SOYBEAN SITUATION AND OUTLOOK ANALYSIS: THE CASE OF TANZANIA

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1. Introduction

Historians believe that soybean (*Glycine Max* (L.) Merrill)) is one of the oldest crops grown by human beings. It originated from Eastern Asia, probably in north and central China (Laswai *et al*., 2005). Soybean is strongly believed to have originated from the orient (Myaka *et al*., 2005). Soybean was first grown in Eastern Asia about 5, 000 years ago (BIDCO, 2005), about 5000 years after agriculture evolved (http://en.wikipedia.org/wiki/Agriculture) making it one of the oldest cultivated crops. Cultivated varieties were introduced to Korea and later to Japan 2000 years ago (Laswai *et al*., 2005). In East and South East Asia it is to this day an important component of traditional diets of the regions (www.gardening.about.com).

Soybean cultivation reached Africa in the late 1800s, although little is known of the countries to which it was first introduced (Shurtleff and Aoyagi, 2007). It is possible, perhaps likely, that soybeans were cultivated at an early date on the eastern coast of Africa, since that region had long traded with the Chinese. The earliest known cultivation of soybeans in Africa was in 1896. Algeria, then a French colony, was important to France as a place for acclimatizing plants. The next record of cultivation of soybeans in Africa dates from 1903, when they were grown in South Africa at Cedara in Natal and in the Transvaal. In about 1907 soybeans were introduced to Mauritius and to Tanzania, at that time a German colony (Shurtleff and Aoyagi, 2007).

Starting in 1908 there was a dramatic increase of interest in growing soybeans in Africa, as Europe for the first time began to import large quantities of soybeans from Manchuria in response to severe shortages and high prices of oil in Europe. European nations turned to their African colonies as potential areas for soybean cultivation. English colonies were most actively involved. Very little was done introduce soybeans to the many French colonies. By 1908 soybeans were being grown on a small scale in Nigeria and in the Belgian Congo. Extensive investigations were made on all British Governmental Experiment Farms in Africa and by 1910, it was found that, given the present demand and prices, the colonies could compete very successfully with imported Manchurian soybeans. The most vigorous and extensive cultivation work was done in South Africa, and a number of detailed reports were published on this work starting in 1910. Despite

the strong European demand for African soybeans in the early 1900s, little is known of the extent of actual trade. It is known that soybean culture failed to become established in Africa after this temporary demand subsided because the soybean varieties were poorly adapted to local conditions, the domestic market was not developed, and the European market became small and erratic.

During the 1920s soybeans were first introduced to Egypt, Zimbabwe (then Rhodesia), and Rwanda. In 1938 they were introduced to Uganda. The earliest known report of soyfoods in Africa dates from the early 1930s, when Catholic missionaries organized soymilk production in Zaire (at that time the Belgian Congo). The earliest known commercial soyfood in Africa was soy flour introduced in South Africa in 1937 by a well known milling company and used by a number of gold mines on the Rand to fortify the diets of mine workers. There was little activity or interest in soybeans and soyfoods during World War II, but shortly thereafter a brief attempt was made to introduce tempeh to Rhodesia). In 1950 soybeans were first grown in Ethiopia.

During the 1960s there was a gradual increase of interest in soybeans and soyfoods throughout Africa. In 1962 Africa's second commercial soyfood, ProNutro, a soy-fortified blend, was introduced in South Africa. In 1964 African women from various countries visited Iowa State University in the US to study the use of soy flour in native diets (*Soybean Digest*, Nov. 1964). During the 1960s, according to the *FAO Production Yearbook* , total African soybean production increased from about 50,000 tonnes (metric tons) in 1960 to 75,000 tonnes in 1969, for a growth of 50% in ten years. The great majority (80-90%) of these soybeans were grown in Nigeria. One of the first ways that soyfoods were introduced to many African nations was in the form of defatted soy flour, shipped to them by the US starting in the mid-1960s in the form of soy-cereal blends under the PL 480 (Food for Peace) program. These shipments continued throughout the 1970s. Starting in about 1973 there was a rapid rise of interest in soybeans and soyfoods in Africa, paralleling the new global interest. The two major reasons for this strong interest in Africa were the sudden rise in world soybean prices and the work of INTSOY, the International Soybean Program headquartered at the University of Illinois. INTSOY's soybean variety trials, starting in 1973, led to the rapid development of soybean varieties

that yielded well under African growing conditions, as tested by cooperators in various African countries. For the first time in history, with yields and prices high, and rising domestic interest in food uses, it made economic sense for African farmers to grow soybeans. In October 1974 INTSOY organized a major conference on Soybean Production, Protection, and Utilization, attended by 97 scientists from Africa, the Middle East, and South Asia. This was a major step forward; the excellent proceedings, describing country-by-country developments were edited by Whigham (1975). A second INTSOY conference, held in Cairo in 1979 to discuss Irrigated Soybean Production in Arid and Semi-Arid Regions, attracted 50 participants; proceedings were edited by Judy and Jackobs (1981). These proceedings and *Soybeans as a Human Food: Unprocessed and Simply Processed* (Wang *et al*. 1977, 1979) are key documents, on which we have drawn heavily.

From the early 1960s until 1976, soybean production in Africa had increased slowly but steadily, but in 1977 takeoff began, fueled by large increases in production in Egypt and Zimbabwe. By 1981 the African total had jumped to 265,000 tonnes; the four largest producers were Egypt (136,000 tonnes), Zimbabwe (97,000), Nigeria (est. 80,000), and South Africa (26,000).

Starting in the mid-1970s Africa began to import US soybeans, soy oil, and soybean meal. Total African soybean imports from the US rose from zero in 1975 to a peak of 102,000 tonnes in 1977, declined to 23,000 tonnes in 1981, then jumped to 85,761 tonnes in 1982. Oil imports rose steadily from 11,000 tonnes in 1975 to 62,377 tonnes in 1981, dropping slightly to 59,371 tonnes in 1982. Meal imports went from 21,000 tonnes in 1975 to a peak of 61,000 tonnes in 1978, falling to 38,743 tonnes in 1982. These imports were relatively small compared with other continents and nations (*Soya Bluebook*).

Two major problems were found in trying to introduce whole soybeans on a home level: they took too much time and fuel to cook and the taste was not well accepted. Like the people of East Asia several thousand years earlier, researchers looked for new approaches.

By 1982 soybeans and soyfoods still played a very minor role in Africa. However, they have great potential in this vast continent where per capita food production has declined steadily and at an accelerating rate from about 1962 to 1982, where total consumption of protein and calories are dangerously low and decreasing, yet where newly developed soybean varieties can be grown with good results.

Soybean is one of human's principal food plants (Myaka, 2005). It is a high protein legume grown for food and feed. Soybean is a versatile source of food that is hard to beat. Although it can be eaten whole after boiling or roasting, most soybeans are transformed into a great variety of foods. Many foods already available on the market contain soybean. This leads to the saying that 'Soybean represents a special opportunity in many countries'. One of soyfood that may well catch on in Africa is soymilk. With more than 80% of all black Africans having lactose intolerance (which makes it difficult for them to digest dairy milk), and with the tsetse fly greatly limiting the areas suited to cattle rearing, soymilk can fill the milk gap. Starting in the early 1980s a Belgian organization, International Investment and Development Corporation (IIDC), began investigating the possibilities of large-scale soymilk production in several African countries. Soymilk equipment manufacturers (such as Alfa Laval and Soya Technology Systems) are actively working with a number of countries and companies to start soymilk plants. Another very promising concept is the development of soy-fortified cereal-based weaning foods produced on low-cost extrusion cookers. Tanzania has led the way in developing such products in Africa.

2. Background information on Tanzania

Tanzania is endowed with 88.6 million hectares of land suitable for agricultural production and an additional 60 million hectares of rangelands, ideal for livestock grazing. However, of the total rangelands, 60% is tsetse infected, leaving a balance of only 40% available for livestock keeping. The carrying capacity of the rangelands is estimated at 20 million animal units. According to the 1994/95 National Sample Census of Livestock, Tanzania has about 15.6 million cattle, 10.7 million goats, 3.5 million sheep, and 27 million chickens. Other livestock include 201 789 pigs, 134 186 donkeys,

4807 buffalo, 47 851 rabbits, 43 159 guinea fowls, and 1.2 million geese. Currently, Tanzania has about 16 million animal units, implying some potential for the expansion of the livestock industry (especially when compared with the carrying capacity of the rangelands in Tanzania, estimated at 20 million).

In Tanzania, about 3.9 million households are involved in agriculture. About 40% of these households are involved in crops and livestock production. Only about 0.4% of the households keep livestock (for manure, hides and skins, draught power, transport, and alternative savings to banks with reasonable protection from inflation). The food crops grown in Tanzania can be classified into:

(i) Major staples (maize, rice and wheat),
(ii) Drought resistant crops (sorghum, millet, and cassava), and
(iii) Other sub-staples (Irish potatoes, sweet potatoes, bananas, plantains and sugarcane).

The primary aim of food crops production is to satisfy domestic demand. The secondary aim is to facilitate the entrance of some of these crops into the export market on a regular basis. An estimated 40% of the Tanzanian population lives in food deficit regions. Malnutrition is currently affecting about 30% of the Tanzanian population (Malema, 2005). About 40% of these comprising mostly children, pregnant and lactating mothers faces moderate to worse malnutrition. In order to cater for the various food needs of the people of Tanzania, it has been estimated that production of food crops will have to register an annual growth rate of at least 4% (The United Republic of Tanzania, 1997).

Soybean is a cheap source of protein – an attribute that increases the potential of soybean in curbing malnutrition that is currently affecting 30% of the Tanzanian population. About 80% of Tanzanians live in rural areas where large portion of the under five are malnourished. Soybean as cheap source of protein is a solution to this problem. Therefore, there is a need of promoting soybean processing techniques and use at household level to ensure that each family get access to use of soybean products. Use of processed soybean at household level can also be facilitated by milling cereal/soybean

mixed at required ratio for preparing several recipes that have been mentioned elsewhere in this publication. The community should be encouraged to use soybean products not only for minors and vulnerable groups like HIV/AIDS victims, but also for all groups of people just like in the Orient where the crop originated.

3. History of soybean in Tanzania

In Tanzania, soybeans were first introduced at Amani, Tanga, by the German traders in 1907 (Myaka *et al.*, 2005). During World War II the British tried unsuccessfully to grow soybeans (Shurtleff and Aoyagi, 2007). The potential of soybeans was later realized and a breeding program, started in 1955, showed good results by the early 1960s, with acreage expanding during the 1970s, when production was steady at about 3,000 tonnes a year for the decade (Mmbaga, in Whigham 1975). At this time there arose a strong interest in expanding the use of soybeans for human foods. Soybeans were bought by the National Milling Corp. In 1973 tests were run in three villages making whole soy flour using the simple process developed at the USDA Northern Regional Research Center in the United States (Shurtleff and Aoyagi, 2007). By 1974 maize flour was being fortified with soy flour (3:1) in porridges and wheat flour was fortified with soy flour (9:1) in breads (Shurtleff and Aoyagi, 2007).

Village soybean projects had been established and future prospects for soy were considered very bright. Using hand operated equipment, villagers processed soybeans into whole soy flour, soymilk, and tofu (Mosha 1976). By 1978 the National Milling Corp. was using low-cost extrusion cookers to make whole soy flour and cereal-soy blends (Wilson, 1979). In 1978 production of Lisha, a corn-soy-milk product, was 572 tonnes. It was distributed through institutional channels to malnourished children in health clinics. In 1979 Tanzania hosted the Second International Workshop on Low-Cost Extrusion Cookers, where much attention was given to cereal-soy blends (Shurtleff and Aoyagi, 2007).

Since introduction (1907) then, there have been several efforts to develop soybean for increased production. These include:

(i) Research such as cultivar introductions in 1909 and 1939,
(ii) Establishment of collection of cultivars at Amani,
(iii) Several breeding programmes at Nachingwea, Lyanwingo, Ilonga, and KATRIN Ifakara,
(iv) Large scale production in Southern Tanzania by Overseas Food Corporation (OFC) in 1947.

In the 1960s, 1970s and 1980s there were efforts to develop soybean in Morogoro, Tanga, Ruvuma, Mtwara, Mbeya and Iringa. During this period Tanzania Agricultural Products Export (GAPEX) and national Milling Cooperation (NMC) encouraged farmers to produce the crop for them to buy and export to Japan and Singapore (Myaka *et al.*, 2005).

Despite all efforts to develop and promote soybean in Tanzania, it has failed to excel as a food crop because of the following reasons:

(i) Limited knowledge on its potential as food,
(ii) Low production,
(iii) Difficulties in processing (knowledge and technology),
(iv) Limited knowledge on utilization options,
(v) Difficulties in marketing the crop (Myaka, 1990; Laswai *et al.*, 2005).

It is even pathetic that many farmers in are still unable to distinguish soybean from common beans (*Phaseolus vulgaris*) (Ndakidemi, and Nyaki, 1999) even in regions like Mbeya where a lot of soybean research work has been carried out (Myaka *et al.*, 2005). The first soybean breeding program was initiated in 1955 to develop high yielding and well-adapted varieties with desired characteristics (Auckland, 1982). In 1959 at *Nachingwea*, enough seeds of *F6* and *F7* generations were available to begin testing for yield and other characteristics. Variety testing continued at *Ilonga* during each season from 1960 to 1969 and at KATRIN from 1968 to 1976 (Anonymous., 1970; 1968 and 1975). This first breeding program contributed to the release of *3H/1* and *7H/192* selections (Aucland, 1982).

The second breeding programme began in 1973 at *Ilonga* Agricultural Research Institute and later shifted to *Lyamungo* Research Institute (Anon, 1978). The major aims of the second breeding programme were to obtain new varieties with: (i) high yielding characteristics, (ii) high protein and oil contents, (iii) resistance to lodging and shattering, (iv) resistance to major diseases, (v) good adaptations to the environment, (vi) ability to set pods at 10-15 cm above the ground, (vii) medium plant height (60-90 cm), and (viii) good branching habit (Sanchansky, 1976).

In the late 1970s, the program was shifted back again to *Ilonga* which became the national coordinating centre for soybean research in Tanzania. At that time, self-nodulation was included as one of the breeding objectives together with the above-mentioned other characteristics. In 1989 agricultural research zones were formed and zones were mandated to coordinate their own research.

Alternative crops research of *Selian* Agricultural Research Institute (Arusha) began in 1986 with the objective of identifying crops which could be grown in alternate with wheat particularly on large scale mechanized wheat farms. The criteria for the choice of such crops include: ability to use the existing machinery to perform most of the operations such as seeding, spraying and if possible harvesting. Soybean, sunflower, safflower, and flax were found to be the most appropriate (Kweka, 2005).

Soybean variety trials involving *Bossier*, *Bossier IL*, *Duicker*, *Sable*, *EAI 3715*, *Still*, *Delma*, and *SAB/7* were carried out in 1992 at Selian and also at Lambo Estate (Kilimanjaro) (Mwandemele, and Nchimbi, 1990). Unlike the trial at Lambo, the trial at Selian did not include *PERY 41*.

4. Crop distribution

Soybean is mainly produced in *Ruvuma*, *Mbeya*, *Iringa*, and *Morogoro* regions. Apart from these, the other potential soybean growing regions include *Rukwa*, *Arusha* and

Kilimanjaro (Malema, 2005). The present annual soybean production level in Tanzania is estimated at 3000 MT by Myaka *et al*. (2005) and at 5000 MT by Malema (2005).

Soybeans can grow from the coastal belt to areas of Tanzania 2000 m.a.s.l. This means that soybeans can grow in almost all areas of the country (including in areas where there is widespread malnutrition) provided there is adequate moisture and that the right varieties are planted (Myaka *et al*., 2005, Malema, 2005). Even zones such as Lake, Southern and Western also have good potential for soybean production (Malema, 2005). There are however, significant differences in the potential of the different regions to support soybean with (i) Mbeya, Ruvuma, and Rukwa being regions of very high potential, (ii) Morogoro, Tanga, Kigoma, Arusha, and Kilimanjaro belonging to regions of high potential, (iii) Kagera, Mara, and Manyara being of medium potential, while (iv) Mwanza, Tabora, Shinyanga, Singida, Mtwara, Lindi, and Dodoma are low potential regions, and (v) Dar es Salaam and Coast belonging to regions of very low potential (**Table 1**).

Table 1: Potential for soybean production in different regions of Tanzania

Region	Production (tons)	Rank (Very high, High Medium, Low, Very low)
Mbeya	300,000	Very high
Ruvuma	225,000	Very high
Rukwa	225,000	Very high
Morogoro	120,000	High
Tanga	120,000	High
Kigoma	120,000	High
Arusha	120,000	High
Kilimanjaro	115,000	High
Kagera	100,000	Medium
Mara	100,000	Medium
Manyara	100,000	Medium
Mwanza	65,000	Low
Tabora	50,000	Low
Shinyanga	45,000	Low
Singida	30,000	Low
Mtwara	30,000	Low
Lindi	25,000	Low
Dodoma	15,000	Low
Dar Es Salaam	500	Very low
Coast	500	Very low
Total	**2 166 000**	

Source: Adapted from Malema (2005)

Available historical data (1978 – 1988) from 12 regions of Tanzania (Iringa, Kagera, Kilimanjaro, Lindi, Morogoro, Mtwara, Mwanza, Rukwa, Ruvuma, Singada, Tabora, and Tanga) indicate the erratic trend in the production of soybean in the country. Across the regions, while the highest quantity of soybean produced during the period was 1 547.9 metric tons (in 1987), the least was 187.0 metric tons (in 1981). Within the 11 years (1978 – 1988), soybean production was consistently recorded in three regions (*Mtwara* (3511.7), *Lindi* (2648.4), and *Morogoro* (2054.1). *Rukwa* (226.5), *Tabora* (13.4), *Ruvuma* (141.3), and *Iringa* (96.0) followed these. In the remaining regions, soybean production was recorded for two or less number of years out of the 11 years considered. The main districts in which soybean is currently grown in Tanzania include *Arumeru*, *Babati*, *Hai*, *Rombo*, and *Moshi* rural.

The varieties of soybean grown in Tanzania include *Bossier*, *Bossier IL*, *Duicker*, *Sable*, *EAI 3715*, *Still*, *Delma*, *SAB/7*, and *PERY 41*. The yield obtained from 1992 soybean variety trial at Selian ranges from 0.27 t/ha (from *Bossier IL*) to 0.72 t/ha (*from Sable*). The other top yielding varieties are *Duicker* (0.66 t/ha) and *Bossier* (0.61 t/ha). Results from the soybean variety trial in *Lambo* Estate indicate yields ranging from 0.72 t/ha (from *PERY 41*) to 1.430 t/ha (from *Duicker*). The other top yielding varieties are *Sable* (1.351 t/ha), *Still* (1.12 t/ha), and *EAI 3715* (1.11 t/ha). Twelve demonstration plots were harvested in *Hai* district in 1999. The average yield ranged from 588 to 2333 kg/ha.

5. Production

This section looks at the production levels of soybean and across regions and undertakes a situational analysis of the status of production along the value chain.

5.1 World production of soybean

In 2003, about 190.1 million MT of soybean (representing 56% of world production of oilseed) was produced in the world. The United States of America accounted for about 65.8 million MT (or 34%) of the soybeans. The other major producers of soybean are Brazil (53.5 million MT or 28%), Argentina (34 million MT or 18%), China (16.2 million MT or 9%), India (6.8 million MT or 4%), Paraguay (4.0 million MT or 2%), and others (9.8 million MT or 5%). The logarithmic trend in the world production of soybean reveals that between 1994 and 2003, there has been steady growth in world soybean production (FAO, 2004). Soybean growers in leading producing countries have been using the Biotechnology options. As a result, most of the soybean that is currently grown has undergone biotech modification (Jagwe and Nyapendi, 2004). Based on the 2003 production records, about 81% of the soybean produced in the United States of America has been modified using biotechnology. The corresponding figure for Argentina is 99% and for Brazil is 34% (Jagwe and Nyapendi, 2004). The use of biotechnology modified planting materials confers the advantages of higher crop yields and greater tolerance to soybean diseases and pests (Jagwe and Nyapendi, 2004). High crop yield increases the profit a farmer makes from selling his or her produce.

5.2 Production of soybean in Africa

Soybean is cultivated in sub-Saharan Africa to a very limited extent (Laswai *et al*., 2005; Shurtleff and Aoyagi, 2007). During the last decade or so, the African continent accounted for 0.4% to 0.6% of the world's total production of soybean, the main producers being Nigeria (437 000 MT global production), South Africa (221 000 MT), Uganda (166 000 MT), Zimbabwe (83 000 MT), and Rwanda. Overall, about 19 African countries appear in the world soybean production statistics (FAO, 2008). These countries and the proportion (%) of African soybean production that each accounts for are: Nigeria (48.9%), Uganda (16.8%), South Africa (14.9%), Zimbabwe (8.4%), Ethiopia (2.7%), Rwanda (2.0%), Egypt (1.7%), and DRC (1.4%). Others are: Cameroon (0.8%), Benin (0.7%), Cote d'Ivoire (0.3%), Liberia (0.3%), Burkina Faso (0.3%), Zambia (0.2%), Gabon (0.2%), Tanzania (0.2%), Morocco (0.1%), Burundi (0.0%), and Madagascar (0.0%). With this minimal share of world production, the sub-Saharan African (SSA) region is a net importer of edible oil and protein cake and protein meal mainly for the livestock industry.

Soybean is ideal as a pure stand crop although it can be intercropped with other crops like maize as it is of shorter duration, dwarfs habit and, being a legume, does not exhaust the soil. Maize grows better after soybean. Planting can be done by hand or with mechanical planters.

5.3 Soybean production in Tanzania

Soybean production data for (FAO) in Tanzania have tended to remain stagnant over the years (1961-1983). However regarding total national soybean production, area, yield and production showed a slight increasing trend after 1983 (Figures 1, 2, and 3). Tables have been supported with figures to enable easy visualization of data.

Figure 1: Soybean planted area (acres) in Tanzania (1961- 2007)

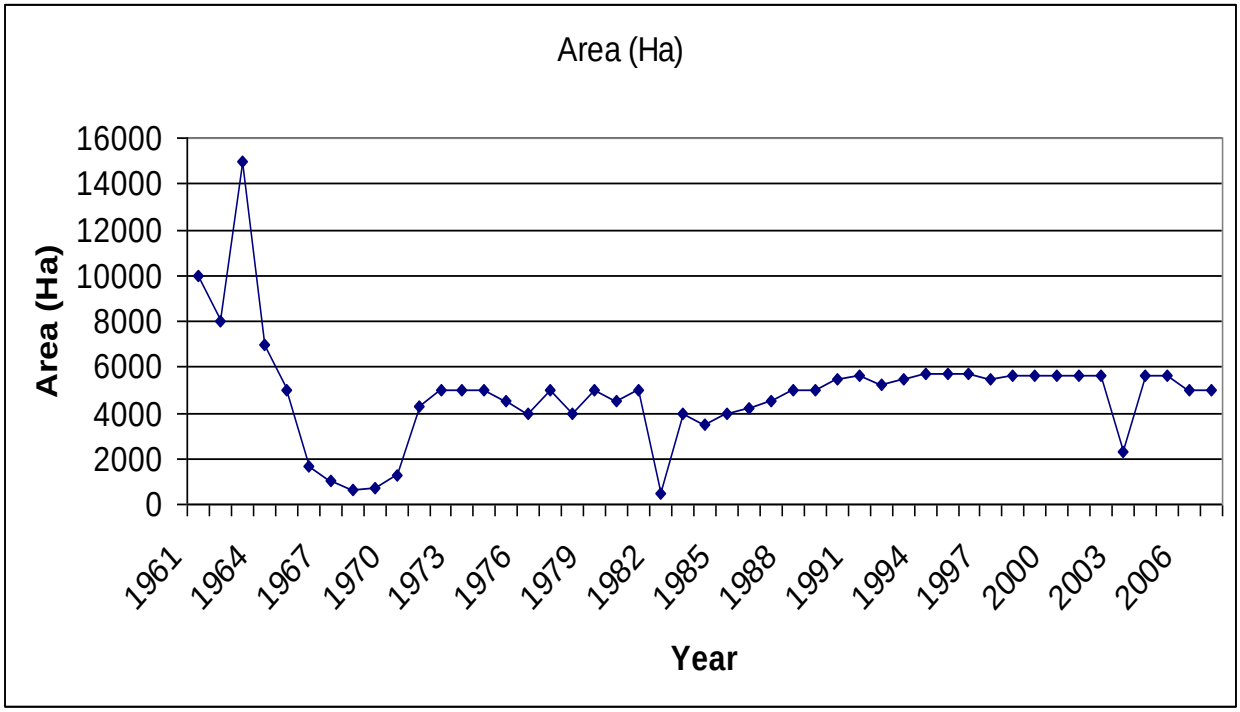


Figure 2: Soybean planted yield (T/ha) in Tanzania (1961- 2007)

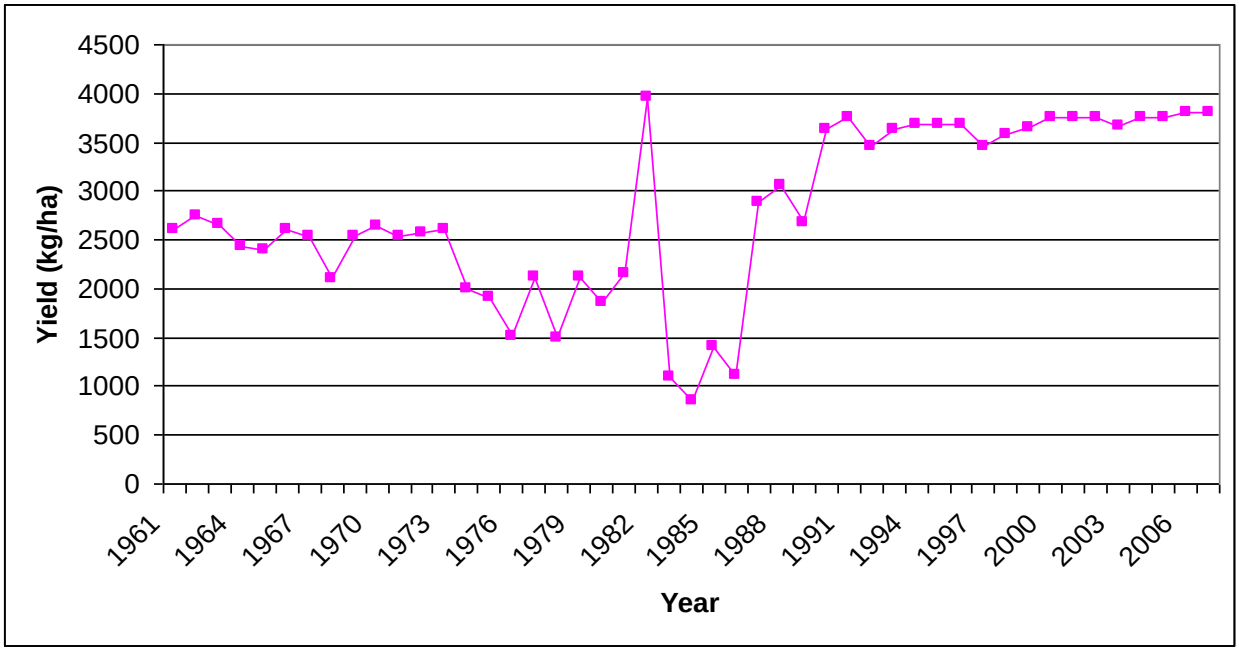


Figure 3: Soybean production (Tonnes) in Tanzania (1961- 2007)

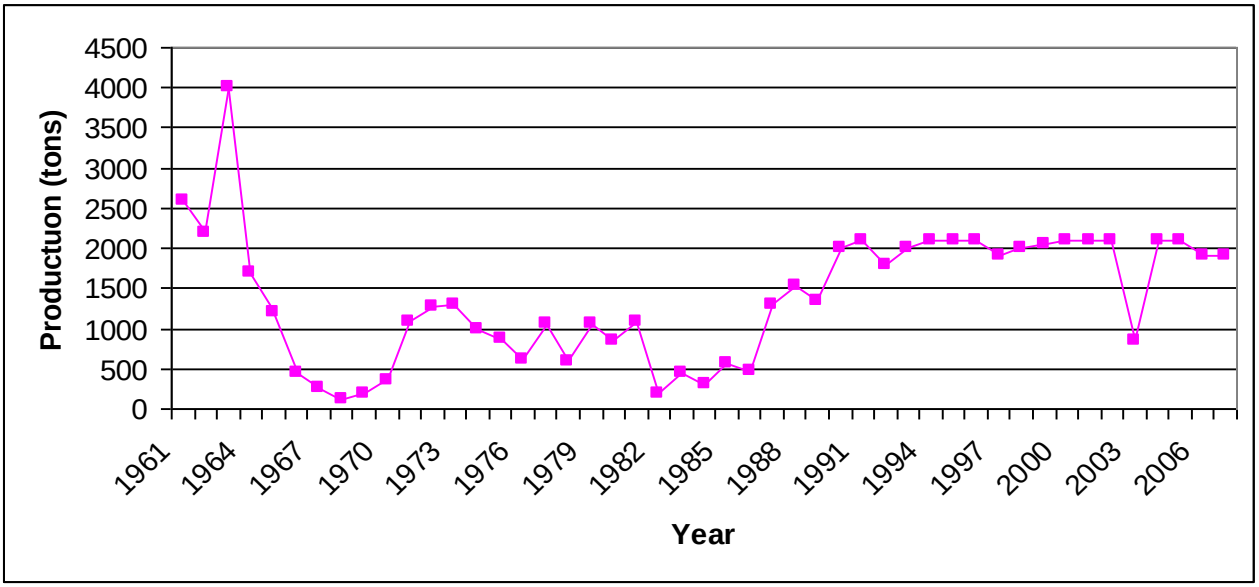


Table 2 shows that when compared with the major soybean producing countries of the world (USA, Brazil, and Argentina), soybean production in Tanzania is very infinitesimal.

Table 2: Comparing soybean production ('000 MT) in Tanzania with production in the three high producing countries in the world ('000 000 MT)

County	Year									
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
USA	59.17	64.78	73.19	74.61	72.22	75.07	78.68	75.01	66.79	85.49
Brazil	24.15	27.30	32.50	31.30	34.20	39.00	43.50	52.00	52.60	53.00
Argentina	12.44	11.20	19.50	19.90	21.00	27.80	30.00	35.50	33.00	39.00
***Tanzania**	-	-	-	-	-	0. 43	1.27	2.06	1.06	1.15

Source: USDA (United States Department of Agriculture)

The large-scale production program by OFC resulted in increased land area (up to 2500 ha) devoted to soybean production in Nachingwea (Myaka *et al.*, 2005). Soybean

production in Tanzania showed an increasing trend in mid to late 1980s when Tanzania's General Agricultural Product Export Company (GAPEX) and Cooperative Unions used to buy and export the crop. But thereafter, production went declined down. Presently, the production and utilization of soybean in Tanzania is still very low when compared with other crops and with its potential, estimated at about 2 million MT per annum (Myaka *et al*., 2005; Malema, 2005). Despite the high potential of soybean in Tanzania, production and utilization still remains low. Notwithstanding, the efforts of the Ministry of Agriculture and other stakeholders to promote the crop there is little response from farmers (Malema, 2005).

Annually, Tanzania has been producing an average of 200 MT of seed per year. Sharp increases in soybean production were realized between 1961 to 1962 (360MT- over 600 MT). After this period, seed production fluctuated widely, stabilizing at an annual average level of 280 MT per year (FAO, 2008). Soybean seed availability is still a major problem in Tanzania, with limited seed multiplication (**Table 3)** shows that soybean seed multiplication is still on a limited scale.

Table 3: Area under soybean seed multiplication, soybean seed produced and estimated yield at ARI Ilonga 2005

Genotype	Area (ha)	Seed Produced (kg)	Estimated yield (kg/ha)
TGX 1895-4F	0.27	194	718
TGX 1895-33F	0.18	155	861
TGX 1895-49F	0.27	120	444
TGX 1876-4E	0.29	132	455
Bossier	0.39	170	436
Total	1.40	771	
Mean	0.28	154	583

Source: Adapted from Myaka (2005)

6. Soybean Utilization and Consumption

Soybean is the most dominant source of protein in livestock feeds through out the world. It can provide 440 to 4809kg crude protein per ton, providing high quality and highly digestible protein (FAO, 2006). It contains the required limiting amino acid lysine – an

essential amino acid (EAA) - that most other legumes lack. However, soybean has trypsin inhibitor but this can be destroyed through systematic application of heat.

Soybean is important because of its nutritional qualities. It has high percentage of high quality and cheap protein and is a rich source of edible oil. Soybean contains up to 45% protein and 23% oil and can be more widely utilized than most of the food legumes. It is used as human food, for livestock feeds, as oil and for various industrial purposes (Myaka *et al*., 2005). Soybean is a major source of a protein in human food and animal feeds in developed countries.

Soybean can contribute to poverty reduction and the eradication of malnutrition among children and expecting mothers (Myaka *et al*., 2005). By fixing atmospheric nitrogen as a legume, the soybean crop improves soil fertility, making it possible for the resource-poor farmers to save on the cost of purchasing mineral fertilizers. Improvement of soil fertility by adding 44 to 103 kg N from the atmosphere (Sanginga *et al*., 2003), reduces the fertilizer needs of companion/subsequent crops. Its external input needs are far less than most other crops in SSA and is hence ecosystem friendly. This attribute also indicates that soybean will be a suitable crop in crop rotation since the subsequent crop in the rotation can benefit from the nitrogen fixed by the preceding soybean. All these indicate that by growing soybean, the resource-poor farmers could reduce the yield loss due to lack of mineral fertilizers that they cannot afford because of their high costs. By reducing the need for mineral fertilizers and integrating organic matter, soybean can contribute to environmental preservation.

Of all legumes, soybeans have the highest concentration of protein. Most other beans contain 20% protein by volume, while soybeans have 40% (Greenberg and Hartung, 1998). Soybean also contains more protein than beef and fish that contain about 18% in protein content. Besides, soybean products are cholesterol free and high in calcium, phosphorus, and fiber (Greenberg and Hartung, 1998). The non-cholesterol content of soybean oil explains its high demand for health reasons. Soybean also has one of the lowest levels of saturated fat among vegetable oils (BIDCO, 2005). Some specialized

industries can esterify soybean oils for the production of bio-fuels (Malema, 2005). **Table 4** shows the high protein content of different parts of soybean. The importance of soybean is based on its high quality protein content compared to other grain legumes (common beans, groundnut, peas, and pigeon peas), livestock products (meat, milk, and egg), cereal products (wheat flour, finger millet flour, and maize flour), root and tubers products (cassava flour, round potatoes, and sweet potatoes) and plantain and banana (**Table 5**).

Table 4: Protein content of different parts of soybean

Component or part of soybean	Protein (%)	Fat (%)	Carbohydrate (%)	Ash (%)
Whole	40	20	34	4.9
Hull	43	23	29	5.0
Cotyledons	8	1	86	4.3
Hypocotyls	41	11	43	4.4

Source: Osho, 1989

Table 5: Percent nutrients content per 100 g in soybean compared to other foodstuffs

Food type	Water	Energy	Protein	Oil	Calcium	Iron
Grain legumes:						
Common beans	10	334	**25.0**	1.7	110	8.0
Ground nuts	6	579	**27.0**	45.0	50	2.5
Peas	10	337	**25.0**	1.0	70	5.0
Pigeon peas	10	328	**26.0**	2.0	100	5.0
Soybean	8	382	**40.0**	20.0	200	7.0
Livestock products:						
Meat	66	202	**20.0**	14.0	10	3.0
Milk	74	140	**7.0**	8.0	260	0.2
Egg	74	158	**13.0**	11.5	55	2.0
Cereal products:						
Wheat flour	13	346	**11.0**	1.6	20	2.5
Finger millet flour	12	332	**5.5**	0.8	350	5.0
Maize flour	12	362	**9.5**	4.0	12	2.5
Root & tuber products:						
Cassava flour	12	342	**1.5**	0.0	55	2.0
Round potatoes	80	75	**2.0**	0.0	10	0.7
Sweet potatoes	70	114	**1.5**	0.0	25	1.0
Plantain & banana:						
Plantain (banana)	67	128	**1.5**	0.2	7	0.5

Source: Adapted from Malema (2005) (Sourced originally from Marealle (1974 - Tanzania food Tables)

Soybean has high commercial value and contains all the amino acids required by the human body except methionine that can be found in cereals such as maize (Osho, 1995). In summary, soybean can contribute to household cash income, create employment, improve human and livestock health, and improve standard of living and quality of livestock products (Malema, 2005).

6.1 World consumption of soybean

China is the largest customer for U.S. soybeans with annual purchases totaling about US$2.9 billion. The European Union followed China in the purchase of U.S. soybeans with purchases worth US$ 1.1 billion. The other significant buyers of the U.S. soybean

included Mexico (US$ 981 million) and Japan (US$ 957 million). Compared with the Japanese people, Americans consume relatively little fewer soybeans in their daily diets. Most of the soybeans grown in USA are processed into soybean oil, used widely in vegetable oils, shortenings and margarines, high-protein animal feed and biofuel.

However, with respect to the U.S. soybean meal, Canada is the largest customer, purchasing soybean meals worth US$242 million. The other U.S. soybean meal customers included Mexico (US$ 150 million), and Indonesia (US$ 96 million).With respect to the purchases of the U.S. soybean oil, Mexico was the largest customer with purchases worth US$82 million in 2003. Canada comes next with soybean oil purchases worth US$ 72 million. In the United States, soybean provided 80% of the edible consumption of fats and oils in 2003. The domestic crush level was 40 million metric tons, with the U.S. ending stocks of soybeans down to 3.13 million metric tons.

New use opportunities are opening up for soybean in the world following the increasing importance of bio diesel. Presently, the development of the bio diesel industry is an important issue under discussion in the US and soybean is to be considered a major source for this fuel.

6.2 Soybean utilization options

These include: (i) weaning food (Annan and Plahar, 2003), (ii) roasted soybeans (ingredients in traditional confectionery products and snacks), (iii) immature whole green soybeans (as vegetable), (iv) germinated soybean and soybean sprouts (as vegetable), (v) dehulled whole beans full fat flour (bakery and dietetic food), (vi) very finely ground full fat flour (as spray-dried milk alternative), (vii) oil source (shortening, margarine, cooking oil and salad dressing, paint, varnishes, printing inks, lecithin) (Gibson and Benson, 2002), oil highly digestible (CGIAR, 2001), and (viii) soy meal for animals (soybean cake) (Laswai *et al*., 2005).

7. Processing and utilization of soybean in Africa

Processed soybeans have been widely used in many countries for many years as a source of energy and protein (Zulu, 2005). There are a number of products that can be derived from raw soybeans. These include the following:

(i) Soy Oil Cake - a product obtained from solvent vegetable oil plant. It is toasted to deactivate trypsin inhibitors (*Urease* and *Haemaglutinins*) which all have adverse effects on poultry performance. The protein content ranges between 44 – 48%. The production of Soya Oil Cake requires large capital investments.

(ii) Low fat Soya cake - a product obtained by expelling oil from hot full fat soybean using mechanical expellers. This product has a protein content of about 48%. The capital investment required is less than that required by the soy oil cake and ranges from US$ 20 20,000 to US$ 80 000; and

(iii) Full Fat Soybean - a product obtained by subjecting milled soybeans to heat treatment. Its protein content is usually 38% and varies depending on farm management and weather factors. The rest of the discussion here will focus on Full Fat Soybean.

7.1 Full Fat Soybean

Soybeans, though a superb source of nutrients, cannot be fed to poultry in its raw or unprocessed form because it contains natural anti–nutritive factors such as trypsin inhibitors (trypsin is an enzyme in poultry that is involved in the digestion of protein) such as Urease and haemaglutinins all which adversely affect protein digestion in poultry. These are readily deactivated and reduced to low levels by heat processing.

Full fat soybean meal (FFS) is heat-treated whole soybeans – nothing is added or removed in the process. The process is achieved by the use of dry extruders. These machines produce heat through friction under pressure as the whole soybeans are forced by a screw through a series of restrictions inside a cylindrical barrel. The moisture in the beans produces the steam. The vigorous process shears and grinds so that the cell walls of the soybeans are ruptured, thereby increasing nutrient availability in general as well as oil. The process takes less than 30 seconds but during that time a final cooking

temperature of 140 ^{o}C–145 ^{o}C is achieved. This temperature is sufficient to denature the anti–nutritive factors but because the high temperatures are held for a few seconds the amino acid availability is maintained. During the process, a pressure of 35–40 atmospheres is generated. As the full fat soybeans leave the extruder barrel the sudden release of pressure that causes a rapid expansion of beans and further rapture of cell walls to increase nutrient availability occurs. The unique nutritional value of full fat soybeans has led to its wide use all over the world (e.g., USA, Republic of South Africa RSA, etc.).

Table 6: Comparison of fishmeal and silver fish nutrition content

Nutrient	**Fish meal (%)**	**Full fat soybean (%)**
Crude protein	42	38
Crude fat	9	-
Moisture	15–18	8
Lysine	6.34	2.4
Methionine	2.66	-
Tryptophan	9.51	0.05
Threonine.	2.79	1.7
Digestive protein	-	33.5
Methionine and cystine	-	1.15
Metabolizable energy poultry	-	16.50 mj/kg
Vitamin E	-	551 u/kg
Linoleic acid	-	9
Linolenic	-	2
Oil content	-	20

Source: Zulu (2005)

The protein content of fishmeal from Mwanza is variable. It can be as low as 32%. There are usually a lot of contaminants like sand, stones, paper, grass, and snails etc. that traders add to get more weight whereas in soybeans it is not possible to get such contaminants. The disadvantages of using fishmeal include (i) it has high levels of bacteria (e.g. salmonella) which cause serious production problems in poultry (Zulu, 2005) (e.g. diseases that can cause as much as 100% mortality on poultry farms), (ii) in breeding and hatchery operations, the bacteria can lead to about 50% reduction in egg production, (iii)

hatchability could be reduced by up to 30%, (iv) chick quality is lowered due to bacteria, viruses and fungi in hatching eggs, (v) Micotoxins from bacteria reduce poultry performance and result in usage of drugs which have residual effects and result in huge livestock medical bills, (vi) Fishmeal causes gizzard erosion – chemicals during decomposition burn the gizzard of poultry thereby causing metabolic disorders, (vii) Fishmeal from the sea is very salty causing wet droppings, (viii) Salmonella in meat and eggs, (ix) Bones in fish cause damage to the intestinal linings – also chock birds, (x) Fishy taint or smell in eggs and meat, (xi) Product can be expensive (e.g. up to 1000 Tsh kg^{-1}), (xii) Short shelf life due to high moisture, (xiii) Unhygienic, usually rotten, (xiv) Depress growth in broilers due to bacteria, viruses and fungi and other birds, and (xv) Protein value is reduced due to rotting as bacteria feeds on it (Zulu, 2005). Nutrient characteristics of dry extruded full fat soybeans are shown in **Table 7**.

Table 7: Nutrient characteristics of dry extruded full fat soybeans

Nutrient	Amount of AS (%)
Moisture	8.00
Crude protein	38.00
Digestive protein	33.50
Lysine	2.40
Methionine and cystine	1.15
Tryptophan	0.05
Threonine	1.70
Metabolizable energy poultry	16.50 mj/kg
Vitamin E	551 u/kg
Linoleic acid	9.00
Linolenic	2.00
Oil content	20

Source: Zulu (2005)

The advantages of full fat soybeans as opposed to fishmeal (*Dagaa*) in poultry production include: (i) long shelf life, (ii) product is fresh unlike fishmeal, (iii) high energy and protein content, (iv) high digestibility of over 90% as product is cooked during processing, (v) consistent (unlike fishmeal that is variable) energy and protein quality, (vi) high oil content (vital for reducing heat stress), (vii) high tocopherol (antioxidants) for oil stability, (viii) high levels of essential fatty acids like linoliec and linolenic, (ix)

reduction in feed wastage and dustiness of the feed due to its oil, (x) product is sterilized during cooking (therefore has less bacteria, viruses, and fungi), (xi) product is comparable in price to fish meal, (xii) poses no salmonella danger in eggs and poultry meats, (xiii) achieves very good feed conversion rates, (xiv) very low mortality in poultry, and (xv) no fishy taint in eggs and meat (Zulu, 2005).

7.2 Quality characteristics desired of soybean

The buyers of soybean in the international market often desire certain quality characteristics. Some of these characteristics and the expected levels are presented in **Table 8**.

Table 8: Quality specifications for soybean in the world market

Characteristic	% Minimum	% Maximum	% Basis
	Test weight: 54 lbs/bu		
Protein	35		
Oil content	18		
Moisture content		14	
Splits		20	
Foreign matters		2.0	
Soybean other color		2.0	
Heat damaged kernel		0.5	
Total damaged kernel		3.0	
Oil content			18

Source: Adapted from Jagwe and Nyapendi, 2004

8. Soybean in urban markets in Tanzania

8.1 Soybean in livestock feed industries in Tanzania

The livestock kept in Tanzania are mainly ruminants (cattle, sheep, and goats) and mono gastric (poultry and pigs). Ruminants have bacteria in their rumen that significantly influence protein synthesis and absorbable amino acids. Mono gastric livestock do not have this capacity, hence the need to provide them with rations that are rich in high value protein. In the context of the livestock feed industry, soybean is suitable use in feed formulation as a source of healthy, safe, and quality crude protein.

The development of livestock feed industry in Tanzania has highly been influenced by the government (through professional and infrastructural development). One of the milestone undertakings by the government in this sector was the establishment of the Tanzania Feed Company (TAFCO) under the umbrella of the defunct Livestock Development Authority (LIDA). The collapse of the most parastatal organizations in the late 1908s and early 1990s negatively affected the livestock feed industry. Since then the private sector has been the main player in the livestock feed industry amidst daunting globalization and trade liberalization challenges (Mwasha, 2005).

The private livestock feed sector is not well organized with numerous small-scale unregistered backyard livestock feed producers being the majority. The livestock sector in all its dimensions is growing in Tanzania. An estimate by the International Food Policy Research Institute (IFPRI) indicates that meat consumption in Tanzania is expected to increase by 58% between 1995 and 2020. According to the World Bank, the livestock sector will produce 30% of the value of global agricultural output and will become the most important agricultural sub sector in terms of value addition and land use.

Domestic animals make critical contribution to society and human existence throughout the world, and play a key role in agriculture. Livestock products account for estimated 30 percent of the total global value of food and agriculture, and approximately 10 percent of the value of global food production (Heap, 1998). Products from food animals provide over 33 percent of protein consumed in human diets globally and about 16 percent of food energy (Martin, 2001). Livestock provides humans with non-food products such as wool (for clothing), hides (for leather for bags and shoes), bones (for bone meal used in livestock feed formulation), dung (for bio fuel and soil fertility, thereby protecting the environment), and draft power (leading to savings in human energy and foreign exchange that would have been expended to pay for fossil fuel).

Consumer preferences are increasingly dictating what should be in the market, especially in developed countries. However, this behavior is trickling down to even the developing

countries following globalization. A simple example is the niche market for broiler meat being imported from Brazil due to quality and preference reasons for the niche market.

The consumption of meat from mono gastric animals (poultry and pigs) is on the increase especially in urban areas where both income and the demand for animal protein are higher than in the rural areas. Production of these types of livestock (mono gastric animals) can be highly intensive even the landless can improvise structures for their production. Fishmeal is presently the main source of protein in the formulation of feeds for the mono gastric animals in Tanzania. However, fishmeal is faced with the threats of containing dioxin residues (highly toxic) and is associated with the risk of spreading serious microbes such as salmonella and bird flue virus (Mwasha, 2005). Dioxin residues in fishmeal are produced as a by-product during livestock feed manufacturing. Scavenger and migratory birds spread microbes such as salmonella and bird flu as the fish is usually sun dried under inadequately protected environments. In the process of feed formulation, if by any chance the microbes escape to and get on humans they can cause serious health problems. Also there is competition between humans and the animal feed processing industry for fish, as there are a substantial proportion of people with animal protein deficiency. Animal protein intake for most Tanzanians is still low as indicated in the high malnutrition incidences in children below the age of five years (Mwasha, 2005). Fish can be more easily distributed and accessed by communities in remote areas compared to other forms of animal protein. Efficient use of available resources needs to be considered when allocating fish for the animal feed industry or for humans (Mwasha, 2005).

In Tanzania, sardines and fishmeal are mostly used as sources of protein especially in poultry feed instead of using soybeans (Malema, 2005). The use of poultry feeds containing sardines and fishmeal transmits fowl typhoid. The associated poultry products do not often meet internationally acceptable standards. Besides, the chemical control of fowl typhoid requires additional costs that can increase the cost of production and reduce the competitiveness of the resultant poultry products (Malema, 2005).

In the past, there was neither special attention nor emphasis on the use of soybeans in livestock feed formulation. Soybean was being seen by many as an alien crop the uses of which were not yet clear to many people (Mwasha, 2005). The ready availability of fish also contributed to the diminished need for feed industries to search for alternative sources of protein for livestock feed formulation (Mwasha, 2005). Fishmeal was, therefore, the main source of crude protein in livestock feedstuffs in Tanzania especially for the small-scale poultry keepers who compound feed at the backyard (Mwasha, 2005). However, more than 30% fishmeal in feeds lead to the resultant products (poultry meat and egg) that pick fishy smell, not liked by most consumers. Besides, if not properly treated to destroy microbes, the use of fishmeal can result in bird typhoid – a serious threat to the poultry industry and human health.

However, safety reasons and taste preferences (especially from the niche market) have been forcing poultry feed manufacturers in Tanzania to import soybeans to substitute for fish meal (Mwasha, 2005). The fact that feed manufacturers are importing soybean into the country it means that there is a short supply of this product (Mwasha, 2005). Importing soybean into Tanzania gives advantage to soybean producers and processors in the source countries. Besides, genetically modified (GMO) soybean can easily enter the country especially since Tanzania does not have the capacity to detect GMOs (Malema, 2005).All key stakeholders are, therefore, challenged to establish sustainable soybean production, processing, and marketing systems to ensure consistency in production, quality and timely delivery of soybean raw materials to manufacturers of livestock feeds.

The current main source of animal protein in livestock feed in Tanzania, (fish), has shortcomings as indicated above. This source is met with several challenges that range from health safety and taste of the desired products (like eggs and meat) as well as competition for animal protein between human and livestock (Mwasha, 2005). At present, use of sardines in livestock feeding is facing resistance. This is because the fishy smell is not preferred in broiler meat for export or sale in supermarkets in the country. Also there are increasing cases of salmonellosis in hatcheries and poultry farms. These have increased the need for using soybean as a substitute of fishmeal.

Presently, livestock feed producers import soybean from different developed European countries that are less endowed with climatic conditions for soybean production than Tanzania (Mwasha, 2005). For many reasons, however, such importation is less beneficial to the country than domestic production of soybean (Mwasha, 2005). For instance, there is the danger of importing genetically modified (GM) soybeans, especially since Tanzania does not have the capacity to assess the safety of such products (effect on human and livestock health). Secondly, the importation of soybean has serious economic implications on the meager foreign exchange of the country that is best used on products beyond the capacity of the country to produce.

There are many reasons why many poultry feed millers and poultry farms are reluctant to use soybean as a source of protein. They include:

(i) Lack of large-scale extruder,
(ii) Taxes on the importation of soybean processing machines,
(iii) Uncertainty about regular supply of soybean throughout the year,
(iv) High farm gate price of soybean among others.

There have been requests to the Tanzania Ministry of Agriculture for the removal of some importation taxes from soybean and livestock feed manufacturing equipment by the operators in the livestock sector (Malema, 2005).

It is important to note that the use of soybean in livestock feed formulation requires special treatment for soybean to be suitable as a source of protein in livestock feed. There is, therefore, the need to disseminate the relevant soybean preparation (for livestock feed) technologies before it is successfully incorporated into livestock feed (Mwasha, 2005). This knowledge is especially important for the small-scale poultry producers who are the main poultry producers in Tanzania and who many a time also formulate the feeds that they use. The use of soybean in animal feed will improve the quality of animal feed if the right technology is used. Currently, large-scale manufacturers of animal feed import and use soybean. Due to costs involved in the importation process, taxation and lack of technology small-scale manufacturers in backyards do not use soybeans.

With increasing globalization and the influence of information technology, the number of local consumers accessing knowledge on health and safety issues related to livestock products (e.g., poultry meat and egg) will likely increase. It is critically important that livestock feed industries are aware of this likely trend and prepare to produce feeds with desired raw materials to ensure that the resultant products possess acceptable standards that can guarantee demand (Mwasha, 2005). The small scale animal feed backyard producers will bear positive impact on the quality of products from small scale poultry and pig producers if they have information, technology and access to soybean.

If the Tanzania livestock industry is to improve on market access and attain international recognition, use of acceptable feed ingredients is one of the several critical foundations for consumer confidence (Mwasha, 2005).

8.2 Soybean in food industries

As human food soybean has got so many utilization options that can vary from one location to another. In Tanzania, these soybean utilization options include: (i) porridges (*uji, ugali*, weaning food), (ii) soymilk, (iii) drink (Coffee-like), (iv) added to vegetables (ground/paste), (v) bread, buns, chapatti, cake, biscuits, (vi) snack (like groundnuts), and (vii) Oil source (Laswai *et al*., 2005). Not all these utilization options have been fully exploited. Most of it has been consumed as weaning food. However, presently there are new demands as adult food especially those who have developed increased needs like the sick, the old and people living with HIV/AIDS.

The promotion of soybean, especially through the joint efforts of agricultural extension, researchers at Ilonga (Eastern zone) and Uyole (Southern Highlands), and Sokoine University of Agriculture (SUA) and the use of the farming systems approach (technology development, refinement, and demonstration) led to increased local demand and resulted to in the emergence of soybean processors and local traders (Myaka *et al*., 2005). However these groups operate in isolation without any sharing of information and the use of common strategies.

8.3 Large-scale soybean processing in Tanzania

There are only two large-scale soybeans processing companies (one food processing company and one feed processing company) in Tanzania and their capacity utilization is far less than 100%that are underutilized (Malema, 2005).

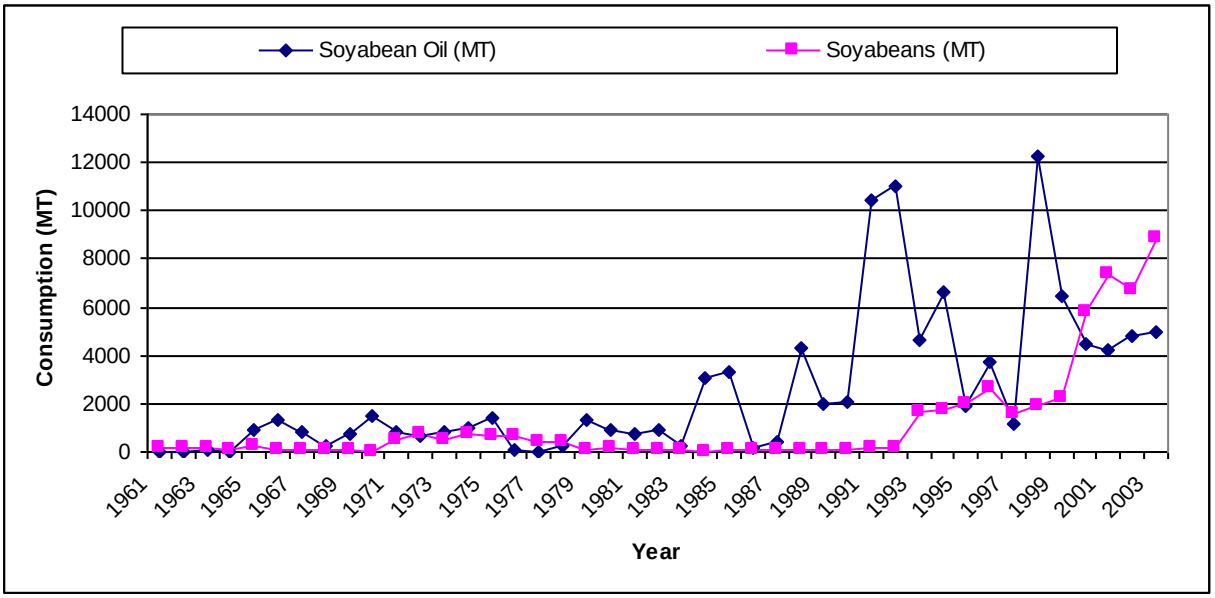
8.4 Soybean in other uses in Tanzania

Soybean oil is a good quality, highly digestible polyunsaturated oil with no cholesterol. This underscores its potential in fighting heart problems that are now widespread in the country especially in communities where animal fat is the source of lipids in the diet. Soybean oil is seen found in market but mostly imported into the country (Laswai *et al.*, 2005).

8.5 Home-level processing and utilization of soybean

Although soybean was introduced in Tanzania almost 100 years ago, its production and utilization is negligible compared to other countries (Malema, 2005). However, a number of small-scale soybean processors, producing soybean products have recently emerged in Tanzania (Malema, 2005). The consumption of soybean in Tanzania tended to be stable up to 1983, after which it increased. Before 1983, annual consumption of soybean oil was averagely more than 700 MT, while between 1984 to 2003, an annual oil consumption of more than 3000 MT was recorded. Respectively, 255 MT of soybeans were consumed before 1983 annually, with more than 1000 MT recorded consumption in 1983- 2003 (**Figure 4, Appendix 2**).

Figure 4: Soybean consumption in Tanzania (MT): 1961-2003



Market and know-how on processing blamed for non-tapping of the huge potential of soybean: The unutilized potential of soybean is due to lack of reliable market and knowledge on processing and utilization at household level (Malema, 2005). According to Malema (2005), lack of market was responsible for the failure of the past initiatives aimed at promoting soybean in Tanzania

9. International trade

9.1 World market and export for soybean

Over the past decade, the United States of America has maintained the lead and dominance in world soybean production and trade and has remained the world's largest total exporter of soybeans and soybean products. The U.S. supplied about 40% of the soybean traded in the world soybean market. The U.S. soybean and soybean products export attracted US$ 9.7 billion in 2003. Between 1995 and 2002, the world soybean export volume (MT) has been on the increase. However, the value of soybean exports (US$) has been more or less stagnant due to the steadily falling world price of the commodity.

Brazil has remained the leading exporter of *soybean meal*, although Argentina is narrowing the gap with Brazil (Jagwe and Nyapendi, 2004). Argentina has remained the world's largest exporter of *soybean oil* over the past decade and the United States has overtaken Brazil as the second largest net exporter of soybean oil (Jagwe and Nyapendi, 2004). In the industrialized world, the oil is viewed nearly as a by-product, important to make the high-protein feed cake (Schmidt, 1992). The worldwide demand for soybeans is driven by the demand for protein meals for the dairy and meat production industries (Jagwe and Nyapendi, 2004).

9.2 Marketing of soybean in Africa

9.2.1 How use of soybean in feed can help capture international market for poultry

The livestock sector need soybean for use in animal feed so that local and international market for poultry products is captured. This will reverse the current situation where some international hotels, supermarkets and expatriate communities prefer imported poultry products (Malema, 2005). This current situation is so because local poultry products are produced using sardine and fishmeal as main source of protein. Increased demand of soybean by animal feeds processors could benefit soybean farmers who could sell raw soybean to the processors.

9.2.2 Disadvantages of importing soybean into Tanzania

Importing soybean into Tanzania gives advantage to soybean producers and processors in the source countries. Besides, genetically modified (GMO) soybean can easily enter the country especially since Tanzania does not have the capacity to detect GMOs (Malema, 2005).

9.2.3 Oilseed (including soybean) export in Tanzania

The traditional export crops in Tanzania include coffee, cotton, cashew nuts, tobacco, tea, sisal, and pyrethrum. The non-traditional export crops are those crops whose export depend on the availability of surpluses and include *oilseeds*, pulses, horticultural items, spices, livestock, sugar, cardamoms, cocoa beans, and the major staples. In recent years, rice, maize, sorghum, millet, cassava and beans have qualified to enter the list of non-

traditional export crops. This development is more important for *Ruvuma*, *Iringa*, *Mbeya*, and *Rukwa* regions located at a great distance from the main domestic markets but closer to lucrative markets across the borders.

The oilseeds comprise of the industrial and edible oilseeds. Castor seeds fall under the first category (industrial) and the second group consists of sunflowers, groundnuts, sesame, copra, cottonseeds, and soybeans. The crop value of soybean exports in Tanzania was low (US $ 54000 annually) before 1985, and rose to US $186000 annually after 1985, but with large fluctuations (**Figure 6, Appendix 4**). Most of the exports were soybean grains, with almost no oil exports.

Figure 5: Soybean Import Value in Tanzania (1961- 2005)

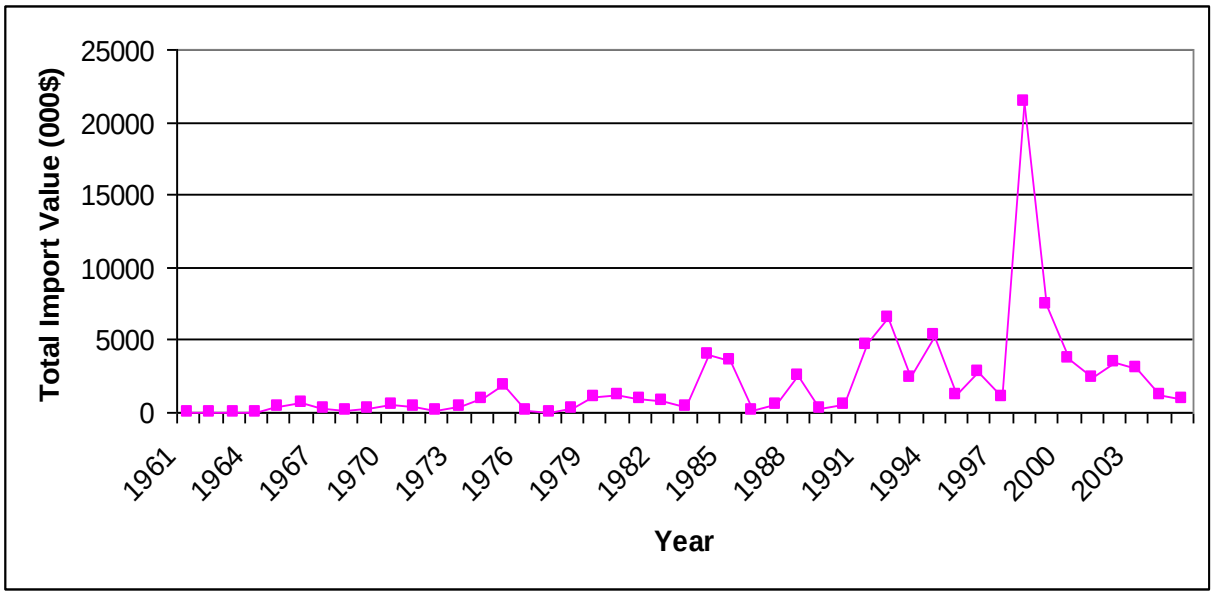
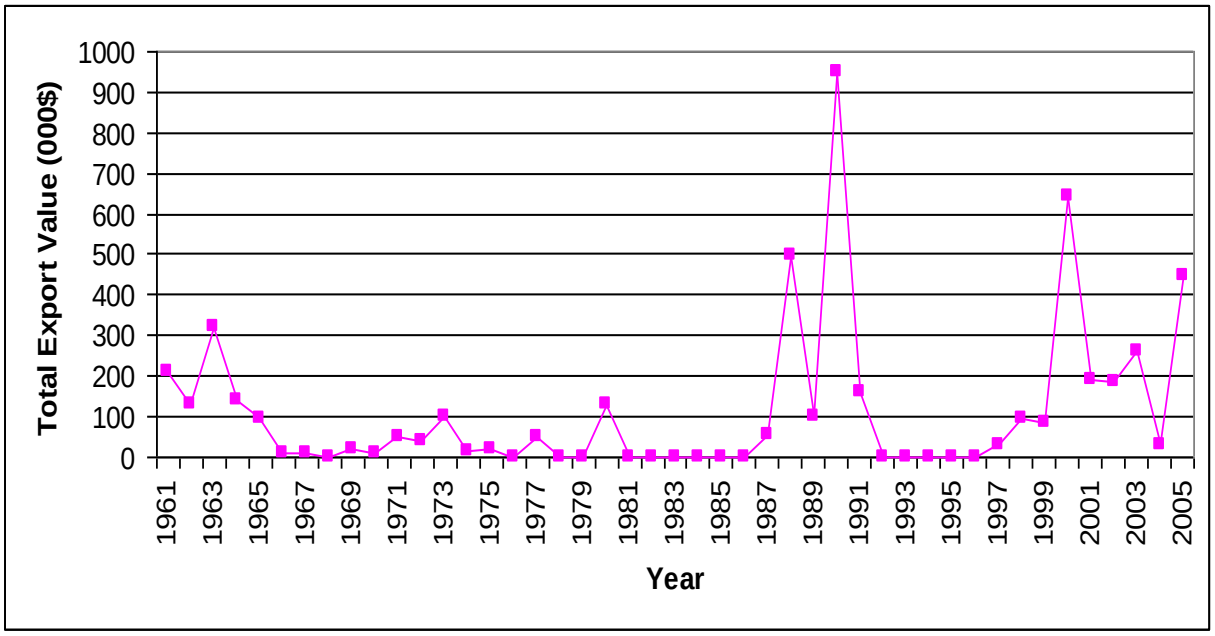


Figure 6: Soybean Export Value in Tanzania (1961- 2005)



9.3 International prices

The world soybean prices are mainly influenced by the Rotterdam port, Argentina, and Brazil prices (Margarido *et al*., 2004). As at December 2004, soybean sold at USD 228 per ton CIF Ravenna. Similarly, large world soybean producers sell the product at between US$ 200 and US$ 323 MT^{-1} CIF Rotterdam (**Table 9**). The world soybean price increased by 48% in 2007/08, driven by a stagnant supply and strong world demand (European Communities, 2008). It is expected to continue to rise over 2009/10 because of shrinking carryover stocks. With time, area expansion in South America and yield improvement will stabilize the price up to a projected 2017/ 18. However, the soybean price is not expected to return to its historical levels for the remainder of the decade. Because of corn area expansion in 2007/08, U.S. soybean production shrank by 19% and pulled the world soybean output down by 6%.

World production is expected to recover by 10% in 2008/09 as the U.S. and Brazil respond to the record high price (European Communities, 2008). Encouraged by expected price increases, Brazil's soybean area expansion is expected to post an average growth of

3% annually upto 2017/18; Brazil is expected to outpace the U.S. to become the leading soybean producer in 2016/17. World production is expected to reach 297 MMT at the end of the outlook period and is concentrated in Argentina, Brazil, and the U.S. By 2017/18, Brazil will hold a 31% share while the U.S. contributes 30% of global production. Falling real domestic prices and expanding urban area will cause a very limited growth in China's soybean production.

Meanwhile, robust economic growth encourages domestic consumption to increase by 40% over the next 10 years. Policies favoring oilseed imports and domestic crush make China the world's leading soybean importer. China will expand its imports to 52 MMT, accounting for 55% of total world imports over the next 10 years. This strong demand for soybeans becomes a focus of attention for major exporting countries. Brazil and the U.S. dominate the soybean net exports market. Brazil surpassed the U.S. to become the largest soybean net exporter in 2007/08. Brazil's export share reaches 59% by the end of 2018 while the U.S. share of world soybean net exports is projected to decline to 25% in 2017/18. Paraguay is expected to emerge as an important soybean net exporter and holds a 7.6% share of the world market. The price of soybean meal soared by 53% during the 2007/08 season because of high soybean prices.

Prices are expected to decline over the period (2008-2018) as production outpaces demand from the livestock sectors around the world. World soybean meal production will be expected to grow by 2.5% per year on average over the next decade in response to rising feed demand.

China is likely to increase its consumption by 3.4% annually because of strong expansion in its livestock sector. U.S. domestic consumption will likely expand by 19% over the next decade whereas the U.S. share of world consumption is expected to fall slightly. The volume of net exports in the soybean meal market will increase by 32% by 2018. Argentina, the leading soybean meal net exporter, will export 98% of its production to the world market because of its differential export tax policies. Argentina will export 40 MMT by 2017/18 and its market share will grow to 52%. The EU is expected to remain

the top net importer, accounting for 38% of world net imports. The price of soy oil will rise over the projection period because of escalating demand for both food and bio-diesel uses. Because of its income and population growth, China became the largest soybean oil consumer in 2006/07 and continues to increase its share, accounting for 29% by 2017/18. Because of their bio-diesel mandates, Argentina, Brazil, and the U.S. are expected to increase soybean oil industrial use by 187%, 208%, and 101%, respectively, over the next decade.

Export is likely to be dominated by a few countries, but importers will be diverse. Despite the domestic biodiesel mandate, Argentina will still dominate world soybean oil exports, satisfying 72% of the world market. Brazil and the U.S. together will account for 21% of world soybean oil net exports by 2017/18 while China and India's combined share of net imports will hold 48% of the world market.

Table 9: World soybean prices 1993 -2004 CIF Rotterdam

Year	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**
US$/Ton	264	259	248	304	307	259	225	208	200	203	267	323
US$/Kg	0.264	0.259	0.248	0.304	0.307	0.259	0.225	0.208	0.200	0.203	0.267	0.323
US FGP[1] (US$/Ton)	213	233	205	263	274	230	176	173	167	170	209	291

Year	**07/08**	**08/09**	**09/10**	**10/11**	**11/12**	**12/13**	**13/14**	**14/15**	**15/16**	**16/17**	**17/18**
US$/Ton*	496	506	478	483	478	484	487	491	490	492	487
US$/Kg											
US FGP[1] (US$/Ton)											

[1]US FGP- Farm gate prices

Source: Adapted from Malema (2005) who originally sourced from USDA.

* CIF Rotterdam prices (2007- 2018) sourced from European Communities, 2008.

Exporters of crops reported that, in order to export soybean the price in Dar es Salaam should be about TSh 300 kg^{-1} (Malema, 2005). This price is similar to the one that is offered by large-scale processors at their mills and the price farmers get if they sell their soybean in Dar es Salaam. With this price of raw soybean, the price of the processed soybean will be equal to that of sardines and fish-meal (**Table 11**) this will make soybean be able to compete with sardines and fish meal and lead to an increase in the use of soybean in livestock feed production. At this price, soybean exporters from Tanzania could then sell about TSh 530 kg^{-1} in the world market (**Table 9**). However, some of the present intending exporters of soybean would like to purchase soybeans at a CIF price of TSh 228 kg^{-1}.

Table 10: Estimated cost (TSh kg-1) of exporting soybean by different components

Activity	**Cost (Tsh kg^{-1})**
FOB Dar es Salaam	300
Freight and insurance to the world market	80
Grading (3%) of FOB price	9
Empty bags	12
Bagging costs	7
Cleaning	5
Interest	48
Profit 15%	70
TOTAL	**530**

Source: Adapted from Malema (2005)

9.4 Soybean price trends in Tanzania (e.g., off-lorry prices in selected markets)

The nominal producer price for soybean steadily increased from about T.Shs 2250 per metric ton in 1977 to about T.Shs 17000 per metric ton in 1988. This is illustrated in **Figure 7**. The data used were sourced from Ministry of Agriculture (MoA) (1990).

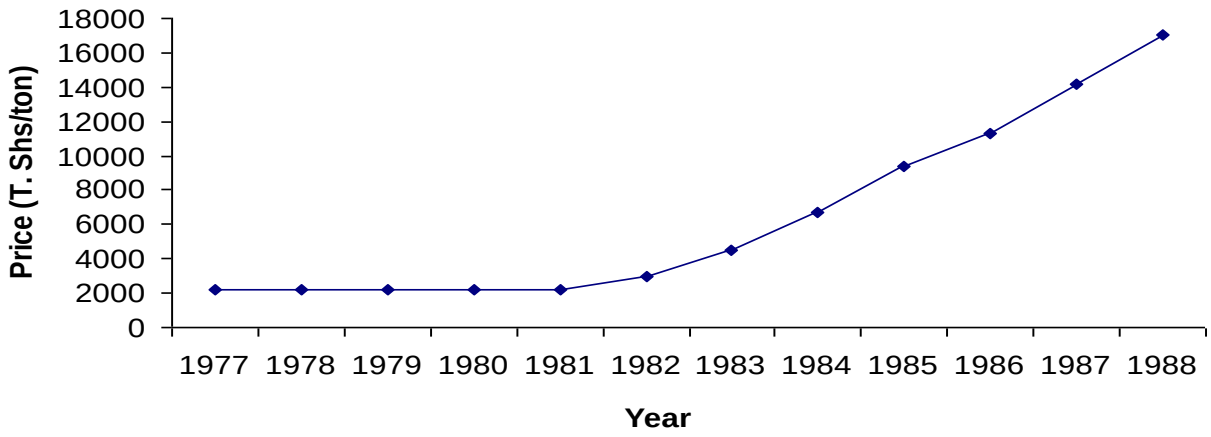


Figure 7: Price of soybean in Tanzania: 1977 - 1988

9.5 Price of soybean in Tanzania vs. world market

Presently, the average market price of soybean in Tanzania is about 500 Tshs kg^{-1}, which is higher than the world market price estimated at 240 Tshs kg^{-1} (Myaka *et al*., 2005). The high farm gate prices of soybean discourage investment in food and feed processing enterprises that use soybean as raw material (Malema, 2005). Due to high farm gate prices, Tanzania cannot compete in selling soybean at world market. The high local price has forced livestock feed processors in Tanzania to use other sources of protein such as fishmeal (*dagaa*) in their feed formulation (Myaka *et al*., 2005). The other implications of the high domestic price of soybean is that for soybean production in Tanzania to be competitive, resource use efficiency must be emphasized in order to reduce the cost of production and create a good incentive for soybean producers in Tanzania to export part of their output and enjoy the benefits associated with turnover, even when the unit price is low.

The high price of soybean per kilogram is attributed to among other factors: (1) Small-scale production which is characterized by high production costs when compared to large

scale which have low production costs per unit due to economies of scale, (2) Tanzania farmers tend to aim at meet their expenses by selling small volumes they produce for sale that unnecessarily increases unit cost, (3) Also the cost of collecting small volumes from scattered smallholder farmers in villages increases unit costs, (4) The transport cost in Tanzania aggravates the high cost problems (Myaka *et al.*, 2005). Price of soybean at world market is low because other countries give subsidies to their farmers hence their prices are lower (Myaka *et al.*, 2005).

10. Soybean production trends and costs in Tanzania

10.1 Cost of soybean production in Tanzania

In *Sumbawanga* (Southern Highlands), the average cost of production is about 147 TSh kg^{-1}. Based on this average cost of production it was suggested that farm gate price could be somewhere between 221 – 257 TSh kg^{-1}. Assuming that transport cost (*Sumbawanga* to Dar es Salaam) is 75 TSh kg^{-1} and that insurance is 5 TSh kg^{-1}, it was also suggested that soybean could be sold at 337 kg^{-1} in Dar es Salaam (Malema, 2005). This price will likely attract investment in soybean processing plants, enhance the market for soybean and at the same time lead to employment generation (Malema, 2005). If 100 TSh kg^{-1} is charged for extruding one kilogram of soybean, the extruded soybean could be sold at 437 TSh kg^{-1}, a price that is similar to the price of sardines and fishmeal mostly used presently as sources of protein in livestock feed formulation in Tanzania (**Table 14**).

Table 11: Price (Tsh kg-1) of different protein sources for livestock feeds Dar es Salaam: 2004/2005

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Mean
Sardine	425	425	465	470	545	550	550	550	550	550	500	475	459
Soybean	500	600	550	500	400	300	340	350	370	400	450	450	434
Fish meal	350	350	360	370	380	400	400	400	400	400	390	360	380
Cotton cake	195	200	200	200	195	110	110	120	130	150	170	180	163
Sunflower	140	145	150	150	130	110	100	100	110	110	120	130	125

Source: Adapted from Malema (2005)

If this happens, soybean will likely be given priority by the livestock feed industries especially since it has no salmonella and taints which are undesirable in poultry products and which sometimes result from the use of poultry feeds formulated using sardines and fish meal as sources of protein.

10.2 Soybean marketing in Tanzania

Soybean marketing is just like the marketing of other agricultural crops and involves the transfer of produce from farmer to consumer. This transfer happens along the marketing chains, which vary both in length and in complexity. Examples: (i) Farmer takes produce from farm to local rural market (farmer unloads produce here and sells it in small quantities to consumer), (ii) Farmer takes produce from farm to wholesale market (produce is unloaded, weighed and delivered to wholesaler). Retailer purchases produce from wholesaler and takes it to his/her shop and sells produce to consumer, and (iii) Farmer takes produce from farm to assembly market (buyer purchases produce here). Buyer takes produce to wholesale market. Sub-wholesaler distributes produce to retail shops (retailer sells produce to consumer).

Roadside selling and buying is often the beginning of the marketing chain. In the marketing chain, virtually every kind of transport (head load, pack animal, animal cart, bicycle, motorcycle, boat, motor vehicle, truck-train, airplane, etc.) is being used. Generally, the more complex and lengthy the marketing chain the higher are the marketing costs. Thus simple comparison of farmer prices with retail prices is a poor indicator of marketing efficiency as it does not take into account the costs involved in moving produce along the marketing chain from farmer to consumer.

Marketing margins is the percentage share of the final price that is taken up by the marketing function. A marketing margin can also be defined as the percentage of the final weighted average selling price taken by each stage of the marketing chain. It must cover all the costs involved in moving or transferring produce from one stage to the next (e.g., from farmer to consumer) and provide a reasonable return to those doing the marketing. It is common to find small-scale grain traders in various markets (local, peri-urban, and

urban) in Tanzania. Most of these traders deal more with grains that are easily marketable including maize, common beans, and sunflower. Only a few of those grains traders also deal on soybean grains (Malema, 2005).

11. Soybean production constraints

Soybean, unlike other crops and particularly legumes has a number of advantages including (i) increase soil fertility (soil nitrogen), (ii) Has fewer pests and diseases compared to other common legumes, e.g., cowpeas and pigeon peas, (iii) Stores better than other legumes (Laswai *et al*., 2005).

Till date, no attempt has been made to have comprehensive information on the animal feed industry including demand and supply information. Similarly, there is yet no information on the nutritional values of different soybean cultivars under specific environmental and agronomic conditions, and practicalities of soybean uses (Mwasha, 2005). No comprehensive survey has also been carried out to provide an indication on the demand of soybean that will be required by different consumers or potential consumers (including livestock feed manufacturers) in Tanzania (Mwasha, 2005).

Tanzania's Ministry of Agriculture recently assessed the current status of soybean processing and utilization in the country. Preliminary results indicate that:

(i) Most of the respondents do not know soybean,

(ii) Some of those who claim to know about soybean were unable to differentiate it from common beans (*Phaseolus vulgaris*),

(iii) Most of the interviewees do not know how to process soybean for home consumption,

(iv) Some of the soybean farmers did not know where to sell their soybean grains,

(v) High domestic price compared to world market price (probably due to low production in the country), and

(vi) Lack of exploitation of the potential of soybeans the fortification of food for children, expecting mothers, and people living with HIV/AIDS (Myaka *et al*., 2005).

The high domestic price of soybean grains was attributed to high demand compared to supply, a situation that demoralized processing investments that would have stimulated more production in a sustainable fashion manner (Malema, 2005).

The major factors that have influenced the production of oilseeds (including soybean) in Tanzania are poor producer prices and the collapse of the domestic and export marketing systems. Research and extension services have been weak in supporting this industry with the result that improved seeds and good crop husbandry have not reached many producers, thereby occasioning low productivity and production.

Inadequate support services in terms of research, extension and modern inputs have combined to depress yields and total production. Disorganized domestic and export marketing system, coupled with insufficient information to link domestic market with the export markets have acted against producers and traders, particularly those operating at primary procurement level. Ignorance on soybean utilization is widespread in Tanzania and is a cross cutting issue to all stakeholders (not only farmers) (Myaka *et al*., 2005).

12. Institutions involved in soybean research and development in Tanzania

These institutions include: Nairobi University (maintained the culture collection of Selian Agricultural Research Institute and supplied specified rhizobial inoculants); Zambia (from where soybean seeds were imported); CIAT Columbia (from where non nodulating bean isolines were imported); Australia, UK, USA, and Kenya (from where some Rhizobium isolates were imported).

The most useful local partnership was from Extension Department in Tanzania. Danish volunteer services in Arumeru District also assisted in establishing and evaluating the demonstration plots in Arumeru district.

Sokoine University of Agriculture (SUA), Eastern Zone Agricultural Research Institute Ilonga Kilosa, Northern Zone Agricultural Research Institute *Selian Arusha*, Southern Highland Zone Agricultural Research Institute at *Uyole Mbeya* and Southern Zone

Research Institute at *Naliendele Mtwara*, Asian Vegetable Development Research Center (AVDRC) – a World Vegetable Regional Center for Africa, and the Processing and Chemical Engineering Department of the University of Dar es Salaam (for technologies on soybean processing).Local extruders that can be fabricated at University of Dar Es Salaam (UDSM) and at the Small Industries Development Organization (SIDO).

In November 2005, the Crop Development Division of the Crop Promotion Services of the Tanzanian Ministry of Agriculture organized the first soybean stakeholders' workshop in Morogoro (Mughendi, 2005). More than 32 participants from both the public and the private organization and other stakeholders interested in soybean attended the workshop (Myaka *et al*., 2005). As a result there is an increase of soybean stakeholders who often ask for data and information on soybean (Malema, 2005).

13. Prospects for soybean production in Tanzania

Soybean in feed can help capture international market for poultry. The livestock sector needs soybean for use in animal feed processing so that local and international market for poultry products is captured. This will reverse the current situation where some international hotels, supermarkets and expatriate communities prefer imported poultry products (Malema, 2005). This current situation is so because local poultry products are produced using sardine and fishmeal as main source of protein. Increased demand of soybean by animal feeds processors could benefit soybean farmers who could sell raw soybean to the processors.

The processing and chemical engineering at UDSM can develop alternative cheap extruders to the one that costs between USD 20 000 and USD 80 000. It is possible to design and develop equipment according to the requirements ranging from household to industrial scale (Myaka *et al*., 2005).

The motivation for increased production to our farmers is market for the crop (local and export), therefore contract farming (a successful arrangement between the Tanzania

Spices Company and Paprika) should be advocated because very few farmers can violate the conditions under the contract.

Given the problems that are evident from the use of fishmeal in livestock feed formulation, it has been suggested that there be legislations banning the use of fishmeal in livestock feed formulation.

14. Policy on soybean

One important driver of soybean research in the USA has been the Soybean Promotion and Research Order authorized by the Soybean Promotion, Research, and Consumer Information Act (7 U.S.C. 6301-6311). For more information, go to this web site http://www.ams.usda.gov/lsg/mpb/soy/soychk.htm. This Congressional act authorized the establishment of a national soybean promotion, research, and consumer information program, to be administered by the 62 members of the United Soybean Board (USB). The goal of this program is to "strengthen the position of soybeans in the marketplace and to maintain and expand domestic and foreign markets and uses for soybeans and soybean products." In so doing, USB funding has been used to stimulate, and coordinate soybean research in the USA in a variety of areas. For example, the USB recently created and funded the Better Bean Initiative, which establishes research targets and goals designed to increase the value of soybean by modifying compositional quality of soybean oil and protein. Such research on oil and protein quality and marketing will eventually bring a "Better Bean" to the consumer (Boerma and Specht, 2004).

The present Tanzanian government policy supports private sector involvement in development (Myaka *et al*., 2005). Recently, the Ministry of Agriculture brought together the isolated players working on soybean development in order to discuss and forge common strategies for sustainable soybean development (production, processing, marketing and utilization) of soybean. Promoting small to large-scale soybean processing is in accordance with Tanzania's Agricultural Sector Development Strategy (ASDS) and also its Agricultural Sector Development Program (ASDP) and will create demand for

soybean (Malema, 2005).It was suggested that the Government should put in place a policy for processing and utilization of soybean (Myaka *et al*., 2005).

Although both the Ministry of Agriculture and Food Security and the Ministry of Water and Livestock Development are aware of the disadvantages of using sardines as a source of protein for livestock feeds instead of soybean, they were yet to develop strategies to extend the awareness to livestock keepers and industries (Myaka *et al.,* 2005).

15. Major results, outcome and impact of soybean research in Tanzania

Research and extension services have been weak in supporting the oilseed industry (including soybean) in Tanzania with the result that improved seeds and good crop husbandry have not reached most of the potential producers, thereby occasioning low productivity and production.

So far, there is no serious pest and disease of soybean reported in Tanzania (Myaka, 2005; Buruchara, 2005). It stores well without chemical dressing and with no significant deterioration in its food value. However, if not properly handled, soybean can loose its viability withing a short period of time (Myaka, 2005).

The stagnation and fall of soybean production in Tanzania can be attributed to several factors including: (i) ignorance of farmers on how to process and utilize soybean for human and livestock feeding, (ii) lack of knowledge on the wide attributes of soybean since it was only being produced for export, and (iii) the dissolution (in the late 1980s) of GAPEX and the cooperatives that used to purchase and export the crop following the structural adjustment program of the late 1980s and early 1990s (Myaka *et al*., 2005).

16. Conclusion

Soybean production in Tanzania has been faced by many challenges despite the many. They range from lack of knowledge on processing and use to the agronomic aspects of soybean. All stakeholders in the soybean production, processing, utilization and marketing and other relevant fields need to work together as a team to ensure that

soybean crop picks up in Tanzania. This move will be beneficial for income generation and improvement of health of all household members (especially in households that are victims of HIV/AIDS pandemic) (Laswai *et al*, 2005). Majority of those affected by the HIV/AIDS pandemic cannot afford to buy the nutrients needed by their bodies but could obtain the same or similar nutrients through the incorporation of soybeans into their diets (Laswai *et al*., 2005). Soybean can also be traded on as an income earner and thus reduce poverty in the country. If exploited, it could benefit the nation in bringing to an end the ever increasing malnutrition problem (PEM, Anaemia, Vitamin A deficiency) and deficiency of other micronutrients.

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Appendices

Appendix 1: Soybean area (Ha) and production in Tanzania

Year	Area (Ha)	Yield (Hg/ha)	Production (Tonnes)
1961	10000	2600	2600
1962	8000	2750	2200
1963	15000	2666	4000
1964	7000	2428	1700
1965	5000	2400	1200
1966	1700	2605	443
1967	1000	2540	254
1968	600	2100	126
1969	700	2528	177
1970	1300	2638	343
1971	4300	2537	1091
1972	5000	2564	1282
1973	5000	2600	1300
1974	5000	2000	1000
1975	4500	1917	863
1976	4000	1515	606
1977	5000	2118	1059
1978	4000	1497	599
1979	5000	2114	1057
1980	4500	1864	839
1981	5000	2160	1080
1982	500	3960	198
1983	4000	1095	438
1984	3500	857	300
1985	4000	1407	563
1986	4200	1107	465
1987	4500	2888	1300
1988	5000	3056	1528
1989	5000	2680	1340
1990	5500	3636	2000
1991	5600	3750	2100
1992	5200	3461	1800
1993	5500	3636	2000
1994	5700	3684	2100
1995	5700	3684	2100
1996	5700	3684	2100
1997	5500	3454	1900
1998	5600	3571	2000
1999	5600	3650	2044
2000	5600	3750	2100
2001	5600	3750	2100
2002	5600	3750	2100
2003	2300	3665	843
2004	5600	3750	2100
2005	5600	3750	2100
2006	5000	3800	1900
2007	5000	3800	1900

Appendix 2: Outlook (and unclassified materials)

The strategies for increasing soybean production and utilization adopted at the end of the First National Workshop on soybean are summarized in the matrix in **Table A**.

Matrix of strategies for increasing soybean production and utilization in Tanzania

Strategy	Activities	Responsible
Make available to farmers: marketable and high yielding varieties of soybean and improved management practices.	Research to develop new marketable and high yielding varieties of soybean	Ministry of Agriculture, Food Security and Cooperatives and Sokoine University of Agriculture
	Research on improved appropriate soybean management practices	Ministry of Agriculture, Food Security and Cooperatives and Sokoine University of Agriculture
	Conduct on-farm trials and demonstration plots on improved soybean production technologies	Ministry of Agriculture, Food Security and Cooperatives and Sokoine University of Agriculture
	Extend and encourage farmers to inoculate their soybeans with rhizobium before planting especially the use of NITROSUA	Ministry of Agriculture, Food Security and Cooperatives and Sokoine University of Agriculture
Provide soybean processors with affordable improved post-harvest technologies for value addition to soybean grains.	Introduction of extruders for use by small and medium scale enterprises in order to get full fat soybean, oil and cake.	Ministry of Agriculture, Food Security and Cooperatives and Ministry of Livestock Development
	Research on the quality of local extruders and processing machines	University of Dar Es Salaam
	Encourage the production of local extruders through funding support	Ministry of Agriculture, Food Security and Cooperatives, MIT, University of Dar Es Salaam, INTERMECH, PAMBA ENG.
	Assist soybean processors to get acceptable and attractive packing materials	Ministry of Agriculture, Food Security and Cooperatives

Matrix of strategies for increasing soybean production and utilization in Tanzania contd

Strategy	Activities	Responsible
Create awareness by all stakeholders on the potential of soybean as a crop for cash, industrial uses and on its wide utilization.	Prepare and air radio and TV programmes	Ministry of Agriculture, Food Security
	Prepare and distribute brochures, leaflets and posters	Ministry of Agriculture, Food Security
	Prepare and publish articles in local new paper magazines	
	Sensitization workshop at zonal and district levels	Ministry of Agriculture, Food Security, POLARG
	Start annual soybean day and also 100 years anniversary day next year 2007.	Ministry of Agriculture, Food Security, POLARG
Conduct capacity building programmes to soybean farmers and processors	Train extension officers and farmers on soybean seed production	Ministry of Agriculture, Food Security and Cooperatives
	Train and demonstrate to soybean farmers on improved processing and utilization of soybean	Ministry of Agriculture, Food Security and Cooperatives and Sokoine University of Agriculture
	Train processors and farmers on entrepreneurship	Ministry of Agriculture, Food Security, POLARG
Make sure affordable and good quality seed is available to farmers	Provide adequate funding to Ilonga and Uyole for breeders seed production	Ministry of Agriculture, Food Security and Cooperatives
	Provide enough funding to foundation seed farms to produce enough foundation seed for soybeans.	Ministry of Agriculture, Food Security and Cooperatives
	Initiate on-farm soybean seed production to make soybean seed affordable by farmers.	Ministry of Agriculture, Food Security and Cooperatives
	Provide subsidies on soybean seed sold to farmers	Government of Tanzania

Source: Adapted from Myaka *et al.* (2005)

Matrix of strategies for increasing soybean production and utilization in Tanzania contd

Strategy	Activities	Responsible
Create enabling environment to soybean producers and processors at all levels (large scale, medium scale and village level)	Introduce soybeans into agricultural and livestock policy	Local Government Areas and other Institutions
	Value Added Tax exemption to extruders importation	Ministry of Agriculture and Food Security
	Formulate and enforce policies that encourage and favors increased soybean production, processing and utilization	Ministry of Agriculture and Food Security, Ministry of Education, Ministry of Health
	Formulate policies that discourage the use of *dagaa* and fish meal in livestock feed processing	Ministry of Agriculture, Food Security and Cooperatives and Ministry of Livestock Development
	Subsidization of certified seed, processing machines, livestock feeds should be tax exempted	Ministry of Agriculture and Food Security, MIT, Ministry of Finance, Ministry of Water and Livestock Development
	Formulate policies that emphasize on food fortification with soybeans as well as setting standard for the same.	TFDA, TBS, Ministry of Health, MiT, Ministry of Agriculture and Food Security, University, Processors TFNC
	Introduction of school feeding program that use soy based food.	Ministry of Education, Ministry of Health, Ministry of Agriculture and Food Security
	Sensitize hospitals and health centers to use soybeans in the food that they feed to patients and encourage them to promote soybean-based food products to out-patients and during MCH Clinics	Ministry of Education, Ministry of Health, Ministry of Agriculture and Food Security

Source: Adapted from Myaka *et al.* (2005)

Matrix of strategies for increasing soybean production and utilization in Tanzania contd

Strategy	Activities	Responsible
Facilitate and strengthen information sharing between soybean stakeholders and make sure soybean activities in the country are well coordinated	Establishment of soybean farmers groups at village level	Local Government Areas and Ministry of Agriculture Food Security and Cooperatives
	Form National soybean farmers and processors association	Local Government Areas, Research, Extension, and MCC
	Identify and inventorise soybean producers, processors, traders	Local Government Areas and Ministry of Agriculture Food Security and Cooperatives
	National soy production and utilization steering committee	Ministry of Agriculture Food Security and Cooperatives
	Organize regular soybean sub-sector meetings	Ministry of Agriculture and Food Security, POLARG, Ministry of Water and Livestock Development, MIT, Ministry of Health, Private sector
Linking market information to producers and buyers	Assigning responsibilities person at all levels for gathering and disseminating market information	Local Government Areas and Ministry of Agriculture and Food Security
	Inventorying and establishing database of producers, buyers and processors	Local Government Areas and Ministry of Agriculture and Food Security
	Establishment of contract farming	Local Government Areas, Ministry of Agriculture and Food Security and Private organizations

Source: Adapted from Myaka *et al*. (2005)

Appendix 3: Soybean consumption (Soybean oil and Soybean) (MT) in Tanzania (1961-2003)

Year	Soyabean Oil (MT)	Soyabeans (MT)
1961	30	140
1962	27	205
1963	62	156
1964	9	54
1965	901	260
1966	1323	105
1967	811	63
1968	266	88
1969	715	117
1970	1465	34
1971	815	511
1972	671	738
1973	829	500
1974	1019	764
1975	1414	690
1976	55	643
1977	39	426
1978	257	439
1979	1290	102
1980	928	142
1981	785	104
1982	878	107
1983	284	60
1984	3084	39
1985	3290	46
1986	169	44
1987	448	93
1988	4279	82
1989	2000	70
1990	2100	81
1991	10400	161
1992	11000	162
1993	4600	1644
1994	6600	1738
1995	1903	1961
1996	3709	2631
1997	1182	1562
1998	12278	1926
1999	6472	2274
2000	4436	5807
2001	4222	7394
2002	4790	6743
2003	4997	8897

Appendix 4: Soybean Import and Export Value (1000 $) in 1961- 2005

Year	Import Value				Export Value		
	Soya Sauce	Soybean oil	Soybeans	Total Import Value	Soybean oil	Soybeans	Total Export Value
1961	0	10	0	10	0	212	212
1962	0	10	0	10	0	131	131
1963	0	22	0	22	0	323	323
1964	0	0	0	0	0	141	141
1965	0	421	0	421	0	93	93
1966	0	627	0	627	0	8	8
1967	0	329	0	329	0	12	12
1968	0	97	0	97	0	0	0
1969	0	265	0	265	0	20	20
1970	0	598	0	598	0	11	11
1971	0	381	0	381	0	48	48
1972	0	189	9	198	0	41	41
1973	0	442	9	451	0	100	100
1974	0	893	24	917	0	15	15
1975	0	1393	510	1903	3	18	21
1976	0	100	1	101	0	0	0
1977	0	0	0	0	48	0	48
1978	0	285	0	285	0	0	0
1979	0	1041	0	1041	0	0	0
1980	0	1169	0	1169	0	132	132
1981	0	925	0	925	0	0	0
1982	0	791	2	793	0	0	0
1983	0	352	1	353	0	0	0
1984	0	3884	77	3961	0	0	0
1985	0	3616	2	3618	0	0	0
1986	0	145	11	156	0	0	0
1987	0	594	3	597	0	53	53
1988	0	2514	0	2514	0	500	500
1989	0	320	0	320	0	99	99
1990	0	500	0	500	0	950	950
1991	0	4700	0	4700	0	160	160
1992	0	6500	0	6500	0	0	0
1993	0	2400	0	2400	0	0	0
1994	0	5300	0	5300	0	0	0
1995	2	1169	66	1237	0	0	0
1996	14	2418	352	2784	0	0	0
1997	17	1085	0	1102	28	0	28
1998	80	21159	128	21367	77	19	96
1999	31	7102	265	7398	80	7	87
2000	32	2415	1327	3774	0	644	644
2001	15	164	2212	2391	0	189	189
2002	24	2013	1465	3502	0	186	186
2003	35	667	2334	3036	0	259	259
2004	35	206	916	1157	0	28	28
2005	30	905	12	947	0	445	445