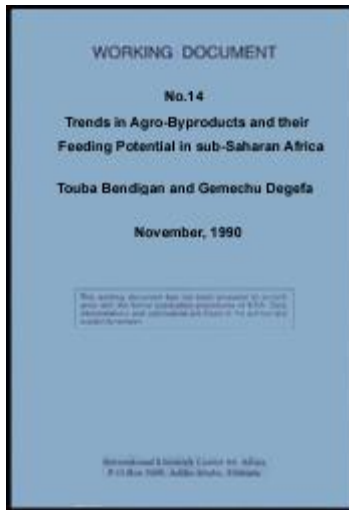


Trends in agro-byproducts and their feeding potential in sub-Saharan Africa

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LED

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1. Introduction

Feed is the most important input in livestock production, and its adequate supply (quantity and quality) throughout the year is an essential prerequisite for any substantial and sustained expansion in livestock output. In Sub-Saharan Africa, animals depend almost exclusively on natural pasture and crop residues with great seasonal variations in quantity and quality. Not only has the rate of growth in livestock output declined over the last two decades, but also the percentage of output growth attributable to productivity per animal rather than to more animals has also decreased (Anteneh, 1984).

Among the major reasons for this low performance, poor animal nutrition is paramount. Feed resources are inadequate in both quantity and quality, with a ration which does not enable African breeds to reach their full genetic potential for meat or milk production. Although it is widely accepted that African breeds are generally of low genetic potential, available evidence indicates that their productivity has been suppressed significantly by inadequate nutrition (Olaloku, 1976; ILCA, 1979; Pullan and Grindle, 1980).

While there is a general consensus that the lack of reliable and adequate feed resources imposes a major technical constraint on increasing livestock output in Sub-Saharan Africa, considerable quantities of agricultural byproducts, particularly molasses, oilcakes and fishmeal are being exported or wasted. Agricultural byproducts are important sources of high-energy or high-protein feedstuffs and therefore can make a substantial contribution to feed supplies, particularly during the dry season when crop residues and natural pasture are scarce. However, their use for animal feeding in Sub-Saharan Africa remains very limited owing to export policies aimed at earning foreign exchange, poor internal transport infrastructure coupled with the great distances involved, the lack of convenient and reliable suppliers, and unfavourable price ratios.

Many experiments in Sub-Saharan Africa, show that some form of mixed ration (roughage, oilcakes, and molasses) could increase the productivity of local breeds. This suggests that the introduction of exotic breeds is not a prerequisite for increasing livestock output in Sub-Saharan Africa. Therefore, improved feeding strategies which include agro-byproducts together with crop residues and natural pasture should allow greater technical efficiency to be achieved in the Sub-Saharan Africa's livestock sector. The purpose of this paper is to review macro data on production and utilization of major agro-byproducts in Sub-Saharan Africa and to evaluate their feeding potential in relation to their nutritive values for cattle feeding systems in the sub-continent. Of the major agricultural byproducts, particular attention is focused on those involved in international trade. These are molasses, groundnut cake, cottonseed cake, sunflower seed cake, palm kernel cake, and fishmeal. The term 'byproduct' will usually refer to molasses, oilcakes, and fishmeal. The analysis of past trends in byproducts is based on FAO computer data base and covered the period between 1961 and 1984.¹

1. The choice of this period is dictated solely by the availability of data. Data after 1984 were not available at the time this paper was written.

2. Trends in major agricultural byproducts: Production, consumption, and trade

Sub-Saharan Africa is a major producer and a net exporter of agro-byproducts. Table 1 summarizes continental production and utilization data for byproducts by region and for Sub-Saharan Africa in 1984. It also shows real export values for by-product other than fishmeal for which data on value are not available. Detailed figures for year 1961 to 1984 are shown in Appendix A for Sub-Saharan Africa and in appendices B to E for West Africa, Eastern Africa, Central Africa, and Southern Africa respectively. Figure 1 describes the patterns of total real export value² of byproduct exports between 1961 and 1984 by region and for Sub-Saharan Africa.

2. Real export value is derived from the nominal export value deflated by the consumer price index for industrial countries.

Table 1 shows that Sub-Saharan Africa produced about 1.3 million metric tons (mmt) of molasses in 1984, but only 35 percent of it was used as animal feed. The rest was shared between exports and other uses or wasted. Table 1 also indicates that 442 thousand metric tons (tmt) of groundnut cake, 497 tmt of cottonseed cake, 63 tmt of sunflower seed cake, 271 tmt of palm kernel cake, and 29 tmt of fishmeal were produced in Sub-Saharan Africa in 1984. The utilization of these byproducts as feed was relatively much greater than that of molasses while exports in 1984 were moderately below their 1980 levels (see tables in Appendix A).

The estimates from table 1 also reveal that in 1984 Southern Africa was the major producer of molasses, followed by Eastern Africa, West Africa, and Central Africa in that order. West Africa dominated in groundnut cake, palm kernel cake, and fishmeal production while Eastern Africa and Southern Africa dominated in cottonseed cake and sunflower seed cake production respectively. Regional trends in these byproducts are presented in the subsequent sections.

Table 1. *Production, utilization and real export values of by-products in Sub-Saharan Africa, 1984.^a*

Region		Molasses	G. nut* cake	C. seed* cake	SF. seed* cake	Palmk.* cake	Fish meal
West Africa	Production	160	270	93	NA	211	26
	Feed use	31	190	43	NA	173	6
	Exports	43	102	53	NA	43	22
	Real Exp. value	767	15372	7975	NA	4844	NA
East Africa	Production	415	84	268	21	NA	0
	Feed use	235	50	210	21	NA	2
	Exports	101	101	34	0	NA	0
	Real Exp. value	3144	4954	4176	0	NA	NA
Central Africa	Production	77	53	48	8	57	3
	Feed use	57	53	40	8	33	1
	Exports	13	0	7	NA	23	2
	Real Exp. value	537	0	322	NA	1917	NA
Southern Africa	Production	603	36	87	34	NA	1
	Feed use	118	33	87	34	NA	2
	Exports	283	7	4	0	NA	_ _b
	Real Exp. value	13650	514	667	NA	NA	NA
SSA	Production	1255	442	497	63	271	29
	Feed use	441	327	381	63	210	11
	Exports	441	210	98	0	67	25
	Real Exp. value	18098	20840	13140	0	6761	NA

Source: Derived from "FAO Agricultural Supply/Utilization Accounts Tape, 1985", Rome, 1987.

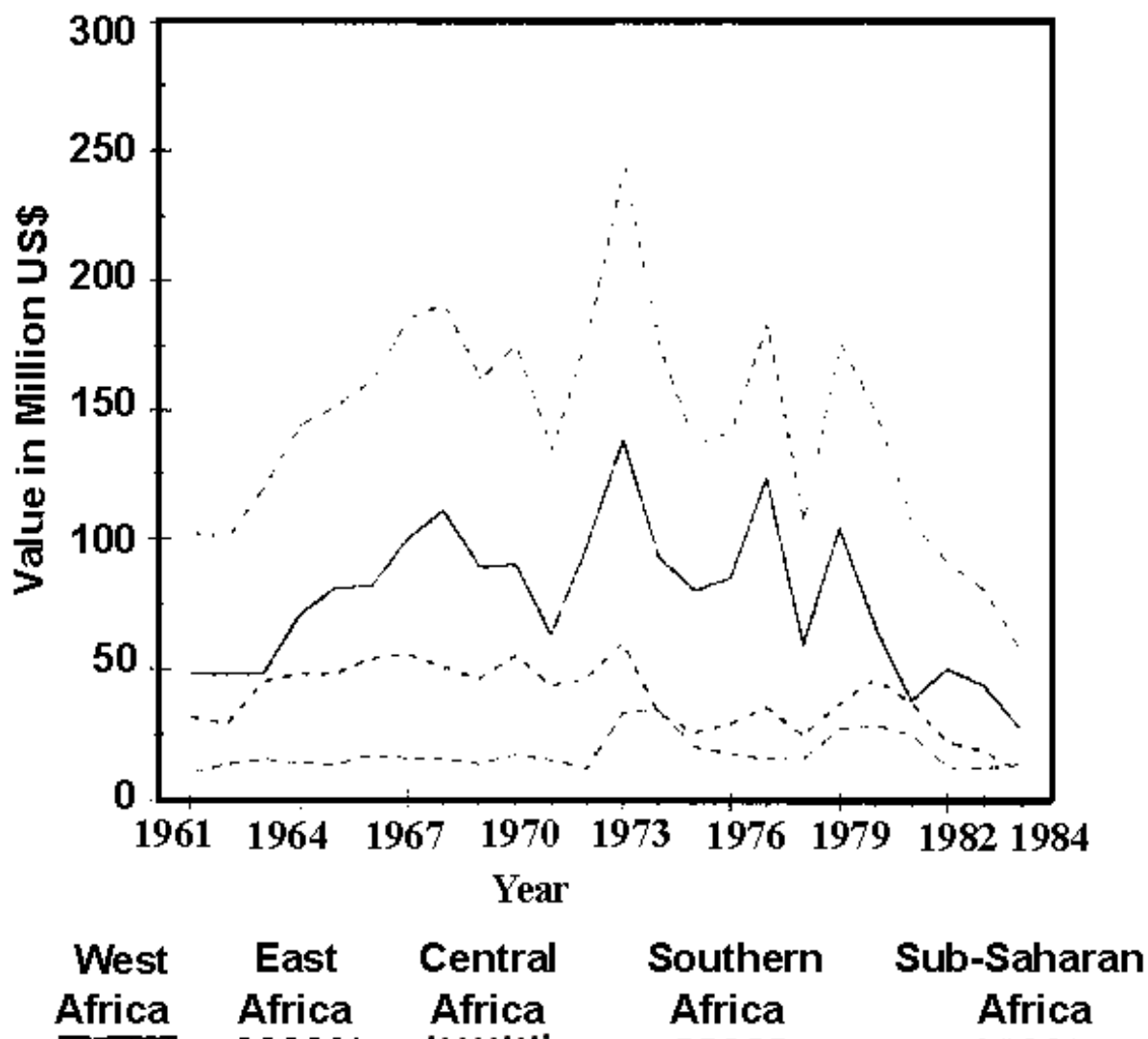
a. Quantities are in 1000 metric tons and values are in 1000 US dollars.

b. Less than half of the unit.

NA: not available

* G. nut - Groundnut; C. seed = Cotton seed; SF = Sunflower; Palmk.= Palm kernel

Figure 1: Real export value of by-products by region and by sub-Saharan Africa (SSA) as a whole.



2.1 Production and utilization of byproducts in West Africa

2.1.1 Production

West Africa led the rest of Sub-Saharan Africa in the production of groundnut cake and palm kernel cake between 1961 and 1984. It also became the top producer of fishmeal between 1978 and 1984, displacing Central Africa which has been the leading producer of this byproduct since 1961 (Appendix B. table 5).

Groundnut cake is the major byproduct in West Africa. Its production showed intermittent growth during the study period with its highest level in 1976 and lowest level in 1981 (Appendix B. figure 2). This decrease was most likely caused by the drought during the 1970s and the sharp

increase in world soybean production over the same period (Hamby, 1978). Increased soybean production is probably a determinant factor since it has depressed the prices of the competing oilseed crops such as groundnut and others. As a result, there was pressure on governmental agencies to offer low prices for oilseeds, which has not stimulated production. With reduced oilseed production, byproduct production is also reduced. This was witnessed by a marked decrease in groundnut cake production in 1974 in Nigeria, the second largest producer after Senegal and in a shut down of the groundnut oil factory (SEPAMA) in 1982 in Mali.

Palm kernel cake is the next major byproduct in West Africa with Nigeria accounting for the bulk of production. Unlike groundnut production, palm kernel cake production was not severely affected by drought because the palm tree is drought resistant. Its production has grown steadily from 75 tmt in 1970 to 211 tmt in 1984. Figure 4 (Appendix B) generally indicates that palm kernel cake production was on an upward trend during the study period.

Fishmeal is the fifth important byproduct over the period of 1961–1984 in terms of quantity produced in West Africa. Fishmeal production is concentrated in only three countries of the West African region with Mauritania, the leading producer, followed by Senegal and Cote d'Ivoire. Figure 5 (Appendix B) shows the major characteristics of the production patterns between 1961 and 1984.

Until 1965, molasses was not recorded as produced in West Africa. Since 1966, recorded molasses production has been expanding steadily to reach its peak at 180 tmt in 1983 (Appendix B, table 1). Until surpassed by Senegal and Cote d'Ivoire in the mid-1970s, Nigeria, Mali, and Ghana were the major producers of molasses. In 1983, Senegal and Cote d'Ivoire together produced 68 percent of total molasses in West Africa.

Cottonseed cake is also a significant byproduct in West Africa. Its production has increased steadily between 1961 and 1974, dropped in 1975, then was strengthened again until 1977 and increased at a lower rate thereafter (Appendix B, figure 3).

2.1.2 Consumption as feed

In general, the utilization of agro-byproducts for animal feeding in West Africa has been increasing since 1961, but still remains low in comparison to total supply in the region. As expected, West Africa is also a leading consumer of groundnut cake as feed in Sub-Saharan Africa. Among the countries of the region, Nigeria was apparently the major user of groundnut cake as feed between 1961 and 1981.

The consumption of molasses, cottonseed cake, and palm kernel cake increased sharply between 1972 and 1984 (see figures in Appendix B). Most of this increase may be caused by increasing awareness of the feeding values of these byproducts as a result of many feeding experiments and livestock development projects which took place in West Africa during this period.

2.1.3 Trade

West Africa is a net exporter of oilcakes, molasses, and fishmeal. Groundnut cake still leads all other feed exports despite its downward trend since 1972 (Appendix B, figure 2). Its real export value reached a record high of US\$ 124 million in 1973 when 368 tmt were exported, 51 percent higher than the real value level in 1970 when 403 tmt were exported. This increase in real export value can be attributed mainly to rising prices due to increased demand for byproducts from livestock feeders in importing countries who switched from feedgrains to byproducts to cut down their cost of production.

Exports of cottonseed and palm kernel cakes, fishmeal, and molasses are also of considerable importance. Cottonseed cake exports followed almost the same pattern as those of cottonseed cake production and increased sharply from their 1975 level (Appendix B, figure 3). Palm kernel cake exports came third after groundnut cake and cottonseed cake exports. However, since 1980 they have been decreasing due to increased domestic consumption as feed (Appendix B, figure 4). Until 1969, fishmeal exports matched production exactly. Thereafter fishmeal production and exports diverged but followed the same patterns (Appendix B, figure 5). Although, exports of all by-products showed a general decrease in the 1980s, they still remained major sources of foreign exchange earnings in West Africa. For instance, in 1984 these byproducts earned over US \$28 million (table 1).

2.2 Production and utilization of byproducts in Eastern Africa

2.2.1 Production

Eastern Africa leads the rest of Sub-Saharan Africa in cottonseed cake production and is improving its position as second largest producer of molasses, groundnut cake, and sunflower seed cake. Between 1961 and 1972, the trend in cottonseed cake production was positive. In contrast, negative trends were observed for the period between 1972 and 1981, a dramatic decrease which has been caused by drought and declining world prices of cotton during this period. After 1981, cottonseed cake production was up again, probably due to good weather conditions.

Molasses is the next important byproduct in Eastern Africa. Its production has been increasing steadily since 1961 and the production patterns are similar to those of Sub-Saharan Africa as a whole (Appendix C, figure 1). Groundnut cake is also an important byproduct in Eastern Africa, but its production has not been as steady as that of molasses (Appendix C, figure 2). Groundnut cake production rose from 26 tmt in 1961 to a record high of 240 tmt in 1978 and then dropped sharply to 84 tmt in 1984 (Appendix C, table 2). This decrease can be readily understood in terms of crises which have occurred in the world vegetable oil markets owing to increased soybean production during this period.

Sunflower seed cake and fishmeal are also produced in Eastern Africa. Production of sunflower seed cake showed a steady growth until 1973 and increased tremendously between 1974 and 1978 before becoming somewhat stable thereafter (Appendix C, figure 4). Unlike sunflower seed

cake, fishmeal production showed a declining trend and ceased in 1976 (Appendix C, figure 5). Presumably the continuing exports and use of feed are supplied from imports.

2.2.2 Consumption as feed

Eastern Africa is a major consumer of its byproducts. Molasses consumption levels were close to production and followed similar patterns as production except for the years 1978-1983 when exports surpassed consumption (Appendix C, figure 1). Groundnut cake consumption was relatively low compared to production but the trend has been positive between 1961 and 1980. Thereafter, groundnut cake consumption was slightly reduced as a result of a sharp decrease in production since 1978 (Appendix C, figure 2). Although cottonseed cake dominated byproducts production in Eastern Africa, its consumption was below export levels until the period after 1977 (Appendix C, figure 3).

The utilization of sunflower seed cake as feed was high and kept close pace with production. Between 1961 and 1971, sunflower seed cake consumption was moderate and relatively stable. With the exception of 1974 and 1975, production surpassed consumption between 1965 and 1978 and climbed to a high level in 1980. During the early 1960s and after 1979, all sunflower seed cake production was consumed as feed (Appendix C, figure 4). While production and export of fishmeal in Eastern Africa continued on a declining trend until they ceased in 1976 and 1978 respectively, consumption of fishmeal as feed has been irregular with a positive trend until 1978 and a negative trend thereafter.

2.2.3 Trade

Like the rest of Sub-Saharan Africa, Eastern Africa is a net exporter of byproducts. Despite a drastic decrease in exports of some byproducts during the 1980s, export earnings (in real terms) still totalled about US\$ 12.3 million in 1984 (Appendix C, table 6). Between 1961 and 1984, the total real value of byproduct exports remained relatively stable, giving Eastern Africa second place after West Africa (figure 1).

Cottonseed cake led all byproduct exports until 1978 when molasses and groundnut cake exports took over. Cottonseed cake exports were at their peak in 1970 and dropped sharply to their lowest level in 1984 (Appendix C, figure 3). This drop is apparently due to increased consumption of cottonseed cake in Eastern Africa during this period. Molasses exports have shown a positive trend since 1961, while consumption of molasses as feed has not shown any very definite trend throughout the study period. Exports rose to 187 tmt in 1983 but dropped sharply to 101 tmt in 1984. Groundnut cake exports rose parallel with consumption until 1979 when they dropped sharply due to reduced production (Appendix C, figure 2). Exports of sunflower seed cake and fishmeal were not important in Eastern Africa. Sunflower seed cake exports were initiated in the late 1960s but dropped to zero in the late 1970s, apparently as a result of high utilization for animal feeding in the region. Since 1968 consumption of fishmeal in Eastern Africa has been higher than the production level, while exports followed the same trend as production and were discontinued in 1978 (Appendix C, figure 5).

2.3 Production and utilization of byproducts in Central Africa

2.3.1 Production

Of the four regions, Central Africa is the smallest producer of byproducts. Palm kernel cake dominated byproduct production in the early 1960s, but its production showed a moderate decline since 1961 (Appendix D, figure 4). Within the region, Zaire is the leading producer of this byproduct, holding 67 percent of total production. Molasses, groundnut and cottonseed cakes, in that order, are the next most important byproducts in Central Africa. Molasses production declined slightly between 1967 and 1978, but the general trend from 1961 to 1984 was positive (Appendix D, figure 1). The production of groundnut cake has been rising strongly since 1964, despite a slight dip in 1974 and 1975 (Appendix D, figure 2). Cottonseed cake production trends were negative between 1961 and 1966, but turned strongly positive between 1966 and 1974, since when production has been subject to substantial fluctuation (Appendix D, figure 3).

2.3.2 Consumption as feed

Overall, Central Africa consumed more of its byproducts than it exported (except palm kernel cake). Throughout the study period molasses consumption remained well below production level while its general trend was similar to that of exports until 1977. Consumption as feed rose strongly from 1976 until 1984 (Appendix D, figure 1). Groundnut cake production has been almost entirely used as feed through the period. Figure 2 in Appendix D shows the major characteristics of groundnut cake consumption in Central Africa. While cottonseed cake was also mostly used as feed, palm kernel cake was not significantly used as feed until the late 1970s when exports were reduced (Appendix D, figure 4).

Until surpassed by West Africa in 1977, Central Africa was the major producer of fishmeal in Sub-Saharan Africa. Fishmeal production fluctuated between 1961 and 1972, but the general trend seemed to be positive. The period after 1972 has been characterized by a rather dramatic drop in fishmeal production (Appendix D, figure 5). Angola was the only major producer of fishmeal in the region.

2.3.3 Trade

Central Africa is the smallest producer of byproducts among the regions of SSA and is also the smallest exporter. There were large fluctuations in the total real value of exports (excluding fishmeal for which price data are not available) between 1961 and 1984. Total real export value reached its peak at US\$ 21.0 million in 1972 and dropped drastically to US\$ 2.8 million in 1984 (figure 1). Central African export was mainly dominated by fishmeal until 1975 and by palm kernel throughout the study period. It has also been observed that trends in feed and export of palm kernel were in an opposite direction indicating that higher exports resulted in low level of feed in the region and vice versa. Exports of molasses, groundnut and cottonseed cakes were not significant owing to their high utilization for animal feeding. For instance, groundnut cake exports ceased in 1977, 1983 and 1984, but reached its peak in 1979 with a declining trend thereafter.

2.4 Production and utilization of byproducts in Southern Africa

2.4.1 Production

Southern Africa is third in overall byproduct production after West Africa and Eastern Africa, but is the leading producer of molasses and sunflower seed cake in Sub-Saharan Africa. Molasses production has increased steadily between 1961 and 1984 (Appendix E, figure 1). Sunflower seed cake production increased moderately between 1961 and 1973. Thereafter, the production strengthened dramatically to reach its highest point of 34 tmt in 1984 (Appendix E, figure 4).

Within the region, cottonseed and groundnut cakes, and sunflower seed cake are the most important byproducts after molasses. Cottonseed cake is the second leading byproduct after molasses in Southern Africa. Its production has grown considerably since 1961 to reach a peak in 1973. Thereafter, the production fell off sharply below its 1971 level in 1976 and then strengthened again between 1976 and 1984. However, the growth in this period has been much more moderate than in the preceding period (Appendix E, figure 3). Groundnut cake production, on the other hand, followed the same patterns as those in the other regions of Sub-Saharan Africa. The production trend was positive between 1961 and 1973 and then turned negative between 1973 and 1984. The decrease in this period was probably due to the combined effect of drought and the general price decline for oilseeds owing to drastic increases in soybean production (Marches Tropicaux et mediterranneens, 1983, p. 2841).

Until 1976, there was no fishmeal production recorded and it continued at a minimal level thereafter. Palm kernel cake is the least important byproduct in Southern Africa. Its production revealed patterns of no significant importance between 1961 and 1984 (Appendix E, table 5).

2.4.2 Consumption as feed

Southern Africa consumed most of its byproducts, except molasses and fishmeal. Molasses consumption as feed was relatively low in relation to total production during the period under study while fishmeal consumption was dependent on imports (Appendix E, figures 1 & 5.) The utilization of groundnut, cottonseed and sunflower seed cakes was well above the export levels throughout the period between 1961 and 1984 and kept close pace with production patterns.

2.4.3 Trade

Apart from molasses which was the top foreign exchange earner among traded byproducts, byproduct exports were relatively low in relation to consumption as feed in Southern Africa. Molasses led all byproduct exports, but seemed to be decreasing over the 1980s. The gap between molasses production on the one hand and its export or consumption as feed on the other hand grew sharply after 1975 implying increased use for other purposes or wastage. Exports of groundnut, cottonseed, and fishmeal were not important and sunflower seed cake was exported in only three years out of twenty four.

3. Feed values and feeding potential of major agro-byproducts

3.1 Feed values

Trends in production, consumption, and trade of major agro-byproducts in Sub-Saharan Africa (SSA) have been discussed with a view to establishing their potential availability for animal feeding. In this section, particular attention is focused on the feed values of these byproducts and their feeding potential for cattle.

Molasses and oilcakes in SSA were and are being fed almost exclusively to cattle. Molasses is mostly used as an energy supplement or as a carrier for urea in utilizing non-protein nitrogen (NPN) whereas oilcakes are incorporated into diets as protein supplements. Because of their high protein content, oilcakes could also be used to upgrade low-quality roughage to a maintenance diet. Table 2 provides the nutritional characteristics of the major byproducts in Sub-Saharan Africa. Since variations in feed values of these byproducts are to be expected between byproduct samples and seasons, the nutrient values presented in this table should be taken as averages of information available. Where information on the nutritive value of the byproduct is not available within the Subcontinent, nutrient values from international tables have been taken as proxies.

Molasses

Molasses can be used for all classes of livestock. However, the use of molasses in rations for cattle feeding is more extensive than with any other livestock species. As an energy supplement, molasses can be used as a substitute for grain. As such, molasses has often been used to supplement cattle grazing poor-quality roughages when energy intake is a limiting factor. However, molasses is a poor source of protein (table 2) and needs to be supplemented with urea as a non-protein source of nitrogen for sustaining higher levels of production. The constraint in utilizing high levels of molasses is its toxicity. Experience indicates that molasses may be toxic when fed in large quantities. As a result, recommended inclusion rates do not usually exceed 15% for cattle and 8% for sheep (Gohl, 1981).

Table 2. Feed values of major agro-by products in Sub-Saharan Africa (Data expressed on an As-Fed and Dry Matter Basis for cattle).

Byproduct	Production ('000MT, 1984)	Dry Matter (%)	ME (Mcal/kg) (%)	CP (%)	DP (%)	TDN (%)
Molasses ^a	1255	AF 75	2.47	3.2	1.8	68
		DM 100	3.29	4.3	2.4	91
Groundnut cake ^b	442	AF 94	3.27	46.4	41.7 ^d	83
		DM 100	3.50	49.6	44.6 ^d	89
Cottonseed cake ^b	497	AF 92	2.63	36.5	23.1 ^d	68
		DM 100	2.87	39.8	25.1 ^d	74
Sunflower seed cake ^c	63	AF 93	2.49	41.5	36.9	69
		DM 100	2.68	44.6	39.6 ^d	74
Palm kernel cake ^e	271	AF 92	3.05	18.8	15.9	84
		DM 100	3.31	20.4	17.3	91
Fish meal ^b	29	AF 92	3.38	60.9	54.2	85
		DM 100	3.69	66.2	59.2	95

Sources: a - Crampton and Harris, 1969

b - Kearn, 1982

c - NRC, 1984

d - Calculated by $(DP_a/CP_a) * CP_b$ from 5 - 04 -738 in Crampton and Harris, 1969

e - Gohl, 1981. The values are for sheep, but are taken as proxies for cattle

Note:

ME = metabolizable energy; CP = crude protein

DP = digestible protein;

TDN = total digestible nutrients.

AF = As fed

DM = Dry matter

Groundnut cake

Groundnut cake is generally a safe feed for all classes of livestock. Unlike molasses, the use of groundnut cake has no general limitations in livestock feeding. Groundnut cake has been used as a protein supplement in cattle feeding. However, its low fiber and high protein contents (table 2) make it an even more valuable ingredient for poultry rations. Thus most groundnut cake consumed internally in Sub-Saharan Africa during the 1970s and the 1980s may have gone to poultry because of rapid poultry development during the period. The main constraint to its utilization is its easy contamination by toxic substances due to bad storage. The most dangerous substance is aflatoxin.

Cottonseed cake

Cottonseed cake is an excellent protein supplement for ruminants, but its use in monogastric rations is restricted due to the presence of gossypol. In normal concentrations, gossypol has no toxic effect on cattle, but it has been shown that liveweight gain in beef cattle is reduced when the gossypol content is high. When cottonseed cake is used in poultry and pig rations, levels of up to 10% are usually recommended (Chicco and Shultz, 1977). In Sub-Saharan Africa, cottonseed cake has been used extensively in ruminant feeding.

Sunflower seed cake

While sunflower seed cake has been used extensively in ruminant feeding in temperate countries, it has not received much attention in the literature in Sub-Saharan Africa. Like groundnut cake, sunflower seed cake is also a source of high-quality protein (table 2) and can be used freely in balanced diets for poultry and pigs owing to the absence of toxic compounds. Sunflower seed cake, produced in Sub-Saharan Africa, was almost entirely consumed as feed between 1973 and 1984. Although no information on aggregate feed use of this byproduct by species of livestock is available, much of it has probably been fed to monogastric animals rather than to ruminants.

Palm kernel cake

In spite of its comparatively high oil content, palm kernel is usually dry and unpalatable and is not readily accepted by all classes of livestock. There seems to be no nutritional limitations to its use in ruminant feeding when it is mixed with well-liked feeds. Palm kernel cake is relatively low in protein content as compared to the other oilseed cakes in Sub-Saharan Africa (table 2). Although, some observations (Chicco and Shultz, 1977) indicate that palm kernel cake can be used in rations for monogastrics, it has been largely used in Sub-Saharan Africa for cattle feeding, especially dairy animals where it can serve as the main protein source (Adegbola, 1977).

Fishmeal

Fishmeal is among the best sources of high-quality protein for animals (table 2). In Sub-Saharan Africa, most of the fishmeal fed has probably been used in poultry and pig rations. Much of Sub-Saharan fishmeal production between 1961 and 1984 was exported. However, in some regions, e.g. East and Southern Africa domestic feed use was in excess of domestic production and the gap was presumably filled with imports. Use of fishmeal in ruminant feeding is rare due to its high cost although many experiments with cattle indicate better responses to fishmeal than to other sources of protein (Creek et al, 1974; Preston and Willis, 1974).

3.2 Feeding potential of major byproducts

Protein is an essential nutrient for animals, and more importantly for dairy cows because milk production requires more protein than meat production. This is because when inadequate amount of protein are fed milk production can not be sustained due to the negative effect on the animal's utilization of body fat (Orskov and Dolberg, 1985). Therefore, if good milk yields are to be achieved, protein requirements of dairy cows must be met. For this reason, an attempt is made in

this section to estimate the feeding potential, for protein supplementation of milking cows, of the available oilseed cakes in Sub-Saharan Africa.

In this estimation, annual feed requirements of milking cows made by Crampton and Harris (1969) were used. They assumed that a milking cow, producing 1800 kg of milk annually, needs about 450 kg annually of concentrates (including both energy and protein feeds). Further, based on available dairy feeding practices in Sub-Saharan Africa (Mulder et al, 1973), it is assumed that the concentrate ration should contain at least 14 percent of crude protein. Using the above information and assuming that cereals³ will provide the energy in the diet of concentrates, very crude approximations were made to gain a relative idea on the number of animals these byproducts would supplement. The crudest part of the exercise is the implicit assumption that cereals are in relatively plentiful supply. The results⁴ in table 3 indicate that groundnut cake could have supplemented approximately 6.1 million head of milking cows in 1984 while cottonseed cake would supplement about 5.2 million heads. On the other hand, sunflower seed and palm kernel cakes would supplement about 0.8 and 1.1 million head of dairy cows respectively. This evaluation is made on the assumption that no byproducts would have been exported in 1984 and that they were readily available for supplementing dairy cows. It should be noted that this evaluation omits fishmeal because fishmeal is mostly fed to poultry.

3. It is assumed that cereal grains contain at least 8 percent crude protein.

4. The results in table 3 are derived through the following procedure. The percentage of the protein-rich oilseed cake in the diet of 450 Kg of concentrate per cow is calculated as follows:

$$p(\text{CP}) + (1 - p) * (.08) = 14$$

Where p = percentage of oilseed cake in the diet of concentrates, 1-p = percentage of cereals in this diet, and CP = crude protein content (proportion) of the byproduct. This formula, of course, overlooks the contribution of other feed sources than the 450 Kg of concentrates such as roughages. But, nevertheless, it can provide a good approximation since protein content from roughages is generally low. This percentage is then applied to the annual feed requirement to determine the requirement per animal and per year for oilseed cake. Total byproduct available is then divided by oilseed cake requirement per animal to obtain the approximated number of milking cows the byproduct can supplement every year.

Table 3. *Feeding potential of major agro-byproducts in Sub-Saharan Africa in 1984.*

Byproduct	Production (' 000 MT)	Requirement/animal/year (Kg)	Dairy herd potentially supportable ('000 head)
Groundnut cake	442	72	6139
Cottonseed cake	497	95	5232
Sunflower s. cake	63	81	778
Palm kernel cake	271	243	1115
Molasses	1255	400	3138

The above calculations were based on the assumption that cereals would provide the energy in the diet of concentrates. However, if cereals were to be replaced by molasses, a cow, producing 1800 kg of milk per lactation, would require about 400 kg of molasses per year. This implies that the quantity of molasses available in 1984 would supplement about 3.1 million head of milking cows (table 3).

4. Summary and conclusions

The trend analysis reveals that Sub-Saharan Africa is a major producer and a net exporter of agro-byproducts. The domestic consumption of these byproducts as feed has been increasing but has still remained relatively low in relation to total production. Exports of byproducts still remained a major source of foreign exchange earnings in Sub-Saharan Africa. On a regional basis, West Africa dominated in byproduct production as well as in exports, followed by Eastern Africa, but the latter consumed more of its byproducts than it exported.

A review of the nutritional characteristics of byproducts indicates relatively high nutritive values with generally no major nutritional limitations in livestock feeding. Moreover, oilcakes have a high feeding potential for milking cows. Due to their relatively high protein content and if readily available, these byproducts can supplement a substantial number of dairy cows every year.

Many experiments indicated the technical feasibility of supplementary feeding with byproducts in Sub-Saharan Africa. However the economic viability of such supplementation depends not only on the technical relations between feed input and livestock product, but also on the ratio of their prices. Such ratios, due to transport costs, national policies and differences in the balance between domestic supply and demand, vary greatly between countries. For some countries, it makes economic sense to feed byproducts to increase domestic livestock production. For other countries, it may make more sense to export them to be fed in other countries where the price ratios are more favourable.

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Appendix A: Tables

Table 1. Molasses production, utilization and nominal export value¹ in Sub-Saharan Africa

Year	Production	Feed	Export	Export value (US \$ 1000)
	MT			
1961	404991	163707	98370	1480
1962	420344	174351	150108	2382
1963	470229	184402	197912	3744
1964	457784	197495	196075	3248
1965	516681	222130	197435	2143
1966	579806	248418	299931	4283
1967	631962	208205	295847	4933
1968	645367	251409	347160	4637
1969	734392	238589	347460	4829
1970	750278	289576	318276	4373
1971	748469	253300	403623	4813
1972	779793	262461	394204	3564
1973	802953	216404	486785	13635
1974	781382	268035	418617	17091
1975	747711	238833	392827	11783
1976	842839	248879	388659	12911
1977	897205	271969	452338	12089
1978	928468	317658	404770	13219
1979	1032132	328258	481193	29307
1980	1049335	287579	579894	49532
1981	1132186	340649	638673	46886
1982	1231372	345803	590410	26067
1983	1253800	355093	574322	25414
1984	1255350	440699	440637	38443

1. i.e. at current prices

Table 2. Groundnut cake production, utilization and nominal export value¹ in Sub-Saharan Africa

Year	Production	Feed	Export	Export value (US \$ 1000)
	MT			
1961	411265	122415	304744	18268
1962	436306	137062	292689	18233
1963	491269	137969	293434	20154
1964	614235	168935	411480	29087
1965	568409	134667	378475	31475
1966	618092	128769	413335	30370
1967	541333	141215	484569	38620
1968	609561	157113	529961	44337
1969	618222	168940	444953	35891
1970	637391	182334	462990	41082
1971	542529	210367	303318	28039
1972	697046	206115	538116	48827
1973	721440	241270	425361	75111
1974	590139	253887	291619	49673
1975	715339	243815	411702	48466
1976	773408	282318	484403	54771
1977	809998	293292	488022	87434
1978	634323	336724	288580	45957
1979	773431	350138	409209	83163
1980	628776	394717	309217	52821
1981	491296	411093	132307	23169
1982	637756	400771	297984	48630
1983	598766	321414	302001	42971
1984	442384	326575	209935	27175

1. i.e. at current prices

Table 3. Cotton seed cake production, utilization and nominal export value¹ in Sub-Saharan Africa

Year	Production	Feed	Export	Export value (US \$ 1000)
	MT			
1961	200461	40095	176129	10454
1962	221637	48227	171633	10423
1963	226929	38954	217745	14429
1964	251144	55116	233254	14864
1965	301344	57983	268675	17687
1966	325588	62035	280103	19674
1967	372222	60277	273265	18802
1968	345634	57592	301344	17991
1969	395106	73284	301055	18896
1970	448530	119975	372028	23901
1971	450050	143233	321925	21257
1972	480943	145201	332843	21540
1973	448090	198249	244190	28754
1974	531536	216590	209280	22280
1975	413247	208753	221534	18216
1976	354390	202983	222843	22068
1977	413297	189124	196505	30170
1978	467661	285372	147630	17865
1979	415564	255027	176005	23807
1980	410341	270269	154526	21936
1981	401093	277133	129699	28512
1982	420930	281001	122840	18896
1983	467402	309463	124058	20143
1984	496576	380543	97946	17135

1. i.e. at current prices

Table 4. Sunflower seed cake production, utilization and nominal export value¹ in Sub-Saharan Africa

Year	Production	Feed	Export	Export value (US \$ 1000)
	MT			
1961	5211	2461	4750	0
1962	4399	2029	2370	0
1963	4991	3211	1780	0
1964	6052	4292	3760	0
1965	6588	3020	3268	0
1966	6145	2697	2848	0
1967	6986	2743	3843	8
1968	5447	3356	2343	26
1969	5628	1580	5840	137
1970	7671	4255	5350	173
1971	7141	4508	2634	11
1972	9835	6282	6078	143
1973	10604	6730	3874	172
1974	19499	18911	2031	138
1975	26566	27531	631	83
1976	37942	34541	3401	324
1977	43848	43160	688	127
1978	46025	45196	829	151
1979	49290	46790	2500	380
1980	53753	53753	0	0
1981	58176	52410	0	0
1982	53504	53504	5766	0
1983	57461	57461	0	0
1984	62998	62998	0	0

1. i.e. at current prices

Table 5. Palm kernel cake production, utilization and nominal export value¹ in Sub-Saharan Africa

Year	Production	Feed	Export	Export value (US \$ 1000)
	MT			
1961	82789	32428	49540	2784
1962	76526	30916	40550	2189
1963	68475	17902	34001	2278
1964	78656	25262	47226	2682
1965	85079	27056	53890	2771
1966	121543	28803	79080	5487
1967	143748	29713	110596	7917
1968	132688	29714	116465	8283
1969	148333	36828	113649	7459
1970	131683	23974	104200	6884
1971	148507	27536	112212	7579
1972	142105	26707	114938	12512
1973	145234	35647	93677	8530
1974	157823	48332	118701	13306
1975	161745	62932	97596	10427
1976	162734	67971	91203	9802
1977	169624	73593	84531	10735
1978	180442	95158	87684	11104
1979	248688	135481	110407	21031
1980	258223	112514	141106	25327
1981	261186	152517	114169	19558
1982	284051	181496	101355	15469
1983	269618	180679	88639	13011
1984	271383	209794	66589	8816

1. i.e. at current prices

Table 6. Fishmeal production and utilization in Sub-Saharan Africa²

Year	Production	Feed	Export
	MT		
1961	56200	7050	51200
1962	33720	6420	33300
1963	33620	8470	28800
1964	57440	7240	55400
1965	47120	8800	49200
1966	49120	10272	54700
1967	42300	12100	37900
1968	48200	11800	46600
1969	92500	16100	95100
1970	70900	16500	69200
1971	62400	17700	59000
1972	140400	19600	131700
1973	107700	15000	99500
1974	74800	14600	71800
1975	589420	11670	58100
1976	20156	11102	16797
1977	16271	7262	14802
1978	20470	19936	17963
1979	17701	17006	14677
1980	23375	15864	18598
1981	19226	15824	13595
1982	24911	19174	19910
1983	44954	17515	38665
1984	29474	11265	24619

2. Data on the export value of fishmeal are not available.

Table 7. Real¹ export value of byproducts in Sub-Saharan Africa

Year		Groundnut	Cotton	Sunflower	Palmkernel	TOTAL REAL EX. VALUE
	Molasses	seed cake	seed cake	seed cake	Cake	
(US \$ 1000)						
1961	4596.27	56732.92	32465.84	0.00	8645.96	102440.99
1962	7218.18	55251.52	31584.85	0.00	6633.33	100687.88
1963	11076.92	59627.22	42689.35	0.00	6739.64	120133.14
1964	9387.28	84066.47	42959.54	0.00	7751.45	144164.74
1965	6002.80	88165.27	49543.42	0.00	7761.90	151473.39
1966	11607.05	82303.52	53317.07	0.00	14869.92	162097.56
1967	13015.83	101899.74	49609.50	21.11	20889.18	185435.36
1968	11769.04	112530.46	45662.44	65.99	21022.84	191050.76
1969	11692.49	86903.15	45753.03	331.72	18060.53	162740.92
1970	10029.82	94224.77	54818.81	396.79	15788.99	175259.17
1971	10485.84	61087.15	46311.55	23.97	16511.98	134420.48
1972	7425.00	101722.92	44875.00	297.92	26066.67	180387.50
1973	26373.31	145282.40	55617.02	332.69	16499.03	244104.45
1974	29215.38	84911.11	38085.47	235.90	22745.30	175193.16
1975	18127.69	74563.08	28024.62	127.69	16041.54	136884.62
1976	18365.58	77910.38	31391.18	460.88	13943.10	142071.12
1977	15844.04	114592.40	39541.28	166.45	14069.46	184213.63
1978	16140.42	56113.55	21813.19	184.37	13558.00	107809.52
1979	32818.59	93127.66	26659.57	425.53	23550.95	176582.31
1980	49532.00	52821.00	21936.00	0.00	25327.00	149616.00
1981	42584.92	21043.60	25896.46	0.00	17763.85	107288.83
1982	22016.05	41072.64	15959.46	0.00	13065.03	92113.18
1983	20429.26	34542.60	16192.12	0.00	10459.00	81622.99
1984	29480.83	20839.72	13140.34	0.00	6760.74	70221.63

1. i.e. nominal export values are deflated by consumer price index (CPI) for industrial countries.

Appendix A: Figures

Figure 1. Molasses production and utilization in sub-Saharan Africa (1961–1984)

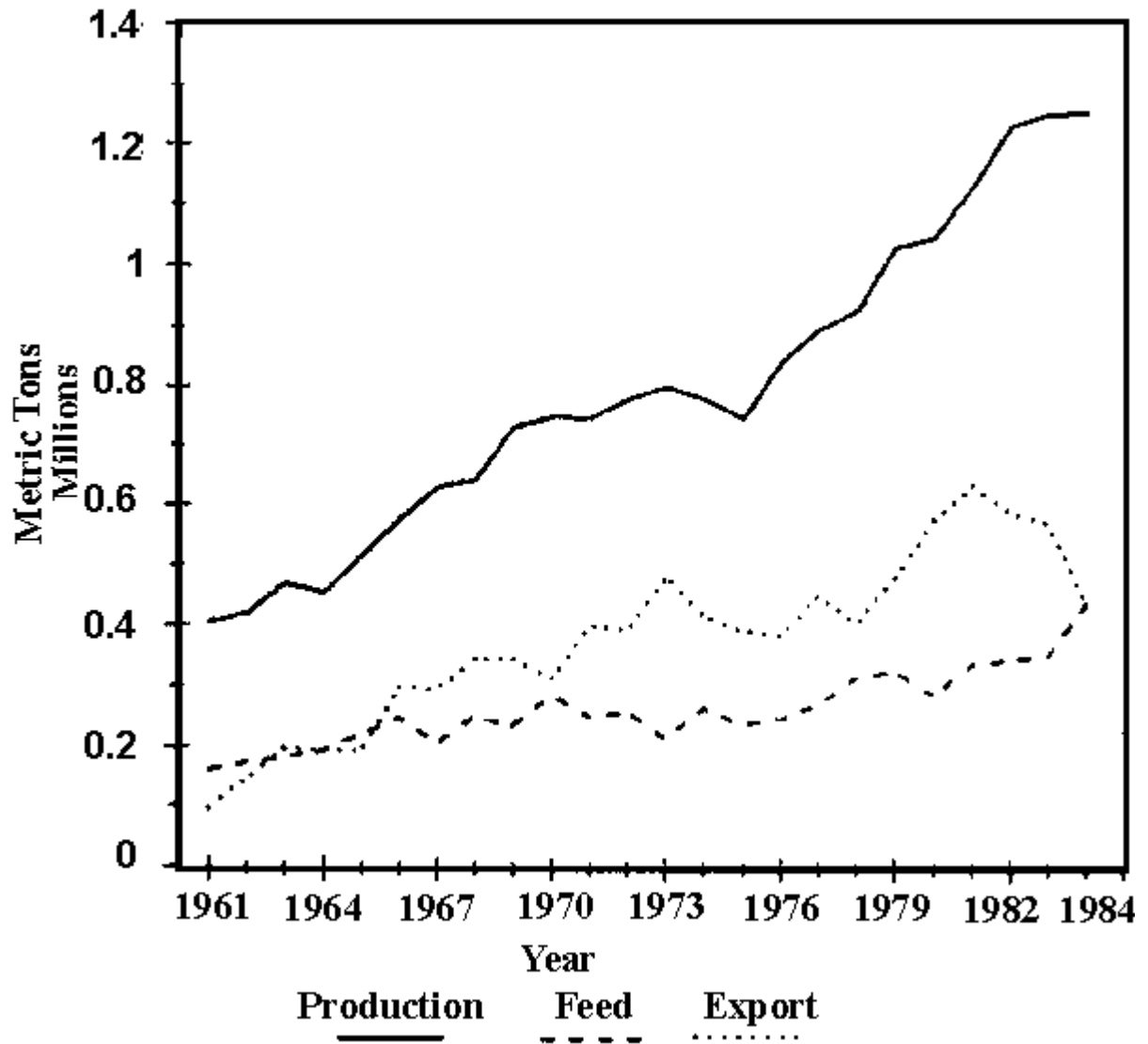


Figure 2. Groundnut cake production and utilization in Sub-Saharan Africa (1961–1984)

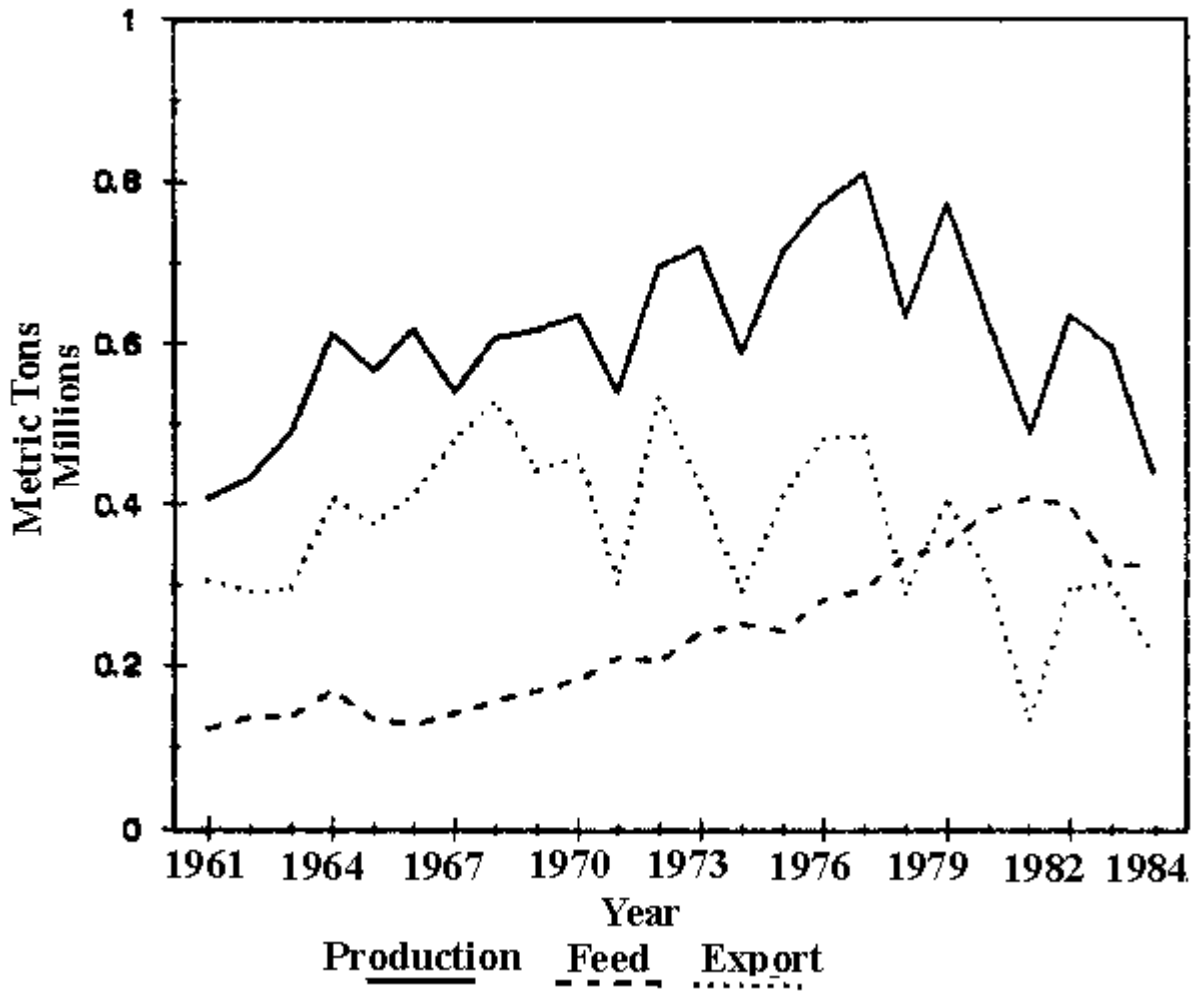


Figure 3. Cottonseed cake production and utilization in sub-Saharan Africa (1961–1984)

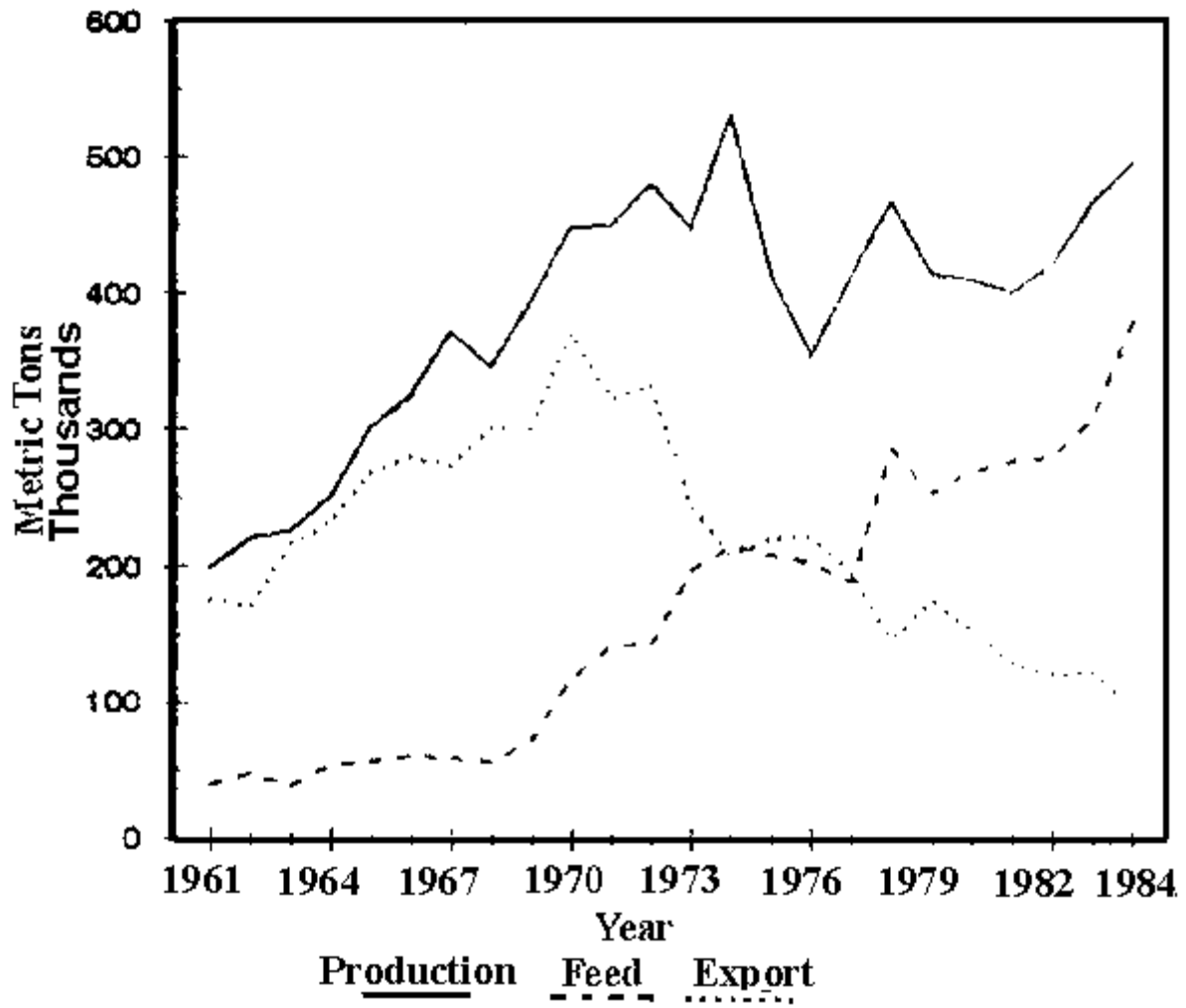


Figure 4. Sunflower seed cake production and utilization in sub-Saharan Africa (1961–1984)

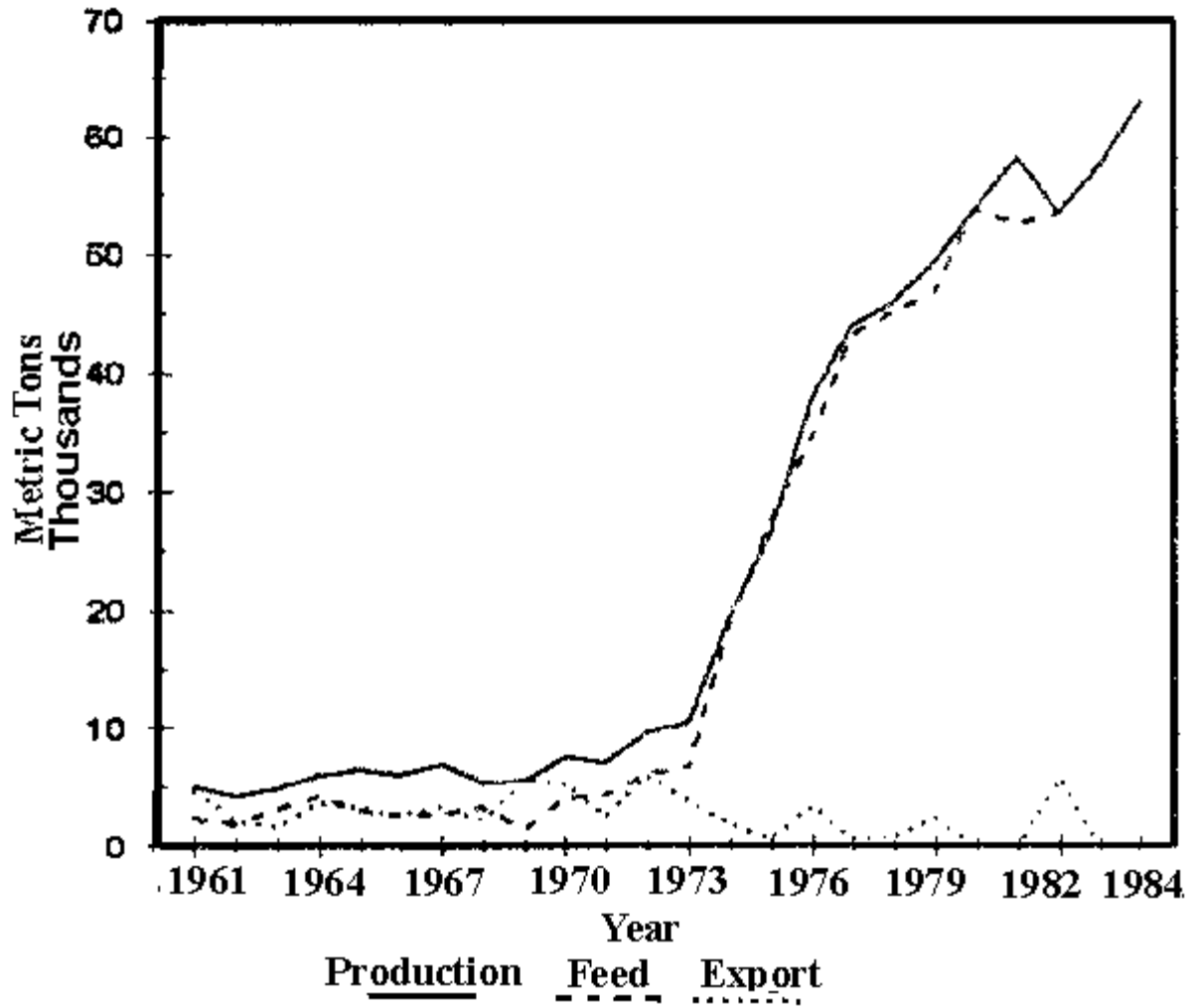


Figure 5. Palm kernel cake production and utilization in sub-Saharan Africa (1961–1984)

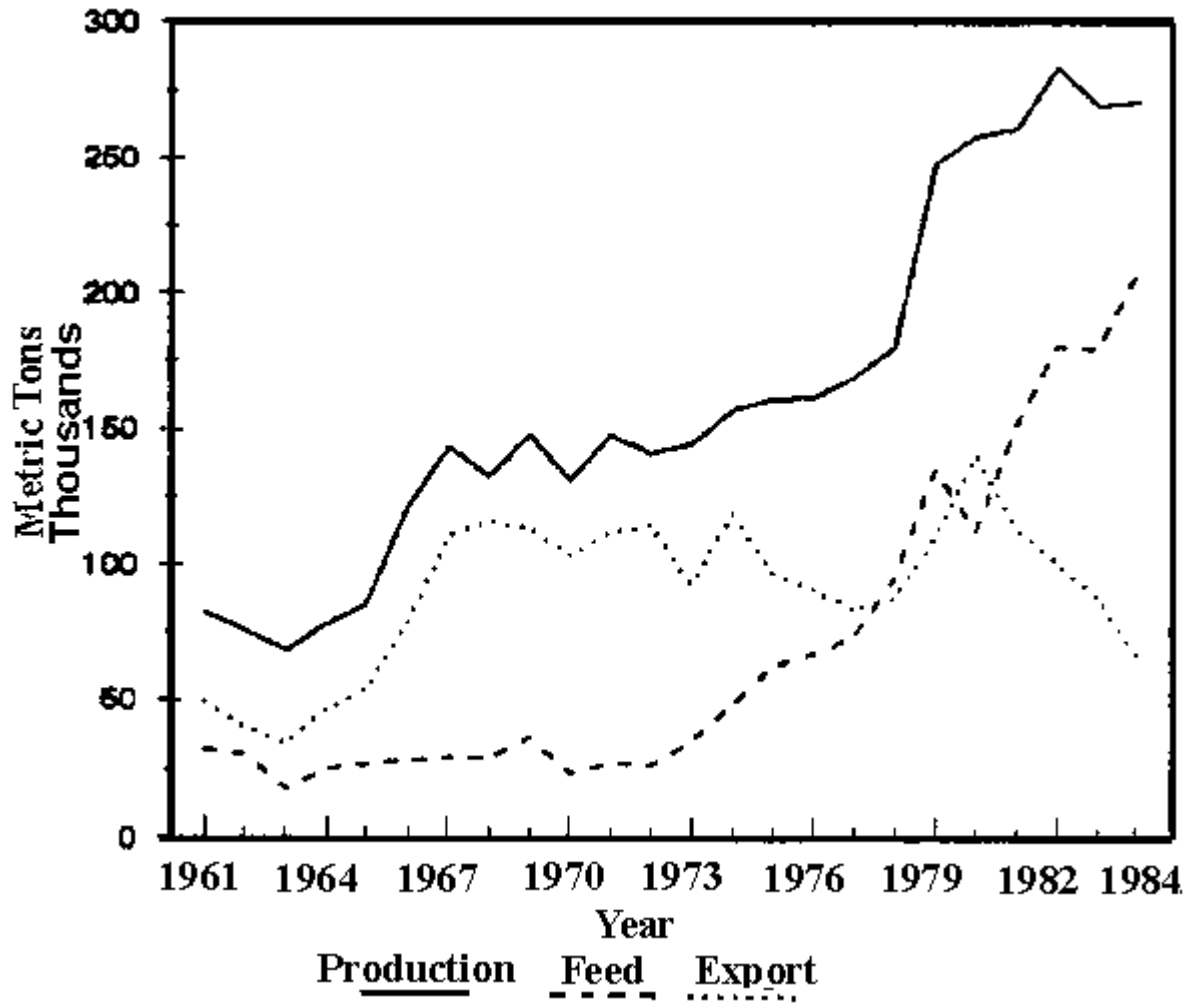
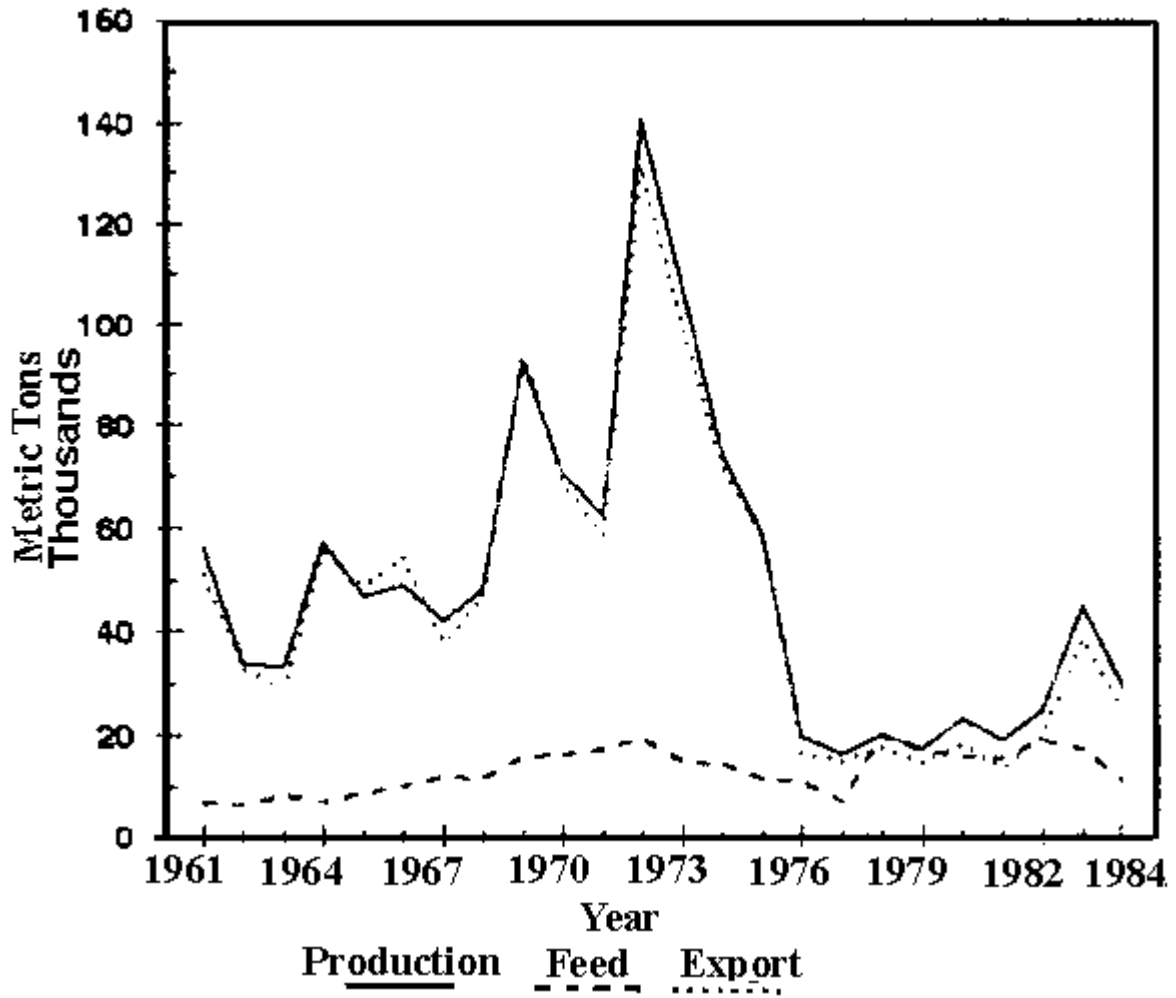


Figure 6. Fishmeal production and utilization in sub-Saharan Africa (1961–1984)



Appendix B: Tables

Table 1. Molasses production, utilization and nominal export value¹ in West Africa

Year	Production	Feed	Export	Export value (US \$ 1000)
	MT			
1961	0	6	0	0
1962	0	4	0	0
1963	0	8	0	0
1964	0	14	0	0
1965	0	4	0	0
1966	6500	19	0	0
1967	13875	1879	0	0
1968	15912	4523	0	0
1969	18932	2907	0	0
1970	19535	3942	0	0
1971	19003	4837	0	0
1972	21189	7408	0	0
1973	23241	7147	0	0
1974	23389	5619	2	0
1975	40188	9490	0	0
1976	70230	21662	0	0
1977	84300	24492	0	0
1978	85420	24020	0	0
1979	110931	31209	28530	1714
1980	155422	36020	55368	11214
1981	162157	36592	77830	7578
1982	170944	29891	65137	3576
1983	179841	46073	50859	1339
1984	159702	30558	43295	1000

1. i.e. at current prices

Table 2. Groundnut cake production, utilization and nominal export value¹ in West Africa

Year	Production	Feed	Export	Export value (US \$ 1000)
	MT			
1961	329968	57683	266179	15463
1962	347899	68948	262357	15978
1963	378483	70824	246320	16337
1964	486389	102160	354181	24554
1965	450925	60207	340063	28067
1966	497909	60035	368712	26509
1967	407419	65638	412539	32877
1968	462781	68236	459671	38798
1969	466663	66440	400762	32658
1970	471136	76307	402847	35772
1971	380096	85906	265350	25025
1972	532822	87656	466366	42846
1973	485629	104603	368619	64259
1974	362274	116870	258139	43765
1975	471533	125366	364550	44169
1976	537678	126573	427316	50390
1977	498148	120633	405425	77289
1978	312118	156067	184374	33994
1979	465545	160614	285747	63840
1980	315275	208701	127477	25713
1981	239417	209506	43953	9636
1982	425649	210783	213756	34177
1983	409602	141007	211491	30730
1984	270118	189838	101540	20045

1. i.e. at current prices

Table 3. Cotton seed cake production, utilization and nominal export value¹ in West Africa

Year	Production	Feed	Export	Export value (US \$ 1000)
	MT			
1961	1579	579	1000	80
1962	4429	3429	1000	80
1963	3540	2010	1530	83
1964	2824	1824	1000	78
1965	3065	2415	650	51
1966	6047	4603	1444	82
1967	4331	3008	1323	77
1968	6462	3730	1532	110
1969	8908	5508	1500	110
1970	8906	5205	6101	315
1971	14657	8603	4554	299
1972	14073	8459	6314	533
1973	19903	7939	8264	2115
1974	44264	13516	26048	2896
1975	31868	18099	13969	1449
1976	63197	16454	36343	4286
1977	83756	14156	67100	10741
1978	75410	28411	53199	7295
1979	89558	32119	56339	9223
1980	94592	42518	55474	8299
1981	98532	42670	57062	9363
1982	93916	33206	67610	10089
1983	96503	28638	72365	13179
1984	93311	42548	52763	10400

1. e. at current prices

Table 4. Palm kernel cake production, utilization and nominal export value¹ in West Africa

Year	Production	Feed	Export	Export value (US \$ 1000)
	MT			
1961	9239	7228	1190	70
1962	10720	8740	920	62
1963	13180	8227	1381	112
1964	14174	7810	4196	178
1965	33350	9191	22026	1004
1966	71901	12995	48246	3676
1967	88043	15274	71330	5042
1968	77327	15837	68981	5092
1969	87567	22206	59505	4555
1970	75413	18331	50573	3678
1971	87567	19781	53027	3991
1972	86380	22463	59457	4004
1973	94257	29297	55050	5398
1974	105289	39275	75224	8594
1975	109508	46916	61375	7291
1976	108556	48798	53198	5827
1977	116870	48008	53362	6767
1978	126316	70064	58652	8419
1979	190910	102418	90692	19079
1980	195955	78928	111827	22610
1981	202228	122240	80488	16835
1982	224547	145892	77455	13148
1983	213611	143609	69702	11139
1984	211406	173128	43278	6316

1. i.e. at current prices

Table 5. Fishmeal production, and utilization in West Africa¹

Year	Production	Feed	Export
	MT		
1961	0	50	0
1962	0	100	0
1963	0	50	0
1964	0	200	0
1965	0	180	0
1966	0	0	0
1967	0	0	0
1968	1600	0	1600
1969	2000	0	2000
1970	6700	400	6300
1971	10400	200	10200
1972	11600	200	11400
1973	11500	300	9600
1974	11700	300	11200
1975	3300	1100	4400
1976	6538	3141	3597
1977	12557	1819	10776
1978	15200	1337	13863
1979	13399	4282	11177
1980	17902	6144	15598
1981	13715	7132	11095
1982	19358	9692	16266
1983	39392	9929	35664
1984	25916	6127	22616

1. Data on the export value of fishmeal are not available.

Table 6. Real² export value of byproducts in West Africa

Year		Groundnut	Cotton	Palmkernel	TOTAL REAL EX. VALUE
	Molasses	seed cake	seed cake	Cake	
(US \$ 1000)					
1961	0.00	48021.74	248.45	217.39	48487.58
1962	0.00	48418.18	242.42	187.88	48848.48
1963	0.00	48334.32	245.56	331.36	48911.24
1964	0.00	70965.32	225.43	514.45	71705.20
1965	0.00	70619.05	142.86	2812.32	81574.23
1966	0.00	71840.11	222.22	9962.06	32024.39
1967	00.0	86746.70	203.17	13303.43	100253.30
1968	0.00	98472.08	279.19	12923.86	111675.13
1969	0.00	79075.06	266.34	11029.06	90370.46
1970	0.00	82045.87	722.48	8435.78	91204.13
1971	0.00	54520.70	651.42	8694.99	63867.10
1972	0.00	89262.50	1110.42	8341.67	98714.58
1973	0.00	124292.07	4090.91	10441.01	138823.98
1974	0.00	74811.97	4950.43	14690.60	94452.99
1975	0.00	67952.31	2229.23	11216.92	81398.46
1976	0.00	71678.52	6096.73	8288.76	86064.01
1977	0.00	101296.20	14077.33	8868.94	124242.46
1978	0.00	41506.72	8907.20	10279.61	60693.53
1979	1919.37	71489.36	10328.11	21365.06	105101.90
1980	11214.00	25713.00	8299.00	22610.00	67836.00
1981	6882.83	8752.04	8504.09	15290.64	39429.61
1982	3020.27	28865.71	8521.11	11104.73	51511.82
1983	1076.37	24702.57	10594.05	8954.18	45327.17
1984	766.87	15371.93	7975.46	4843.56	28957.82

2. i.e. nominal export values are deflated by consumer price index (CPI) for industrial countries.

Appendix B: Figures

Figure 1: Molasses production and utilization in West Africa (1961–1984)

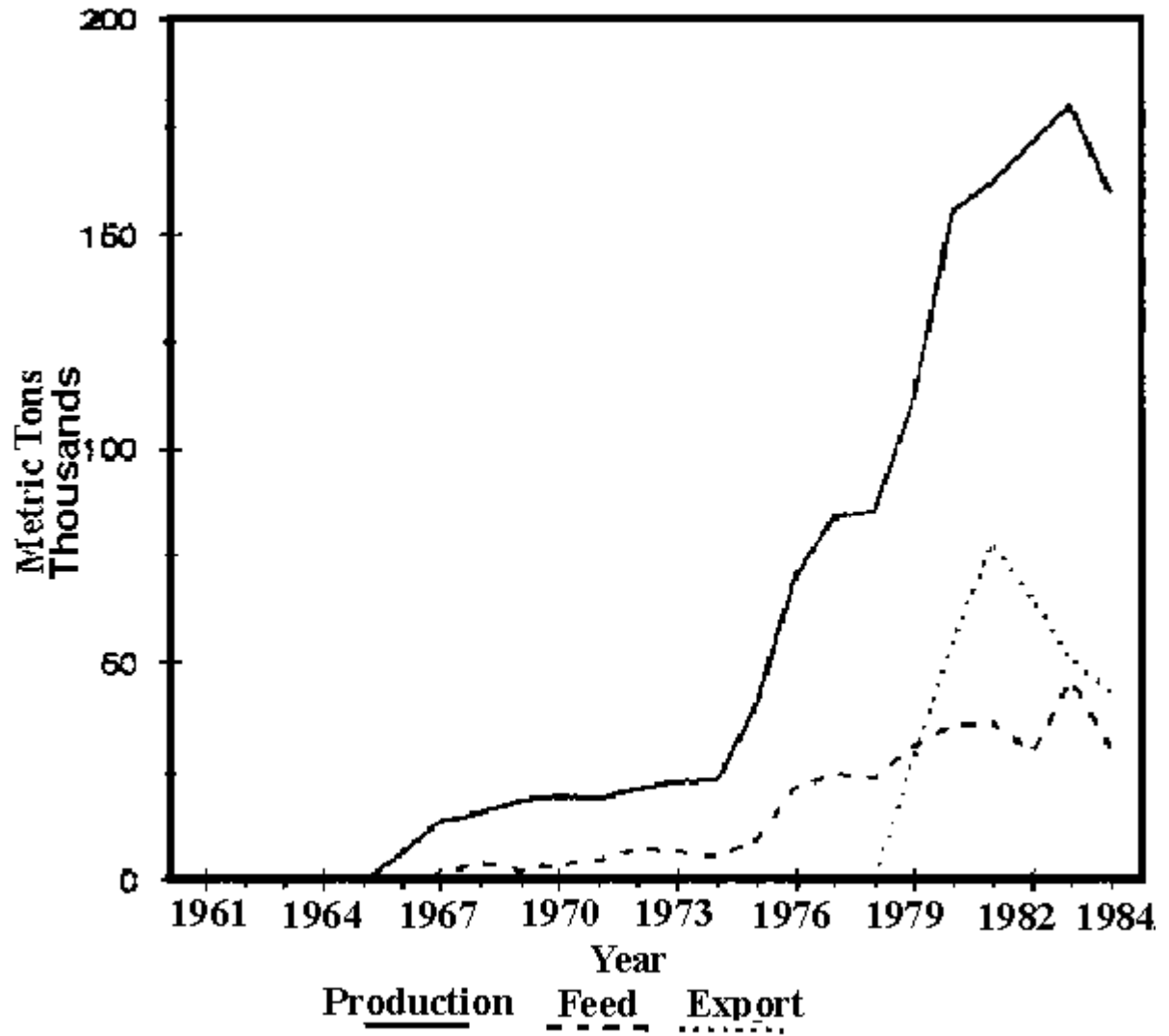


Figure 2. Groundnut cake production and utilization in West Africa (1961–1984)

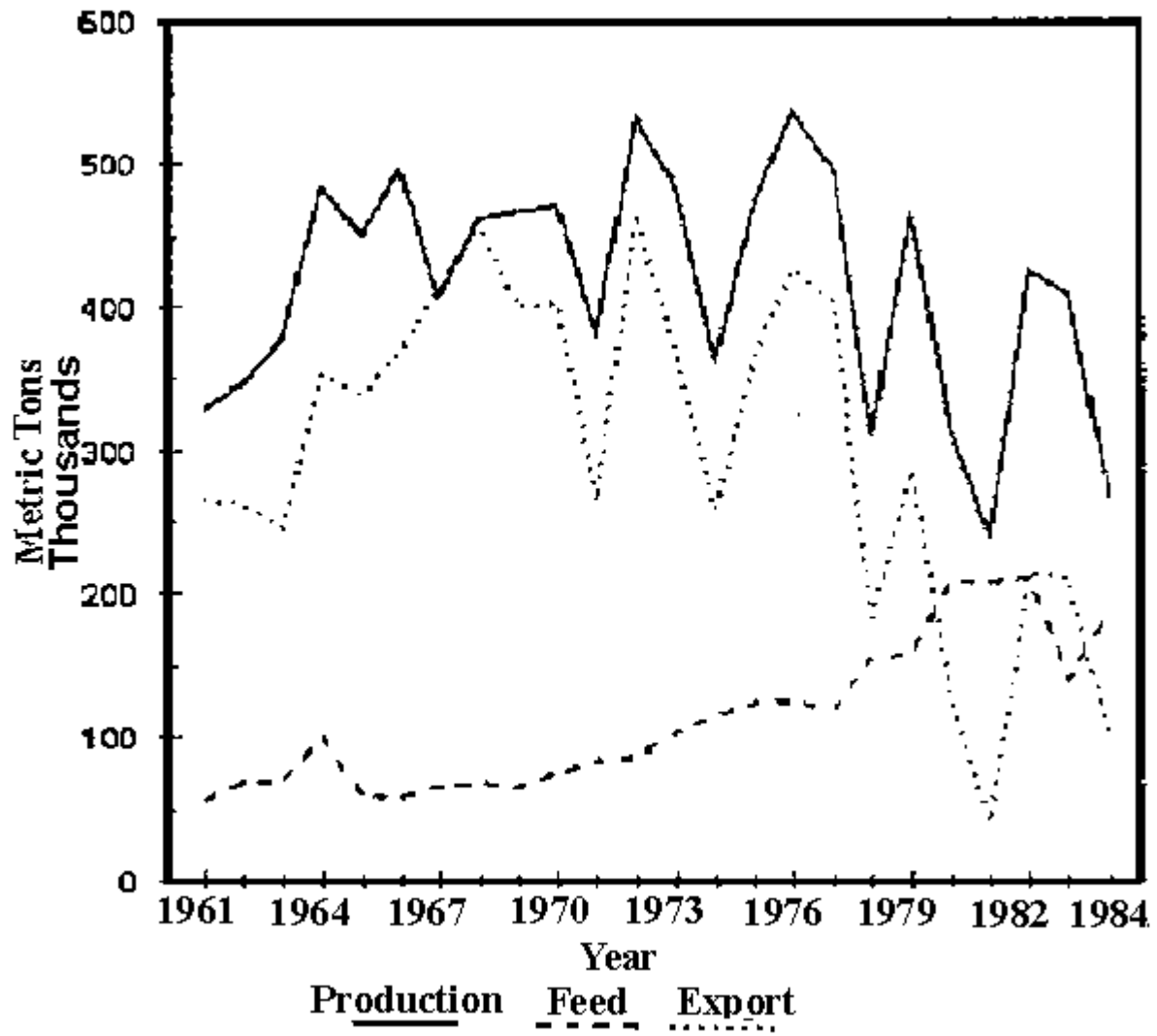


Figure 3. Cottonseed cake production and utilization in West Africa (1961–1984)

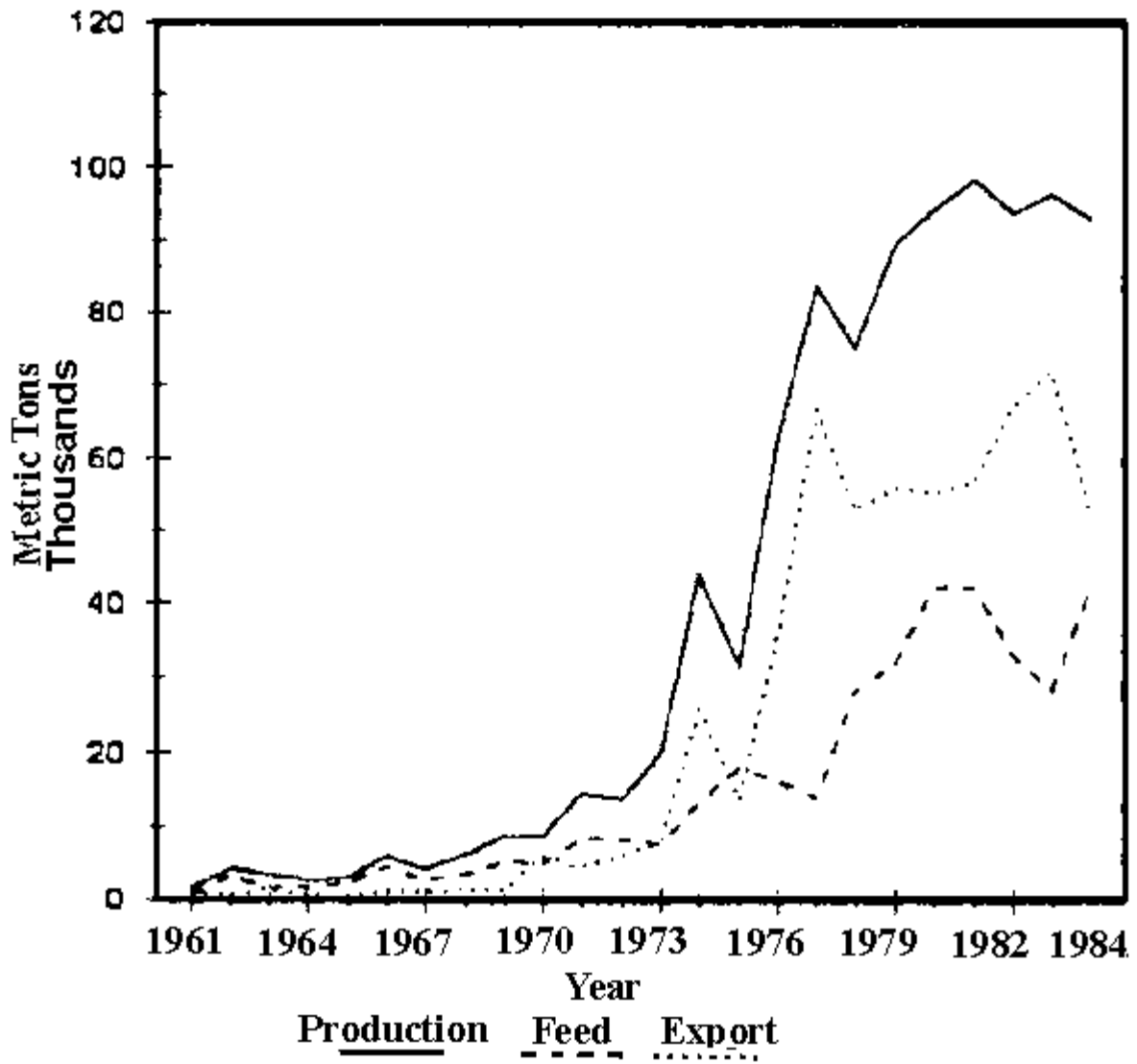


Figure 4. Palm kernel cake production and utilization in West Africa (1961–1984)

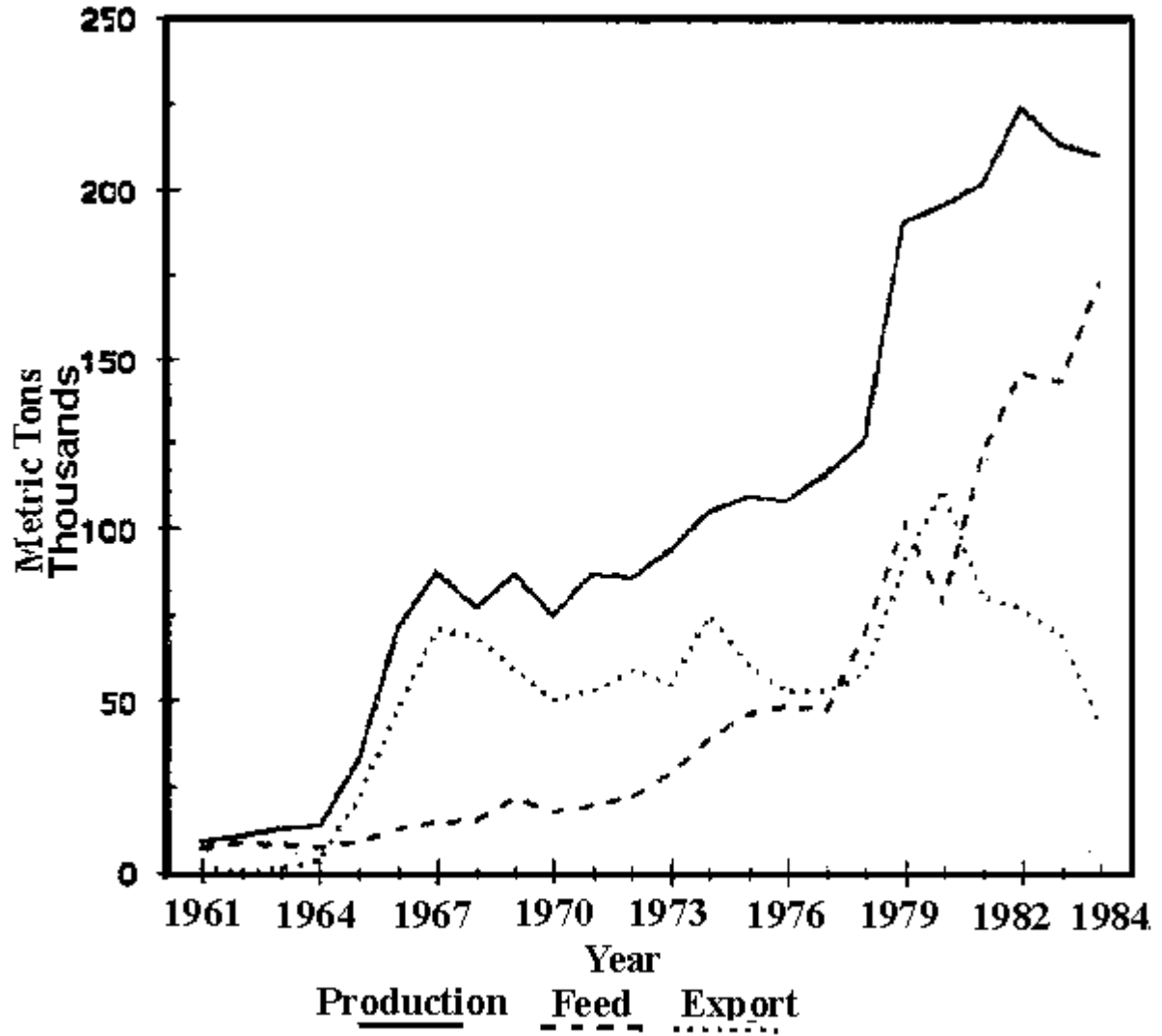
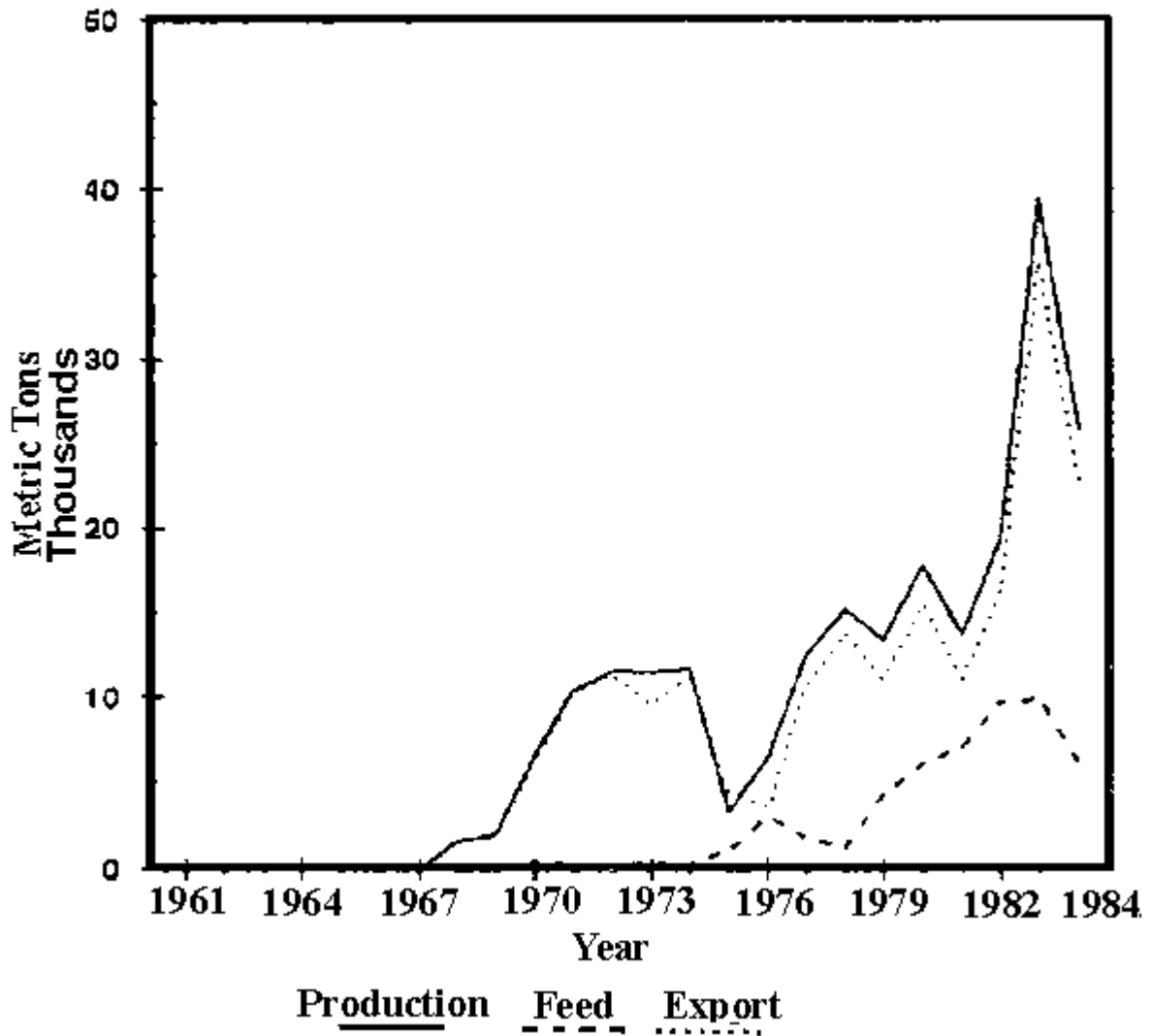


Figure 5. Fishmeal production and utilization in West Africa (1961–1984)



Appendix C: Tables

Table 1. Molasses production, utilization and nominal export value¹ in East Africa

Year	Production	Feed	Export	Export value (US \$ 1000)
	MT			
1961	114294	106854	5269	51
1962	124803	110514	10605	110
1963	140994	119152	17319	252
1964	150774	120843	25342	511
1965	150571	129300	15696	216
1966	167974	141807	23637	320
1967	197671	148153	44592	729
1968	217618	166617	43610	641
1969	235176	144760	82019	1003
1970	249562	185426	55533	718
1971	247212	167855	70548	816
1972	234923	167990	58091	758
1973	232390	123548	95959	1575
1974	221895	164585	33995	743
1975	209648	140579	54977	1094
1976	202175	122489	49247	2222
1977	233393	157481	62287	2070
1978	250538	183376	50860	1510
1979	290241	174076	75735	5740
1980	299582	134697	148963	11968
1981	310499	129258	179137	15646
1982	325218	146062	146624	9120
1983	375507	134960	186732	8324
1984	415395	235395	101297	4100

1. i.e. at current prices

Table 2. Groundnut cake production; utilization and nominal export value¹ in East Africa

Year	Production	Feed	Export	Export value (US \$ 1000)
	MT			
1961	25896	18216	29680	2129
1962	34007	22832	21175	1609
1963	55848	20169	35679	2941
1964	65685	17286	41834	3209
1965	46472	18374	20214	1810
1966	53002	19657	23569	2008
1967	53008	16135	51016	3891
1968	56648	15983	50856	3946
1969	66951	25482	31695	2375
1970	77032	31259	42895	3626
1971	72710	42419	28132	2184
1972	70657	37832	53291	4373
1973	129202	46709	35535	7576
1974	133801	45632	24005	4335
1975	161172	48302	32870	2745
1976	142653	71513	46140	3094
1977	216200	84890	70310	8645
1978	240074	99643	100431	11471
1979	219478	110501	106977	17069
1980	219760	104828	164932	24650
1981	163033	118669	77364	12051
1982	124009	109551	74458	13431
1983	105557	101749	83808	11591
1984	83751	50356	101395	6460

1. i.e. at current prices

Table 3. Cotton seed cake production, utilization and nominal export value¹ in East Africa

Year	Production	Feed	Export	Export value (US \$ 1000)
	MT			
1961	141472	14080	139645	8119
1962	156446	13160	135059	7976
1963	181538	16997	187041	12327
1964	187994	18125	207965	13052
1965	251302	21375	236961	15330
1966	263414	19973	256978	17887
1967	296691	23063	244448	16832
1968	262530	19202	263973	15588
1969	317904	32383	257749	16015
1970	339599	58641	313338	19979
1971	337963	77598	269154	17493
1972	353696	80979	276528	17600
1973	308306	103256	199811	22264
1974	337510	103501	145065	14797
1975	279836	104857	170124	13538
1976	198982	107202	165103	15653
1977	223865	86203	110912	17187
1978	268013	151035	71316	7990
1979	215169	137344	92825	11291
1980	195430	123535	81945	11229
1981	171899	128298	47624	14472
1982	201060	135806	34254	5461
1983	244254	165046	38208	5555
1984	268448	210191	34257	5445

1. i.e. at current prices

Table 4. Sunflower seed cake production, utilization and nominal export value¹ in East Africa

Year	Production	Feed	Export	Export value (US \$ 1000)
	MT			
1961	157	157	0	0
1962	404	404	0	0
1963	1196	1196	0	0
1964	1017	1017	0	0
1965	957	657	0	0
1966	1044	444	0	0
1967	1480	594	86	8
1968	778	738	292	26
1969	925	667	2049	137
1970	1014	203	2744	173
1971	1158	958	200	11
1972	2820	1982	3363	143
1973	2851	1554	1297	172
1974	6896	7186	1153	138
1975	10756	11721	631	83
1976	12549	10744	1805	197
1977	21209	20521	688	127
1978	22049	21720	329	86
1979	21051	21051	0	0
1980	21945	21945	0	0
1981	19866	19866	0	0
1982	20945	20945	0	0
1983	21240	21240	0	0
1984	20720	20720	0	0

1. i.e. at current prices

Table 5. Fishmeal production and utilization in East Africa¹

Year	Production	Feed	Export (US \$ 1000)
	MT		
1961	900	400	900
1962	720	520	700
1963	820	620	800
1964	2040	240	1400
1965	720	620	1300
1966	1020	420	400
1967	1400	900	1000
1968	100	900	900
1969	400	1300	500
1970	700	1400	600
1971	500	2300	500
1972	300	2300	300
1973	400	1200	400
1974	100	900	300
1975	120	1420	0
1976	0	1995	200
1977	0	1904	426
1978	0	5544	0
1979	0	2244	0
1980	0	3509	0
1981	0	1312	0
1982	0	2239	0
1983	0	2023	1
1984	0	2402	0

1. Data on the export value of fishmeal are not available.

Table 6. Real export value² of byproducts in East Africa

Year		Groundnut	Cotton	Sunflower	TOTAL REAL EX. VALUE
	Molasses	seed cake	seed cake	seed cake	
	(US \$ 1000)				
1961	158.39	6611.80	25214.29	0.00	31984.47
1962	333.33	4875.76	24169.70	0.00	29378.79
1963	745.56	8701.18	36470.41	0.00	45917.16
1964	1476.88	9274.57	37722.54	0.00	48473.99
1965	605.04	5070.03	42941.18	0.00	48616.25
1966	867.21	5441.73	48474.25	0.00	54783.20
1967	1923.48	10266.49	44411.61	21.11	56622.69
1968	1626.90	10015.23	39563.45	65.99	51271.57
1969	2428.57	5750.61	38777.24	331.72	47288.14
1970	1646.79	8316.51	45823.39	396.79	56183.49
1971	1777.78	4758.17	38111.11	23.97	44671.02
1972	1579.17	9110.42	36666.67	297.92	47654.17
1973	3046.42	14653.77	43063.83	332.69	61096.71
1974	1270.09	7410.26	25294.02	235.90	34210.26
1975	1683.08	4223.08	20827.69	127.69	26861.54
1976	3160.74	4401.14	22266.00	280.23	30108.11
1977	2712.98	11330.28	22525.56	166.45	36735.26
1978	1843.71	14006.11	9755.80	105.01	25710.62
1979	6427.77	19114.22	12643.90	0.00	38185.89
1980	11968.00	24650.00	11229.00	0.00	47847.00
1981	14210.72	10945.50	13144.41	0.00	38300.64
1982	7702.70	11343.75	4612.33	0.00	23658.78
1983	6691.32	9317.52	4465.43	0.00	20474.28
1984	3144.17	4953.99	4175.61	0.00	12273.77

2. i. e. nominal export values are deflated by consumer price index (CPI) for industrial countries.

Appendix C: Figures

Figure 1. Molasses production and utilization in East Africa (1961–1984)

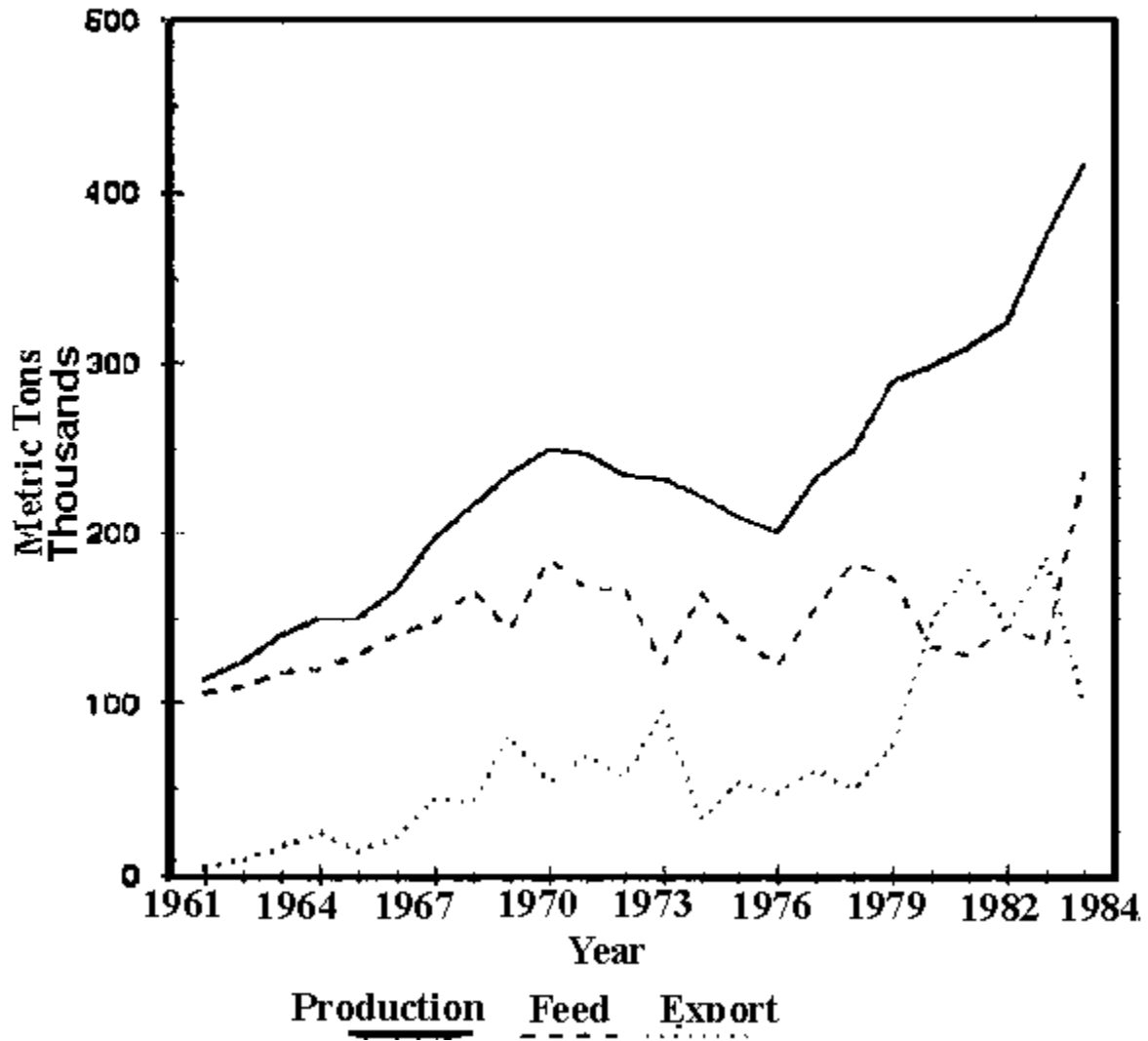


Figure 2. Groundnut cake production and utilization in East Africa (1961–1984)

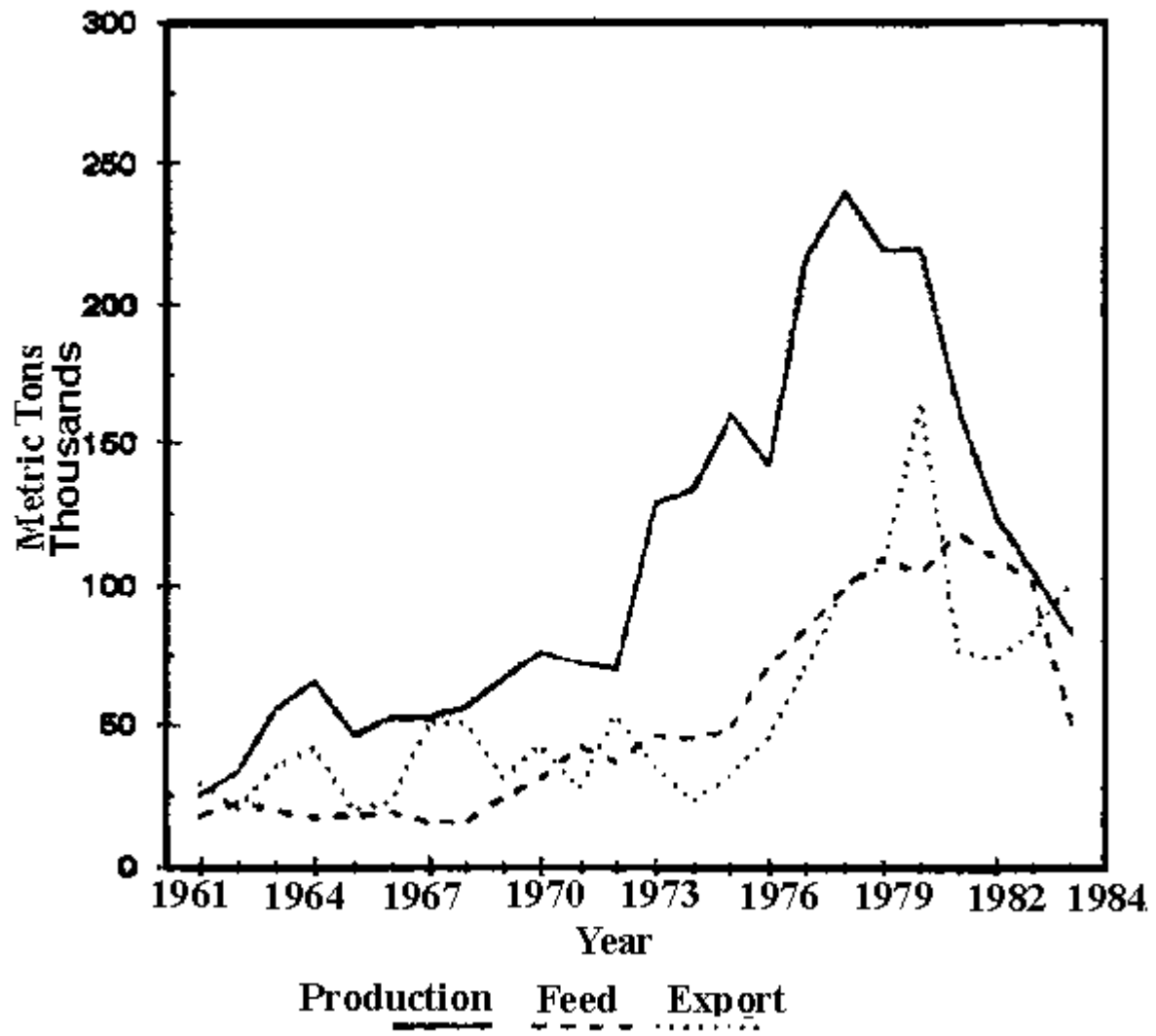


Figure 3. Cottonseed cake production and utilization in East Africa (1961–1984)

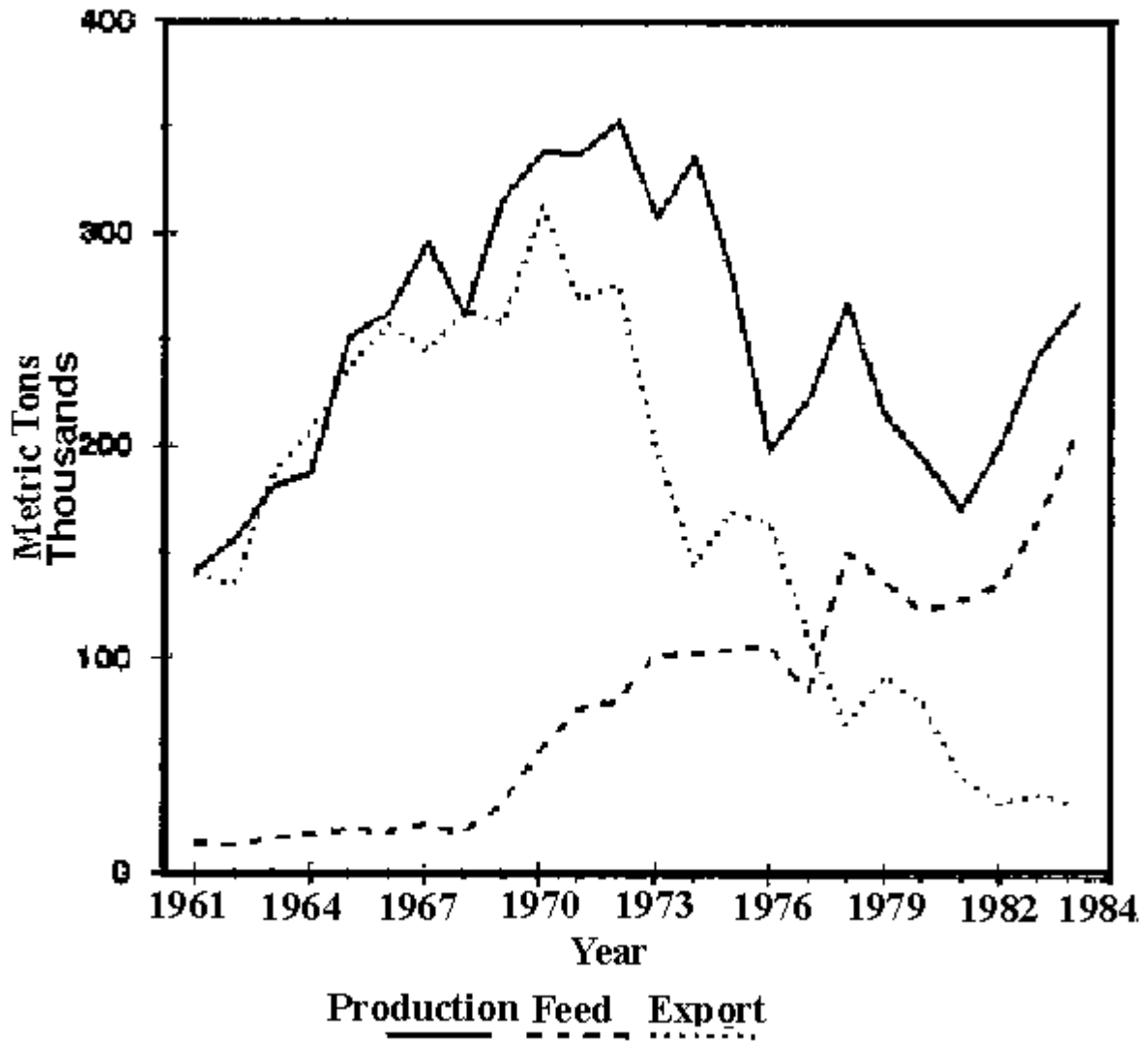


Figure 4. Sunflower seed cake production and utilization in East Africa (1961-1984)

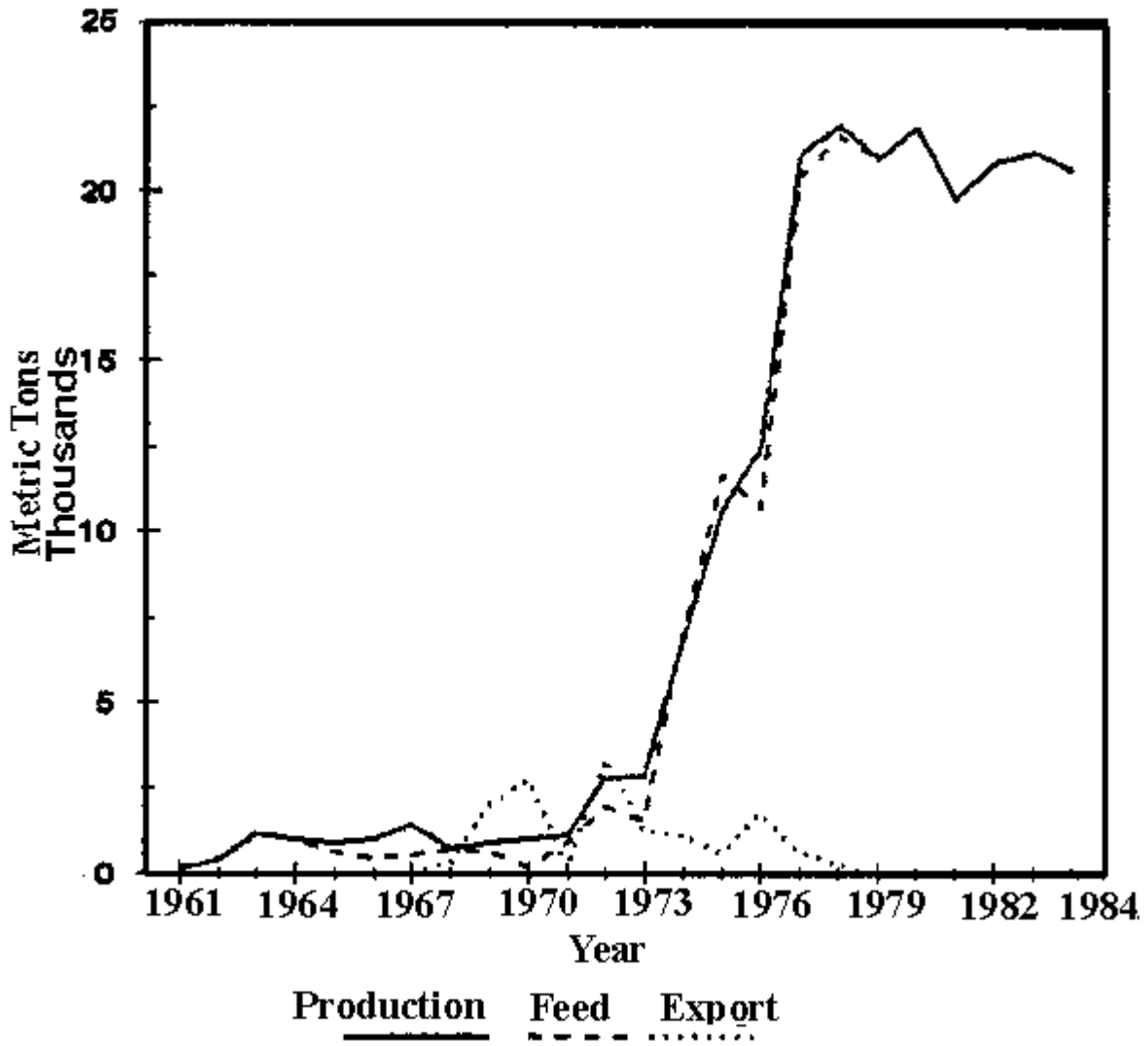
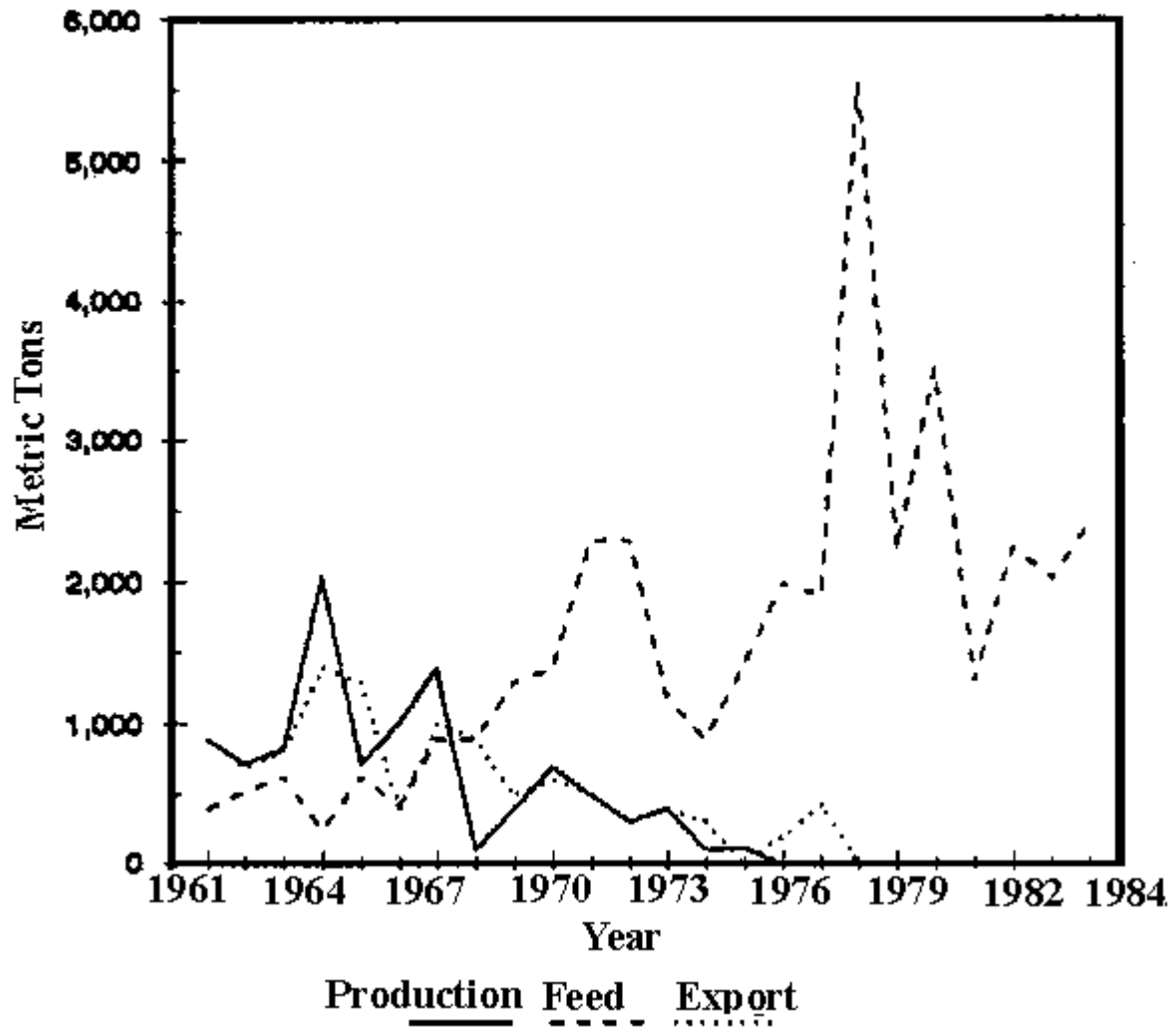


Figure 5: Fishmeal production and utilization in East Africa (1961–1984)



Appendix D: Figures

Figure 1: Molasses production and utilization in Central Africa (1961–1984)

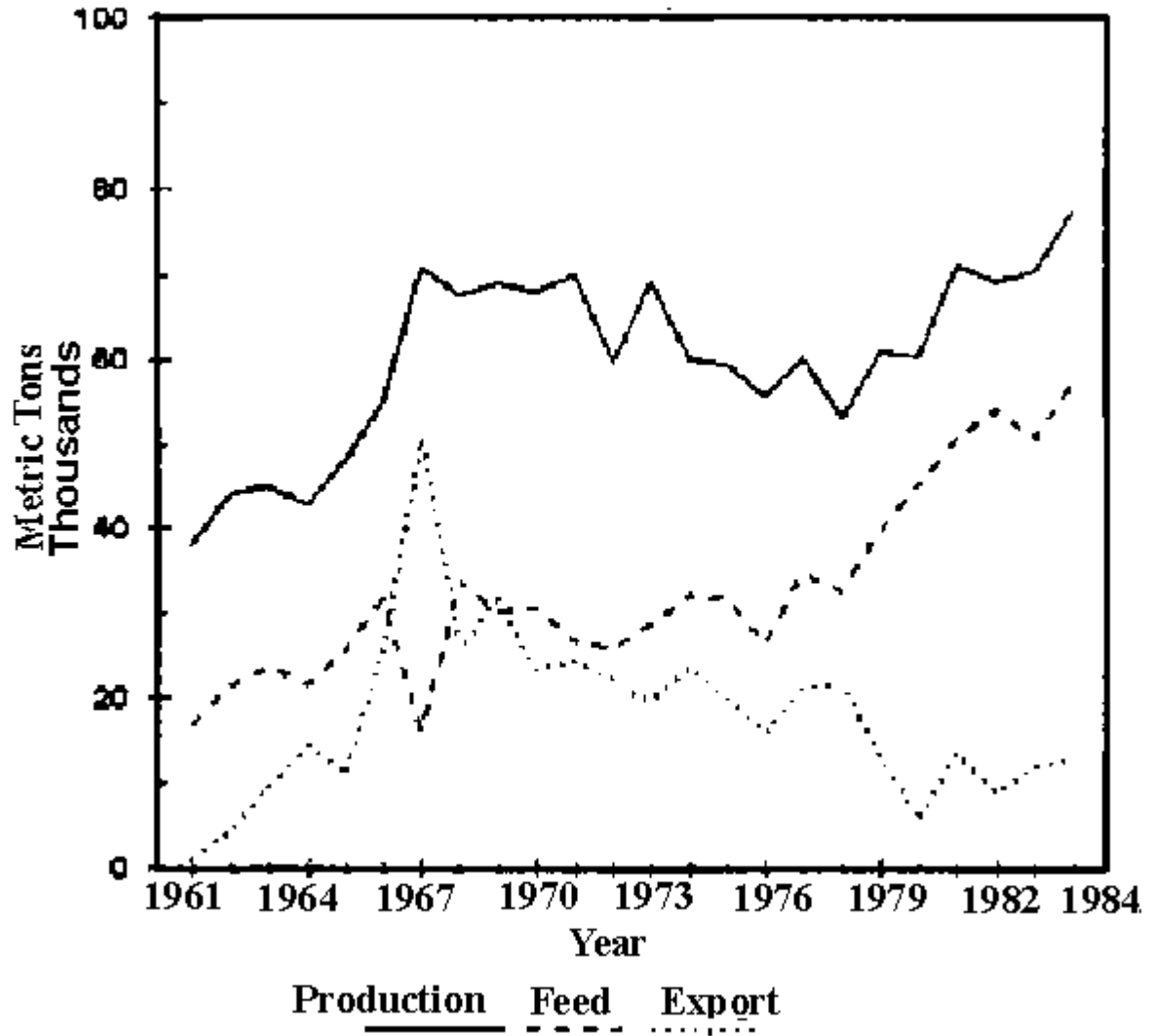


Figure 2: Groundnut seed cake production and utilization in Central Africa (1961–1984)

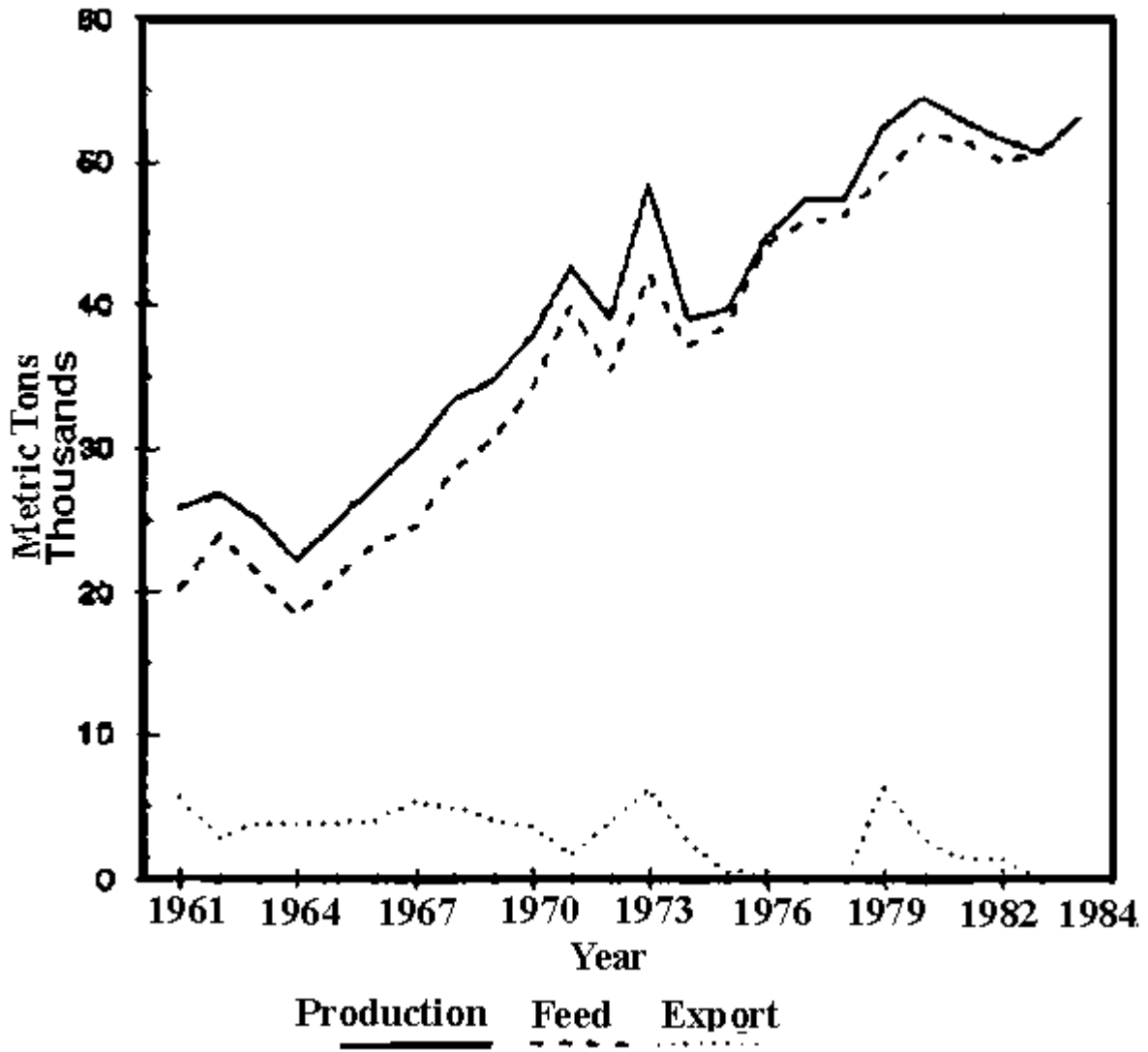


Figure 3: Cottonseed cake production and utilization in Central Africa (1961–1984)

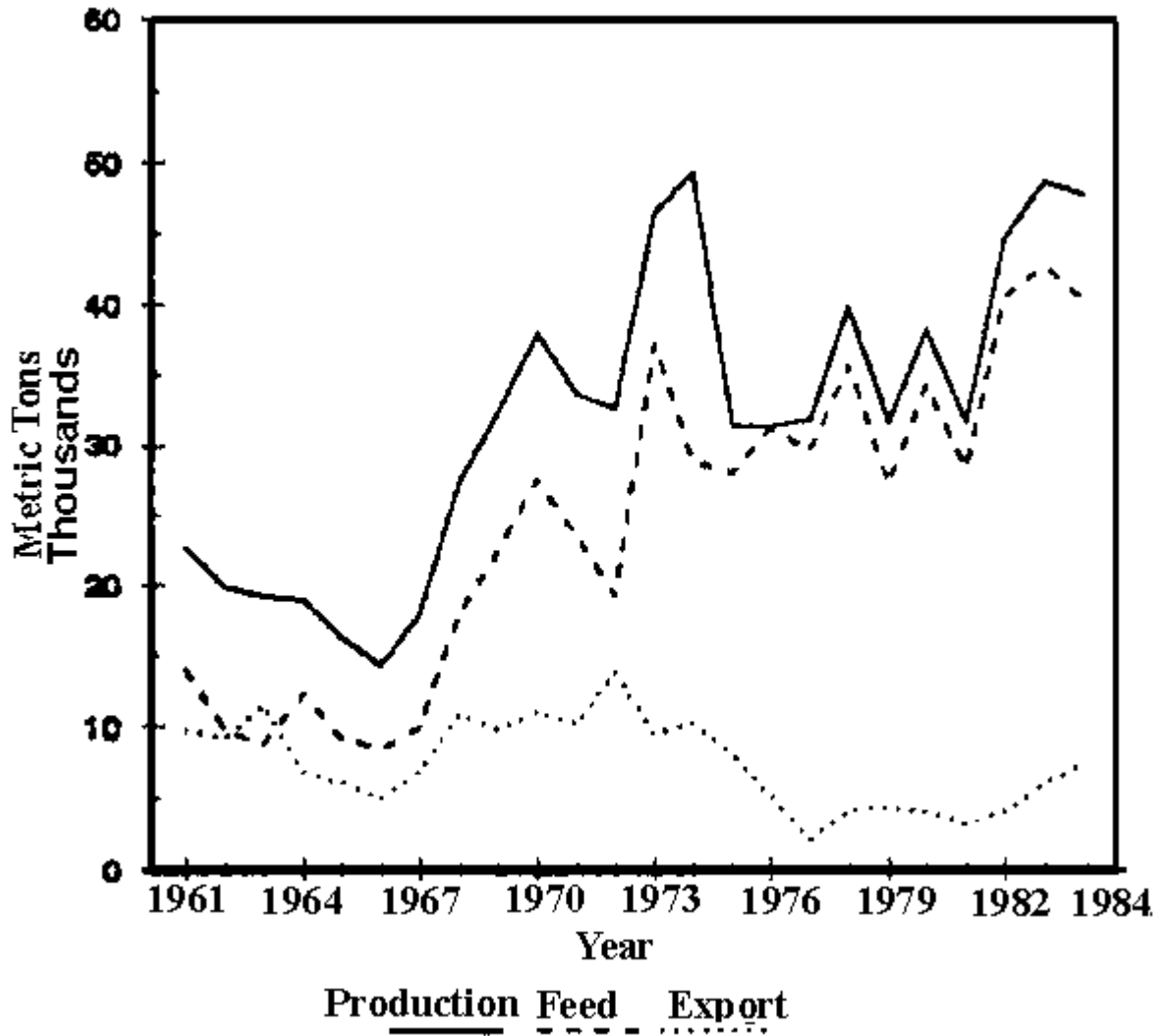


Figure 4: Palm kernel cake production and utilization in Central Africa (1961–1984)

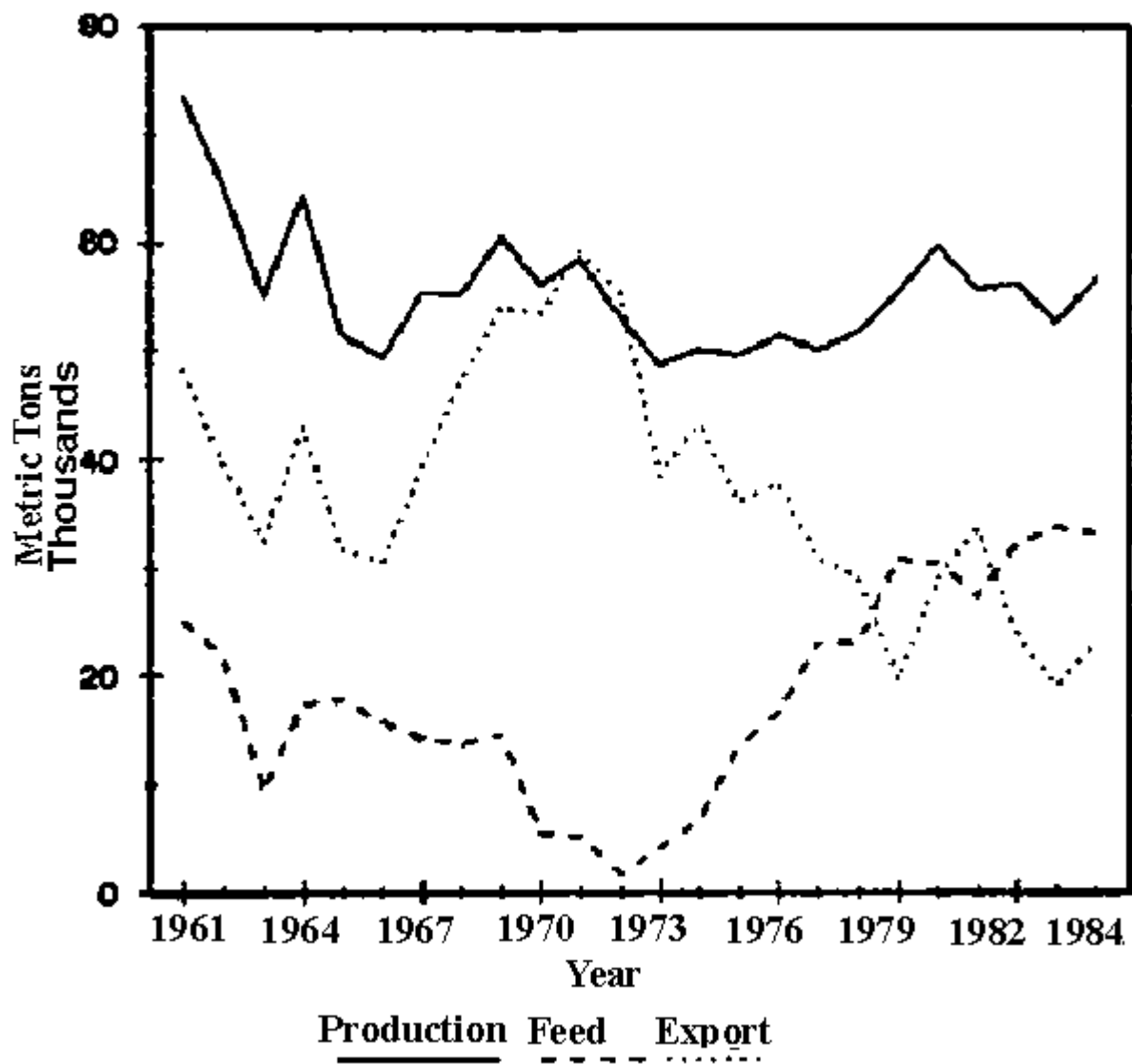
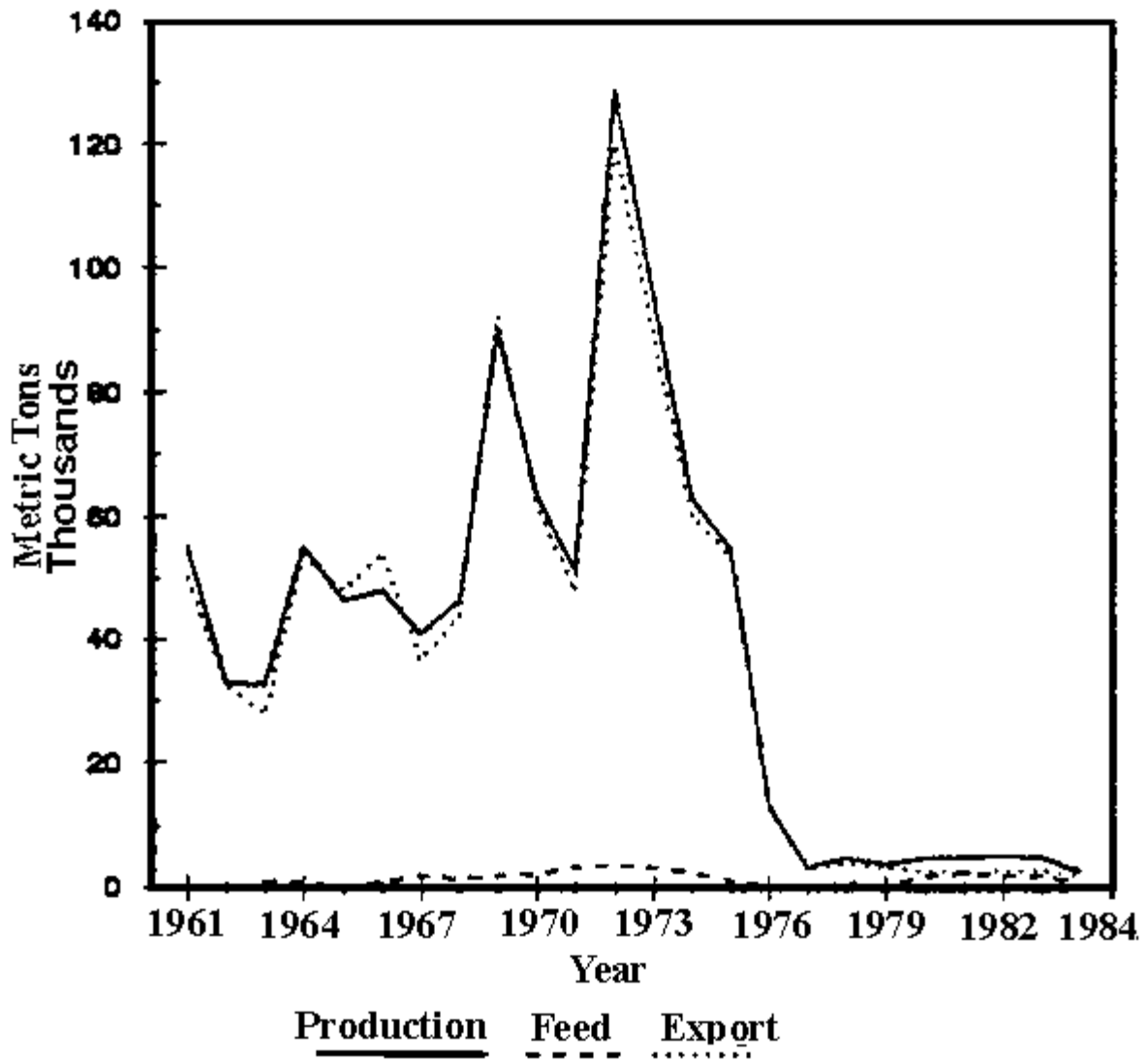


Figure 5: Fishmeal production and utilization in Central Africa (1961–1984)



Appendix E: Tables

Table 1. Molasses production, utilization and nominal export value¹ in Southern Africa

Year	Production	Feed	Export	Export value (US \$ 1000)
	MT			
1961	252655	39941	91876	1401
1962	251288	42413	135253	2223
1963	284240	41560	170833	3367
1964	264032	54929	156154	2524
1965	317946	66990	170503	1762
1966	350255	74952	251111	3541
1967	349471	41982	200455	3089
1968	344146	46425	277835	3488
1969	411077	60708	233707	3336
1970	412996	69559	239388	3295
1971	412037	53861	308848	3605
1972	463889	61133	314020	2409
1973	477933	56900	371241	11638
1974	475931	65669	361115	15718
1975	438080	56916	317850	9817
1976	514680	78194	323409	10001
1977	519212	55159	368701	9185
1978	539334	77652	332023	10811
1979	569869	82993	363728	21799
1980	533867	71497	369563	26180
1981	588383	123982	368055	23031
1982	665979	115665	369457	12771
1983	627877	123284	324731	15051
1984	603008	117581	283161	17799

1. i.e. at current prices

Table 2. Groundnut cake production, utilization and nominal export value¹ in Southern Africa

Year	Production	Feed	Export	Export value (US \$ 1000)
	MT			
1961	29423	26223	3200	249
1962	27425	21226	6230	424
1963	31778	25688	7540	579
1964	39794	31034	11550	1005
1965	46032	34862	14310	1250
1966	39621	25646	16905	1489
1967	50849	34793	15606	1406
1968	56610	44259	14427	1213
1969	49969	46362	8395	537
1970	51449	40620	13622	1450
1971	47136	42129	8161	704
1972	54452	45198	14469	1339
1973	58244	47906	14894	2601
1974	55050	54259	6887	1264
1975	42982	31635	13642	1510
1976	48444	40072	10474	1242
1977	48255	41874	12287	1500
1978	34696	34858	3475	439
1979	35988	29903	10185	985
1980	39259	29301	14008	1838
1981	35916	31289	9530	1201
1982	36619	30407	8321	822
1983	33065	28116	6702	650
1984	35571	33437	7000	670

1. i.e. at current prices

Table 3. Cotton seed cake production, utilization and nominal export value¹ in Southern Africa

Year	Production	Feed	Export	Export value (US \$ 1000)
	MT			
1961	34702	11332	25730	1704
1962	40839	21859	26300	1839
1963	22535	11085	17600	1368
1964	41224	22794	17430	1364
1965	30618	24894	24864	1937
1966	41806	28980	16559	1372
1967	53178	24125	20553	1593
1968	49285	16609	24893	1683
1969	35982	12952	31865	2058
1970	62063	28576	41540	2992
1971	63783	33484	38018	2841
1972	80502	36500	36192	2505
1973	73403	49857	26634	3536
1974	100527	70626	27879	3584
1975	70237	57689	29243	2569
1976	60827	48154	16186	1634
1977	73804	59009	16377	1995
1978	84425	70277	18951	2079
1979	79188	58285	22471	2665
1980	82045	69967	13082	1756
1981	99091	77819	21788	4105
1982	81402	71437	16976	2746
1983	78020	73119	7520	1024
1984	87053	87412	3554	870

1. i.e. at current prices

Table 4. Sunflower seed cake production, utilization and nominal export value¹ in Southern Africa

Year	Production	Feed	Export	Export value (US \$ 1000)
	MT			
1961	1208	1208	0	0
1962	890	890	0	0
1963	655	655	0	0
1964	1407	1407	0	0
1965	1970	1970	0	0
1966	1425	1425	0	0
1967	1292	1292	0	0
1968	1537	1537	0	0
1969	689	690	0	0
1970	1522	1523	0	0
1971	2701	2702	0	0
1972	3584	3584	0	0
1973	3883	3883	0	0
1974	7369	7369	0	0
1975	10561	10561	0	0
1976	20157	18561	1596	127
1977	17403	17403	0	0
1978	18740	18240	500	65
1979	23003	20503	2500	380
1980	26572	26572	0	0
1981	27308	27308	0	0
1982	26736	26736	0	0
1983	29705	29705	0	0
1984	34054	34054	0	0

1. i.e. at current prices

Table 5. Palm kernel production and utilization in Southern Africa¹

Year	Production	Feed
	MT	
1961	0	0
1962	0	0
1963	0	0
1964	0	0
1965	0	0
1966	0	0
1967	0	0
1968	0	0
1969	0	0
1970	0	0
1971	0	0
1972	0	0
1973	0	0
1974	0	0
1975	0	0
1976	0	0
1977	0	0
1978	0	0
1979	0	0
1980	324	921
1981	331	331
1982	550	550
1983	550	550
1984	550	550

1. Data on the export value of palm kernel and fishmeal are not available.

Table 6. Fishmeal production and utilization in Southern Africa¹

Year	Production	Feed	Export (US \$ 1000)
	MT		
1961	0	6300	0
1962	0	5800	0
1963	0	6700	0
1964	0	5700	0
1965	0	7900	0
1966	0	8952	100
1967	0	9000	100
1968	0	9300	100
1969	0	12700	200
1970	0	12300	300
1971	0	11800	300
1972	0	13500	0
1973	0	10000	0
1974	0	10700	0
1975	0	7816	0
1976	168	5439	0
1977	214	3499	100
1978	270	11995	100
1979	302	9934	0
1980	285	3995	0
1981	309	4678	0
1982	348	5007	644
1983	562	3563	0
1984	558	1698	3

1. Data on the export value of palm kernel and fishmeal are not available.

Table 7. Real export values¹ of byproducts in Southern Africa

Year		Groundnut	Cotton	Sunflower	TOTAL REAL EX. VALUE
	Molasses	seed cake	seed cake	seed cake	
(US \$ 1000)					
1961	4350.93	773.29	5291.93	0.00	10416.15
1962	6736.36	1284.85	5572.73	0.00	13593.94
1963	9961.54	1713.02	4047.34	0.00	15721.89
1964	7294.80	2904.62	3942.20	0.00	14141.62
1965	4935.57	3501.40	5425.77	0.00	13862.75
1966	9596.21	4035.23	3718.16	0.00	17349.59
1967	8150.40	3709.76	4203.17	0.00	16063.32
1968	8852.79	3078.68	4271.57	0.00	16203.05
1969	8077.48	1300.24	4983.05	0.00	14360.77
1970	7557.34	3325.69	6862.39	0.00	17745.41
1971	7854.03	1533.77	6189.54	0.00	15577.34
1972	5018.75	2789.58	5218.75	0.00	13027.08
1973	22510.64	5030.95	6839.46	0.00	34381.04
1974	26868.38	2160.68	6126.50	0.00	35155.56
1975	15103.08	2323.08	3952.31	0.00	21378.46
1976	14226.17	1766.71	2324.32	180.65	18497.87
1977	12038.01	1965.92	2614.68	0.00	16618.61
1978	13200.24	536.02	2538.46	79.37	16354.09
1979	23851.06	1103.02	2984.32	425.53	28363.94
1980	26180.00	1838.00	1756.00	0.00	29774.00
1981	20918.26	1090.83	3728.43	0.00	25737.51
1982	10786.32	694.26	2319.26	0.00	13799.83
1983	12098.87	522.51	823.15	0.00	13444.53
1984	13649.54	513.80	667.18	0.00	14830.52

1. i.e. nominal export values are deflated by consumer price index (CPI) for industrial countries.

Appendix E: Figures

Figure 1: Molasses production and utilization in Southern Africa (1961–1984)

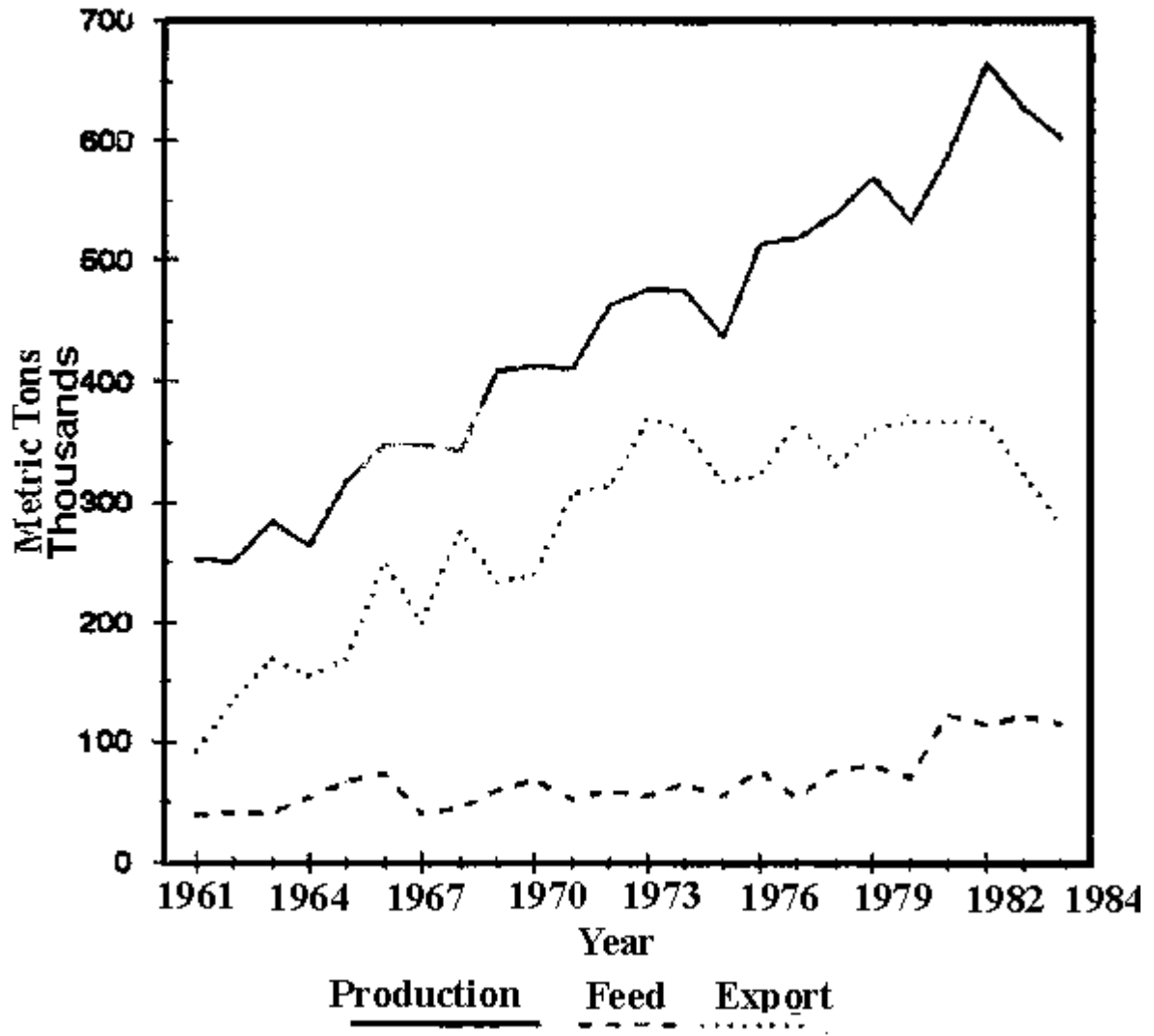


Figure 2: Groundnut cake production and utilization in Southern Africa (1961–1984)

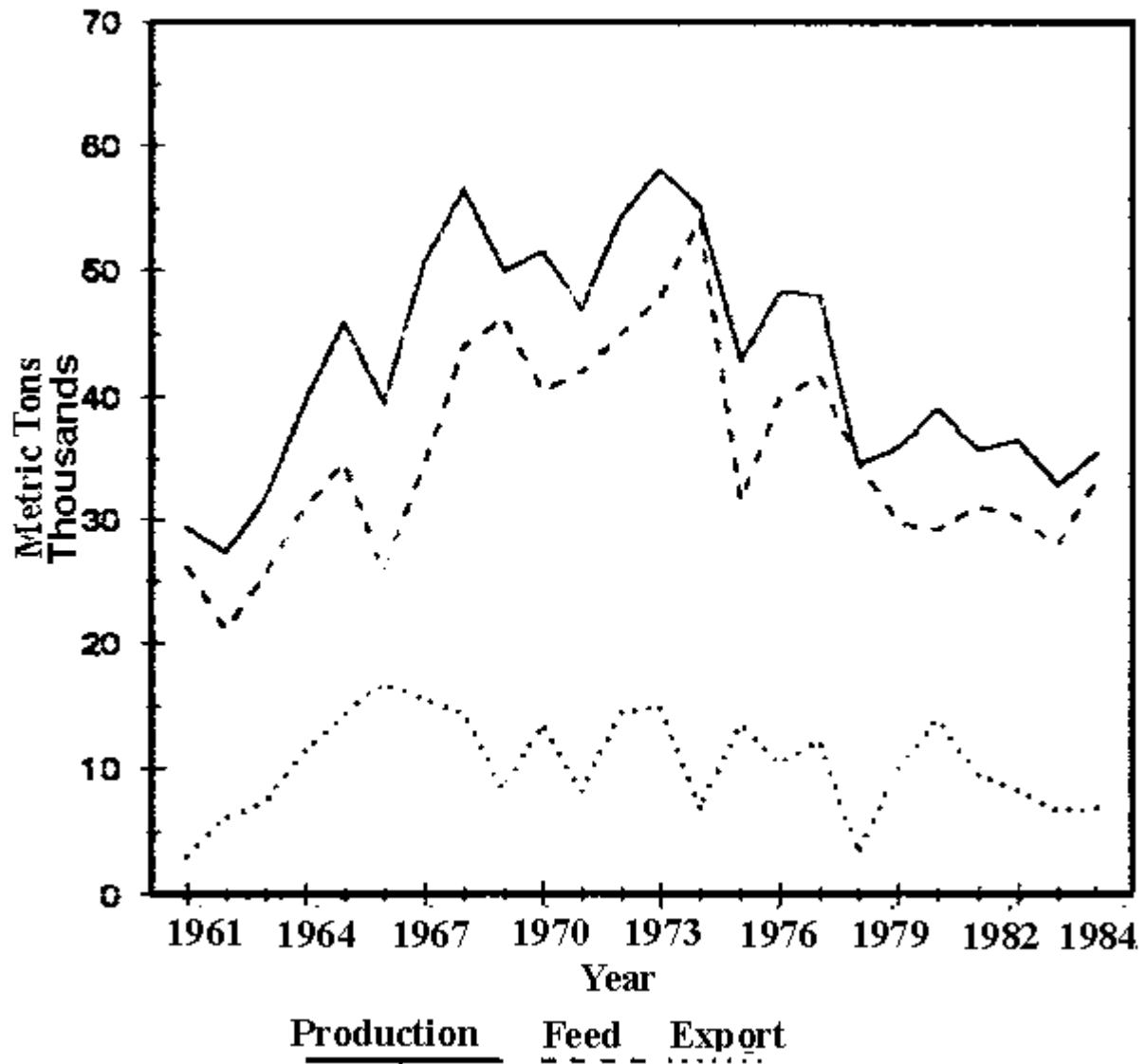


Figure 3: Cottonseed cake production and utilization in Southern Africa (1961–1984)

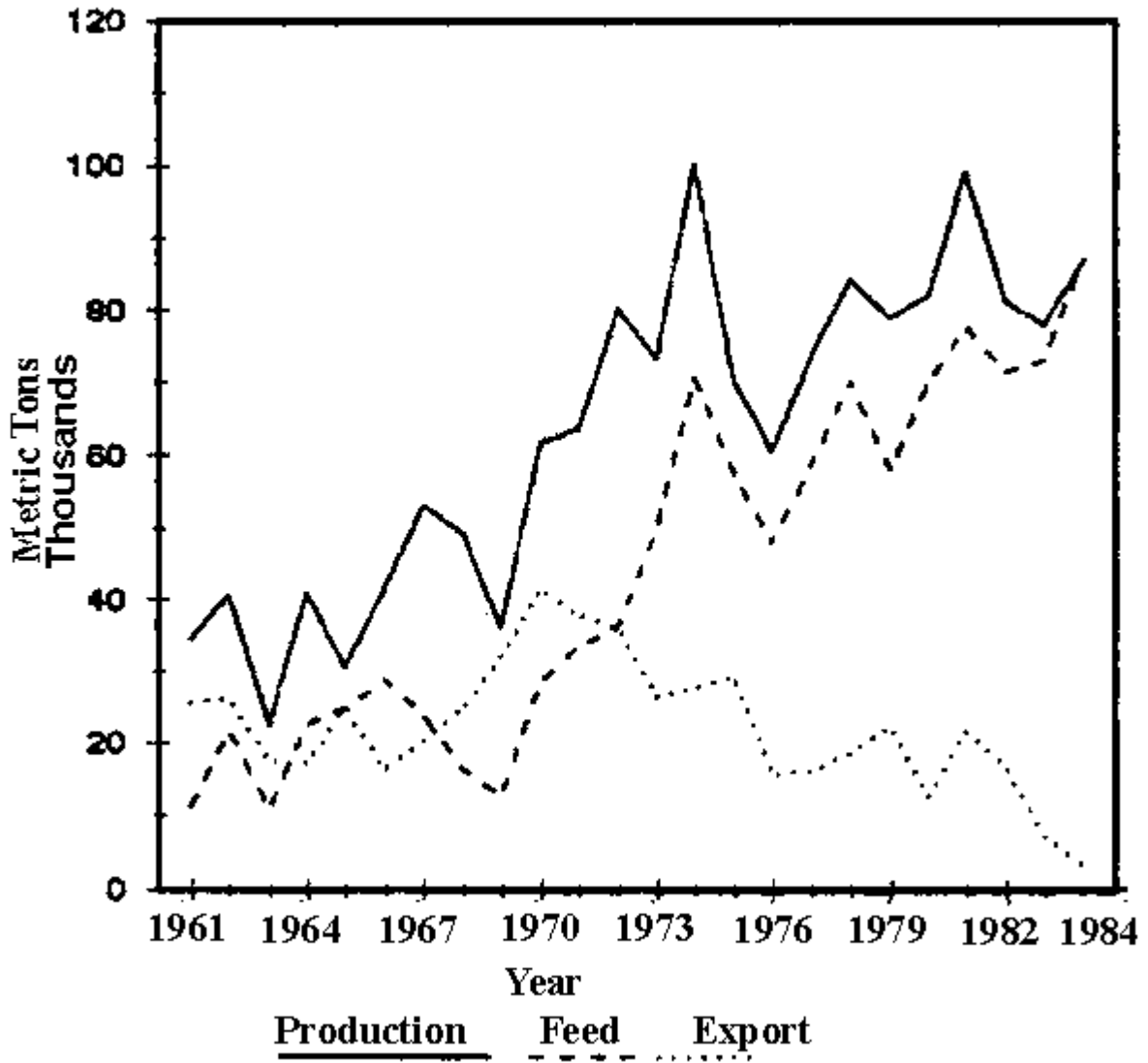


Figure 4: Sunflower seed cake production and utilization in Southern Africa (1961–1984)

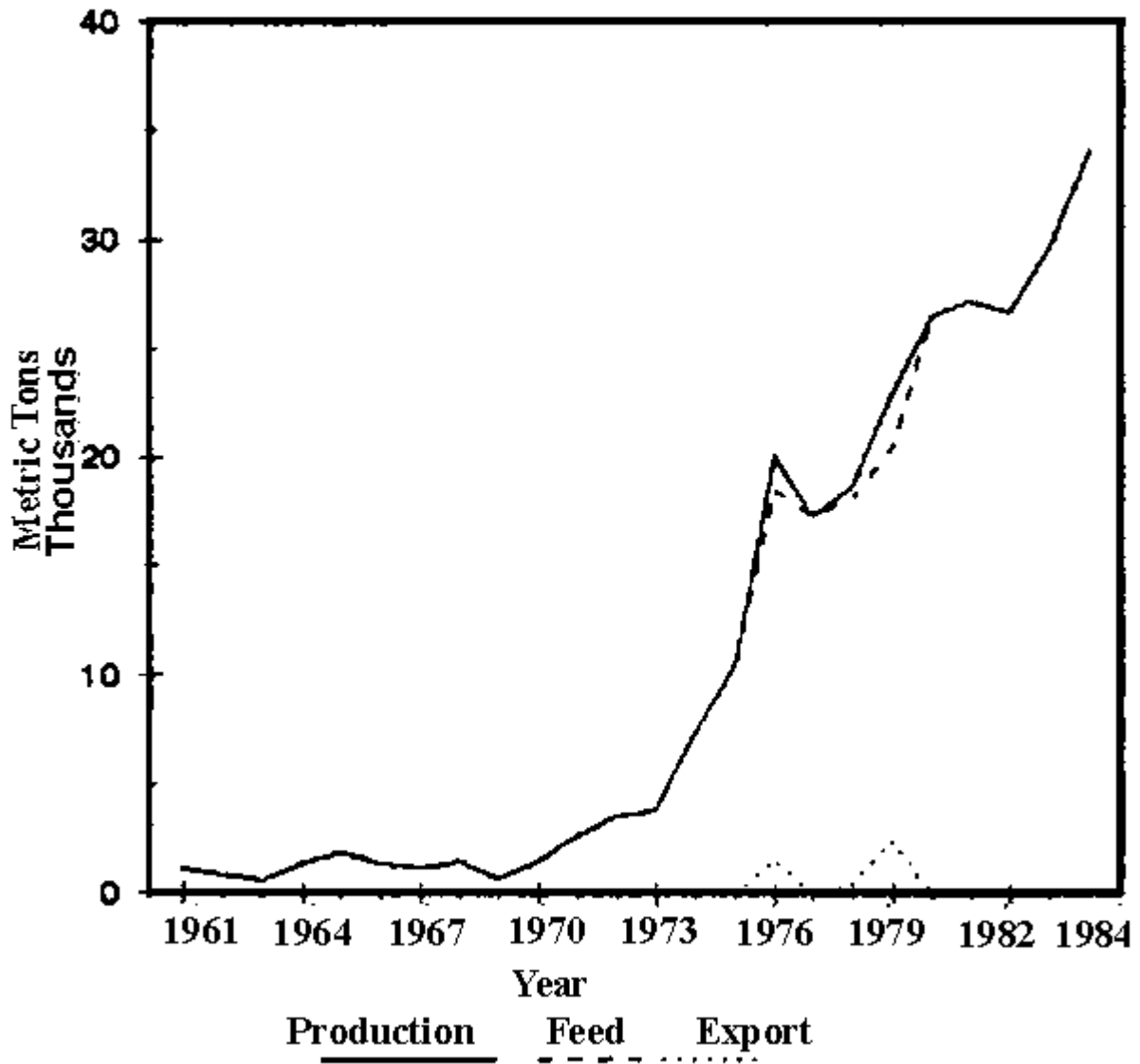
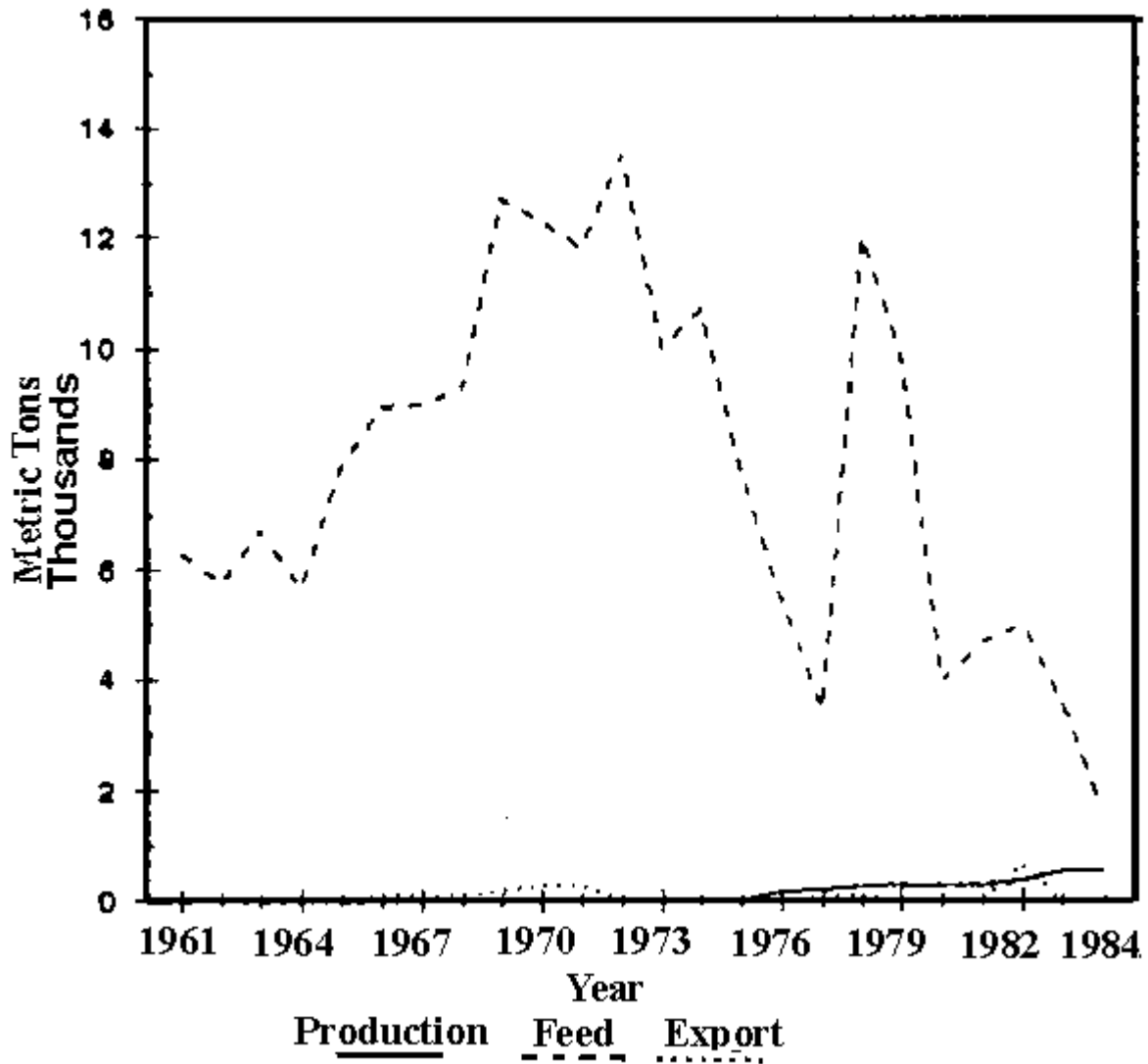


Figure 5: Fishmeal production and utilization in Southern Africa (1961–1984)



Appendix F: Country geographical groupings

West Africa	Central Africa
Benin	Angola
Burkina Faso	Burundi
Chad	Cameroon
Cote d'Ivoire	Central African Republic
Gambia	Congo
Ghana	Gabon
Guinea	Rwanda
Guinea Bissau	Zaire
Liberia	
Mali	
Mauritania	
Niger	
Nigeria	
Senegal	
Sierra Leone	
Togo	
East Africa	Southern Africa
Ethiopia	Botswana
Kenya	Lesotho
Somalia	Madagascar
Sudan	Malawi

Tanzania	Mauritius
Uganda	Mozambique
	Swaziland
	Zambia
	Zimbabwe