975 and 1977 the main season LGPs were very favourable for crop production. In 1981 the main-season LGP again fell below 90 days although the short rains in that year were favourable. In 1982 good short rains and a very favourable July-to-September rainfall distribution again assisted crop production.

In 1983 the short rains were limited and the main-season LGP fell to about 70 days, almost certainly resulting in crop shortfalls. However, because of the relatively good season in 1982, reserves were probably available to farmers in 1983.

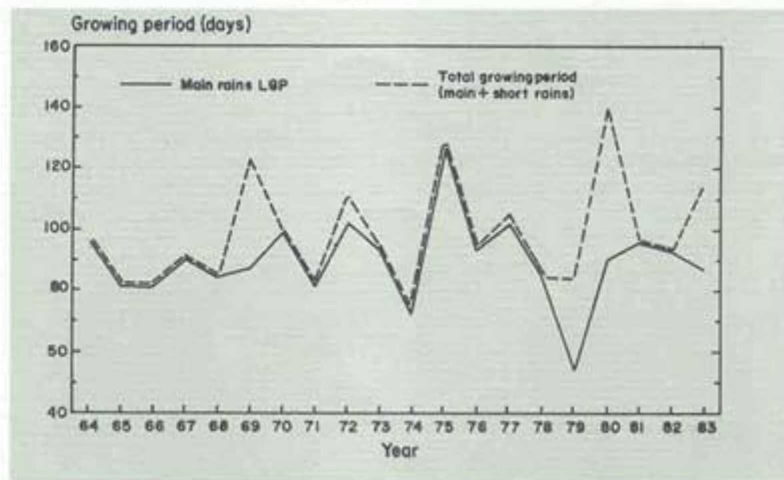
Figures for the first half of 1984 for Asmara suggest that while the short rains did fall, the July rainfall was poor and the prospects for successful crops depended on the August and

September rainfall. In the past, 2 successive years of crop shortfalls have been associated with famine. The year 1984 was therefore a crucial year in this respect.

Mekele, 1964–1983

Unfortunately, the meteorological data available for Mekele do not allow as comprehensive an analysis as for Asmara, but the 20-year period does span three reported drought periods in northern Ethiopia (Figure 6). Historically, Mekele is one of the hardest-hit famine areas in the country, and its recent climatic history warrants close inspection.

Figure 6. *Main rains LGP and total growing period, Mekele, 1964–1983.*



The years 1964 and 1965 are reported as drought years in Ethiopia (Tafesse Olkeba, 1984), but little regional documentation is available. In view of the marginal LGPs, particularly in 1965 and 1966, food reserves around Mekele in 1966 and 1967 must have been low. The inadequate 1967 rainfall and poor harvests must have contributed to an accumulating shortfall in grain supplies, and animal and human condition in the region during 1967 and 1968 will have been poor.

Although the main-season LGP in 1969 was not very long, the considerable short rains would have assisted land preparation and provided good forage for livestock. In 1970 the short rains failed and the main season LGP was less than 100 days, with land preparation cutting into this period. The year 1971 was a poor year with no short rains to assist land preparation and only 80 days of moisture available for crop growth. In 1972 the combination of some short rains and a growing season longer than 100 days provided a slight respite, but cumulative effects on the seed supply and on the condition of both draught animals and the human population were probably being felt.

The 2 years which followed led to the widely reported famine of 1974. No effective short rains fell in either 1973 or 1974, and the main-season LGPs of just over 90 and 70 days respectively resulted in yield reductions in 1973 and almost total crop failure in 1974. The build-up to the famine in 1974 around Mekele is less obvious than for Asmara. However, warning signs were certainly apparent by 1973, and perhaps even by 1971, when a possible poor seed supply and the deteriorating condition of both draught animals and the human population meant that farmers were unable to take advantage of the somewhat improved farming conditions in 1972.

As in Asmara, conditions around Mekele in 1975 improved greatly with a total LGP of almost 130 days. Conditions in 1976 and 1977 were marginal with LGPs of between 90 and 100 days. No short rains in 1978, and an LGP of less than 90 days, must have again put food production at risk in the region. A serious problem is indicated in 1979, both from the total rainfall figures and from the unusual rainfall distribution. The total LGP for 1979 was less than 90 days, which in itself would have limited production, but the longest component of the total LGP recorded was less than 60 days. Fortunately, considerable short rains fell in 1980, followed by a main season LGP of 90 days. To what extent farmers were in a position to take advantage of this improved situation is unknown.

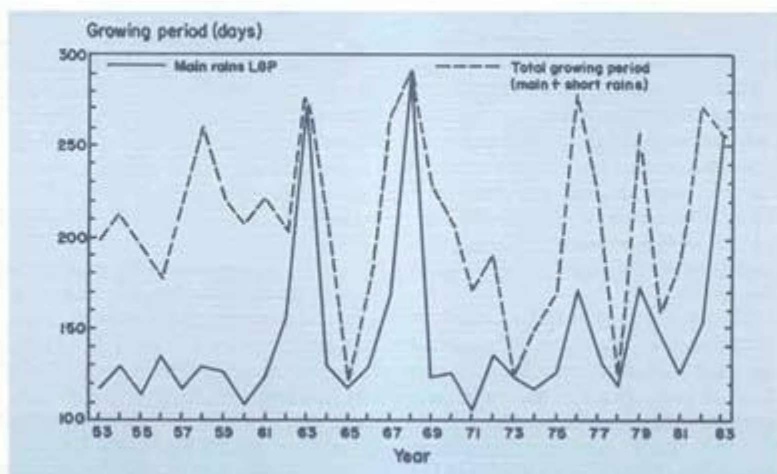
LGPs of between 90 and 100 days, with no short rains, were recorded in 1981 and 1982. Total rainfall improved in 1983, but this was mainly due to reasonable short rains. The main-season LGP was again less than 90 days.

Thus 3 consecutive years in which the main-season LGPs were barely 90 days, and only 1 year in which the short rains fell, indicate that problems were accumulating. If the short rains were to fail in 1984, famine would be the likely consequence, especially if the main-season rains did not begin until late June or early July. Although no reliable meteorological data were available at the time of writing, indications were that this unfortunate scenario did indeed take place.

Kombolcha, 1953–1983

Figure 7 indicates a more favourable situation in Kombolcha. LGPs were generally much longer than those in Mekele or Asmara, although serious departures from the norm are likely to disrupt agricultural production since plantings in any one year are influenced by the farmers' anticipation of the growing season.

Figure 7. *Main rains LGP and total growing period, Kombolcha. 1953–1983*.



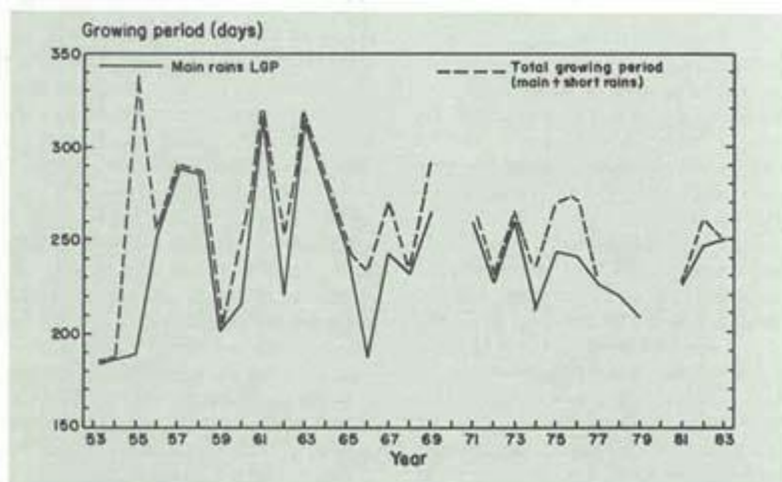
For several periods over the 30 years studied the main-season LGPs for Kombolcha remained between 100 and 130 days, as in the period 1953–1961. The clearer bimodality of rainfall however ensures more time for land preparation and even allows two cropping seasons in some years. A combination of a failure of the short rains and a main-season LGP of less than 130 days occurred in 1965, 1973 and 1978. In fact this situation in 1965 coincided with reported drought elsewhere in the country, as did that for the 1973 cropping season. It is interesting to note that substantial short rains fell in 1971, but that the main-season LGP in that year was the shortest recorded in the period studied. Crop production around Kombolcha was probably lower than usual during 1971 and 1973, and this may have reduced the grain surpluses available for distribution to nearby famine areas in those years.

The failure of the short rains and the low main-season LGP in 1978 was followed by a considerably better season in 1979. Sufficient short rains fell in 1977 and the carry-over production from a very favourable year in 1976 would have buffered any production shortfall in 1978.

Debre Markos, 1953–1983

Data from Debre Markos (Figure 8) are included to permit comparison with one of the most productive grain-growing areas of the country. No data are available for 1970 and 1980, but the remaining data are sufficiently clear to show that reliable production was to be expected. It is notable that the shortest main-season LGP recorded in this 30-year time span was 185 days. The probability of total crop failure due to moisture stress in the region is thus negligible.

Figure 8. *Main rains LGP and total growing period, Debre Markos, 1954–1983.*



Conclusions and recommendations

LGP and the development of an effective early warning system

The argument developed above underlines the fact that if soil moisture levels are less than those required by crops for uninhibited growth, then yield reductions, and in the most severe cases total crop failures, are inevitable. Low annual rainfall, poor rainfall distribution throughout the year, high evapotranspiration and shallow soils all contribute to a moisture deficit. Since the calculation of LGP encompasses all these factors, an analysis of LGP on a year-to-year basis gives some insight into the reasons for repeated famine over much of the country.

The present study indicates that the serious famine periods recorded at Mekele and Asmara over the past 20 to 30 years were preceded by 2 or more consecutive years in which the main-season LGP was less than 90 days, and in which the short rains failed. Up-to-date analyses of

LGP could therefore constitute the basis of an early warning system to indicate the likelihood of serious famine in drought-prone areas of the country.

Danger signals based on these criteria were apparent at Mekele after the 1981 and 1982 seasons. Small but significant short rains in 1983, although followed by a main season LGP of less than 90 days, may have bridged the gap in production until 1984. Preliminary rainfall figures obtained from the Relief and Rehabilitation Commission (RRC) in September 1984 indicate that no effective short rains fell until April, after which data were not available. It is clear from the widespread famine in the region that the main rains were insufficient and did not extend significantly into September; the 1984 crops failed and the preceding years had left no reserves.

For Asmara, danger signals were less apparent until 1983. This could explain the present lack of famine reports from further north in Eritrea, the region surrounding Asmara. However, based on the analysis for Asmara presented above, shortfalls in crop production seemed inevitable in 1984 unless the long rains persisted into September. A crucial indicator for Asmara will be whether or not substantial short rains occur before the end of April 1985. Alternatively, a long main-season LGP in 1985, from May/June until September, may enable land preparation to begin sufficiently early in the season to ensure good crop growth without moisture stress. If neither occurs, severe shortages of locally produced food reserves must be expected, extending the famine much further north during 1985.

Obviously, Asmara and Mekele represent only a small sample of the famine-stricken areas of Ethiopia. Historical analysis of as many additional locations as possible is desirable in order to develop a more generally applicable early warning system. Using the LGP computer programs installed at ILCA, it is now possible to review moisture conditions on a monthly or yearly basis for any location in the country for which suitable monthly climatic data are available. Periods of extreme moisture stress and probable crop failures in drought-prone areas can thus be identified. This suggests that patterns leading to famine, similar to those detected in Asmara and Mekele, might be identified in other areas after more extensive analysis. It is possible that patterns of moisture conditions and famine are very location specific, but this can only be confirmed by additional data collection and analysis.

Regardless of the detailed nature of such patterns, an index of the moisture conditions preceding former famine periods for each new location could be built up in a manner similar to that discussed for Asmara and Mekele. When historically unfavourable patterns begin to emerge, a close watch on the current season's rainfall would provide, by late July, an early warning of crop failures for most of the central and northern highlands of the country. However, such an early warning system can only be effective if meteorological data are recorded and transmitted rapidly to a centre equipped to analyse them. Such analyses could be carried out by ILCA's Computer Unit.

Calibration of satellite early warning systems using LGPs

Information from the NOAA series of satellites has been used in West Africa to estimate vegetative biomass production (Tucker et al, 1982). The use of such satellite imagery has also been proposed to monitor, and to give early warning of, drought conditions throughout Africa.

When compared with the spectral responses of vegetation recorded on NOAH imagery, a time sequence of moisture indices calculated from the LGP computer-program opens up the possibility of calibrating satellite data with moisture availability and LGP. If this proves feasible, the LGP in a given year could be monitored directly using NOAA data, eliminating the need for monthly meteorological inputs.

Long-term agronomic limitations in drought-prone areas

A striking feature of the agro-climatic analysis for both Mekele and Asmara is the limited duration and the high degree of variability of the crop growing periods. This inevitably leads to marginal crop yields in many years, and because of increasing population, famine can be expected to recur with increasing frequency in the future. This is borne out to some extent by the relatively short period of unfavourable agricultural conditions preceding the current famine in northern Ethiopia, compared with the longer build-up to the 1974 famine. To what extent other factors such as disruption of traditional supply routes and cultivation patterns, due to civil unrest, contributed to the rapid onset and severity of the current famine is unknown.

An effective early warning system is, unfortunately, only a means of detection; it does not solve the problems associated with drought and famine. Over the longer term fundamental changes will need to be made to existing production systems: land use will have to be rationalised so that erosion-prone soils are conserved by sowing on them permanent grassland and leguminous forages; better adapted, rapidly maturing crop cultivars should be sought; alternative cultivation systems which conserve soil moisture should be investigated; and it may be possible to trap and store the excessive and destructive runoff associated with heavy rains in ponds or dams constructed using draught oxen. Even a small store of irrigation water could be used on a limited area basis to establish crops just before the onset of the main rains or to enable them to mature without experiencing moisture stress; in either case, the growing period would be extended. When combined with more suitable crop cultivars and more widespread use of fertilizer, much better crop production could be expected; perhaps more importantly, the production would be more reliable than at present.

A partial and possibly only a temporary alternative to agricultural change is to alter the distribution of the population, by resettlement programmes in less drought-prone areas of Ethiopia. There are significant costs, both human and material, attached to both approaches. However, unless major change is attempted, more frequent and massive imports of food aid will be needed to alleviate the suffering associated with the inevitable famines of the future.

References

Doorenbos J and Kassam A H. 1979. Yield response to water. FAO Irrigation and Drainage Paper No. 33, FAO, Rome.

FAO. 1978. Report on the Agro-Ecological Zones Project. Vol. I. Methodology and results for Africa. Rome. 158p.

FAO. 1984. Agroclimatic resources inventory for land-use planning, based on the work of Victor Odenyo and Wolfgang Goebel. In: *Assistance to land-use planning*, *Ethiopia.* Technical Report 2, AG: DP/ETH/78/003. Rome.

FAO. 1984a. Geomorphology and soils, based on the work of Henricksen B L, Ross S, Sultan Tilimo and Wijntje-Bruggeman H Y. In: *Assistance to land-use* planning, *Ethiopia.* Technical Report 2, AG: DP/ETH/78/003. Rome.

Penman H L. 1948. Natural evaporation from open water, bare soil and grass. Proc. *R. Soc. London, Ser. A.* 193: 120–146.

Stocking M and Pain A. 1983. Soil life and minimum soil depth for productive yields: Developing a new concept. Discussion paper No. 150. School of Development Studies, University of East Anglia, UK. 24p.

Tafesse Olkeba. 1984. The role of meteorology in the early warning system. Paper presented at the conference on Drought, held in Nazareth, Ethiopia, 1984.

Tucker C J, Vanpraet C, Boerwinkel E and Gaston A.1982. Satellite remote sensing of total dry matter production in the Senegalese Sahel. *Remote Sensing of Environment* 13: 461–473.

The productivity and potential of pastoral systems*

N.J. Cossins
Ethiopian Rangelands Programme, ILCA,
P.O. Box 5689, Addis Ababa, Ethiopia

** The original version of the paper was presented at the International Rangelands Congress held in Adelaide, Australia, May 1984.*

Summary

AFRICAN PASTORAL *systems are often considered to be relatively unproductive, with poor breeds of animals, poorly fed and badly managed, present in such large numbers that serious rangeland degradation is unavoidable. The large herds are viewed as the result of the pastoralists' irrational attachment to their animals, with prestige and status, rather than economic gain, allegedly being the pastoralists' main concerns.*

An analysis of the Borana pastoral system in southern Ethiopia has shown that this view is wrong. The Borana system is very productive; compared with Australian commercial ranches in a similar climatic environment, the Borana produce nearly four times as much protein and six times as much food energy from each hectare. Their major concern is not the number of cows owned but the number of people supported by the rangeland.

Introducing food crops and legume forages into the Borana pastoral system would effect some improvements. The study suggests that the present Borana family's annual income of approximately US$ 240 could be doubled if a 'package' of improvements were adopted, but an income of US$ 480 is still very modest, and continuing population increases could negate even this advance.

Introduction

East African pastoral systems have been described as inefficient and unproductive, and as making a disproportionately small contribution to national production and export earnings. East African pastoralists have been described as bad range managers and livestock husbandmen, whose communal use of land and poor stock breeding policies have denuded vast areas of rangelands.

Development projects have been aimed at restructuring traditional systems of extensive livestock production in the belief that this would increase offtake and pastoralists' incomes. High stocking rates were alleged to lead to low productivity and degradation of the rangelands. 'Solutions' generally included a reduction of stocking rates and the introduction of 'improved' range management techniques. However, very few of these projects have been successful.

If pastoralists seem unduly attached to unproductive animals, or to anachronistic economic activities or social organisations, this is the result of the environment in which they live, and of the objectives of their society. While there are some intangible 'romance' factors associated with pastoral life, it is more often hard, insecure and uncomfortable.

Pastoralists, like any other human group, will change from one way of life to another if they perceive significant economic and social benefits. They are not opposed to the idea of change but express a healthy scepticism about the advantages it may bring them. Pastoralists can be entrepreneurs but, in an environment where the margin between survival and disaster is slim, and in a production system where the effects of decisions are felt for years, they are naturally cautious.

If pastoralists are indeed rational people, are their grazing systems really as unproductive and inefficient as they have been described? To the pastoralist the basic unit is land, and the productivity per unit area of this land determines how many people can be directly supported. It is this measure rather than the productivity per animal that is important. Work near Athi River in Kenya (Potter, 1979) has shown that while a stocking rate of 0.2 head/ha produced a liveweight gain of 418 g/day/ head and 84 g/day/ha, a stocking rate of 0.5 head/ha produced only 342 g/day/head but 171 g/day/ha. High stocking rates in pastoral systems mean poorer productivity per animal but greater production per unit area.

In African pastoral systems land is a scarce and shrinking resource. Under this pressure, the objective of a pastoral society is to support more people per unit area of arid land and to give them as much security as possible, by maximising food production per hectare. Most pastoralists achieve these multiple goals by increasing the production and consumption of milk, which is far more important for them than the consumption and sale of meat. This objective of pastoral systems has been overlooked in the past, and superficial comparisons with western-type beef ranching systems have led to false conclusions about the efficiency and productivity of African pastoral systems.

The productivity of pastoral systems

The productivity of pastoral systems has usually been measured in terms of market offtake, completely ignoring the food used for human subsistence. The animal protein (AP) and gross energy (GE) produced annually from each hectare are more appropriate comparative indices of productivity. Table 1 shows that the pastoral Borana of southern Ethiopia produce about 2 kg AP/ ha/yr compared with about 1.9 kg AP/ha/yr from ranches in the Laikipia District of Kenya. These ranches are also based on Boran animals and have a better, but comparable, bimodal rainfall regime. In terms of energy output the Borana pastoralists outstrip the ranchers, producing 148 MJ GE/ha/yr from a combination of 10 kg/ha/ yr of animal liveweight gain and 25 kg/ha/yr of milk, compared with 94 MJ GE/ha/yr produced from 18.6 kg/ha/yr of animal liveweight gain in Laikipia.

Table 1. *Livestock production in East Africa and comparable regions*.

System/region	Offtake per year			Annual rainfall	
	(kg L W/ha/yr)	(kg AP/ha/yr[a])	(MJ GE/ha/yr[b])	(mm)	(mode)
Pastoral Borana, Ethiopia	10.0	2.05	148	450–600	bi
Transhumant, Mali	–	0.6–3.2	–	500	mono
Laikipia ranches, Kenya					
Best	31.9	3.25	153	690	bi
Average	18.6	1.9	94	650	bi
Cattle stations, Australia					
Alice Springs District[c]	4.95	0.51	24	300[d]	bi
Barkley Tablelands[c]	3.5	0.36	17	375–300	mono
Victoria River District[c]	4.46	0.45	22	400–900	mono

[a]AP = Animal protein calculated as 0.102 kg/kg LW gain and 0.033 kg/litre of milk. In the Borana system, 0.020 kg is added for edible offal consumed.
[b]MJ GE = Megajoules of gross energy edible by humans. A value of 11.5 MJ/kg of meat and a dressing-out percentage of 51% of which 15% is bone gives values of 4.14 MJ GE/kg LW for the Borana system and 5.04 MJ GE/kg LW for the Laikipia ranches. For the Borana system, 1.2 MJ GE/kg LW was added for edible offal and 3.73 MJ/kg is used for whole milk.
[c]Figures for Australian stations represent the area grazed which is 30–50% of total area leased to the stations.
[d]Area grazed may receive up to 600 mm of rainfall.
Sources: Nicholson and Cossins (1984); Petty et al (1979); Holt and Bertram (1981); Robertson (1983); Kenya Boran Breeders Society (pers. comm.); Breman and de Wit (1983); Foran (pers. comm.); Semenye and Chabari (1980); Agren and Gibson (1968).

Comparable ranches in the Northern Territory of Australia produce less than 30% of the animal protein and less than 16% of the energy per hectare of the East African Borana system (Petty et al, 1979; Robertson, 1983). The Borana pastoral system thus compares very favourably with East African ranching areas in productivity per hectare and outproduces by far ranches in the arid areas of Australia. The starting point for any improvement of the Borana and other pastoral systems in Africa is thus quite high.

The Borana pastoral system produces about as much animal protein as, and 56% more energy per unit area than, commercial ranching in Kenya's ecologically equivalent Laikipia District, and does so more cheaply.

When measured against operating costs and labour inputs, the same set of production indices shows the real differences between pastoral systems and commercial ranches. The costs per unit of production for ranching systems in Laikipia and the Northern Territory are similar, while the costs in the Borana pastoral system are about 10% of those in the ranches (Table 2). Production per man-day, however, is 25 to 50 times higher for ranches in the Northern Territory than it is in the Borana system (Table 3).

Table 2. *Estimates of comparative costs of livestock production in three systems in arid areas*.

System	Production costs		
	(US$/kg LW)	(US$/kg AP)	(US$/100 MJ GE)
Pastoral Borana	0.023–0.046	0.14–0.28	0.17–0.34
Laikipia ranches	0.21	2.01	4.28
Northern Territory ranches	0.20–0.40	1.93–3.89	4.08–8.25

Table 3. *Comparative livestock production per man-day in three systems in arid areas.*

System	Production	
	(kg AP/man-day)	(MJ GE/man-day)
Pastoral Borana	1.04	84
Laikipia ranches	2.5–3.4	116–157
Northern Territory ranches	47–53	2247–2515

Sources: Nicholson and Cossins (1984); Petty et al (1979); Holt and Bertram (1981); Kenya Boran Breeders Society (pers. comm.).

One great advantage of the pastoral system is its abundant labour supply. This feature permits individual treatment and handling of animals, facilitates the intensification of production, and has been largely ignored in development projects. Instead, such projects have concentrated on improving the extensive aspects of pastoral systems.

Pastoralists have been criticised as poor husbandmen, insensitive to rangeland degradation, who keep an unduly high number of females in their herds compared with ranching enterprises. Table 4 shows that this is not necessarily true.

Table 4. *Comparative livestock production parameters in different systems in arid areas.*

System/region	Calving percentage (%)	Calf Mortality (%)	Females as % of herd		Total animal biomass (kgLW/ha)
			adult	total	
Borana, pastoral	75	10–23	42	66	64–73
Maasai, pastoral	76	8–10	33–45	68–73	36–89
Mali, transhumant	56	28	41–42	65–68	–
Laikipia ranches (range)	52–83	5–24	38	62	63–125
Abernossa ranch, Ethiopia	70–78	5	38	73	140
Alice Springs ranches	72–77	5–10	37	59	16[a]
Barkley Tablelands ranches	57	5–10	42	66	13[a]

[a]Calculation based on area grazed.
Sources: Nicholson and Cossins (1984); Semenye and de Leeuw (1984); Debebe (pers.

comm.); Kenya Boran Breeders Society (pers. comm.); Petty et al (1979); Holt and Bertram (1981); Diallo et al (1981); Bille and Ole Pasha (1982).

The percentage of females maintained in the herd depends on the objectives of the cattle owner. The pastoralist's primary goal of milk offtake contrasts with the rancher's goal of meat production, and requires a higher proportion of cows in the pastoral herd. In fact there are many ranches where, for very good reasons such as low calving rates, the percentage of females approaches that found in pastoral herds.

Reproductive performance also should be seen in relation to the objectives of the system and to stocking rates. Pastoral systems, with their focus on production per hectare, may show poorer reproductive performances than ranches when reproduction rates are expressed per breeding female rather than per hectare.

The annual variations in production within systems are often as large as those between systems, and seasonal climatic variations usually have a major influence on calving percentage and calf mortality. Calving percentage at the Athi River station in Kenya varied from 25% to 94% between 1974 and 1979, the major causes being varying rainfall (Potter, 1979) and the susceptibility of Zebu cows to anoestrus as a result of undernutrition during lactation.

If the above data show that there are more similarities than differences in some production parameters between pastoral and ranching systems, there is nevertheless one parameter for which the difference between the two systems is startling. This difference is the basis of the misunderstanding about the productivity of pastoral systems.

Milk offtake

African pastoralists depend on milk for a large proportion of their diet and compete with their calves for this product; ranchers do not. As a result, while the production of animal protein and energy per unit area may be high in pastoral herds, calf growth from birth to weaning is extremely slow. Pastoral animals achieve mature weights much later than do comparable ranch animals; and mature body weights tend to be much lower than those of similar breeds in ranching situations.

The effect of low weaning weights is to slow down the whole reproductive process. The age at first calving is 45 to 47 months in the Borana system compared with 29 to 33 months in a ranch system, and the age at which mature male breeding or sale weights are reached is 5 years rather than 3 years. The weights of Boran animals over 4 years in the Borana pastoral system, on the Ministry of Agriculture ranch at Abernossa, Ethiopia, and on commercial ranches in Laikipia District, Kenya, are shown in Table 5.

Table 5. *Boran cattle weights under different grazing conditions*.

System	Boran cattle weights (kg)							
	Birth		210 days		2 years		4 years	
	M	F	M	F	M	F	M	F
Pastoral Borana	18.2	17.8	48	47	141	129	270	220
Laikipia ranches								
Best	–	–	230	210	430	315	568	400
Average	28	25	121	115	260	232	312	284
Abernossa ranch	26	24	170	140	280	250	475	350

Sources: Nicholson (1983a); Nicholson and Cossins (1984); Debebe (pers. comm.); Kenya Boran Breeders Society (pers. comm.); Semenye and Chabari (1980).

Low calf weaning weights are common to all African pastoral systems. For example, Kenyan Maasai cattle have average weaning weights of 65 kg (Semenye and de Leeuw, 1984) and the cattle in the Mali transhumant system 61 kg (Diallo et al, 1981). To a self-sufficient pastoral society, the production of a regular supply of food in the form of milk is of primary importance. Slow calf growth rates and late maturity are far less important. Milk offtake by the pastoralists ranges from 200 kg/lactation for the Maasai (Semenye and de Leeuw, 1984), to 235 kg/lactation for the Mali transhumant system (Diallo et al, 1981), to 312 kg/lactation for the Borana (Nicholson, 1983). Total milk production per lactation, including the estimated consumption by the calf, is about 800 kg, 430 kg and 680 kg for the three systems respectively.

The differences between the systems in calf growth over the first 210 days of life are striking. Boran calves raised under pastoral conditions gain on average 140 g/day while the same genotype averages 436 g/ day on the Laikipia ranches, 620 g/day at Abernossa, and 914 g/day on the best Laikipia ranch. Thereafter, although direct comparisons are complicated by differences in energy required for maintenance, the rate at which animals gain weight in the different systems is approximately the same. In Ethiopia, Nicholson (1984) has calculated that the approximate energy costs to raise a 450 kg mature steer from grass alone are 35 000 MJ to reach maturity as a 3-year old animal and 63 500 MJ to reach maturity as a 5-year old.

The potential of pastoral systems

Pastoralists and calves compete for milk. Most pastoral systems are characterised by high animal offtake despite traditional theories about the unwillingness of pastoralists to sell their animals. The Borana, for example, sell at least 10% of their herd each year and another 8% is consumed as fallen or slaughtered meat (Negussie Tilahun, 1984). This pattern of offtake is common to other East African pastoral systems.

Increasingly, the income generated by animal sales is being used to purchase grain to supplement the pastoralists' diet. Up to 40% of the income derived from cattle sales by the pastoral Borana is used to purchase grain or grain equivalents (Negussie Tilahun, 1984). Their subsistence diet is summarised in Table 6.

Table 6. *The diet of the Borana: requirements and availability*.

Energy and protein source	kg protein/ha/yr	MJ GE/ha/yr
Animal products directly consumed	1.34	117
Vegetable products purchased[a]	0.34	64
Total available	1.68	181
Total required	1.10	183

[a]1983/84 animal to grain price ratios, i.e. kg liveweight: kg grain, range from 2.0 to 2.4.
Figures do not include sugar, tea and coffee.
Sources: Nicholson and Cossins (1984); Nicholson (pers. comm.); Agren and Gibson (1968); Negussie Tilahun (1984); Economist Measurement Guide (1983).

In addition to meeting his own subsistence food requirements the Borana pastoralist sells produce worth about US$ 2.00/ ha/yr (or US$ 198 to 230 per family), 10% of which comes from butter, ghee and other sales. If there were no livestock sales, and no purchased grain or grain equivalent, then while the system would produce sufficient protein there would be an energy shortfall of approximately 40 MJ GE/ha/yr.

Pastoral systems are thus partially dependent on food grain, a fact which raises the question: What would be the characteristics of the Borana pastoral system if it were commercialised, with nearly all the milk fed to the calves and with livestock offtake and sales maximised. Using existing Boran calving percentages and mortality figures potential animal weights[1], and an offtake rate of 20%, the subsistence and income of the Borana would then be as given in Table 7.

1. Potential animal weights are estimated weights with calves receiving all the milk.

Table 7. *The Borana pastoralists as market-oriented producers*.

	kg LW/ha/yr	kg AP/ha/yr	MJ GE/ha/yr	US$/ha/yr
Production	11.26	1.15	54	
Gross income from sales				5.13
Cost of grain and other subsistence purchases				2.70
Net income after subsistence needs are met				2.43

Sources: Cossins (1984); Negussie Tilahun (1984).

From their gross income of US$ 5.13/ha the Borana would need to buy at least 13.5 kg maize/ha/yr or its equivalent to meet protein and energy requirements. At May 1984 prices this would cost US$ 2.70/ha/yr, so that income after food subsistence needs were met would be US$ 2.43/ha/yr or US$ 238 to 279 per family.

This income might be increased slightly by better range management, but there is little incentive for the Borana pastoralists to change their present production system. The comparison depends critically on the meat to grain price ratio but not on the relative levels of protein or energy production. The market-oriented approach would also yield only 40% of the energy produced by the pastoral system.

At present the Borana system can more or less support itself in most years even if market supplies of grain are small; a change to market orientation would increase food security risks markedly, and increase reliance on external grain producers and market forces. Ethiopia annually receives large food aid grants to offset food crop deficits, which in 1984 probably exceeded 450 000 t. Sub-Saharan Africa imported 24.9 million tonnes of cereals in 1981 (FAO, 1981), and such imports are increasing. From where, might argue the Borana, would the 40 000 to 45 000 t of market grain come that they would require each year? Commercialisation of pastoral systems would also destroy the traditional patterns of income distribution, as it has done for the Somali and other pastoralists in recent years (Swift, 1979). The potential gains are not worth the certain risks. Is it possible, then, for the Borana and other pastoral groups to continue as rangeland dairy producers yet also to obtain much better calf growth rates, so that their system becomes a dairy-beef system?

Improvements

One of the main reasons for the different calf growth rates on commercial ranches and in the Borana system is the 312 kg of milk drunk by the pastoralists each lactation. This is equivalent to about 1164 MJ GE and 10.1 kg AP (Nicholson, pers. comm.) which could be replaced by 124 kg DM of good legume hay (McDonald et al, 1975). Nicholson (1983) has calculated that Boran calves could have reached weights of 105 to 140 kg at 210 days had they had access to the additional energy denied them by milk offtake for humans.

Some Borana families have already begun to cultivate small grain plots in the rangelands (450 to 650 mm bimodal rainfall). This attempt to produce rather than purchase supplementary food grain for humans could be combined with the production of a forage legume, to provide a good-quality supplement for animals. The legume crop would also provide residual soil N for subsequent food crops, in addition to an estimated 3–5 t/family/yr of animal manure that is readily available from Borana encampments where the night enclosures are cleaned out daily. The animal manure contains at least 1% N which adds 600–1000 kg grain/ha to present yields, if applied at about 2 t DM/ha (de Ridder, pers. comm.).

The general idea of forage crop production in rangeland areas is not new. The Muguga research station in Kenya has produced 6 t DM/ha/yr of forage sorghum from a rainfall of 220 mm per crop season (Potter, 1979). The supplementation of animals in other arid African environments has also been the subject of a number of experiments. The specific notion of introducing a forage legume to support an additional cereal crop and to supplement calf growth during the critical birth-to-210-day period in a pastoral system is a new slant on an old idea, as is the notion of pastoralists operating an improved dairy-beef enterprise.

If a pastoral family could produce the 600 to 700 kg DM/year of legume required to supplement its calves, and could also produce 400 kg maize/year and sell its cull animals and steers, then a very favourable production model would emerge. The cereal crop would provide approximately 0.34 kg protein/ha/yr and 58 MJ GE/ha/yr. A further 1.34 kg AP/ha/yr and 117 MJ GE/ha/yr would be provided by the consumption of milk and some meat, and an additional 1 kg maize/ha/yr would have to be purchased to provide all the energy required. This mode of production could provide in 7 to 9 years out of 10 a cash surplus after food subsistence needs were met, of US$ 490 to 575 for each Borana family (Bille, 1982).

Not only could this form of production provide a cash income twice that which might be earned by present subsistence or theoretical commercial production, but the pastoral system would in most years continue to produce directly all the protein and 80% of the energy required by the pastoral population. In Africa today this is crucial.

Many improvements proposed for pastoral systems run into the problem of equitable income distribution. Traditional pastoral systems handled this fairly well in the past: the demands for labour for herding or watering led to the sharing out of a labour-poor but cattle-rich family's animals to labour-rich but cattle-poor families who, in exchange for their labour, obtained milk and meat. This worked well at a subsistence level where the difference between rich and poor was defined in terms of capital rather than income. However, a change to market-oriented production provides the motive for a rich pastoralist to retain direct control over his animals, and labour-saving aids such as engine-driven water pumps, and even fencing, would provide the means to do so. Development and change can often lead to income inequities and poverty; it may therefore be important to retain a subsistence- and resource-sharing orientation amongst pastoralists.

Prospects for development

Most of the improvements attempted in East African pastoral areas to date have been aimed at improving existing patterns of resource use and rangeland management. For example, additional water points can provide a more uniform access to grazing resources.

However, production data presented to date, and the ecological evidence accumulated throughout East Africa, do not demonstrate that pastoralists are bad range managers, or that pastoral areas are deteriorating and productivity is declining (Cossins, 1984). It has been suggested that very little increase in production could be attained in the Borana system by introducing other forms of grazing management (Bille, pers. comm.), and it is foolish to talk about de-stocking in order to increase individual animal productivity and unit area productivity, or about finding ways to syphon-off pastoral populations to alternative areas and enterprises. There is no pastoral system in East Africa today where the animal/people ratio is high enough to provide anything but a subsistence living; removing animals simply creates an impoverished population.

The control of pandemic disease is one improvement that is now easily introduced through vaccination programmes. Such control provides better security of production.

A recent study in West Africa (Breman and de Wit, 1983) showed soil nutrients to be a more important limiting factor on rangeland productivity than water, in areas where rainfall exceeded 300 mm. This might also be the case in some East African rangelands. Work in Zambia has shown that 3 years' application of nitrogen fertilizer changed a *Hyparrhenia* sward into a more productive Star grass*(Aletris farinosa)* sward which persisted for some years, and which could be maintained by further periodic fertilizer application (Potter, 1979). However, the economics of fertilizer use on rangelands are very doubtful.

Marketing is rarely a major constraint. Milk offtake in the Borana system, for example, is already high, and further increases will be limited by constraints on production such as rate of growth. The present marketing system also appears to be relatively efficient, and trading margins are not excessive. Increasing prices may increase the income of pastoralists, but will not increase offtake.

Intensification of production, by increasing calf growth rates while retaining milk offtake and subsistence independence, appears to be the best bet for pastoral systems. In this way pastoral systems, which are already very productive in terms of supporting people and providing a cash income, might be made even more so. Even so, it is sobering to note that African pastoralists will never be well off, in a very modest western sense, unless there are fewer of them per unit area, or unless some completely unforeseen intervention, such as has happened to the suddenly oil-rich pastoralists of the Middle East, occurs.

References

Agren G and Gibson 8.1968. Food composition table for use in Ethiopia. CNU Report No. 16, University of Addis Ababa.

Bille J C. 1983. The climatic risks to livestock production in the Ethiopian rangelands. JEPSS Working Document No. 4. ILCA, Addis Ababa.

Bille J C and Ole Pasha I K. 1982. Olkarkar, Merueshi and Mbirikani areas: A first comparison. ILCA/Kenya Working Document, Nairobi.

Bille J C, Eshete A and Corra M. 1983. Ecology and ecosystems of the Borana deep wells area. JEPSS Working Document No. 13. ILCA, Addis Ababa.

Breman H and de Wit C T. 1983. Rangelands productivity and exploitation in the Sahel. *Science* 221: 4618.

Cossins N J. 1984. Resource conservation and productivity improvement under communal land tenure. Paper presented at the International Rangelands Congress, Adelaide, May 1984.

Diallo A, Wagenaar K and de Leeuw P N. 1981. *Livestock productivity and nutrition in systems research in the arid zones of Mali.* ILCA Systems Study No. 5. ILCA, Addis Ababa.

Economist Measurement Guide and Reckoner. 1983. The Economist Newspaper Ltd, London.

FAO. 1981. FAO *Trade Yearbook, 1981*. FAO, Rome.

Holt R M and Bertram J D. 1981. The Barkley Tablelands beef industry survey, 1980. Technical Bulletin No. 41. Northern Territory Department of Primary Production, Australia.

McDonald P, Edwards R A and Greenhalgh J F D. 1975. *Animal Nutrition.* Second Edition, Longmans, London.

Negussie Tilahun. 1984. Borana household economics study. JEPSS Working Document No. 15. ILCA, Addis Ababa.

Nicholson M J. 1983. Calf growth, milk offtake and estimated lactation yields of Boran cattle in the southern rangelands of Ethiopia. JEPSS Working Document No. 6. ILCA, Addis Ababa.

Nicholson M J.1983a. Sarite cooperative ranch: Cattle growth and production characteristics, 1981 and 1982. JEPSS Working Document No. 11. ILCA, Addis Ababa.

Nicholson M J. 1984. Pastoralism and milk production. In: *Milk production in developing countries.* Proceedings of the international conference held at the Centre for Tropical Veterinary Medicine, University of Edinburgh.

Nicholson M J and Cossins N J. 1984. Animal productivity parameters. Sensitivity analysis. Background paper No. 1. ILCA/RDP, Addis Ababa.

Petty D, Holt R and Bertram J. 1979. Alice Springs district cattle industry survey. Technical Bulletin No. 31. Northern Territory Department of Primary Production, Australia.

Potter H L. 1979. Strategies for the settled pastoralist. *Proc. Boran Breed. Soc.,* Kenya.

Robertson J A. 1983. The Victoria River district cattle industry survey, 1982. Technical Bulletin No. 66. Northern Territory Department of Primary Production, Australia.

Semenye P P and Chabari F N. 1980. Ranch performance under the Kenya Livestock Development Project. ILCA/Kenya Working Document. ILCA, Nairobi.

Semenye P P and de Leeuw P N. 1984. Milk for calves or man in a Maasai pastoral system in East Africa. ILCA, Nairobi.

Swift J. 1979. The development of livestock trading in a nomad pastoral economy: The Somali case. In: *Pastoral production and society.* Cambridge University Presss.

Dairy imports into sub-Saharan Africa and their policy implications*

**This paper is a summary version of Working Paper No. 4 of ILCA's Livestock Policy Unit.*

Valentin H. von Massow
Livestock Policy Unit, ILCA,
P.O. Box 5689, Addis Ababa, Ethiopia

Summary

COMMERCIAL IMPORTS *of dairy products into sub-Saharan Africa increased sixfold over the last decade, reaching US$ 707 million net in 1981 in addition to US$ 140 million worth of dairy products received as food aid. The subcontinent now imports roughly 30% of its total milk consumption. These imports are not evenly distributed: West and central Africa import 46% and 57% of their needs respectively while East Africa imports 13%.*

This paper describes the development of African dairy imports and highlights the factors that have caused their recent tremendous increase. The role of national policies with their objectives and instruments, and possible effects, are discussed and the paper gives a brief assessment of how further research may help solve some of the problems that have arisen.

It is obvious that some countries have an alarming dependence on dairy imports, particularly in the form of food aid. No single reason is readily apparent but, in some countries, national policies have been to blame. In many countries, dairy imports are likely to discourage domestic milk production, particularly where there is direct competition between the production of re-constituted milk from imported milk powder and butter oil, and the local production of *fresh milk.*

However, in the absence of data on milk prices and reliable production statistics, no firm conclusions can be reached for the subcontinent. In-depth studies of individual countries and the effects of their governments' policies for the dairy sector are recommended.

Introduction

The fact that imports exist in sub-Saharan Africa should not in itself be a source of unease. Economic theory provides some clear arguments to show that external trade policies based on the principle of comparative advantage can enhance human welfare in a country, even if substantial imports of certain products occur. However, there tends to be more concern over imports of basic foodstuffs. Governments hesitate to expose their countries to the uncertainties of highly volatile international markets in basic products, particularly foodstuffs, whose supply can affect political stability. Moreover, imports have to be offset by equivalent exports to maintain a balance of foreign exchange. If a country faces an increasing dependence on imported food at a time of acute or latent shortage of foreign exchange, then imports may pose severe problems.

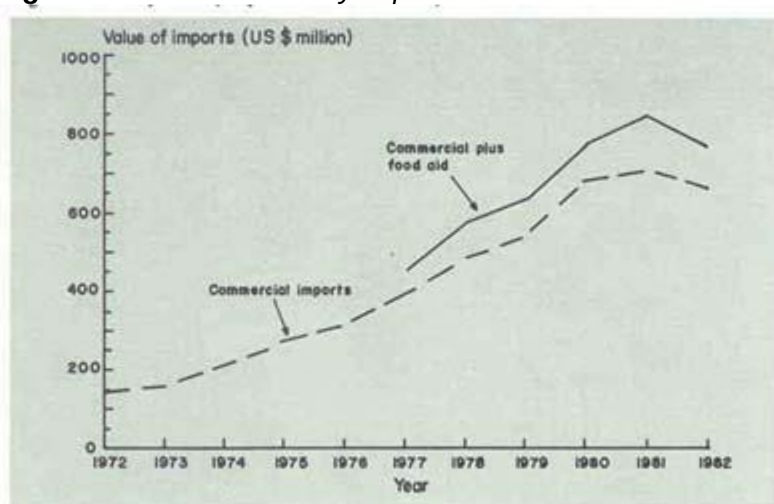
Over the last decade there has been a tremendous increase in dairy imports into sub-Saharan Africa and, in most of the countries concerned, there has also been a chronic shortage of foreign exchange. Given the importance of dairy products, both for human consumption and as a source of farm income, it is vital to study the causes and effects of this development. There is a considerable amount of published literature on the theory of international trade and food policy (see for example Heidhues, 1979; Oyejide, 1983) and there have been several studies of the related problem of cereal imports and policy reactions (McIntire, 1981; Morrison, 1984; Huddleston, 1984). However, there has been no published study of dairy imports into sub-Saharan Africa (see also Eicher and Baker, 1982). This article attempts to correct this deficiency.

Increases in dairy imports into sub-Saharan Africa

Background

Commercial imports of dairy products into sub-Saharan Africa have increased steadily since 1960. According to FAO *Trade Yearbooks* they rose in *value* from US$ 43 million in 1960 to US$ 113 million in 1970 and then to US$ 680 million in 1980. The increase continued in 1981(US$ 707 million) but appears to have come to a halt in 1982 and 1983 (Figure 1). In 1980, sub-Saharan African countries spent approximately 5% of their total revenues from agricultural, forestry and fishery exports on imports of dairy products. Dried and condensed milk made up two thirds of the total dairy imports in 1960 but accounted for almost 90% from 1970 to 1983. This indicates that there has been a shift from imports of items such as cream, yoghurt and cheese, to imports of the more basic dairy products.

Figure 1. *Value of net dairy imports into sub-Saharan Africa, 1972–82.*



Non-commercial imports

Before the commercial import figures are broken down into regional groupings and countries, the role of non-commercial imports of dairy products, in the form of food aid, must be mentioned. The major items of food aid are skimmed milk powder and butter oil which can be recombined to form liquid milk. In 1981, sub-Saharan African countries received as food aid a total of about 88 000 t of dried skimmed milk, and 9000 t each of butter oil and other dairy products (FAO, 1984). This is equal to almost 770 000 t of liquid milk equivalent (LME)[1]. These imports are provided free of charge by the donor, although the recipient country sometimes has to contribute to shipping and/or distribution costs. Valued at current prices of commercial imports (c.i.f.)[2], dairy food aid to sub-Saharan Africa in 1981 was equivalent to almost US$ 140 million, or 16% of the total value of all dairy imports (Figure 1)[3].

1. For the conversion of dairy products into milk equivalents, see FAO (1978a).

2. The c.i.f. import price is inclusive of the cost of insurance and freight.

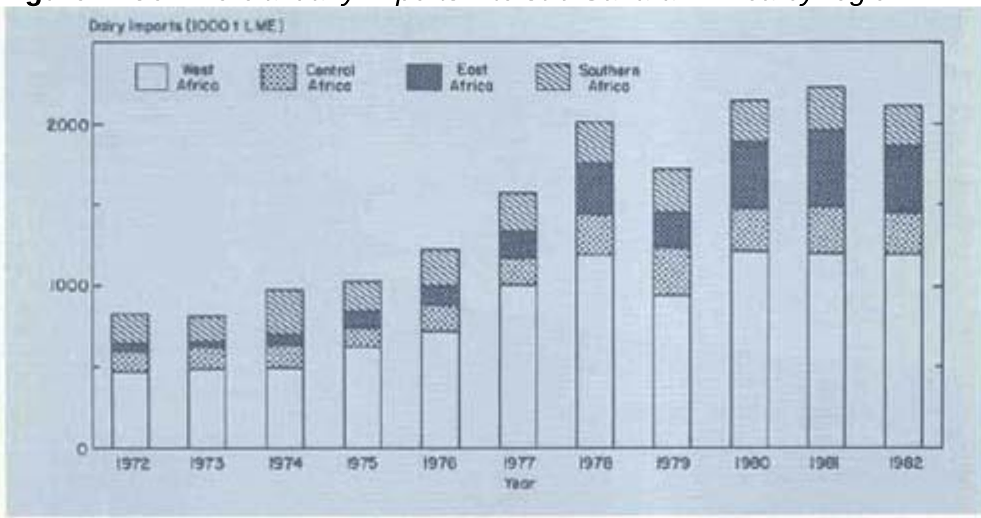
3. Butter oil has been valued at 1.2 times the import (c.i.f.) price for butter according to the price ratio set for the GATT minimum prices (GATT, 1983). 'Other dairy products' have been valued as equivalent to the price of condensed milk. A weighted regional average has been used for those countries and commodities where no price for commercial imports for the year in question is available.

Detailed statistics on food aid are available for the period 1977 to 1981, when food aid increased in volume by almost 140% in LME against an increase of 43% for commercial imports. On average the share of food aid in total dairy imports (in LME) rose from 17% in 1977 to 25% in 1981 and 23% in 1982. Both the quantities of dairy products imported commercially and as food aid have to be considered when the effects of imports on domestic prices, production and consumption are analysed. However, since food aid can be given in various ways, e.g. with special conditions attached to its use or as a direct contribution to domestic supplies, the precise effects of each type of donation have to be carefully analysed for each country.

Dairy import statistics by region

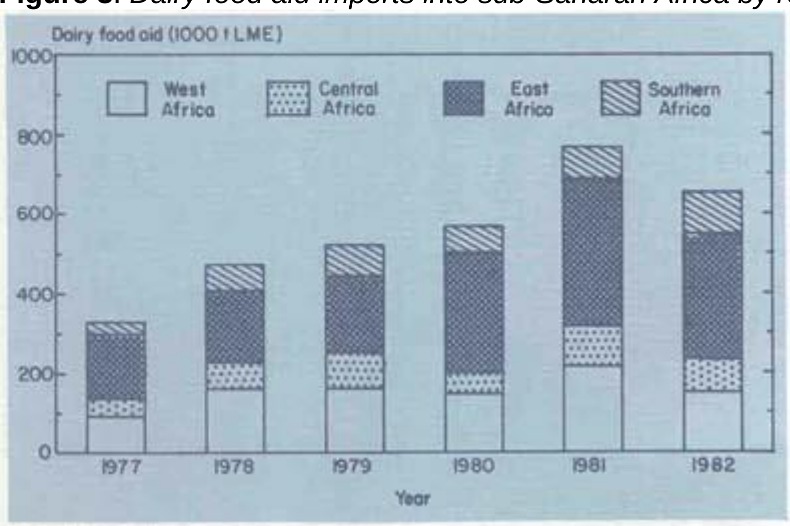
It would be of interest to study dairy imports by ecological zones, but this is not possible given the form of the available data. Instead, all sub-Saharan African countries have been grouped into four regions i.e. West, central, East and southern Africa. As can be seen in Figure 2, West African countries are responsible for most (about 55 to 60%) commercial imports. The other three regions share the remaining 40% more or less equally, although East Africa increased its share from about 5% to 20% in the last decade. There is a different regional pattern for food aid. East Africa receives almost 50% of all food aid deliveries to sub-Saharan Africa (Figure 3), while the share of West Africa fluctuates between 25 and 33% of the total.

Figure 2. *Commercial dairy imports into sub-Saharan Africa by region.*



Source: *FAO Trade Yearbooks* (various years).

Figure 3. *Dairy food aid imports into sub-Saharan Africa by region.*



Source: FAO, 1984.

Further information can be obtained by comparing regional dairy imports per caput. As can be seen from Table 1, only in southern Africa was the volume of commercial dairy imports per caput more or less stable from 1972 to 1982. East Africa showed the biggest increase in commercial imports per caput, from 0.62 kg/head for 1972 to 3.87 kg/head for 1982. Combined food aid and commercial dairy imports per caput increased by 104% from 1977 to 1982 in East Africa. With 8.77 kg/head in 1982, West Africa imports most dairy products per caput.

Table 1. *Net dairy imports per caput by the regions of sub-Saharan Africa, 1972, 1977 and 1982*.

Year	Type of Imports	Net dairy imports (kg LME/caput)				
		West Africa	Central Africa	East Africa	Southern Africa	Sub-Saharan Africa
1972	Commercial	4.12	2.71	0.62	5.25	3.00
	Food aid	n.a.[1]	n.a.	n.a.	n.a.	n.a.
	Total	n.a.	n.a.	n.a.	n.a.	n.a.
1977	Commercial	7.59	3.18	1.70	5.91	4.91
	Food aid	0.71	0.81	1.60	0.82	1.00
	Total	8.30	3.99	3.30	6.73	5.91
1982	Commercial	7.78	4.29	3.87	5.52	5.78
	Food aid	0.99	1.36	2.86	2.36	1.77
	Total	8.77	5.65	6.73	7.88	7.55

[1]n.a. = not available.
Sources: Calculations based on FAO *Trade Yearbooks* (various years), FAO (1978a); FAO (1984) and World Bank (1983).

The dependence on commercial dairy imports and food aid is best illustrated by comparison with total milk consumption i.e. total domestic milk production plus total dairy imports. Although in general milk production data for African countries are not very reliable, changes in import consumption ratios may be used, if interpreted cautiously. These are presented in Table 2 for 1971–73 and 1981–83.

Table 2. *Contribution of commercial, food aid and total imports of dairy products to total milk consumption for the regions of sub-Saharan Africa, 1971–73 and 1981–83*.

Period	Type of Imports	Dairy imports/milk consumption				
		West Africa	Central Africa	East Africa	Southern Africa	Sub-Saharan Africa
1971–73	Commercial	0.26	0.33	0.01	0.23	0.11
	Food aid	n.a.	n.a.	n.a.	n.a.	n.a.
	Total	n.a.	n.a.	n.a.	n.a.	n.a.
1981–83	Commercial	0.41	0.39	0.07	0.25	0.21
	Food aid	0.05	0.13	0.06	0.10	0.06
	Total	0.46	0.52	0.13	0.35	0.27

Note: Consumption is calculated as all liquid milk production plus total imports. All figures are the respective 3-year averages.
Sources: Calculations based on *FAO Production Yearbooks, FAO Trade Yearbooks,* FAO (1978a) and FAO (1984).

The overall dependence on dairy imports was highest in West and central Africa, where imports comprised about 50% of total consumption. In East Africa local milk producers provide most of the dairy products consumed, but the increase in the ratio between commercial imports and consumption between 1972 and 1982 was as large for East Africa as for West Africa. Furthermore, East African countries are more dependent on food aid. In two thirds of East African countries food aid accounted for 40% or more of total dairy imports in 1982, whereas in other regions less than two fifths of countries fall into this category. Five out of the 45 sub-Saharan African countries depend on food aid for more than 50% of their total dairy imports.

Share of total dairy imports in total consumption

When the food needs, incomes and dairy imports of African countries are examined more closely, three broad groupings can be discerned.

There are nine countries (Benin, Congo, Ghana, Ivory Coast, Liberia, Nigeria, Sierra Leone, Togo and Zaire) with less than 20 kg milk consumption per caput that import more than 60% of their requirements. These countries are highly dependent on dairy imports. However, with the exception of Ghana and Sierra Leone, all meet at least 90% of the total calorie requirement of their populations (World Bank, 1983). Dairy imports do not, therefore, appear to play a crucial role in overall human nutrition in these countries. Ghana and Sierra Leone, with lower nutritional levels, are not only dependent on dairy imports but more than 30% of these imports are in the form of food aid. Benin (in common with Central African Republic, Lesotho and Somalia) shows the atypical feature of a high share of dairy food aid in total milk consumption. For the majority of all countries the proportion of dairy food aid decreases with a rising share of total dairy imports in total consumption.

Congo, Ivory Coast, Liberia and Nigeria are highly import-dependent yet have a relatively low per caput consumption. However, all these countries have comparatively high average incomes, i.e. their GNP per caput exceeds US$ 400. Most dairy imports are purchased rather than received as food aid.

The third group comprises nine countries—Burkina Faso, Burundi, Chad, Ethiopia, Malawi, Mali, Somalia, Tanzania and Uganda. Each of these countries has a GNP per caput of less than US$ 300 and receives more than 30% of all dairy imports as food aid. In all of these countries, with the exception of Somalia, more than 80% of the population lives in rural areas.

It is clear that sub-Saharan Africa cannot easily, or quickly, meet its demand for milk from domestic supplies.

Some potential influences

Population growth

The human population of sub-Saharan Africa increased annually by an average of 2.9% from 1970 to 1980 (World Bank, 1981). With all other factors remaining constant, and assuming no changes in demand caused by changes in age distribution, demand for milk would have increased at the same rate. However, commercial dairy imports (in LME) into sub-Saharan Africa increased by an annual average of 9.9% over the same period, indicating that factors other than population must have been influential.

Urbanisation

Rapid urbanisation is widely assumed to boost the demand for imports of all food products. The mechanism behind this is the change of status from one of rural subsistence to that of the urban dweller whose milk demand, given the present stage of agricultural development and infrastructure in many sub-Saharan African countries, cannot be met by domestic supply. In other words, people move to the cities but their milk source does not, The World Bank (1981) reports that urban populations in sub-Saharan Africa have increased overall by 6% a year, and by 8.5% a year for 35 major capitals. However, there is no formula available to translate this growth into a growth of demand for dairy imports.

Income

Incomes in the countries of sub-Saharan Africa increased by an average of 0.8% over the last 10 years (World Bank, 1981). It can be assumed that part or all of this additional income was spent on food, and on milk products in particular. The increase in demand for milk due to rising incomes can be estimated from the income elasticity of quantitative demand for milk which was calculated to be 0.68 for sub-Saharan Africa in the mid-1970s (FAO, 1978b). This means that the demand for milk increases at about two-thirds the rate of the increase in total income. Solely in terms of the income elasticity of demand, an annual growth rate in demand for milk of about 0.54% could thus be expected. However, there are several complicating factors because a population is composed of individuals, not averages. High-income consumers differ from those on a low income, just as urban consumers differ from rural, and consumer preferences can change over time. However, the figure does give an indication of the relationship between income and demand for dairy products.

Consumer prices

The effect of price changes on the demand for milk is well defined by economic theory. Rising prices for milk will, under normal circumstances, lead to a decrease in demand and *vice versa.* The extent of the change is determined by the price elasticity of quantitative demand. Cross price elasticities, which indicate the effects of changes in the prices of commodities that are complementary to or substitutes for milk, can also be defined. However, in practice there are several problems.

Milk can hardly be considered a homogeneous product. Qualitative differences with regard to fat content, purity and, above all, freshness and taste, may well lead to substantial price differences. In many countries reconstituted milk (from milk powder and butter oil) cannot compete at the same price as fresh milk. In many countries the marketing channels are very diverse. Often petty traders compete with cooperatives and/or parastatals, and each tends to provide different services to the consumers. Thus, differences in both the level of service and the quality of milk can have an important influence on price structures.

A special problem is the role of rural producer-consumers. In a system where a significant, if not dominant, share of the milk produced is used for the farmer's own subsistence, it is sometimes hard to determine what his reaction to changing prices will be. The ratio between milk and cereal prices plays an important role in this respect. Again, very little is known about the size, or even the sign (positive or negative), of the cross price elasticity.

Producer prices

Many of the points raised above also apply to producer prices. Again, the economic parameters describing the reaction of subsistence producers are either unknown or incomplete. Even overall estimates of aggregate price elasticities of milk supply are rarely available. There have been efforts to identify the effects of several non-price factors influencing milk supply, and to establish some causal links (McClintock, 1984). However, the results are not encouraging, and only guesses can be made about what caused the decline in African milk production per caput of 0.4% per year over the last decade (see Anteneh, 1984). There is a widespread opinion that milk producers respond significantly to rising prices. With regard to the 'direction' of the effects, economic theory predicts that milk supply will probably increase when the price-cost ratio for dairy production compares favourably with other production alternatives. More detailed case studies may allow us to draw further conclusions. Unsatisfying as this may be, it is maintained here that the price mechanism plays a crucial role in determining both the demand for, and the supply of, milk.

Foreign exchange

The availability of foreign currency to pay for imports is one of the factors that influences imports most directly. In the last decade, balance-of-payment deficits have increased in most sub-Saharan African countries (World Bank, 1981), and this should have curbed rather than stimulated dairy imports. However, many African countries have resorted to market interference, and to controls on exchange rate and currency. Government policy has a decisive influence in this area, but for many countries the limit for expenditures on dairy imports does not yet seem to have been reached.

Food aid

There are two ways in which dairy food aid influences total dairy imports. First, the decision to supply food aid to a particular country is not influenced by the market price for milk in that country; in this respect the availability of food aid must be considered an independent variable. Second, an offer of food aid may well change a country's demand for commercial imports by either complementing them or partly substituting for them.

Only general remarks can be made about the factors which influence the availability of dairy food aid. The EC, the most important donor to African countries, has since 1979 operated within an annual target of 150 000 t of skimmed milk powder and 45 000 t of butter oil. This is allocated to various developing countries and aid organisations or to the FAO World Food Programme (CEC, 1983). There are various forms of dairy food aid. The most frequent are 'food-for-work' programmes, dairy development projects and unconditional or 'emergency' shipments. In all cases the recipient country has to 'apply' for food aid in that a political agreement or contract is required.

No statistics are available to show the relative importance of these different forms of dairy food aid to sub-Saharan African countries. The World Food Programme is committed to dairy projects in nine African countries (FAO/WFP, 1983) but other organisations also cover dairy development, e.g. the EC donations to Mali. Figure 1 shows that the share of food aid in sub-Saharan Africa's total dairy imports increased from 7% in 1977 to 25% in 1981. The present dependence of individual countries has already been described. It is hard to foresee whether the EC's expressed intention to cut back on dairy food aid *(The Economist*, 1984) will stimulate commercial imports or reduce consumption. There may even be a rise in African milk production with the removal of the disincentive effect sometimes ascribed to food aid.

International prices

Relative price differences between individual countries, when translated into absolute price differences (by the exchange rate), are the driving force behind international trade. Relative price differences are due to differing patterns of demand and supply and are relatively constant. When many countries trade in a commodity, countries trading in small quantities have little influence on the world market price that emerges. This lack of influence of 'small' countries certainly applies to sub-Saharan African countries and their role in the world markets for milk products. Assuming no government interference and ample foreign exchange, the ratio between domestic and international prices determines the amount of net imports, ensuring the balance between supply and demand and adjusting domestic prices towards world market levels.

Two amendments to this basic mechanism must be made. First, milk and dairy products are traded mainly in processed forms. With milk the processing charges must be taken into account, unlike wheat for which one can directly compare the import (c.i.f.) prices and the price on the domestic market adjusted for transport costs, storage etc. Although fresh milk is the major domestic dairy product it is rarely traded internationally, and so any comparison of international and domestic prices has to use recombined milk as a substitute. The following example may illustrate the case: skimmed milk powder at a price (c.i.f.) of US$ 1000/t and butter oil at US$ 2500/t can be recombined with water in the proportions of 10% skimmed milk powder, 3.5% butter oil and 86.5% water. Allowing for a processing cost of 10%, the equivalent 'border' price for recombined milk is US$ 0.21/litre. Translated into domestic currency at the current exchange rate and adjusted for transport costs etc., this border price, when compared with domestic prices, determines whether imports will flow in or not. A further complication is that consumers usually recognize a quality difference in favour of fresh milk, and this means that the domestic price for fresh milk can be somewhat higher than the border price of recombined milk, and still remain competitive.

The second amendment to the general theory concerns the effect of government policy. Often heavily distorted exchange rates, import duties, import monopolies and other regulations interfere with the free market assumed in the above example. Because of this interference, any interpretation of the international to domestic price ratio must be adjusted to allow for these policy distortions.

Increases in dairy imports into sub-Saharan Africa are thus caused by a variety of factors. Population growth, urbanisation, income and consumer prices are potential influences on the demand side. The effects of changes in producer prices are probably the main influence on the supply side. Foreign exchange, food aid and international prices also have major direct effects on dairy imports.

The effect of these various influences can be summarised as follows. On the demand side, all factors contribute to rising imports to differing degrees. With regard to prices, both on the demand and supply sides, more analysis is needed in order to judge better their causes and effects. In many African countries prices have been depressed by government policies, and this would further increase the demand for imports. Foreign exchange limitations do not seem to have slowed the increase in total dairy imports, whereas availability of food aid and depressed international prices for dairy products appear to have contributed to the increase. Although varying widely, government policies will have influenced all of these factors and could even have changed the direction of their impact. Some evidence about the potential role of governments in the development of dairy imports in the last decade is given below.

On a sub-continental scale there are few data to quantify the factors influencing international markets. However, an auxiliary calculation, which includes some trend values to allow for different reasons for growth in commercial dairy imports, is given below. Population growth and rising incomes are taken as exogenous factors. No empirical data are available for price changes, government policies and other factors such as shifts in consumer preferences. Thus, the total change in dairy imports (ΔM) is explained below by a term for changes in population (ΔN) plus a term for changes in disposable income per caput (ΔY) minus a term for changes in domestic milk production (ΔQ) plus a residual term (e) comprising all other factors.

The resulting equation is

$$\Delta M = \frac{(\Delta N + \eta . \Delta Y - RSS . \Delta Q + e)}{1 - RSS} \quad (1)$$

The influence of the single factors is weighted by the rate of self-sufficiency (RSS) which is the share of domestic supply in total dairy consumption. Changes in per caput incomes are multiplied by the coefficient of their assumed influence on dairy demand, i.e. the income elasticity of milk demand (η). Table 3 gives results of the calculations for countries listed in order of the magnitude of the residual term. The higher a country ranks in Table 3, the greater are the influences of 'other factors' (i.e. other than population, income and changes in domestic production) on dairy imports.

Table 3. *Indicators of potential policy influence on dairy imports in 29 countries of sub-Saharan Africa*.

Country	Region[a]	Ecological zone[b]	Average annual growth in imports[c] (%)	Share of food aid in total imports[d] (%)	Average annual growth in per caput consumption[e] (%)	Residual term[f]
Zambia	S	SH/SA	–15.0*	0.32	–10.3*	+19.2*
Sierra Leone	W	H/SH	+10.2	0.35	+ 9.3*	+10.0*
Ivory Coast	W	H/SH	+14.4	0.01	+ 8.7	+ 7.6
Somalia	E	A/–	+80.5*	0.49	–14.0*	+ 6.4*
Congo	C	H/SH	+ 8.9	0.08	+ 9.8*	+ 5.4*
Togo	W	SH/H	+12.9	0.18	+ 5.9	+ 4.6
Nigeria	W	SH/SA	+15.4	0.01	+ 6.3	+ 4.5
Liberia	W	H/–	+ 6.5	0.10	+ 3.3	+ 3.2
Niger	W	A/–	–0.7	0.25	+ 3.2*	+ 3.0*
Mauritania	W	A/–	+ 5.5	0.35	+ 1.5	+ 2.3

Uganda	E	SH/H	–1.6	0.43	–0.9	+ 2.2
Malawi	S	SH/SA	+ 1.5	0.41	+ 2.8	+ 1.6
Cent. Afr. Rep.	C	H/SH	+ 3.0	0.30	+ 2.0	+ 1.6
Burundi	C	HL/SH	+35.0	0.40	+ 2.8	+ 0.4
Upper Volta	W	SA/SH	+36.2	0.36	+ 8.0	+ 0.3
Benin	W	SH/SA	+12.2	0.39	+ 1.7	+ 0.2
Ethiopia	E	A/HL	+21.3	0.40	–0.2	–0.2
Senegal	W	SA/A	+ 5.7	0.19	–0.4	–0.3
Mali	W	A/SA	–0.1	0.32	+ 1.2	–0.3
Lesotho	S	n.a.	+10.1	0.51	+ 3.3	–1.2
Guinea	W	SH/H	+ 3.2	0.24	–2.5	–2.7
Ghana	W	H/SH	–2.9	0.30	–5.4	–3.4
Rwanda	C	HL/SH	–3.2	0.95	–2.8	–4.3
Madagascar	S	SH/H	–5.6	0.31	–5.4	–4.3
Cameroon	C	H/SH	+ 8.5	0.17	–1.0	–4.6
Zimbabwe	S	SA/SH	+47.2	0.32	–5.6	–5.1
Sudan	E	A/SA	+ 18.8	0.40	–6.9*	–8.1
Zaire	C	H/SH	–4.2	0.16	–9.2*	–8.5
Tanzania	E	SH/SA	+ 0.4	0.51	–8.6*	–10.1*

* Figures marked thus are considered particularly unreliable.
[a] C = central, S = southern, E = East and W = West Africa.
[b] SH = subhumid, H = humid, SA = semi-arid, A = arid, HL = highlands (see Jahnke,1982, p. 233).
[c] Commercial dairy imports only, from 1972–74 (av.) to 1980–82 (av).
[d] Average of 1980–82 figures.
[e] Consumption = domestic production + commercial imports, for the same period as under note c.
[f] The residual term is the term 'e' in Equation 1; period as for note c.
Sources: *FAO Production Yearbooks, FAO Trade Yearbooks,* FAO (1978a; 1984) and World Bank (1981; 1983).

For example, Nigeria ranks in the upper quarter of Table 3. Commercial dairy imports into Nigeria grew by an average of 15.4% annually even without food aid. Per caput milk consumption increased by 6.3% per year, mainly due to the increase in imports. The residual term of +4.5 indicates that population, income and milk production growth in Nigeria account for only a 10.9% increase in dairy imports. The remaining increase of 4.5% must be due to pricing policy, exchange rate controls, or long-term shifts in demand e.g. substitution of sheep and goat milk for cow's milk. In Cameroon the figures suggest that commercial imports of dairy products would have increased by another 4.6% annually if policy and other factors had not curbed their growth. Per caput consumption declined by 1.0% on average.

Table 3 shows that in 25 out of the 29 countries listed the change in per caput milk consumption, whether positive or negative, was in accordance with the sign of the residual term (e). In two thirds of the countries, growth in imports matched a growth in per caput consumption.

The importance of dairy imports for consumption, and of national policies for the development of dairy imports, is underlined by these results.

Some possible effects of increased dairy imports

The complex interactions between prices, demand and supply in domestic and world markets make it difficult to distinguish causes and effects. On the demand side, population, income growth and urbanisation can be taken as independent variables (although the availability of cheap imported foodstuffs may itself have stimulated migration to the cities). In general, increases in dairy imports have increased the total supply of milk and dairy products in importing countries, thereby halting, or even reversing, upward trends in prices. Consumers in general have benefited from this effect.

Declining producer prices

In the face of declining or stagnant prices, producers can be expected to cut back on dairy production and shift their resources to the production of more profitable items. However, many producers may stay in milk production simply because they have no production alternatives. Similarly, it could be argued that technical innovations, e .g. improvements in management and breeding stocks, would lower production costs and offset the effect of decreasing dairy prices. In Europe, for example, the EC reports an annual average increase in milk yield per cow of 2.2% since 1974, and 3.8% for 1981/82, which is claimed to reflect improved herd structure and quality of milk cows (CEC, 1984). For sub-Saharan Africa, however, virtually no increase in average yield was observed over the last decade, either per productive animal or per total herd. The only regional exception was West Africa which showed a modest improvement in dairy production (Anteneh, 1984).

Unfortunately, the availability and quality of price statistics are very poor for most African countries. It is therefore impossible to quantify, on a sub-Saharan or regional scale, the impact of dairy imports on domestic price levels and production. There have been cases where local milk processing plants have stopped collecting fresh milk because they found it more economic to sell reconstituted milk from cheap milk powder and butter oil imports[4]. There may be a circular effect, with imports depressing local production and this generating even greater demand for imports. Such an effect will approach an equilibrium if prices are not fixed.

4. The dangers of dairy imports are discussed, for example, by the Ministry of Agriculture, Tanzania (1977).

Balance of payments

The level of dairy imports is directly affected by the availability of foreign exchange and variations in the exchange rate. At the same time, growing expenditure on dairy imports poses an additional burden on a country's balance of payments and tends to weaken its currency. The total impact on the economy is not easily quantified, but one can compare the value of net imports of dairy products with total export revenues to get an indication of the burden placed on the balance of payments. It becomes obvious that there are great variations among the countries for which data are available. In those five countries (Burkina Faso, Benin, Mauritania, Senegal and Somalia) that spend a relatively large percentage of total export earnings on dairy imports (5% or more) it is possible that imports have displaced expenditures on long-term development projects.

The role of national policies

It is generally accepted that national policies play a critical role in livestock development (World Bank, 1981). Not only do they modify the overall economic environment for agricultural production, but they often interfere directly with the production processes, marketing channels, and consumption, as well as with external trade.

The use of the word 'policy' requires some explanation. In many cases it is necessary to distinguish between deliberate policies for which governments design effective instruments, and policies which governments publicly espouse but which they know will not be effective. Another distinction needs to be made between policies which are clearly defined and targeted to dairy imports, consumption or production, and other policies, such us the setting of the exchange rate, which are not specially directed towards dairy imports but which may have indirect effects on them. Finally, there is the distinction between policies which are consistent in their effects and those which are not, regardless of the government's original intention. A government may make decisions in two areas which then have a perfectly consistent though unintended influence on a related third area. Consider, for example, a government that devalues its currency in order to comply with IMF or IDA credit requirements, and decides to impose a duty on beef exports to increase its tax revenues. By curbing imports and reducing the profitability of beef production the government produces a consistent policy that also stimulates dairy production.

Objectives of government interference

As Bates (1983) puts it: "Bluntly, food policy appears to represent a form of political settlement—one designed to bring peaceful relations between African governments and their urban constituents". If true, this attitude is in marked contrast to that in most developed countries, especially in the EC, where the overall objective has usually been to support agricultural incomes (Heidhues, 1979).

For African countries it seems appropriate to assume that agricultural policies favour the consumer rather than the producers[5]. What are the possible objectives behind such policies? Three types of objectives can be mentioned: governments aim to survive; they also have general objectives in the area of food policy; and they may have certain, specific objectives relating to dairy imports.

5. Nevertheless, careful examination of existing policies is required, as can be seen, for example, from von Braun and de Haen (1983) who showed that agricultural policy in Egypt was much less at the cost of agriculture than was generally expected.

Food policy is often crucial to government aims because it has direct effects on the population and their goodwill. Therefore, the objectives of food policy, whether to secure food supply, to increase self-sufficiency or to support special groups like city dwellers, are often closely related to government self-interest.

Not all policy objectives are necessarily consistent with each other: they may also be in conflict. Often one objective can only be reached at the expense of others. To try and provide both attractive farm incomes and low food prices—without imposing huge costs on the national budget— is a common example of one objective being sacrificed for the sake of others.

In the field of dairy import policy six common objectives may be distinguished: to meet certain milk consumption targets; to generate tariff revenues; to protect producers against world market competition; to save foreign exchange; to stimulate domestic dairy development; and to realize the benefits of free trade. The starting point for the following descriptions relate to a country that is a net importer of dairy products and whose government has no policy on such imports.

The milk consumption objective

Any increase in milk consumption in a poor country could substantially improve overall nutrition, whether it be that of vulnerable groups like children or pregnant women or that of the whole population. A government wanting to increase milk consumption will have to do so by way of increased imports if domestic production is insufficient or if market links between producers and consumers are weak. The major instruments used to stimulate imports are a reduction in tariffs, import subsidies and (subsidised) state trading and distribution. Alternatively, the government can request food aid. Depending on the instruments used there will be some burden on the national budget.

The tariff revenue objective

If dairy imports already exist, the government can try to make them contribute to the national budget. By imposing an import tariff this will create the desired revenue at the expense of the consumers and/or the external suppliers. Since budgetary considerations are the major force behind such a policy, the economic effects on consumers and producers are given lower priority. There may be a contradiction, and consequent trade-offs, between this objective and a policy that sets consumption targets.

The protection objective

Tariffs to raise tax revenues increase domestic prices over world market prices, and thereby favour domestic production over imports. The same protective wall around local producers can also be erected by introducing quantitative restrictions, i.e. import quotas, or other non-tariff barriers such as quality requirements, port procedures and fees. In any case, the successful protection of domestic milk producers imposes a burden on consumers, either through higher consumer prices or through increased taxes that are needed to finance additional government compensation. The protection objective is not compatible with any objective that seeks increased consumer welfare.

The foreign exchange objective

A government's effort to save foreign exchange has similar effects. Dairy imports, unless they are in the form of food aid or can be paid for in local currency, can be reduced by the same instruments as those used to pursue the protection objective. The primary effects are the same. However, the secondary effects need to be analysed to see whether or not the stimulus to milk production increases the demand for foreign inputs and thus affects the foreign exchange balance. In some situations trade-offs occur between the protection and the foreign exchange and/or the tariff revenue objectives, although some of the instruments used may at first glance appear to serve all three objectives.

The dairy development objective

It may not be immediately clear how a government can develop the domestic dairy sector other than by reducing imports and increasing domestic prices. However, the dairy development objective can be pursued positively by a channelled *increase* in imports. There are two major strategies: the first is based on the assumption that dairy production needs a minimum level of marketing channels and processing facilities to get off the ground. Where production is scattered and insignificant, dairy imports can help create an infrastructure and stimulate demand at the same time. However, many reservations apply and such a policy will usually be only a short-term device. The second strategy is based on the same fundamental assumption but includes the concept of using revenues from food aid sales for investment. As in the Indian 'Operation Flood', dairy food aid can be sold locally to generate funds for dairy development. The same procedure is possible with controlled commercial imports if the balance between domestic supply and demand results in prices above world market levels. It is clear that any such dairy development policy incorporates an array of policy instruments, with those affecting dairy imports being prominent.

The free-trade-benefits objective

In the 'free trade' theory, overall national welfare is considered to be maximised by the undistorted allocation of resources according to their economic value as expressed in international prices. According to the pure theory, governments should not interfere with dairy imports.

However, there is a role for government policy which does not necessarily conflict with the principle of comparative advantage. For example, there may be reasons to offset price movements on the international markets that are not true indicators of the supply and demand situation, but merely reflections of other countries' protectionist policies.

The instruments used to balance out these market defects, e.g. anti-dumping tariffs, will be of a transient nature. They may be supplemented by quality controls, price monitoring and other means to ensure fair competition. The difficulty in such an 'adjusted free trade' policy lies in the inherent temptation for governments to lapse into the protectionist stance they originally set out to combat.

The major instruments and their effects

Import subsidies

Governments can improve milk consumption through import subsidies which can be targeted or non-targeted. A common example of an effort to meet milk consumption requirements of specific target groups is that of a school milk programme in which the government subsidises a particular group. If the government wants to subsidise milk consumption in general rather than that by school children in particular, it can simply subsidise all dairy imports with a fixed amount per tonne. However, even if the same amount of total imports is assumed in each case, the effects are quite different.

The general subsidy will decrease domestic prices and thus have a disincentive effect on producers, whereas the special subsidy to a target group allows them to buy and consume milk that would not otherwise be consumed. The difference between a targeted and untargeted import subsidy is that the latter has disincentive effects on domestic production, whereas a targeting of import subsidy can avoid disincentives, or at least diminish them.

A non-targeted subsidy effect can also be brought about by other countries subsidising their producers whereby world market prices decline. The implications are the same and, as with food aid, the government does not have to pay. This interpretation may well describe what has actually happened: depressed world market price levels, basically due to USA and EC dairy policies, have fuelled Africa's milk demand and dairy imports, thereby hampering the continent's dairy development efforts.

Import tariff

In economic terms a tariff has the opposite effects of an import subsidy. The consumers are the losers since milk consumption and real disposable income are reduced as a consequence of higher prices. However, producers benefit.

Other aspects of government policy

Many African governments have attempted to control trade in foodstuffs directly. They participate in, or even monopolise, import activities by setting up statal or parastatal organisations that often have far-reaching powers. It is hard to generalise about their effects since they can intervene in the market in many ways. Statal or parastatal organisations can be subsidised as well as taxed, can reap monopoly rents or supply isolated areas with high distribution costs at no extra expense. All these activities can substitute, complement or offset dairy import policies, and the eventual effects on production, consumption, trade and welfare are difficult to assess.

In general, state trading tends to act against the market forces rather than to reinforce or complement them. Frequently, through state trading, governments pursue precisely those objectives which the market will not provide for. Keeping consumer prices at an artificially low level despite insufficient supply, or limiting imports in a similar situation, are common examples. This often means an overall decline in welfare. The answer to the question 'Who gains, who loses?' depends on the market situation and on the activity undertaken. The most obvious sign of the effects of state trading against the market forces is the existence of 'black', i.e. free, markets—a common feature of many African countries.

Price policy is another important issue but it is too complex to be thoroughly covered here. In theory, almost all the listed objectives concerning dairy imports can be reached by setting producer or consumer prices. For example, by pushing the domestic milk price below world market levels, a government takes away any commercial incentive to import dairy products, and thereby saves foreign exchange. Any pricing policy, however, faces the major problem of actually controlling administered prices. Sub-Saharan African milk markets in particular, with their abundance of informal marketing channels and direct producer-consumer links, are almost impossible to control effectively. Both Kenya and Mali, to name but two of many possible examples, have at least one milk price with its respective marketing channel in addition to the official, controlled market price (FAO, 1981; 1983).

Some examples of current policies

Dairy import policies do not often feature in African governments' official statements. This is not surprising since they involve details which do not lend themselves to public speeches or election promises, and other products may be considered more important. The result is that information on specific objectives for dairy imports is rare.

Thus, statistics on tariffs, trade regulations and marketing patterns are often hard to find; however, two approximations that are readily available are the relative importance of imports in the domestic dairy sector, and what proportion of these imports is commercial. Both variables are relatively high if the country has followed a policy of relatively open borders. The two criteria selected to identify a relatively open-border policy are whether the share of imports in total milk consumption is over 50%, and whether at least 65% of dairy imports are commercial (Table 4). An interesting pattern emerges. Other than the islands in the Indian Ocean, all 18 countries that meet these criteria are located along the West and central African coastline. Apart from Senegal, none of these countries' dairy imports seem to put a particularly large burden on their foreign exchange account. For Ghana, Nigeria and Senegal the World Bank (1983) states that they have a high or, in the case of Senegal, a medium distortion of the exchange rate, and this may have fuelled dairy imports.

Table 4. *Tentative indicators of an open-border policy with regard to dairy imports for 18 countries of sub-Saharan Africa, 1980–82*.

	Dairy imports as % of consumption	Commercial dairy imports as % of total dairy imports	Value of dairy imports as % of total export revenues
Angola	51	84	2
Cameroon	51	83	1
C.A.R.	56	70	1
Congo	82	92	1
Gambia	68	75	n. a.
Ghana	88	70	1
Guinea Bissau	57	66	n.a.
Ivory Coast	94	99	3
Liberia	94	90	1
Mauritius	77	91	n.a.
Nigeria	66	99	2
Reunion	82	99	n.a.
S. Tome	83	68	n.a.
Senegal	60	81	5
Seychelles	83	88	n.a.
Sierra Leone	69	65	2

Togo	64	72	1
Zaire	91	84	3

Note: All figures are 1980–82 averages.
Sources: Calculations based on *FAO Production Yearbooks, FAO Trade Yearbooks,* FAO (1984) and World Bank (1983).

Again, the speculative character of such calculations must be stressed and before any conclusions can be reached, national price statistics for dairy products must be available.

Kenya and Mali are two countries for which some information is available. Each country contains two markedly different ecological zones and thus features different milk production patterns and supply potentials, i.e. pastoral semi-subsistence and intensive mixed crop–livestock farming. The following descriptions include the findings of country studies within the International Scheme for the Coordination of Dairy Development (ISCDD) (FAO, 1978c; 1981; 1983).

Kenya

Kenya is generally believed to have the potential for meeting domestic milk demand, and throughout the 1970s the trade balance in dairy products showed a modest export surplus. The government encourages development of regional cooperative dairies to improve market outlets; maintains growth of smallholder milk production; aims to improve nutritional levels and to provide 'a stimulus to dairy development' with a school milk programme; and promotes a change to zero grazing systems in the high-potential areas where more than three quarters of all dairy cattle are located (FAO, 1981).

The trade-off between producer and consumer welfare is alleviated by the government's commitment to a school milk programme. The major policy instruments used consist of: setting basic prices at the producer and retail levels; providing artificial insemination, animal health and other extension services; and running the school milk programme. The Kenyan Ministry of Livestock Development (1980) also records the existence of a 50% import duty and a 15% sales tax on dairy products which it wants to be removed at times of strong import demand. Beyond that, no articulate dairy import policy emerges.

However, a rapidly increasing demand and the school milk programme led to a milk deficit in 1979/80; this is likely to persist throughout the 1980s. The policy effect of creating extra demand for milk is obvious in this case and has been realized by the government (Kenyan Ministry of Livestock Development, 1980). Since 1983, the FAO/ World Food Programme (WFP) has provided milk powder and butter oil shipments to support the school milk programme (FAO/WFP, 1983).

One could conclude that the more general measures on the production side, e.g. input provision, could not match the effects of government policy on the demand side. The role of price setting and the adequacy of the marketing system would need further analysis in this respect. The government's reactions, in terms of calling in the WFP and of considering a tax reduction for dairy imports, are well-targeted steps in an import policy, but their effects cannot yet be observed. The Kenyan example shows how easily a fairly balanced market can be disturbed by government interference. It also shows that different periods are needed for policy instruments to become effective: stimulating milk production is unlikely to show quick results, whereas dairy imports and the consumer tend to react immediately to incentives.

Mali

Mali is a country with a low overall potential for intensive milk production. However, the economic importance of livestock is substantial (Wilson et al, 1983; FAO, 1978c). To date, milk policy has had effects only in the Bamako region, where the country's single milk processing plant, Union laitière de Bamako (ULB), is located. This reflects both the government's objective to provide the capital with a reasonable supply of milk and the fact that the majority of milk production in rural areas is consumed at source (FAO, 1978c). Consequently, on the fresh milk market only ULB buying and selling prices are subject to price fixing and government control. However, effects on the domestic supply side are negligible since the plant's output is almost exclusively recombined milk. On the demand side, it is interesting to note that the prices for direct sales of fresh milk in Bamako are about 50% above the official ULB retail price for combined milk. This apparently reflects consumer preferences since no 'black market' for ULB milk exists.

Commercial imports are subject to licensing and foreign exchange allocation, and the parastatal SOMIEX has a monopoly on imports of milk powder and condensed milk in cans. An average of 26 000 t of dairy products (in LME) was imported annually from 1980 to 1982, including about one third as food aid. According to FAO (1983), more than half these total imports are consumed in Bamako. The capital's estimated milk consumption in 1984 was 20 to 25 kg LME per caput. In some parts of the country, especially in the northern pastoral areas, per caput milk consumption is substantially higher.

The main problem is the effect of imports on consumption and production resulting from ULB and SOMIEX policy and price setting. The interactions between ULB and the free market, as well as ULB's role as a market outlet for local milk producers, are crucial for dairy development in the Bamako region (see also von Massow, 1984).

Government policies can be influenced by both the agroclimatic potential and the production system. Government interference seems to be stronger in the 'high-potential' countries, whereas in the case of Mali, policies and their application are uncertain. At least in Kenya and Mali, dairy imports are such that special import policies are considered necessary or are already being pursued.

The contribution of policy research

The above discussion on dairy imports into sub-Saharan Africa and their policy implications has raised a number of issues: the impact of urbanisation on dairy and food imports; differences in demand for fresh vs recombined milk including their respective demand elasticities; the extent to which food aid substitutes or complements commercial dairy imports; and the question of how feasible dairy development along the lines of the 'Operation Flood' in India could be for sub-Saharan African countries.

All these issues should be of considerable interest to policy-makers. However, to foresee the impacts of any dairy import policy, there are two basic requirements: sound information must be available and a synchronisation of the researcher's contribution and the policy-maker's expectations is needed. These two conditions are obviously linked to each other.

The information problem

The set of statistical data that is most needed is that of domestic dairy prices. The close monitoring of a selected sample of markets gives an indication of the success or failure of any policy and enables researchers to advise on any necessary changes. The central role of prices in directing milk production, consumption and imports makes the improvement of price statistics a top priority. Dairy production data are also of great importance but are very unreliable at present. To improve production data is technically and organisationally more difficult than monitoring prices. It would help to monitor the national herds more closely and complement this by systematic analyses of the changes in animal productivity in some of the major production areas. As with prices, the survey emphasis is on continuity rather than absolute completeness of data. A concerted effort in these two areas would yield a high dividend and provide a significant step forward in policy research and formulation.

The congruence problem

Most economists are committed to the ideas and assumptions of the neo-classical theory. However, their perception of a 'welfare-enhancing' policy may be regarded as useless by policy-makers: the economist uses an overall 'social welfare' criterion while the politician may pursue very different targets. The question is how to merge these sometimes conflicting attitudes. Does the economist have to bend to the policymaker's wishes? Or should the policy-maker defer to the economist?

A first step would be to define more clearly the objectives the politician pursues and to see that policy research provides the decision-maker with the relative welfare costs of present or planned policies. To give an example, a government should be informed that while raising revenues of, say, US$ 50 million, an import tariff on dairy products poses a burden of US$ 200 million on consumers' welfare while benefiting producers by only US$ 75 million, i.e. it leads to an overall welfare loss. The policy researchers would then have to consider the alternatives and describe their costs and benefits.

The above assumes that the relationship between policy and research may well remain unequal. Research has to serve policy by providing information about specific policies and their alternatives rather than by presenting one 'optimal' solution. Thus, the inherent claim of the researcher to know better than the politician what might be good for the country or not, is excluded.

This paper, in conclusion, argues that some dairy import policies in sub-Saharan African countries may have to be changed. Policy researchers will have to provide the basic information for policy-makers to make decisions according to their objectives. Both sides should take this as a challenge for cooperation.

Acknowledgements

The author wishes to acknowledge the many contributions from his colleagues in ILCA's Livestock Policy Unit, and to thank Stephen Sandford in particular for his comments and advice.

References

Anteneh A. 1984. Trends in sub-Saharan Africa's livestock industries. *ILCA Bulletin* 18: 7–15. ILCA, Addis Ababa.

Bates R H. 1983. Patterns of market intervention in agrarian Africa. *Food Policy* 8 (4): 297–304.

von Braun J and de Haen H. 1983. *The effects of food price and subsidy policies on Egyptian agriculture.* IFPRI Research Report No. 42. Washington.

CEC (Commission of the European Communities). 1983. Personal communication, DG VIII. Brussels.

CEC. 1984. *The agricultural situation in the Community, 1983 report.* Brussels, Luxembourg.

Eicher C and Baker D. 1982. *Research on agricultural development in sub-Saharan Africa: A critical survey.* MSU International Development Paper No. 1. Michigan.

FAO (Food and Agriculture Organization of the United Nations). *FAO Production Yearbooks.* Various years. Rome.

FAO. *FAO Trade Yearbooks.* Various years. Rome.

FAO. 1978a. Milk and milk products: Supply, demand and trade projections 1985. ESC: PROJ/78/3. Rome.

FAO. 1978b. Parameters of the demand projections (5th run). Rome.

FAO. 1978c. Programme international de coordination du développement laitier et Programme international de développement du secteur des viandes. République du Mali. Rapport final. Rome.

FAO. 1981. International Scheme for the Coordination of Dairy Development. Kenya. Final report. Rome.

FAO. 1983. Programme international de coordination du développement laitier. République du Mali. Rapport final. Rome.

FAO. 1984. *Food aid in figures.* Rome.

FAO/WFP (World Food Programme). 1983. Use of dairy products in WFP projects (mimeo). Rome.

GATT (General Agreement on Tariffs and Trade). 1983. The world market for dairy products. Geneva.

Heidhues T. 1979. The gains from trade: An applied political analysis. In: Hillman J S and Schmitiz A (eds) *International trade and agriculture: Theory and policy*. Boulder, Colorado.

Huddleston B. 1984. *Closing the cereals gap with trade and food aid.* IFPRI Research Report No. 43. Washington.

Kenyan Ministry of Livestock Development. 1980. National livestock development policy. Nairobi.

von Massow V H. 1984. Policy issues related to dairy imports in Africa. Paper presented at the ILCA Conference on Livestock Policy Issues in Africa, held in Addis Ababa, 24–28 September.

McClintock J. 1984. Factors affecting output levels from African livestock sectors: An analysis of available data. *ILCA Bulletin* 17: 10–18. ILCA, Addis Ababa.

McIntire J. 1981. *Food security in the Sahel: Variable import levy, grain reserves, and foreign exchange assistance.* IFPRI Research Report No. 26. Washington.

Ministry of Agriculture, Tanzania. 1977. Price policy recommendations for the 1978/79 agricultural price review. Annex 12: Livestock. Dar-es-Salaam and Rome.

Morrison T K. 1984. Cereal imports by developing countries—Trends and determinants. *Food Policy* 9 (1): 13–26.

Oyejide T A. 1983. Food policy and the choice of trade regime. Paper presented at the IFPRI conference on Accelerating Agricultural Growth in Sub-Saharan Africa, Victoria Falls, 29 August–1 September.

The Economist. 1984. *EC food aid: Mending its ways?* The Economist Development Report. February: 7–8.

Wilson R de Leeuw P and de Haan C (eds). 1983. *Recherches sur les systemes des zones arides du Mali:Résultats preliminaires.* CIPEA Rapport de recherche N° 5. Addis Ababa.

World Bank. 1981. *Accelerated development in sub-Saharan Africa.* Washington.

World Bank. 1983. *World development report 1983.* Washington.

List of abbreviations

AP	animal protein
a.s.l.	above sea level
EC	European Communities
cal	calorie
CEC	Commission of the European Communities (Brussels)
c.i.f.	Import price that includes the cost of insurance and freight
DM	dry matter
GATT	General Agreement on Tariffs and Trade (Geneva
GE	gross energy
GNP	gross national product
IDA	International Development Association
IMF	International Monetary Fund (Washington D.C.)
LME	liquid milk equivalent
LW	Liveweight
mb	millibar
MJ	megajoule
sec	second
SOMIEX	Société malienne d'importations et d'exportations
t	metric tonne
ULB	Union laitière de Bamako
WFP	World Food Programme (Rome)
yr	year