Crop–Livestock Economies in the Semi-Arid Tropics

Facts, Trends and Outlook

International Crops Research Institute for the Semi-Arid Tropics

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Abstract

This report analyzes the structure and trends in the crop-livestock economies of developing countries falling within the semi-arid tropics of the world. Population growth, urbanization and increasing per capita incomes are fuelling rapid growth in the demand for animal-based foods in developing countries including those located in the semi-arid tropics. The rising demand for animal-based foods is likely to have several implications for livestock production systems (structure, production, productivity, intensification etc), the environment, markets, institutions and trade, and ultimately for livestock producers. We are thus witnessing a dualistic mode of development: a fast growing commercial sector that is coming up close to demand centers even as the traditional semi-subsistence sector continues to be the lifeline of many small and poor livestock keepers. In the commercial sector, the non-food functions of livestock (draught, transport, asset etc) are on the decline. The rising demand for animal-based food is also fuelling the derived demand for livestock feed, particularly crop residues in South Asia and SSA, and agro-industrial by-products in all regions of the SAT.

The livestock sector is also under pressure to adjust to forces of market liberalization and globalization. With distortions in the world trading environment for livestock products and stiff SPS standards, the competitiveness of domestic dairy and meat production in SAT countries is under threat. The best option to remain competitive is through the adoption of improved technologies, investments in infrastructure to meet quality standards, domestic reforms, public-private sector partnerships particularly in the delivery of health services, innovative institutions and policies that link small-scale producers with markets/processors.

Poverty is high in all SAT countries of SSA and South Asia. For a majority of the rural poor, livestock rearing is an important means of survival. The productivity of livestock is low owing to numerous constraints. Alleviating these constraints would help improve performance of livestock in SAT countries, which in turn would benefit millions of poor.

Résumé

Ce rapport analyse la structure et les tendances des économies agro-pastorales des pays en développement faisant partie des zones tropicales semi-arides dans le monde. La croissance démographique galopante, l'urbanisation et l'augmentation rapide du revenu par tête, entretiennent la croissance rapide de la demande pour les aliments à base de produits animaux dans les pays en développement, notamment ceux des zones tropicales semi-arides. La demande croissante des aliments tirés des produits de l'élevage aura probablement plusieurs implications pour les systèmes de production animale (structure, production, productivité et intensification), l'environnement, les marchés, les institutions et le commerce, et enfin pour les éleveurs. Nous sommes donc en présence d'un mode de développement double : un secteur commercial qui se développe rapidement et qui se rapproche des endroits où s'exprime la demande même si le secteur traditionnel de semi-subsistance continue d'être vitale pour de nombreux petits éleveurs pauvres. Dans le secteur commercial, les fonctions autres qu'alimentaires du bétail (trait, transport, capital, etc.) disparaissent progressivement. La demande croissante pour les aliments à base de produits de l'élevage entraîne la demande pour les aliments pour bétail - en particulier les résidus de culture en Asie du Sud et en Afrique Subsaharienne - et pour les produits agro-industriels dans toutes les régions des zones tropicales semi-arides.

Le secteur de l'élevage subit également des pressions pour s'adapter aux forces de la libéralisation et de la mondialisation du marché. Compte tenu des distorsions de l'environnement commercial au niveau mondial en ce qui concerne les produits de l'élevage et les normes SPS rigoureuses, la compétitivité de la production nationale de lait et de viande des pays des zones semi-arides est menacée. Pour rester compétitif, la meilleure solution réside dans l'adoption de technologies, les investissements dans les infrastructures afin de répondre aux normes de qualité, les réformes nationales, les partenariats secteur public-privé notamment dans la prestation des services de santé, les institutions et politiques novatrices qui font le lien entre les petits producteurs et les transformateurs de produits qui sont sur le marché.

Il y a une grande pauvreté dans les pays des zones tropicales semi-arides de l'Afrique Subsaharienne et de l'Asie du Sud. Pour une majorité de pauvres du monde rural, l'élevage est un important moyen de survie. La productivité du bétail en général est faible du fait des nombreuses contraintes. La levée de ces contraintes permettrait d'améliorer les rendements de l'élevage dans les pays des zones tropicales semi-arides, ce qui avantagerait en retour des millions de pauvres.

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Needless to say, the content and conclusions in the paper are our responsibility and others cannot be implicated for any sins of omission and/or commission.

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All figures in the report are in US Dollars unless otherwise specified.

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Introduction

Background

Globally, livestock production accounts for about 40% of the gross value of agricultural production; more than half in developed countries, and almost a third in developing countries (FAO 2000). Livestock is a multi-functional productive asset used to produce food and provide services. The multi-functionality is more pronounced in developing countries where livestock, besides fulfilling the dominant function of food production also provide draught services and dung for manure and fuel. For example, more than half of arable land area in developing countries is cultivated with the help of draught animals, and over 70% of total fertilizers applied to land is provided in the form of manure (Fresco and Steinfield 1998). Besides, in most developing countries, livestock is closely interwoven with the social fabric and economic welfare of the rural people. Ashley et al. (1999) indicate that for about 70% of the world's poor, livestock is an important source of livelihood.

Continuing growth in population, rising per capita income and urbanization are fuelling a massive increase in demand for animal-based foods (Delgado et al. 1999) and the trends are stronger in developing countries, where demand for milk and meat increased by 86 and 147% respectively between TE 1982 and 2000[1]. Increase in demand for certain products such as poultry meat, eggs and pork was even higher. While growth in demand has been impressive, domestic production has by and large also kept pace with demand. This course of events is termed 'the livestock revolution' (Delgado et al. 1999). The livestock revolution is demand-driven as opposed to the supply-driven green revolution.

With a steady rise in demand for animal-based foods, the non-food functions of livestock are becoming less important. This is leading to intensification of livestock production. In Asia, land scarcity has led to intensive systems such as cut- and -carry and stall-feeding that have high labor but low land requirements.

This report analyses the structure and trends of crop-livestock economies in developing countries that have some Semi-Arid Tropical (SAT) areas within their borders. Following the definition of SAT given by TAC/FAO (1992), Ryan and Spencer (2001), delineated 55 developing countries that have some proportion of the area under SAT (Appendix Table 1). These countries are concentrated in sub-Saharan Africa, (SSA), Asia and North Central and South America (NCSA). SSA accounts for 63% of global SAT area, followed by Asia (19%) and NCSA (17%). For this study, we have selected 26 countries by creating a SAT index that captures the importance of SAT within the country as well as in relation to total SAT area in developing countries (Appendix Table 2)[2]. The selected countries account for 91% of the SAT area in developing countries.

The SAT countries together account for more than a third of the land area and population, 60% cattle, 59% buffaloes, 42% goats, 32% sheep, 20% poultry and 12% pigs in developing countries. Thus, livestock is an important component of SAT agriculture. Most of the poor in SAT countries own one or another species of livestock, and improving performance of this component of agriculture is considered an appropriate strategy for poverty reduction in the face of rapidly expanding demand for animal based foods (Ryan and Spencer 2001).

Scope and organization

This report provides an overview of the livestock sub-sector in the SAT countries in terms of production, consumption and trade, and highlights the challenges it faces. The analysis is based on the country level data obtained from FAOSTAT and World Development Reports. The data was supplemented by information from national sources and literature survey.

After a brief description of livestock production systems, the study examines the socioeconomic relevance of livestock and analyzes the structure and performance of the livestock sector. Next, we examine the contribution of the crop sector to animal feed, consumption of livestock products, international trade and the role of WTO. Likely changes in demand for livestock products by 2020 and challenges facing the sector are also highlighted.

1. TE or Triennium Ending implies three-year average data ending with the year indicated in the text.
2. The index was constructed by multiplying the share of SAT area in each country with its share in global SAT area * 100. The index varied from 6.8 to 0. The index was sorted in descending order and the top 23 countries were selected as representative of the SAT. Some countries like Mayanmar; Uganda, Malawi and Cameroon were purposively included to this list due to the presence of ICRISAT activities and were among the top 30-35 countries. Eritrea was also selected but its data was merged with Ethiopia and removed from the list.

Livestock Production Systems

Evolution of crop-livestock systems

Based on their degree of integration with crops Sere and Steinfield (1996) classified global livestock production systems into three broad systems, viz. grazing systems, mixed crop-livestock systems and industrial/landless systems. These systems were further classified into 11 subsystems based on agroecology (Table 1).

A number of interactive factors (population, technology, infrastructure, policy, etc.) influence the evolution of production systems. At low population densities, crop and animal production systems are extensive. Land is available and the interaction between crop and livestock production is weak. The only link is through contracts among specialized producers of crops and livestock for manure, animal traction and livestock products. However, as population density increases, there is increasing pressure on cropland, with fallow and pastureland increasingly brought under cultivation. This, in turn, raises farmers' demand for manure and animal traction. Herders, on the other hand, tend to acquire land to grow crops and crop residues for their herds. There is thus a move towards crop-livestock interaction, where crops and animals are integrated on the same farms (McIntire et al. 1992)[3].

With growing demand for crop and livestock products, further intensification of both crop and livestock activities takes place until markets develop. For example, availability of modern inputs (fertilizers, ready-mix feeds), development of infrastructure, transport systems, and new technologies (such as fodder production) lead to re-emergence of specialized production systems, known as industrial systems. In most developing countries, specialized livestock and crop/fodder production takes place primarily in peri-urban areas to meet the growing urban demand for livestock products.

Additionally, in the quest to achieve self-sufficiency in food production, many governments subsidize tradable inputs (fertilizers, concentrate feeds, diesel, etc) to the extent that the terms of trade become unfavorable to the use of non-tradable inputs (manure, crop residues). This in turn weakens crop-livestock integration in favor of specialization (McIntire et al. 1992).

Relative importance

Globally, mixed farming systems are the most important, producing 90% of global milk, 54% of cattle meat and 100% of buffalo meat. Industrial systems contribute 37% of global meat production, two-thirds of which is accounted for by non-

Table 1. Classification of the world's livestock production systems.

Major system	Sub-system
Grass-land based system	Temperate and tropical highland Humid/sub-humid tropics and sub-tropics Arid/semi-arid tropics and sub-tropics
Mixed farming system	Rainfed mixed farming systems - Temperate and tropical highland - Humid/sub-humid tropics and sub-tropics - Arid/semi-arid tropics and sub-tropics Irrigated mixed farming systems - Temperate and tropical highland - Humid/sub-humid tropics and sub-tropics - Arid/semi-arid tropics and sub-tropics
Landless livestock production system	Landless monogastric system Landless ruminant systems

Source: Sere and Steinfield 1996

3. McIntire et al. (1992) carry the debate further and go on to prove that as population density increases the evolution of crop-livestock interactions follows an inverted U shape with integration being weak at the beginning, then increasing and finally decreasing.

ruminant meat (pig and poultry) (de Haan et al. 1997). Grazing systems are the least important, supplying only 9% of global meat production.

Over the last two decades, industrial production systems grew at twice the rate of mixed systems, and more than six times the rate of growth of grazing systems (FAO 1996). Despite the faster growth of industrial systems, mixed farming systems are widespread in developing countries. Mixed systems serve as a risk coping strategy, with livestock providing an important avenue for farm diversification and consumption smoothing (Williams et al. 2000). Evidences indicate that integration of livestock with crops improves farm productivity and income compared to sole production of subsistence crops (Ogle 1996).

Mixed crop-livestock systems are partially closed and thus are environmentally the most benign. The waste products of one enterprise (crop production) are used by another enterprise (animal production), which in turn returns its own waste (manure) back to the first enterprise (Thomas and Zerbini 1999). "Because it provides many opportunities for recycling and organic farming and for a varied, more alternative landscape, mixed farming is the favorite system of many agriculturists and environmentalists" (de Haan et al. 1997)[4].

The interaction between crop and livestock production is unique to most of the developing countries including those in the semi-arid tropics. Mixed systems are important in Asia and account for the bulk of milk and meat production (Table 2). Grazing systems are important in SSA contributing nearly two-thirds of cattle meat and three-quarters of milk production. Grazing systems however, are gradually evolving into mixed systems (Otte and Chilonda 2002, Tiffen 2004). In NCSA both grazing and mixed systems are equally important.

Table 2. Share of milk and meat outputs by production systems in selected regions.

System/ Production	Milk	Cattle meat	Buffalo meat	Sheep and goat meat	Poultry meat
			(percent)		
World					
Grazing	8	23	0	30	2
Mixed	92	65	100	69	24
Landless	0	12	0	1	74
SSA					
Grazing	74	62	0	42	25
Mixed	26	38	0	58	46
Landless	0	0	0	0	29
Asia					
Grazing	0	16	0	22	0
Mixed	100	84	100	78	50
Landless	0	0	0	0	50
Central and South America					
Grazing	31	56	0	55	5
Mixed	69	44	0	45	20
Landless	0	0	0	0	75

Source: Sere and Steinfield 1996

4 Industrial systems on the other hand depend on outside supply of feed, and other inputs, and are least desirable environmentally. Thus, there is a need to internalize the environmental costs, and place stricter controls on pollution due to waste products. Secondly, commercial livestock production is based on very few breeds that have been selected for intensive production, and thus threaten domestic animal diversity.

Livestock and Livelihoods

Relevance to poverty alleviation

Livestock is closely interwoven with the socio-economic fabric of rural people in developing countries. It contributes to the livelihoods of at least 70% of the world's rural poor and their livelihoods are enhanced by strengthening their capacity to cope with income shocks (Ashley et al. 1999). For the poor, livestock performs many functions, ie, output functions, input functions, the assets and security functions and the social and cultural functions (Anderson et al. 2002).

Poverty is all-pervasive in most SAT countries (Table 3). Populations living below the poverty line vary from 30% to 80%. Incidence of poverty among SAT countries is highest in SSA, followed by NCSA and India. A majority of the poor maintain livestock. Poor livestock keepers account for 50-60% of the total poor in SSA, and for about 40% in Asia. Heffernan and Misturelli (2001) observed that the poorer the household the greater the economic and social importance of livestock.

Table 3. Percentage of poor and poor livestock keepers in arid and semi-arid production systems in selected countries, 2000.

Region	Country	Total poor[1] (000 No.)	Percentage of poor[1]	Poor livestock keepers (%)[2]	GDP per capita[3]	Population density[4]	Human Development Index[5]
East Africa	Ethiopia PDR	28176	42.4	62.4	124	543	0.33
	Kenya	13664	46.4	52.8	325	501	0.51
	Madagascar	10944	77.0	50.6	217	377	0.47
	Sudan	13332	45.0	54.9	356	122	0.50
	Tanzania	14822	45.0	65.8	204	571	
	Uganda	9910	45.0	69.4	367	377	0.44
Southern Africa	Angola	5789	45.0	50.5	598	288	0.40
	Botswana	565	45.0	69.9	4233	231	0.57
	Malawi	4840	45.0	75.6	162	419	0.40
	Mozambique	8106	45.0	54.7	229	308	0.32
	Namibia	785	45.0	67.5	2412	149	0.61
	Zambia	8075	88.0	63.3	410	116	0.55
	Zimbabwe	3564	31.0	53.7	522	254	0.43
West Africa	Burkina Faso	5457	45.0	66.8	258	248	0.51
	Cameroon	4829	32.4	77.2	711	128	0.37
	Chad	5159	67.0	65.7	248	167	0.39
	Mali	5064	45.0	66.0	313	163	0.28
	Niger	7469	66.0	63.9	207	192	0.46
	Nigeria	40305	36.4	59.6	248	252	0.43
	Senegal	3740	45	59.4	628	212	0.33
South Asia	Myanmar	10377	23.0	41.1	NA	349	0.55
	India	370045	36.7	40.3	494	454	0.58
NCSA	Cuba	4202	41.0	24.6	NA	76	0.80
	Bolivia	6966	79.1	16.3	947	161	0.65
	Brazil	54040	32.6	29.5	4644	60	0.76
	Paraguay	1537	28.5	38.6	1703	96	0.74
	World	1331192	28.0	41.7	-	-	-

1. Poverty estimates based on rural poverty thresholds as defined by each country in World bank report 2001.
2. Estimates of poor livestock keepers from Thornton et al. 2002.
3. GDP per capita at 1995 constant prices in US$ from World Development Indicators.
4. No per square km of geographical area, FAOSTAT 2003.
5. CIA World Factbook-2003.

Integration of livestock with crops helps diversify income sources of resource-poor farmers. The livestock population in Ethiopia (one of the poorest countries in SSA) is the largest in Africa with greatest concentration in the highlands. Almost the entire population is involved in some way with animal husbandry: draught power in the highlands, food, cash, transportation, fuel in other areas and social prestige in pastoral areas. Most of the cattle are Zebu and are poor sources of milk and meat. However, these cattle do relatively well under the traditional production systems (Blench et al. 2003). In northern and eastern Ethiopia, ownership of cattle contributes to higher crop productivity due to benefits of manure (Pender et al. 2002). Livestock development is thus a win-win strategy contributing to higher agricultural productivity, improved soil fertility, and higher incomes.

Further, in many countries livestock holdings are more equitably distributed than land holdings. For example, in India the bulk of livestock is controlled by marginal and small farmers with less than 2 ha land holdings (see Box Livelihood through livestock). In SSA as well, the bulk of livestock production comes from small-scale producers (ILRI 1995). In Ethiopia, smallholder farmers account for 98% of total milk production (Tsehay Redda 2002). In NCSA, most beef is produced on medium and large ranches but a significant fraction is produced on small farms (Jarvis 1986). The expanding market for livestock products offers an opportunity for augmenting their income, even for those who do not have access to land and capital resources (FAO 2000).

Besides, livestock rearing promotes gender equity, as women play an important role in the care and maintenance of animals (Rangnekar 1995, 1998; Devendra et al. 2000). In Kenya and Tanzania, women contribute more labor in dairy related activities and control income generated from dairying (Muriuki 2002 and Kurwijila 2002).

Income contribution

Agriculture, along with its sub-sector livestock, remains a key economic sector in most SAT countries (Table 4). Its share in GDP is highest in East African countries, followed by West Africa and South Asia.

Livestock contributes immensely to agricultural GDP (AgGDP) in the SAT varying from 9% to 88%. The share would have been higher, had the value of non-monetized outputs like draught power and manure been included in GDP calculations (Winrock 1992).

In SSA, the share is highest in East Africa and lowest in West Africa (Figure 1). Share of livestock sector in AgGDP is high in all countries in NCSA due to high per capita consumption of livestock

Livelihood through livestock: Poverty, equity, nutrition and insurance

Livestock is the lifeline of millions of poor smallholders in developing countries because its distribution is egalitarian compared to land. In India, smallholders (with <2.0 ha) who comprise 62.5 percent of the total rural households, possess only 32.8 percent of the cultivated land, but account for 67 percent of bovines, 65 percent of small ruminants 70 percent of pigs and 74 percent of poultry (Birthal and Parthasarathy Rao 2002). Livestock generates a quarter of the agricultural gross domestic product, and growth in the livestock sector is expected to benefit the majority smallholders. Birthal and Ali (2003) showed that agricultural growth reduces poverty, but growth in the livestock sector does more: it improves interpersonal and inter-regional disparities. A one percent inc rease in the livestock income has the potential to reduce interpersonal inequality by 4.2 percent (Birthal and Singh 1995), and interregional disparity by 12 percent (Birthal et al. 2002).

The problem of nutritional insecurity is acute in developing countries, and greater intake of animal protein helps alleviate this problem. Taneja and Birthal (2003) in a study of selected Asian countries found lower incidence of undernourished population in the countries with a higher consumption of animal protein. In most of the developing world where insurance markets are either missing or imperfect, livestock is considered to act as an insurance against agricultural income shocks. In a study of irrigated region of Pakistan, Kurosaki (1995) found that diversification towards livestock contributed to household income stability particularly for the smallholders as they have a larger livestock holding. The reduction in income variability had a welfare improving effect.

Table 4. Share of agriculture in GDP (2000) and annual compound growth rates[1] of value of production[2] in SAT countries.

Country	Share of agriculture in GDP (%)	Share of livestock in total agriculture GDP	Growth in crop	Growth in livestock
			1981-2000	
Ethiopia PDR	52	36.0	3.4	1.0
Kenya	20	49.5	1.9	3.0
Madagascar	29	31.6	1.1	1.4
Sudan	41	62.2	1.8	3.3
Tanzania	45	29.3	0.6	2.9
Uganda	37	15.4	2.9	2.9
Angola	6	36.4	2.8	2.4
Botswana	3	88.5	0.9	0.2
Malawi	37	8.6	2.6	1.5
Mozambique	22	14.4	1.9	0.8
Namibia	12	74.1	1.8	1.4
Zimbabwe	18	20.6	2.2	0.9
Zambia	22	41.5	2.1	2.1
Cameroon	43	23.1	2.4	3.5
Chad	39	34.9	5.0	2.1
Mali	41	46.7	4.9	0.7
Niger	38	38.0	3.4	1.6
Nigeria	29	14.3	7.1	1.3
Senegal	18	30.5	1.2	4.6
Burkina Faso	40	31.3	4.4	4.7
Myanmar	57	11.0	2.4	1.4
India	25	23.2	2.9	4.0
Cuba	7	17.5	-3.2	-3.4
Bolivia	15	41.7	4.8	3.0
Brazil	7	34.1	2.3	4.7
Paraguay	20	29.8	2.7	4.5

1. Growth rates were calculated using the exponential growth rate, $Y = b_0 (e^{b1t})$ linearized as $\ln Y = \ln (b_0) + b_1 t$, where ln Y = natural logarithm of variable Y, t = time period (years) and b_1 = growth rate of Y.
2. Production quantities of each commodity are weighted by 1999-2001 average international commodity prices and summed up for each year. To obtain the index, the aggregate for a given year is divided by the average aggregate for the base period 1999-2001.

Source: FAOSTAT 2003

products compared to other SAT regions. In India, the share of livestock is highest in hill and mountain regions followed by humid and SAT regions (Birthal and Parthasarathy Rao 2004).

In SSA, in countries with large areas under arid/ semi-arid tropics, livestock accounts for more than 50% share of AgGDP, while in countries with larger proportion of area under humid agroecology it accounts for only 20% of AgGDP[5]. Also, the share of livestock is higher in countries with large areas under highlands, where non-traditional small-scale dairy systems are predominant (Rege and Lipner 1992).

Thus, the economic importance of livestock increases with decreasing rainfall in African countries (Ogle 1996). In arid environments, crop production is risky and livestock production based on pastures/ rangelands is the main source of income for the poor[6]. On the other hand, in humid environments livestock

5 AEZs are one of the important determinants of the characteristics of crop and livestock production systems in terms of stocking rates, productivity etc (Otte and Chilonda 2002). Differentiation by production/farming system is a powerful tool for communicating conclusions to policymakers (Dixon et at. 2001).

6. Two-thirds of Niger is desert, and agriculture is concentrated in the Sudanian region where irrigated production is possible. Livestock is therefore an important source of livelihood for most of the population and a large share of livestock is held by pastoral nomads (Blench et al. 2003).

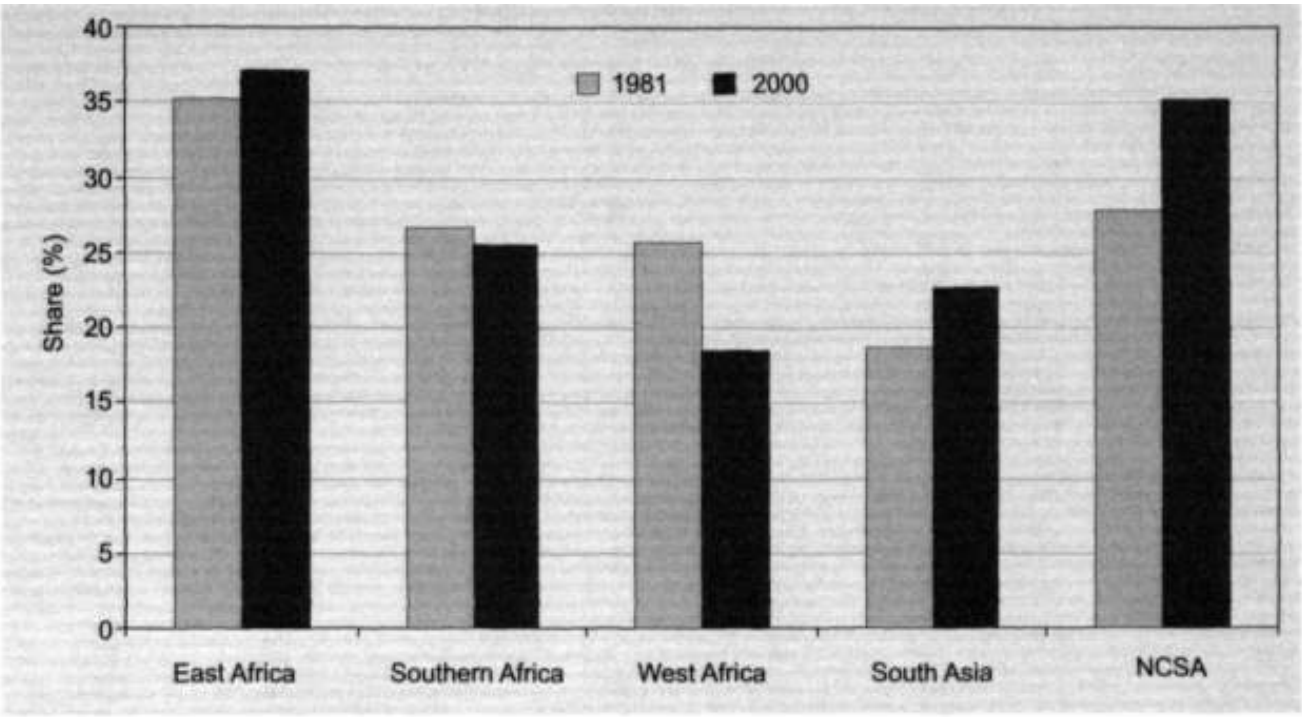

Figure 1. Share (%) of livestock in agriculture GDP by region.

production is risky due to trypanosomiasis and other disease constraints (Wilson 1995). Draught power is particularly important in the semi-arid AEZ and highlands. As mixed crop-livestock systems expand, the relative importance of animal traction and manure also grows (Ogle 1996).

Over the last 20 years, the livestock sector has grown faster in East Africa, South Asia and NCSA. On the other hand, crop production grew faster than the livestock sector in most southern and West African countries. This is probably because foodgrain security is still an important policy concern for these countries.

Livestock Production: Structure and Performance

Population

SAT countries account for 45% of world's cattle, 59% buffalo, 40% goats, 21 % sheep and 20% monogastrics (Table 5). Buffaloes are concentrated mainly in South Asia. India and Brazil together account for 65% of cattle and poultry each, 70% of pig, 30% of sheep and 45% of goats in the SAT. Pigs are less important in SSA because of socio-cultural/religious reasons. Small ruminants are important in SSA. The reason for the dominance of small ruminants in SSA is: although frequent droughts cause decimation of populations of both large and small ruminants, small ruminants tend to recover faster due to shorter reproduction cycles (Mahel 1997, Tiffen 2004).

Large ruminants outnumber small ruminants in South Asia and NCSA. However, even in India, in the arid/semi-arid and densely populated humid zones, sheep and goats are the mainstay of a large number of the poor (Parthasarathy Rao et al. 2004). Small ruminants are mainly raised by resource-poor households in marginal environments with acute shortage of feed and fodder resources. The system of production is mainly extensive and most of the feed and fodder requirements are met from grazing on common lands resulting in low productivity. Despite this, small ruminants are the single largest source of income for the many landless and small farmers, ranging from 20-25% in eastern India, and 50-70% in western and southern India (Birthal et al. 2003). In NCSA small ruminants form a small proportion of livestock population and are predominant only in temperate areas (Jarvis 1986).

At the aggregate level, poultry population has grown faster than any other species in the SAT (3.4%). The population of small ruminants (mainly goat) too grew faster in SSA (Table 6). Continuation

Table 5. Livestock population in SAT countries, 1999-2001 (million no.).

Country/No.	Cattle	Buffalo	Sheep	Goat	Pig	Poultry
Ethiopia PDR	37.2	_[1]	23.9	18.7	0.0	56.8
Kenya	13.2	-	7.0	9.6	0.3	31.5
Madagascar	10.3	-	0.8	1.4	1.1	23.1
Sudan	37.1	-	46.0	26.6		37.0
Tanzania	14.4	-	4.2	10.0	0.4	30.1
Uganda	5.9	-	1.1	6.2	1.5	25.0
Angola	4.0	-	0.3	2.1	0.8	6.8
Botswana	2.4	-	0.3	2.2	0.0	3.5
Malawi	0.7	-	0.1	1.4	0.2	15.0
Mozambique	1.3	-	0.1	0.4	0.2	28.3
Namibia	2.3	-	2.3	1.7	0.0	2.3
Zimbabwe	5.5	-	0.5	2.8	0.3	16.0
Zambia	2.3	-	0.1	1.2	0.3	29.0
Cameroon	5.8	-	3.7	4.2	1.2	30.0
Chad	5.8	-	2.4	5.2	0.0	4.9
Mali	6.6	-	6.2	9.9	0.1	25.0
Niger	2.2	-	4.4	6.7	0.0	23.5
Nigeria	19.8	-	20.5	24.3	4.9	126.0
Senegal	3.1	-	4.6	3.9	0.3	45.0
Burkina Faso	4.8	-	6.7	8.6	0.6	22.2
Myanmar	11.0	2.4	0.4	1.4	3.9	49.6
India	217.8	93.3	57.9	123.0	17.0	400.1
Cuba	4.3	-	0.3	0.2	2.6	13.2
Bolivia	6.7	-	8.7	1.5	2.8	77.9
Brazil	168.8	1.1	14.7	8.9	30.6	888.0
Paraguay	9.7	-	0.4	0.1	2.6	15.9
SAT Total	603.0	96.9	217.7	282.2	71.8	2025.9
World	1343.5	164.1	1055.7	713.9	911.7	15281.7
Share (%) of SAT in World	45	59	21	40	8	13

1. Not applicable: buffalo not reared.

Source: FAOSTAT 2003

of this trend may further skew the structure of livestock in favor of small ruminants.

Although, cattle population has remained stagnant in the SAT as a whole, positive and significant growth is observed in the highlands of SSA, and in many countries in West Africa and NCSA. The largest area of highlands is in Ethiopia (central and northern Ethiopia) where the system is largely a traditional one. A high proportion of oxen, reflecting the importance of animal traction, characterizes cattle herd structure. Non-traditional smallholder dairy systems are becoming important in Kenya, where farmers grow crops and keep two or three improved dairy cows. In these systems, sale of milk accounts for a higher proportion of income from livestock than in the traditional highland mixed systems. Non-traditional dairy systems are also emerging in southern parts of Ethiopia and northern parts of Tanzania (Otte and Chilonda 2002).

In South Asia, cattle population has stagnated due to increasing mechanization of agriculture in intensively cultivated irrigated areas. On the other hand, the dairy buffalo is growing in importance due to a strong consumer preference for high fat milk. In 2000, buffalo milk accounted for 54% of total milk production (Birthal and Parthasarathy Rao 2002; Parthasarathy Rao et al. 2004).

Table 6. Annual compound growth rates in livestock population in SAT countries, 1981-2000.

Country/Region	Cattle	Buffalo	Sheep	Goat	Pig	Poultry
			(percent)			
Ethiopia PDR	1.9	_1	0.1	0.4	1.6	0.5
Kenya	1.0	-	1.4	1.9	8.3	3.2
Madagascar	0.0	-	1.1	-0.6	-0.1	3.0
Sudan	3.7	-	5.5	3.9		1.7
Tanzania	0.7	-	0.8	2.9	4.2	3.3
Uganda	1.1	-	-2.0	4.6	13.2	3.1
Angola	0.9	-	1.6	2.1	1.2	1.1
Botswana	-1.2	-	4.6	6.6	-3.4	6.5
Malawi	-1.4	-	-1.0	3.9	0.7	3.0
Mozambique	-0.3	-	0.6	0.7	1.8	2.2
Namibia	0.5	-	-1.8	1.2	0.6	3.6
Zimbabwe	-0.3	-	0.8	5.1	2.7	4.2
Zambia	0.3	-	6.7	6.6	3.0	3.7
Cameroon	2.1	-	3.3	4.0	0.6	7.6
Chad	1.7	-	0.3	4.0	4.8	2.5
Mali	0.7	-	0.1	3.0	1.6	2.8
Niger	-1.3	-	2.5	0.4	1.0	4.4
Nigeria	2.7	-	4.6	3.4	9.0	2.1
Senegal	1.6	-	4.4	7.7	0.2	10.1
Burkina Faso	2.7	-	3.4	4.0	4.4	3.3
Myanmar	0.9	0.9	1.8	2.3	1.7	1.6
India	0.7	1.7	1.3	1.5	3.2	3.5
Cuba	-0.9	-	-1.1	3.4	2.8	-4.1
Bolivia	1.7	-	0.4	-0.9	2.8	11.3
Brazil	1.8	3.4	-1.4	-0.3	-0.3	3.7
Paraguay	2.5	-	0.3	0.5	5.2	0.9
SAT Total	1.3	1.7	1.7	2.2	1.5	3.4
World	0.5	1.5	-0.3	2.4	0.8	3.7

1. Not applicable: buffalo not reared.

Based on FAOSTAT 2003 data

Milk production

SAT countries account for about 20% of the global milk output (Table 7). By species, about two-thirds of buffalo milk and 44% goat milk is produced here. With-in the SAT, South Asia accounts for the bulk of the milk production (69%), followed by NCSA (19%) (Figure 2). The share of African SAT countries, with the exception of Kenya, Sudan and Ethiopia in East Africa, is low. Over time the share of South Asia increased while that of NCSA has declined.

Cow is the dominant milk species in the SAT, accounting for 57% of total milk output. Buffalo contributes 38% (Figure 3). Total milk production in the SAT grew at an annual rate of 3.9% during the last 20 years (Table 8). It is about four times the growth in global milk production. High growth rates in India and some countries in NCSA and East Africa have fuelled this growth. In East Africa, smallholder dairy is intensifying with increasing proportion of improved breeds. For instance, Kenya has a unique smallholder dairying system, concentrated in the high potential region of the country, contributing 60% to domestic milk production with a share of less than 25% in total cattle population (Muriuki 2002). Similarly, in Tanzania the improved dairy herd has grown faster (6% per annum).

Table 7. Structure of milk production in SAT countries, 1999-2001.

Country/Region	Cow	Buffalo	Sheep	Goat	Total production (000 t)
	Share in total production (%)[1]				
Ethiopia PDR	81	-[2]	5	8	1261
Kenya	93	-	1	4	2278
Madagascar	100	-	0	0	533
Sudan	63	-	10	25	4846
Tanzania	88	-	0	12	779
Uganda	100	-			510
Angola	100	-	0	0	194
Botswana	96	-	0	4	104
Malawi	100	-	0	0	35
Mozambique	88	-	0	12	69
Namibia	100	-	0	0	78
Zimbabwe	100	-	0	0	307
Zambia	100	-	0	0	63
Cameroon	68	-	9	23	184
Chad	72	-	4	14	219
Mali	31	-	19	39	504
Niger	59	-	5	33	308
Nigeria	100	-	0	0	386
Senegal	78	-	11	11	142
Burkina Faso	76	-	0	24	215
Myanmar	81	18	0	1	619
India	42	54	0	4	81560
Cuba	100	-	0	0	615
Bolivia	85	-	11	4	272
Brazil	99	-	0	1	21014
Paraguay	100	-	0	0	368
SAT Total	57	38	1	5	117463
World	85	12	1	2	577898
Share of SSA in SAT (%)	15	0	96	37	11
Share of SAT in world (%)	14	66	9	44	20

1. Does not add to 100 where total milk includes milk from other species.
2. Not applicable: buffalo not reared.

Source: FAOSTAT 2003

In Ethiopia although urban and peri-urban milk production is growing in and around Addis Ababa, subsistence rural milk production (based on low yielding zebu cattle) accounts for the bulk of milk production (Kurwijila 2002). By and large, commercial systems are more productive compared to traditional systems; for example, in Mozambique, commercial livestock is very limited but accounts for the bulk of milk production (Blench et al. 2003).

West African countries too have maintained a steady growth in milk production in the last two decades (Table 8). Milk production has remained stagnant and even declined in southern African countries. Here, dairy cattle form a small percent of total cattle populations. Risk of diseases, lower potential for biomass production and policy environment are the main factors inhibiting dairy production (Muriuki and Thorpe 2002).

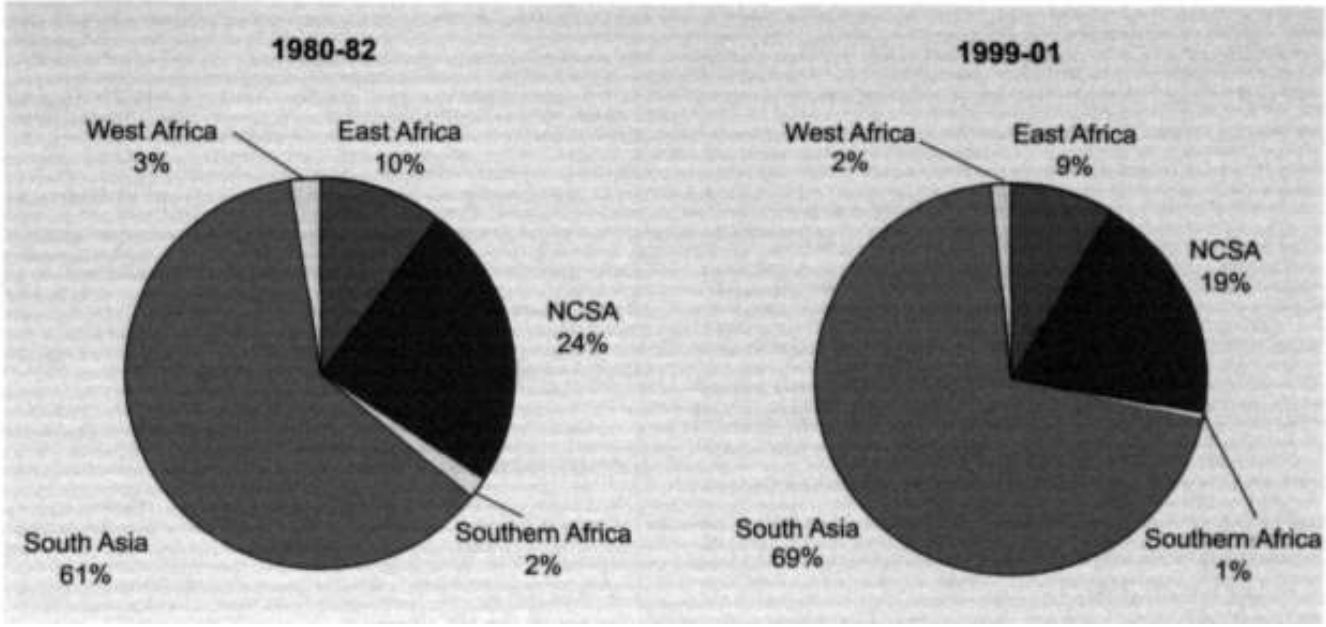

Figure 2. Distribution of milk production in SAT countries by region.

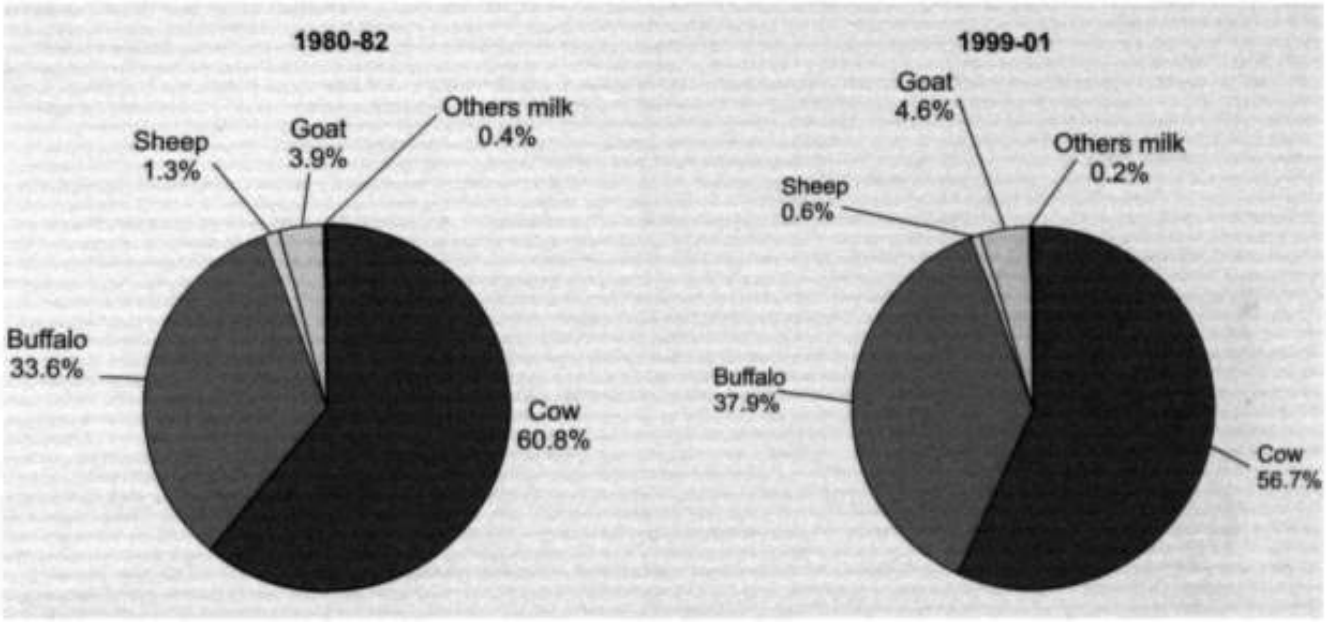

Figure 3. Structure of milk production in SAT countries.

Despite a huge population, SAT's share in global cow milk production is low because of low productivity. In SSA, cow milk yield is less than one-fourth the global average. Only in NCSA is cow milk yield closer to the global average (Table 9). Sheep and goat milk yields too are lower, the difference however is not as huge as in the case of cow milk.

Rather more worrisome is the stagnation of growth in milk yield in most SAT countries except in India and Brazil where it grew by about 3% per annum during the last two decades (Appendix Table 3). Increase in milk yield contributed about 50% to the growth of milk production in India (Birthal 2002). From being a net importer, India entered the export market during 1990s, although the quantities involved were small. The 'White Revolution' was accompanied by a decrease in the ratio of male bovines to female bovines due to mechanization in irrigated areas, an increase in the ratio of buffalos (which are better converters of feed) to cattle, and

increased availability of concentrate feeds like cakes and brans (Parthasarathy Rao et al. 2004). Linkages of production with marketing through an innovative project called 'Operation Flood' played an important role in boosting milk yield as well as production (see Box Role of markets...).

Even in SSA, farmers' milk marketing groups are becoming important for collection, transportation, processing and marketing of dairy products. In Kenya, dairy cooperatives have contributed significantly to smallholder dairying through improved marketing and provision of other services (Omiti 2002). In Ethiopia, the Ministry of Agriculture has formulated a strategy to develop markets for saleable milk. Farmers produce milk privately but sell milk collectively since quantities available at individual household level are too small for effective marketing (Tsehay Redda 2002).

Similar experiments are being tried in Cameroon, Nigeria, etc. These experiments are mainly to support pastoral milk producers.

In summary, in most SAT countries and particularly SSA, the contribution of yield to production growth has been negligible. Much of the growth in milk production was driven by an increase in animal populations which put pressure on available land and feed resources. In a few countries such as Kenya, Madagascar and Uganda, change in the herd structure towards increased milch animals led to higher milk production (Tambi et al. 2001).

Meat production

SAT countries account for 11% of global meat production. Species wise, they produce 47% of buffalo meat, 30% of goat meat and 19% of cattle

Role of markets and institutions in India's revolutionary progress in milk production

India today is the largest producer of milk in the world. This revolutionary progress was due to the development of a marketing network through cooperatives. The dairy cooperatives owe their genesis to the Kaira District Co-operative Milk Producers' Union in Gujarat State, which was established by the dairy farmers of Kaira district in 1946. The aim was to provide a stable market and remunerative prices to dairy producers, who were otherwise being exploited by middlemen. Traders and middlemen would collect milk from the farmers and supply it to the Bombay Milk Scheme, using the seasonal demand-supply imbalances for milk and its perishable nature to their advantage. While the bulk of milk is produced during winter, its demand remains almost stable throughout the year, particularly in the urban areas. During the winters, middlemen often paid milk producers only half of what they paid them during the summers. The Kaira Union started with two co-operative societies with a daily milk collection of about 200 liters, which they supplied directly to the Bombay Milk Scheme. The milk producers were paid 80 percent of the winter prices.

With an increase in the demand for milk, the Union installed processing facilities to meet additional demand. Simultaneously, the Union provided better feed, health and breeding services to its members. By 1965, the number of cooperatives under the Union rose to 518 with a membership of 1,10,000 producers. In 1964, the Kaira Union invited Lal Bahadur Shastri, then the Prime Minister of India, to inaugurate a modern cattle feed plant. He spent a night with the farmers and listened to their experiences of dairy cooperatives. Visualizing the potential of cooperatives in rural transformation, he initiated efforts to replicate this model throughout the country, which culminated in the establishment of the National Dairy Development Board (NDDB) under the leadership of Dr Verghese Kurien, popularly known as dairyman of India.

The cooperative model has been replicated throughout the country. In 2002 there were more than 100,000 dairy cooperative societies with a membership of over 13.5 million producers. Milk production that was stagnating around 20 million t until 1970 increased to 83 million t in 2002. The functions of the cooperative institutions have diversified from procurement and marketing of liquid milk to the production of processed dairy foods. With this, the producers are ensured of a stable market at remunerative prices, and consumers have wider product choices at reasonable prices.

Source: Adapted from Birthal and Ali (2005)

Table 8. Annual compound growth rates in milk and meat production in SAT countries, 1980-2001.

Country/Region	Total milk	Total meat
	(percent)	
Ethiopia PDR	2.2	1.2
Kenya	3.7	2.4
Madagascar	0.9	1.7
Sudan	3.8	2.5
Tanzania	3.0	2.8
Uganda	2.4	3.4
Angola	0.8	2.7
Botswana	0.2	1.6
Malawi	-0.9	1.9
Mozambique	-0.2	1.4
Namibia	0.7	1.8
Zimbabwe	-2.0	2.0
Zambia	0.3	2.0
Cameroon	3.0	3.2
Chad	1.9	3.6
Mali	1.5	2.9
Niger	1.9	2.1
Nigeria	1.5	0.8
Senegal	1.9	4.8
Burkina Faso	5.0	4.2
Myanmar	1.4	1.9
India	4.5	3.2
Cuba	-3.8	-1.8
Bolivia	4.6	3.6
Brazil	3.2	5.5
Paraguay	5.3	4.0
SAT Total	3.9	4.0
World	0.9	2.8

Based on FAOSTAT 2003 data

Table 9. Milk yield in SAT countries by species, 1999-2001.

Country	Cow	Buffalo	Sheep	Goat
	(Kg/animal/annum)			
Ethiopia PDR	204	_[1]	25	50
Kenya	481	-	20	50
Madagascar	281	-		
Sudan	480	-	18	64
Tanzania	207	-		40
Uganda	350	-		
Angola	485	_		
Botswana	350	-		25
Malawi	458	-		
Mozambique	170	-		45
Namibia	402	-		
Zimbabwe	308	_		
Zambia	300	-		
Cameroon	500	_	20	50
Chad	270	-	25	40
Mali	245	-	30	60
Niger	400	-	20	50
Nigeria	243	-		
Senegal	360	-	8	20
Burkina Faso	172	-		20
Myanmar	392	392	23	21
India	945	1425		142
Cuba	1175	-		
Bolivia	1627	-	25	30
Brazil	1220	-		30
Paraguay	2401	-		
World	2175	1391	41	85

1. Not applicable: buffalo not reared.

Source: FAOSTAT 2003

meat. Within SAT, India and Brazil produce over 75 percent of total meat (Table 10). Small ruminant meat production is concentrated mainly in SSA (60%).

Regionally, NCSA accounts for the bulk of meat production and its share has increased from 48% in TE 1982 to 60% in TE 2001. South Asia accounts for 20% followed by East Africa and West Africa (Figure 4). By meat type, beef accounts for 42% of total meat followed by poultry and pig meat. The share of poultry meat increased from 18% in 1982 to 30% in 2000, while cattle meat (beef) declined (Figure 5). The structure of meat production in SSA is different. Here, cattle meat accounts for about 47% of total meat production, and small ruminant and poultry meat account for 21 % each. Additionally, other meats (minor meats) contribute 11 % to the total production.

Trends in meat production in the SAT are stronger compared to global trends. Total meat production in most SAT countries grew in the range of 1 to 3% a year over the past two decades. The growth was above 3% in West Africa, NCSA and India. Poultry meat grew fastest (all SAT average being 7%). Small ruminant meat in West Africa also witnessed high growth (>4%) (Appendix Table 4a).

Carcass weight or meat yield of most of the species is low (Table 11). Beef yield in East and West Africa and South Asia is less than 50% of the

Table 10. Structure of meat production in SAT countries, 1999-2001.

Country	Cattle	Buffalo	Sheep	Goat	Pig	Poultry	Total Meat (000 t)
	Share in total meat production (%)[1]						
Ethiopia PDR	46	-[2]	13	10	0	11	681
Kenya	64	-	6	7	3	12	444
Madagascar	53	-	1	3	19	22	278
Sudan	46	-	21	17		4	681
Tanzania	69	-	4	8	3	13	325
Uganda	37	-	2	9	30	15	261
Angola	61	-	1	7	21	6	139
Botswana	58	-	2	9	1	10	65
Malawi	35	-	1	9	24	31	49
Mozambique	43	-	1	2	14	40	90
Namibia	76	-	9	5	1	5	86
Zimbabwe	57	-	0	7	7	14	175
Zambia	27	-	0	4	9	30	114
Cameroon	43	-	7	7	7	14	216
Chad	66	-	11	15	0	4	115
Mali	42	-	12	18	1	14	212
Niger	31	-	11	19	1	21	131
Nigeria	33	-	10	17	9	19	894
Senegal	30	-	9	10	4	39	165
Burkina Faso	40	-	10	17	7	20	130
Myanmar	23	5	0	2	25	45	442
India	30	29	5	10	12	12	4850
Cuba	31	-	0	0	44	25	243
Bolivia	39	-	4	1	19	35	402
Brazil	45	-	0	0	13	42	14572
Paraguay	55	-	1	0	32	12	435
SAT Total	42	5	3	4	12	30	26194
World	24	1	3	2	39	29	233218
Share of SSA in SAT (%)	22	0	60	54	11	10	20
Share of SAT in World (%)	19	47	11	30	4	12	11

1. Does not add to 100 where total meat include meat from other species.

2. Not applicable: buffalo not reared.

Source: FAOSTAT 2003

global average of 204 kg. Only in southern Africa do beef yields compare with the global average. Yield of small ruminants is closer to the global average in all SAT countries. Poultry meat yield is about 40-50% lower than global yield except in NCSA. Egg yield is less than a third of the global average in many SAT countries, particularly SSA.

Globally, meat yields grew at <0.5% per annum, and growth in most SAT countries was also negligible and even negative in some countries (particularly for beef). Thus, the contribution of yield to meat production growth is insignificant. However in Kenya, Zimbabwe and Niger, yield improvements made significant contribution to beef production. Yield improvements in layers also contributed significantly to egg production in Brazil and Paraguay (Appendix Table 4b).

The slower growth in yields stems from several factors such as lack of access/adoption of improved technology, prevalence of traditional grazing systems,

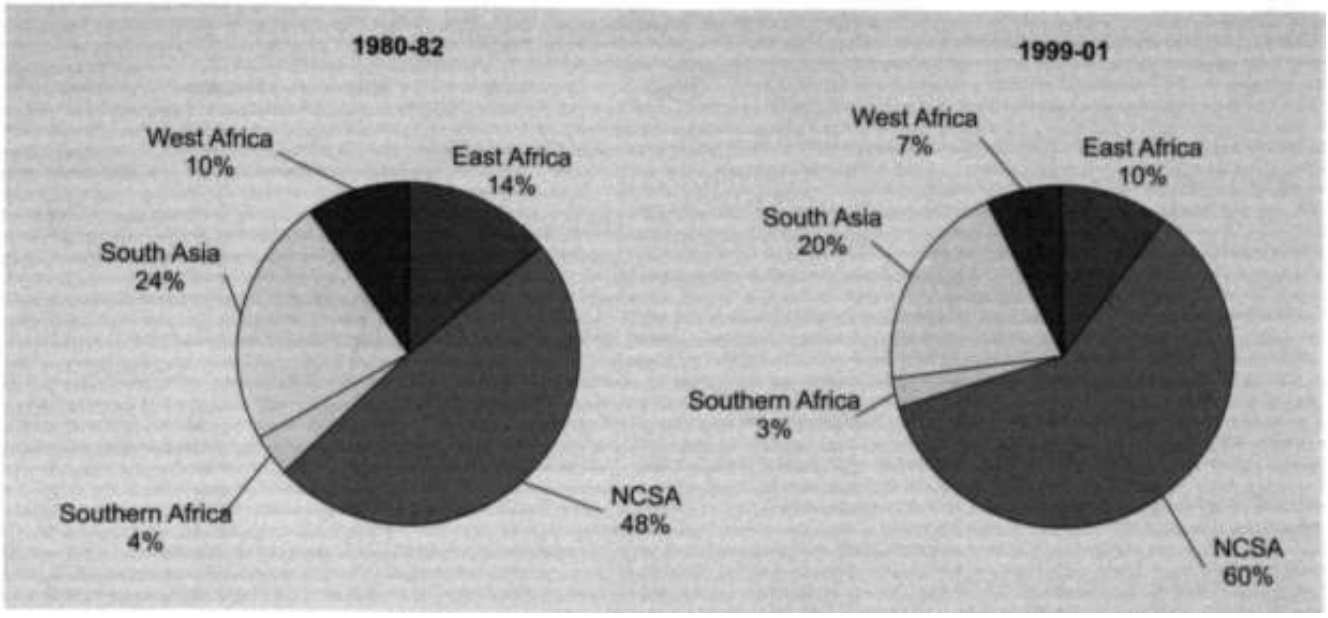

Figure 4. Distribution of meat production in SAT countries by region.

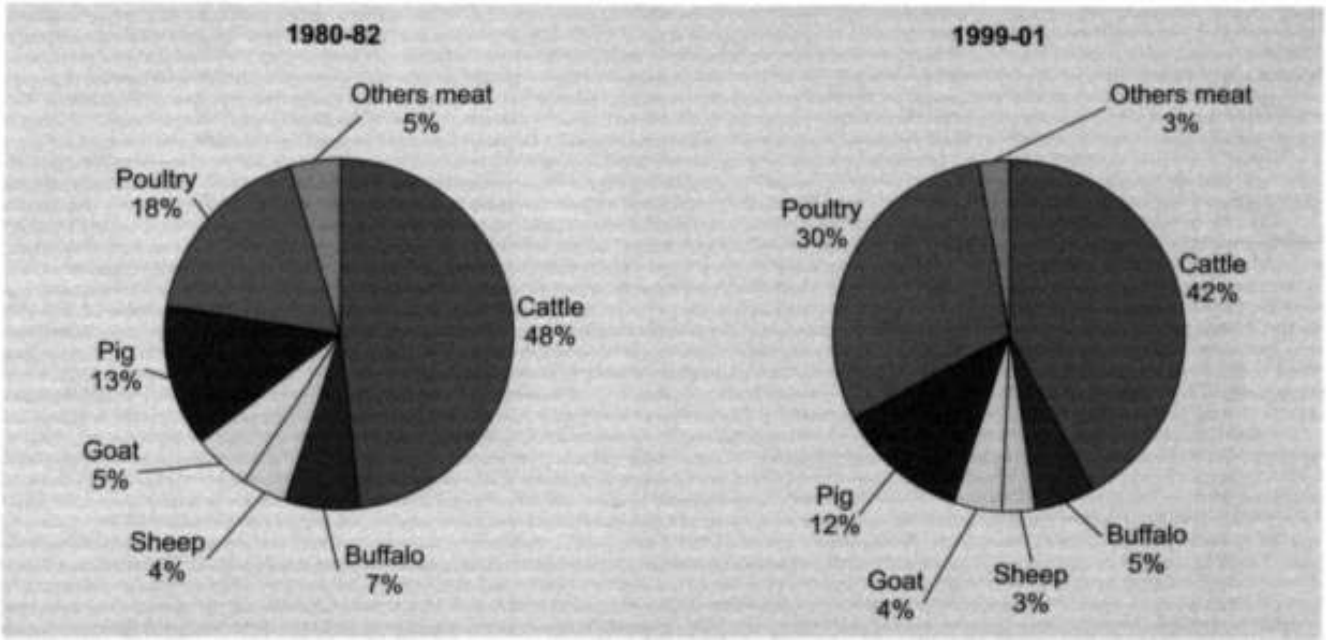

Figure **5.** *Structure of meat production in SAT countries.*

predominance of indigenous breeds among small and large ruminants, high disease incidence and poor veterinary infrastructure.

In SSA, lack of effective demand, scarcity of capital and over-valued exchange rates resulted in the non-adoption of technologies and reliance on imports in the 1970s and 1980s. Adoption of technology is also constrained by disease, especially trypanosomiasis. Only in areas closer tourban centers and where agroecological conditions permit, semi-intensive and intensive dairying has developed using cultivated fodder and agro-industrial by-products. In areas with improved access to markets, dairying is preferred to meat production since it makes more efficient use of feed resources and provides a regular income to the producer (Walshe et al. 1991).

Poultry production has begun to be industrialized in many developing countries and also in the semi-arid tropics (Delgado et al. 1999). Poultry have shorter reproductive cycles and are more efficient converters of feed concentrates (FAO 1996). In Mozambique, poultry production is an important

Table 11. Meat yields by species in SAT countries, 1999-2001.

Country	Cattle	Buffalo	Sheep	Goat	Pig	Poultry	Eggs
	Kg/animal/annum						
Ethiopia PDR	108	_[1]	10	8	50	0.8	2.3
Kenya	154	-	12	11	65	1.2	2.4
Madagascar	128	-	12	15	70	1.2	1.2
Sudan	121	-	16	13		1.0	5.1
Tanzania	107	-	12	12	40	0.9	2.6
Uganda	150	-	14	12	60	1.3	2.0
Angola	146	-	15	15	65	0.9	2.0
Botswana	190	-	14	12	50	0.8	1.8
Malawi	205	-	14	12	50	0.8	2.6
	150	-	12	12	60	0.9	1.3
Namibia	223	-	18	12	42	1.1	2.6
Zimbabwe	223	-	14	12	55	1.2	3.0
Zambia	158	-	14	12	44	1.0	4.0
Cameroon	147	-	12	10	30	0.8	2.0
Chad	123	-	18	12	25	0.7	1.8
Mali	130	-	13	14	40	0.8	1.8
Niger	131	-	16	12	45	0.8	1.7
Nigeria	163	-	11	13	45	1.0	4.1
Senegal	125	-	14	12	30	1.0	1.9
Burkina Faso	110	-	9	8	24	0.8	3.5
Myanmar	120	170	15	12	55	1.1	2.9
India	103	138	12	10	35	0.9	11.9
Cuba	148	-	12	12	61	1.2	12.7
Bolivia	171	-	8	11	50	1.9	3.0
Brazil	213	-	16	15	79	1.4	6.9
Paraguay	173	-	15	10	60	1.0	8.0
World	204	140	16	12	78	1.5	10.1

1. Not applicable; buffalo not reared.

Source: FAOSTAT 2003

source of income for rural people. In recent years, the government has initiated joint ventures with private investors in the poultry sector (Blench et al. 2003).

In NCSA, low land prices allow production systems to be extensive (it is cheaper to expand to new areas by increasing herd size rather than invest in new technology). Price policies have focused on urban consumers and the slow growth in the economy in the 1980s and early 1990s led to stagnation in demand. Nevertheless, with sustained economic growth afterwards, poultry and dairy production is intensifying closer to urban areas. These systems resemble the industrial systems in developed countries.

In India, cattle and buffalo are mainly raised for milk and/or for draft power with meat production an adjunct. Further, cattle is considered be to sacred and its slaughtering is banned in many states. The adoption of crossbreeding technology for sheep and goats is low. Also, due to lack of institutional support grazing lands have declined as also the quantity and quality of grasses (Birthal 2002; Parthasarathy Rao et al. 2004).

On the other hand, the poultry meat industry has undergone rapid intensification in India. The private sector has entered the poultry sector in a big way, thereby providing access to the latest technologies and markets. These intensive systems make use of improved genetic material, improved

feeding, etc. under skilled technical and business management.

Livestock and environment

Livestock production in SAT countries is showing signs of intensification. Livestock pressure on arable land is highest in South Asia, followed by NCSA. In SSA, on average the density is highest in eastern Africa, particularly in the highlands and Uganda, and lowest in southern Africa. There is considerable variation across countries even within a region (Table 12). Intensification of livestock is closely associated with population density (Boserup 1965). The correlation between population density and livestock units (LSU) per ha is positive and significant (0.35). The only exceptions are countries in NCSA where despite low population density, the density of livestock/ha is very high ranging from 3-7 LSU. Increasing demand for livestock products is a major driving force here.

Gass and Sumberg (1993) have shown that factors like urbanization, income growth and inter-regional trade also play an important role in livestock intensification. Birthal and Parthasarathy Rao (2004)

Table 12. Livestock pressure and land resources in SAT countries, 1999-2000.

Country	LSU[1] (000 no.)	LSU/ land area	LSU/ agricultural area	LSU/ permanent pasture area	Permanent pasture as a share to total land area (%)	LSU/ rural population (000)
		(per 000 ha)				
Ethiopia PDR	30119	274	512	672	41	515
Kenya	10819	190	419	508	37	532
Madagascar	7698	132	284	321	41	684
Sudan	32149	135	253	292	46	1601
Tanzania	11485	130	290	328	40	487
Uganda	4812	244	559	2673	9	239
Angola	3087	25	54	57	43	378
Botswana	1894	33	73	74	45	2154
Malawi	647	69	168	349	20	67
Mozambique	997	13	21	23	56	82
Namibia	1956	24	50	51	46	1496
Zimbabwe	4272	110	208	248	44	522
Zambia	1808	24	51	60	40	288
Cameroon	4761	102	520	2380	4	617
Chad	4780	38	98	106	36	798
Mali	5962	49	172	199	25	717
Niger	2396	19	141	200	9	281
Nigeria	17612	193	252	449	43	274
Senegal	2842	148	359	503	29	576
Burkina Faso	4549	166	481	758	22	458
Myanmar	9122	139	868	25130	1	265
India	295209	993	1634	26724	4	401
Cuba	4693	427	703	2126	20	1697
Bolivia	8017	74	223	237	31	2561
Brazil	185347	219	741	1002	22	5724
Paraguay	10525	265	439	485	55	4371
SAT Total	667558	225	547	793	28	596

1. LSU = Livestock units include cattle, buffalo, sheep and goat only. For converting livestock population into LSU, cattle and buffalo weighted by 0.6 in Asia, 1.08 in LAC and 0.73 in Africa, sheep and goat weighted by 0.06 in Asia, 0.08 in LAC and 0.07 in Africa respectively.

Source: FAOSTAT 2003

found that population density and urbanization were among the important factors explaining intensification of livestock in India. Williams et al. (2000), present a broader conceptual framework to explain the evolution and incidence of different crop-livestock systems in SSA. They further demonstrate the interacting effects of agroecological, economic, technological and institutional factors in determining the pathways of intensification at different locations.

Intensification of livestock production, it is argued, might result in negative externalities to environment (land degradation, desertification, effluent pollution, global warming etc). This is already happening in the industrial systems where waste and effluent from livestock production are leading to problems of pollution and water contamination. By not returning manure to cropland these systems negate the positive aspects of crop-livestock interaction. There is, therefore, a need to internalize environmental costs, and place stricter controls on pollution due to waste products. Area wide integration is one concept gaining support and it would preserve some of the positive environmental benefits of mixed systems (de Haan et al. 1997).

More recently, the livestock sector is being seen as an agent of climate change; globally livestock accounts for about 22-27% of global methane emissions and this is expected to increase as livestock production intensifies. In most SAT countries, animals are low yielding and are kept on poor quality straw and forages, and thus methane emission per unit of product would be higher. FAO (2000) predicts that annual methane emissions from livestock could increase by 60% by 2030. Efforts should be made to reduce emissions per unit of output by improving the quality and digestibility of feed.

The sector is also held responsible for desertification and land degradation. With the expansion of cropping and reduction in rangelands, the carrying capacity of rangelands is considerably reduced leading to a decline in the quantity and quality of grasses and ultimately resulting in land degradation. Much of the deforestation in Brazil is attributed to livestock. However, there is another school of thought that implicates expansion in human population density as the main cause for desertification. Notwithstanding these arguments, there is a need for stronger institutions, regulation of access to common resources and greater participation of the communities in the maintenance of common resources.

Animal Feed

Feed and fodder availability is the most important component in livestock production. Feed accounts for 60-70% of total input costs (home produced and purchased inputs) and is thus an important determinant of profitability of the livestock sector.

The main sources of feed for livestock in SAT countries include crop residues from cereal and legume crops; grasses from grazing land/permanent pastures, biomass from tree crops, and agro-industrial by-products (A1BP). Cultivated fodder crops and cereal grains also contribute to the feed basket but are relatively less important.

Crop residues

Crop residues are a major source of feed particularly for large ruminants in the SAT. Being by-products of crops, they do not compete for land required to grow food crops. In many regions, residues are the only source of feed during the dry months that extend between 5-7 months and are used to fill the gaps during periods of acute feed shortage.

In South Asia where small-scale mixed crop-livestock systems are predominant, crop residues have gained in importance as animal feed due to the decline in area under common grazing lands and storability of residues from one cropping season to another. In India, the bulk of crop residues is used as animal feed: a reflection of the importance of mixed crop-livestock systems. On average, crop residues account for 50-60% of total dry matter intake by bovines and form the bulk of feed in dry months (Kelley and Parthasarathy Rao 1996; Parthasarathy Rao and Hall 2003; Parthasarathy Rao et al. 2004). The impressive growth in production of rice and wheat in North India led to substantial increase in availability of residues; so much so, in much of the green revolution belt of North India, large quantities of paddy straw are burnt and chaffed wheat straw is ploughed back into the soil. On the other hand, in the dry semi-arid regions of the country there is increasing pressure on crop residues owing to a decline in area under coarse grains such as sorghum and millets. This in turn has put pressure on their prices (Kelley et al. 1993, Kelley and Parthasarathy Rao 1996).

In contrast, in West Africa two-thirds of residues from millet, sorghum, maize and rice are used as

domestic construction material or fuel, and only one-third is available as feed. For cowpea and groundnut haulms, about two-thirds is available for feed (Fernandez-Rivera et al. 2004). The value of crop residues when used as feed depends on the demand from livestock owners, which varies with the overall demand and supply of feeds (de Leeuw 1997). An important research question often debated is the opportunity cost of using crop residues in competing uses. It is generally presumed that in much of SSA the shift towards mixed crop-livestock systems would stimulate demand for crop residues (Williams et al. 1997; Jabbaretal. 1995).

In NCSA, native and introduced pastures are important feed resources that are complemented by crop residues. However, in the arid and semi-arid areas of northern Brazil crop residues are an important source of feed where natural pastures are scarce (Quiroz et al. 1997).

Crop residues are poor in available proteins, minerals and vitamins and technologies have been developed (like chemical and biological treatment of straw, genetic manipulation of rumen microbes, supplementation etc) to improve the nutrition content of crop residues. However, their adoption is dismal due to high start up capital costs, labor constraints, and lack of evidence with regard to economic benefits to farmers (Williams et al. 1997; Devendra 1997; Parthasarathy Rao et al. 2004).

Pastures

In most countries of SSA rangelands and permanent/ natural pastures are an important source of feed. Permanent pastures account for upto 45% of land area in SAT countries. Pastoral systems are mainly found in the arid and semi-arid zones (with rainfall less than 600 mm per annum) in West and East Africa (Otte and Chilonda 2002). In Nigeria, pastoral communities produce the bulk of milk production; in Cameroon animals are grazed on natural pastures with minimal feeding of concentrates (Njwe et al. 2002). Even in mixed systems, permanent pastures are an important source of feed. In countries such as Senegal, Ethiopia, Kenya, Malawi, and Nigeria, grazing on communal lands, fallows, stubble grazing, browsing tree foliage and grasses are common. However, as in Asia the area under natural vegetation is declining due to the expansion of croplands. For example, in Senegal, crop residues and AIBPs are perceived as alternative sources of feed due to deteriorating natural vegetation cover and increasing cropping intensity (Mahel 1997). In northern Ethiopia, grazing lands are becoming scarce and deteriorating due to growing population pressure (Pender 2001). Free grazing laws in Ethiopia further compound the problem as grazing lands and croplands after harvest are often unregulated open access resources. Community action restricting the use of grazing lands is to some extent helping reduce the degradation, although the evidence suggests that these restrictions have not been able to halt it (Gebremedhin et al. 2002). Besides community action, investments in improving grazing lands (planting fodder trees and grasses) are needed if degradation is to be halted.

In NCSA, permanent pastures account for about 25% of land area (except Paraguay). Additionally, since land is privately owned, feeds are also derived from sown pastures (de Leeuw et al. 1999). In contrast, in India and Myanmar permanent pastures constitute only four and one percent of land area respectively and are of poor quality. For example, in India, due to encroachment and over grazing and lack of maintenance, the quantity and quality of grasses available from common property resources have deteriorated (Jodha 1992). This in turn has put pressure on the poor livestock keepers who rely extensively on communal land to feed their animals. In many countries, population growth, intensification of land use, commercialization, and the policies of many governments have often led to the enclosure and privatization of these resources (Ashley et al. 1999).

Cultivated fodder crops

The area under cultivated fodder crops is low throughout the SAT. To meet the household food and fodder needs farmers prefer to grow crops that meet both food and feed requirements. In India, only 5% of land area is under cultivated fodder crops, which are mostly grown under irrigated conditions. In the rainfed areas fodder crops have to be introduced in novel ways (on bunds, fallow lands) such that they do not compete with main crops. In eastern Africa cultivated fodder/tree crops are slowly being adopted in areas where dairying is emerging as an important activity. Napier grass is grown commonly on the highlands in Kenya. Lack of information on suitable varieties and non-availability of seed are important constraints.

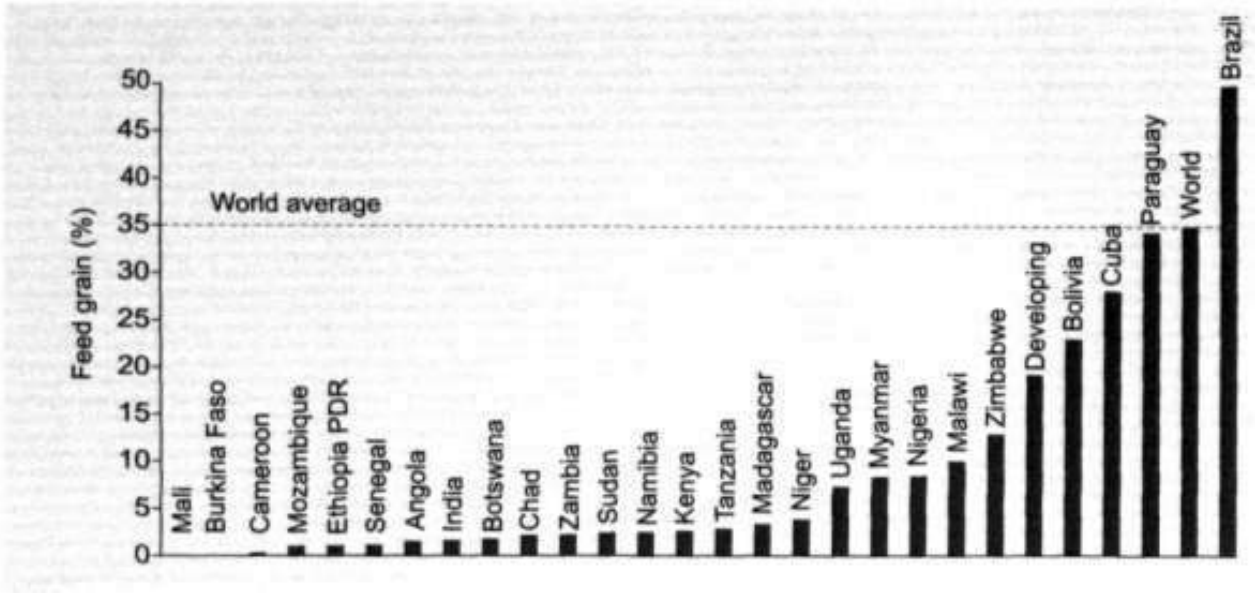

Figure 6. Share of feed grain to domestic grain availability, 1998-2000.

Agro-industrial by-products

At the global level 35% of grain production is used as feed (Figure 6). It is 11% for SAT countries as a whole. Countries such as Brazil (50%)[7], Cuba, Bolivia and Paraguay (25-30%) use higher proportion of grains as feed. In most countries in SSA, grain for feed constitutes only 2-3% of the production. The only exceptions are Malawi, Nigeria and Zimbabwe where it ranges between 8-12%. In Malawi and Zimbabwe maize constitutes the main feed while in Nigeria, maize, sorghum and millets are equally important. The structure of cereal production in SAT countries is shown in Appendix Table 5. Although statistics are not available, much of the grain used as feed is for poultry.

SAT countries are net importers of cereals, accounting for 9% of global imports in value terms (Figure 7), although the gap between imports and exports has narrowed down since the early 1990s (mainly due to large exports from India). Brazil, Cuba, Nigeria, Kenya, Ethiopia, Senegal, Sudan, Cameroon and Angola import large quantities. For many other countries despite imports of small quantities of cereals, these amount to a large proportion of domestic production. For example, imports by Botswana amount to 954% of domestic production, Namibia 484%, Cuba 385%, Senegal 96%, Angola 93%, Cameroon 43%, Bolivia 40% and Kenya 36%. Thus, the self-sufficiency index (SSI) for cereals is significantly below 100 for many SAT countries. Only for India, Malawi, Myanmar, Paraguay is the index above 100 (Figure 8). Imports are mainly to meet domestic food needs.

Brans and oilcakes arc other important sources of feed. Per animal bran consumption in the SAT was 32 kg/annum in TE 2000 (Table 13). In many countries in southern Africa (Malawi, Mozambique, Zimbabwe and Zambia) and West Africa (Niger, Nigeria, Senegal and Burkina Faso) brans per LSU is higher than the SAT average. In South Asia too bran consumption is higher. The availability of brans per LSU increased in all countries during the last 20 years

Amongst the AIBPs, oilcakes are used exclusively for feed. The average availability of oilcakes for the SAT in 2000 is 33 kg/animal/annum. The availability is higher in South Asia and NCSA. In SSA, the availability is higher only in Malawi, Mozambique and Nigeria. Between TE 1982 and 2000 the availability of oilcakes per LSU doubled in the SAT. Similar trends were observed at the global level where consumption of oil meals grew twice as fast as livestock production in the eighties and nineties (FAO 2000).

With faster growth in the availability of brans and oilcakes, total feed availability per LSU from AIBPs increased in the SAT from 88 to 117 kg/animal/ annum (change in absolute quantities are shown in Appendix Table 6). In general the availability increased in all countries.

7 Brazil is a net importer of rice and wheat amounting to 70% of domestic production; and all of this is for usr as food. However, 80% of domestic production of maize (28.3 million t) and 100% sorghum (0.75 million t) is used as feed.

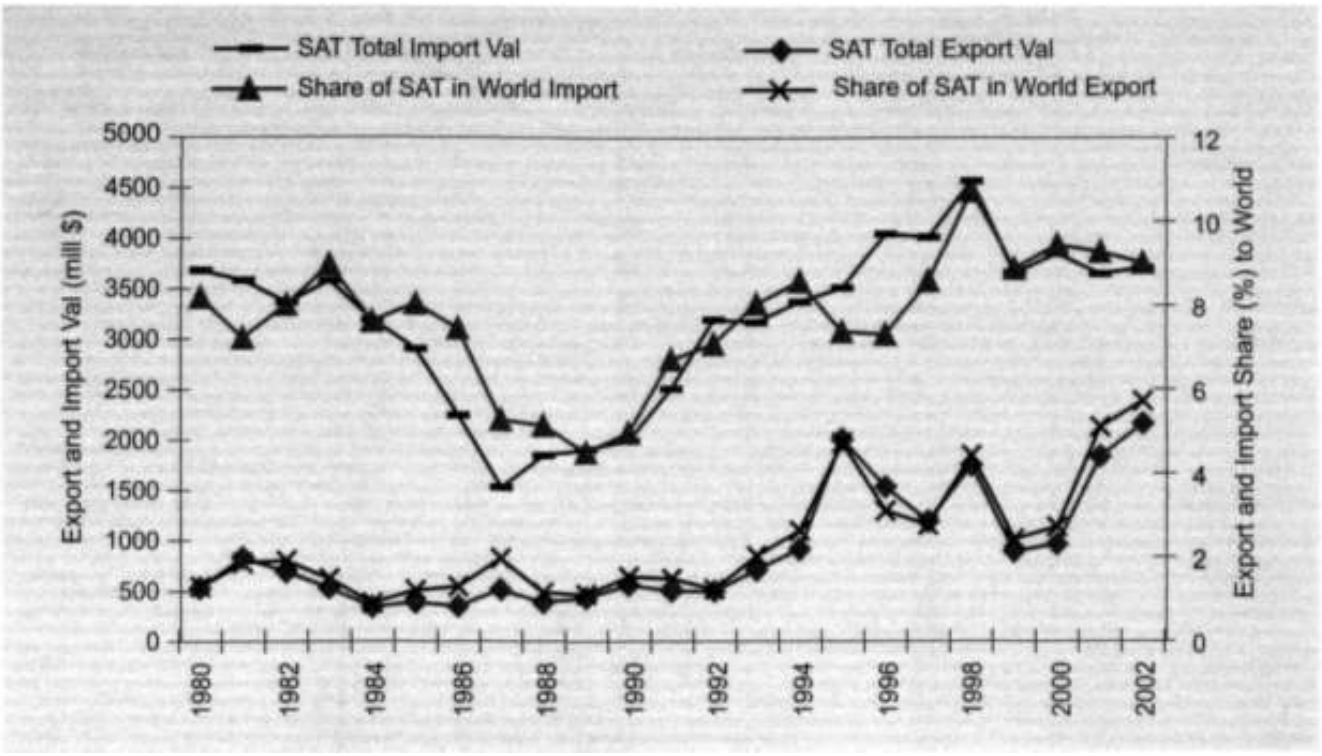

Figure 7. Export and import value of cereals, 1980-2002.

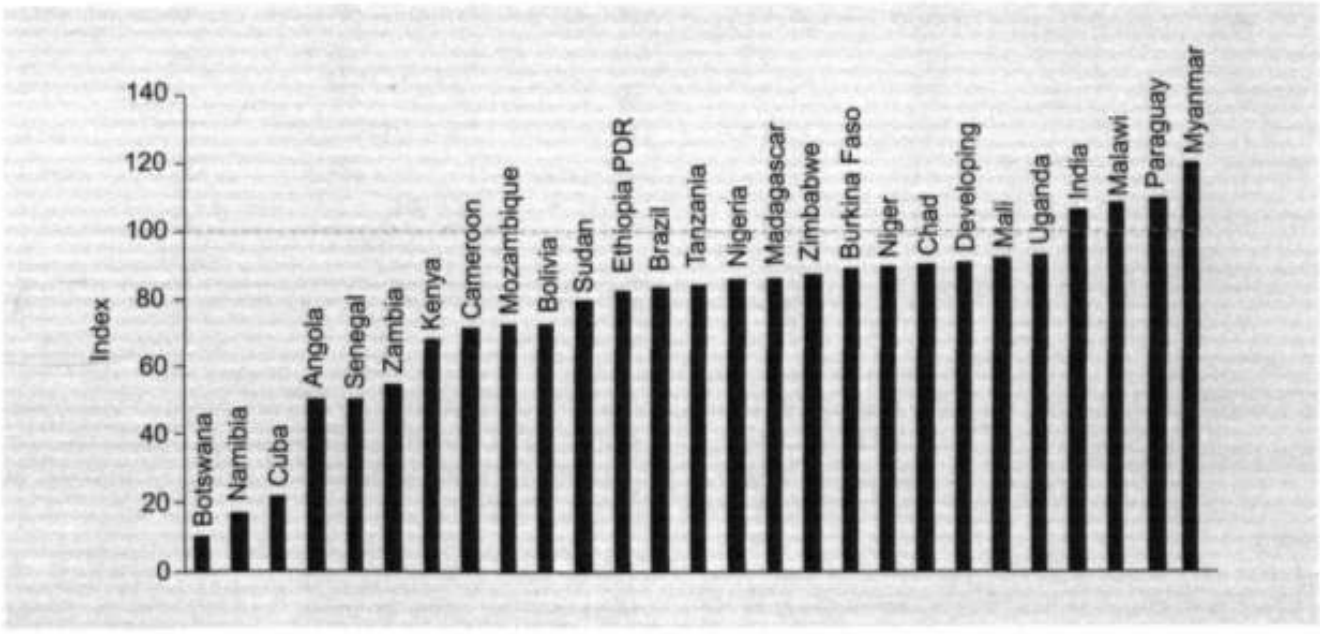

Figure 8: Self Sufficiency Index: cereals, 1999-01.

Table 13. Concentrate feed per LSU in SAT countries (kg/animal/annum).

	Feed grain (Cereals + Pulses)		Brans		Oilcakes		Total feed	
Country	1980-82	1998-00	1980-82	1998-00	1980-82	1998-00	1980-82	1998-00
Ethiopia PDR	5	4	15	19	4	4	24	26
Kenya	14	10	21	28	3	5	38	44
Madagascar	25	9	6	10	2	3	33	21
Sudan	6	4	11	12	12	6	30	22
Tanzania	15	12	10	18	7	8	32	37
Uganda	30	40	18	26	4	7	52	73
Angola	5	5	2	10	6	6	24	21
Botswana	3	2	1	5	1	1	5	9
Malawi	117	287	109	162	19	44	245	493
Mozambique	5	17	71	127	65	87	141	230
Namibia	1	7	7	13	2	2	9	22
Zimbabwe	79	74	41	58	23	32	142	165
Zambia	34	18	51	59	10	21	95	98
Cameroon	6	1	22	26	13	13	41	40
Chad	3	6	15	23	4	14	21	44
Mali	0	0	13	24	9	22	22	46
Niger	22	48	50	107	6	9	78	164
Nigeria	55	114	66	92	16	46	138	252
Senegal	6	6	64	59	2	17	72	83
Burkina Faso	0	0	42	51	3	12	46	62
Myanmar	62	111	108	106	32	61	202	278
India	9	10	39	42	17	38	65	90
Cuba	190	121	25	26	29	45	244	192
Bolivia	42	37	18	20	7	24	67	81
Brazil	117	139	15	14	19	39	151	191
Paraguay	19	37	5	4	11	23	35	64
SAT Total	43	53	29	32	16	33	88	117

Based on FAOSTAT 2003 data

Consumption of Animal-based Food

Milk

The top four milk-consuming countries, Brazil, India, Sudan, and Kenya account for 92% of the milk consumed in the SAT. The share of SSA in total consumption is only 12%.

Per capita milk consumption in SAT is 68 kg/person/annum as against the global average of 89 kg. Sudan, Botswana and Brazil have consumption levels higher than the global average (Figure 9). The consumption levels are above the SAT average in India, Paraguay and Kenya.

The trends in consumption are mixed. Between 1982 and 2000 per capita milk consumption increased by 70% in India, and 40-60% in Brazil and Paraguay. In contrast, per capita consumption in a majority of SSA countries either declined or remained stagnant except for Kenya and Sudan in East Africa where per capita consumption increased (Table 14).

Table 14. Milk[1] consumption in SAT countries.

	Total (000 t)			Per capita (kg/person/annum)		
Country	**1980-82**	**1998-2000**	**Change (%)**	**1980-82**	**1998-2000**	**Change**
Ethiopia PDR	860	1160	35	22	18	-4
Kenya	1050	2390	128	62	81	19
Madagascar	426	518	22	46	34	-12
Sudan	2475	4697	90	124	158	34
Tanzania	466	782	68	24	23	-1
Uganda	358	482	35	28	22	-6
Angola	195	204	5	27	16	-11
Botswana	132	206	56	141	137	-4
Malawi	38	41	8	6	4	-2
Mozambique	68	74	9	6	4	-2
Namibia	65	88	35	64	52	-12
Zimbabwe	407	232	-43	55	19	-36
Zambia	100	68	-32	16	7	-9
Cameroon	114	214	88	13	15	2
Chad	153	208	36	33	28	-5
Mali	412	556	35	59	52	-7
Niger	247	307	24	43	30	-13
Nigeria	757	876	16	11	8	-3
Senegal	139	153	10	24	17	-7
Burkina Faso	106	249	135	15	23	8
Myanmar	546	916	68	16	20	4
India	33148	77368	133	47	79	32
Cuba	1504	659	-56	154	59	-95
Bolivia	218	316	45	40	40	0
Brazil	10107	19327	91	81	116	35
Paraguay	156	403	158	49	77	28
SAT Total	54247	112493	107	47	68	21
SSA	8568	13505	58	32	31	-1
World	418328	526753	26	93	89	-4

1. Quantities in terms of milk equivalent.

Source: FAOSTAT 2003

Total milk consumption however, doubled between 1980 and 2000 in the SAT as a whole mainly due to large increases in Brazil, India, Burkina Faso, Kenya and Sudan. Consumption increased in East Africa and West Africa, while consumption in southern Africa declined in a few countries and marginally increased in others.

Meat

The top four meat consuming countries, Brazil, India, Nigeria and Sudan, account for 78% of total meat consumption in the SAT. The SSA accounts for 22% of total meat consumption in the SAT, a figure higher than that for milk (12%).

Per capita meat consumption in the SAT in 2000 was slightly higher than a third of the global average of 37 kg/capita. Per capita consumption is higher than the global average in NCSA (except Cuba), led by Brazil and Paraguay. The consumption levels in South Asia are less than one-fourth the world average. In SSA, meat consumption *is* one-third to one half the world average with a few exceptions (Figure 10). Consumption levels are high in Botswana, and low in Malawi, Mozambique and Nigeria.

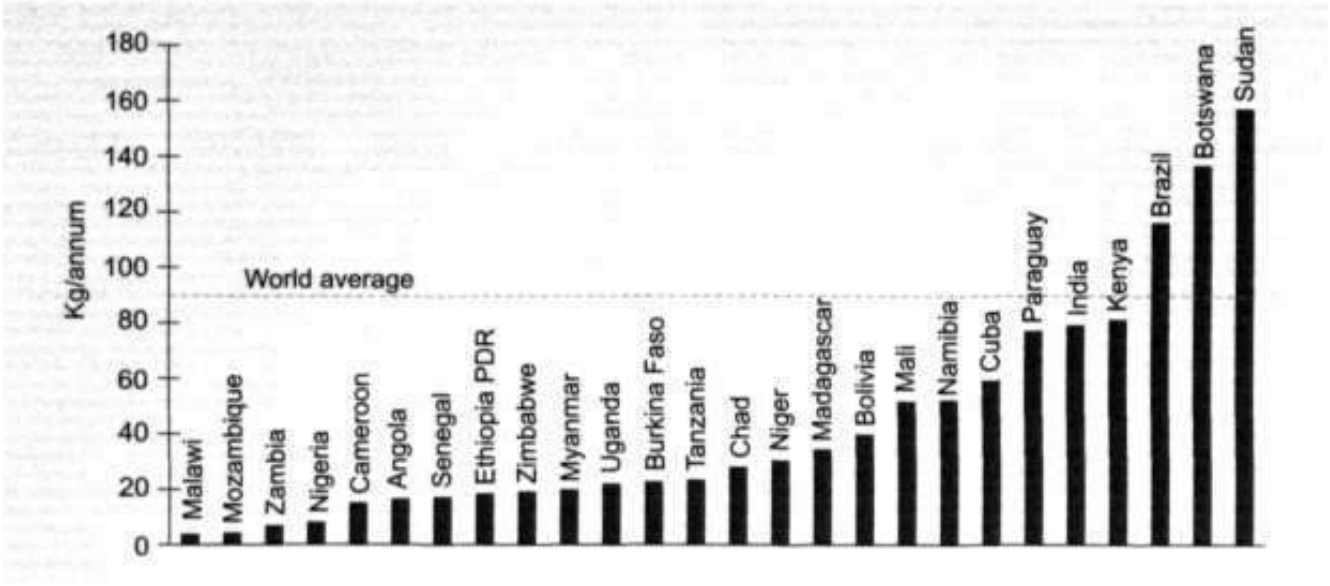

Figure 9. Per capita milk consumption in SAT countries, 1998-2000.

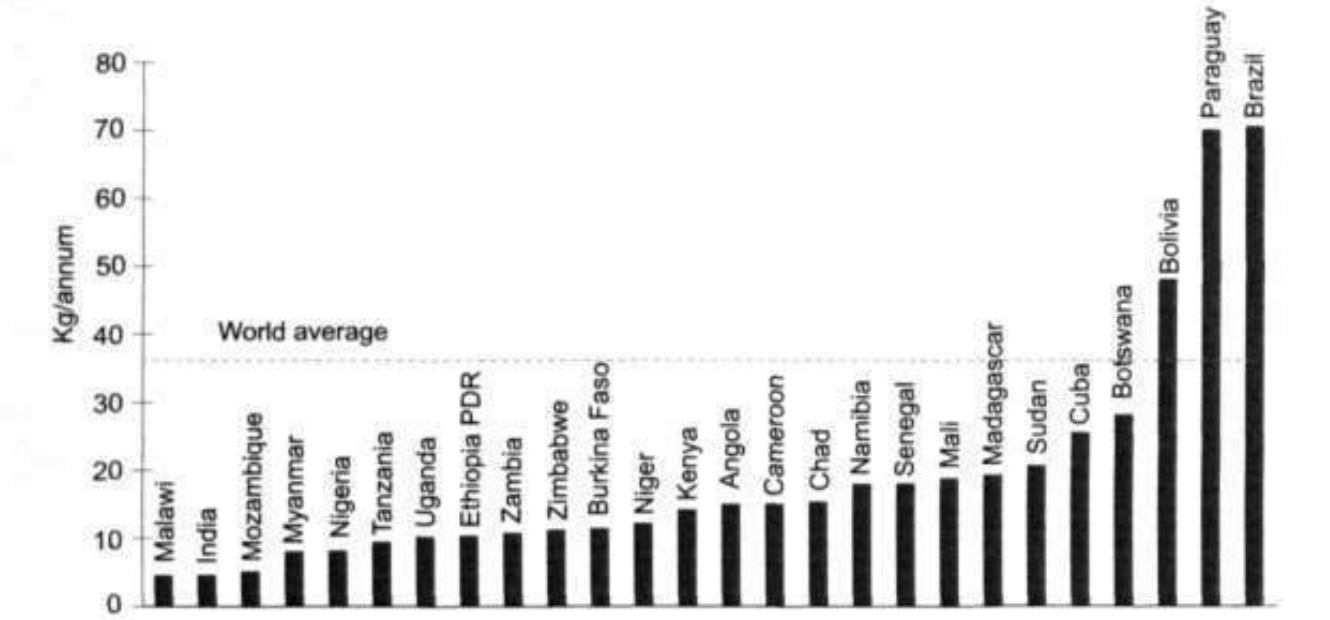

Figure 10. Per capita meat consumption in SAT countries, 1998-2000.

Over the last two decades, per capita meat consumption increased significantly in Brazil and marginally in India. In contrast, per capita consumption declined in many countries in SSA. Significant increase occurred only in Botswana and small increases took place in Senegal and Burkina Faso (Table 15). Thus, as with milk, meat production too did not keep pace with population growth in several SSA countries.

Total meat consumption however, increased everywhere (except Namibia). Its consumption nearly tripled in Botswana and doubled in Brazil, Senegal and Burkina Faso. Other countries where consumption increased significantly include Paraguay, Bolivia, Cameroon, Chad, Tanzania and India.

Ehui and Pender (2003) reported similar findings. They found that while per capita consumption of meat, milk and eggs in developing countries increased substantially between 1975-95, consumption in SSA stagnated or declined. Total consumption however doubled due to population growth.

Table 15. Meat consumption in SAT countries.

	Total (000 t)			Per capita (kg/person/annum)		
Country	**1980-82**	**1998-2000**	**Change (%)**	**1980-82**	**1998-2000**	**Change**
Ethiopia PDR	533	660	24	14	10	-4
Kenya	276	417	51	16	14	-2
Madagascar	209	291	39	22	19	-3
Sudan	444	617	39	22	21	-1
Tanzania	188	316	68	10	9	-1
Uganda	149	226	52	12	10	-2
Angola	115	186	62	16	15	-1
Botswana	15	42	180	16	28	12
Malawi	36	49	36	6	5	-1
Mozambique	70	91	30	6	5	-1
Namibia	37	30	-19	36	18	-18
Zimbabwe	101	137	36	14	11	-3
Zambia	83	108	30	14	11	-3
Cameroon	116	215	85	13	15	2
Chad	63	114	81	14	15	1
Mali	128	203	59	18	19	1
Niger	101	123	22	17	12	-5
Nigeria	753	882	17	11	8	-3
Senegal	72	162	125	13	18	5
Burkina Faso	56	126	125	8	11	3
Myanmar	267	373	40	8	8	0
India	2682	4526	69	4	5	1
Cuba	342	284	-17	35	26	-9
Bolivia	218	382	75	40	48	8
Brazil	4982	11750	136	40	71	31
Paraguay	216	367	70	67	70	3
SAT Total	12550	22675	81	11	14	3
SSA	3545	4994	41	13	12	-1
World	136360	218419	60	30	37	7

Source: FAOSTAT 2003

Calories and protein intake from animal-based foods

Per capita calorie intake in most of the SAT countries is below the world average except in Brazil, Myanmar and Nigeria. Intake of calories is lower by 30-40% in most countries in SSA (Figure 11 and Appendix Table 7). Globally livestock products contribute about 15% of the total calorie intake. The contribution of livestock is higher than the global average in NCSA, Sudan and Botswana.

Per capita protein intake is also lower by 30-40% in most SAT countries compared to the global average (Figure 12). Only in Brazil and Paraguay is the total protein intake closer to the world average. Globally, livestock-based foods contribute 31% to the total protein intake. The intake is significantly higher than the global average in all countries in NCSA and Botswana. The contribution of livestock to protein intake is low in India, Nigeria, Malawi and Mozambique.

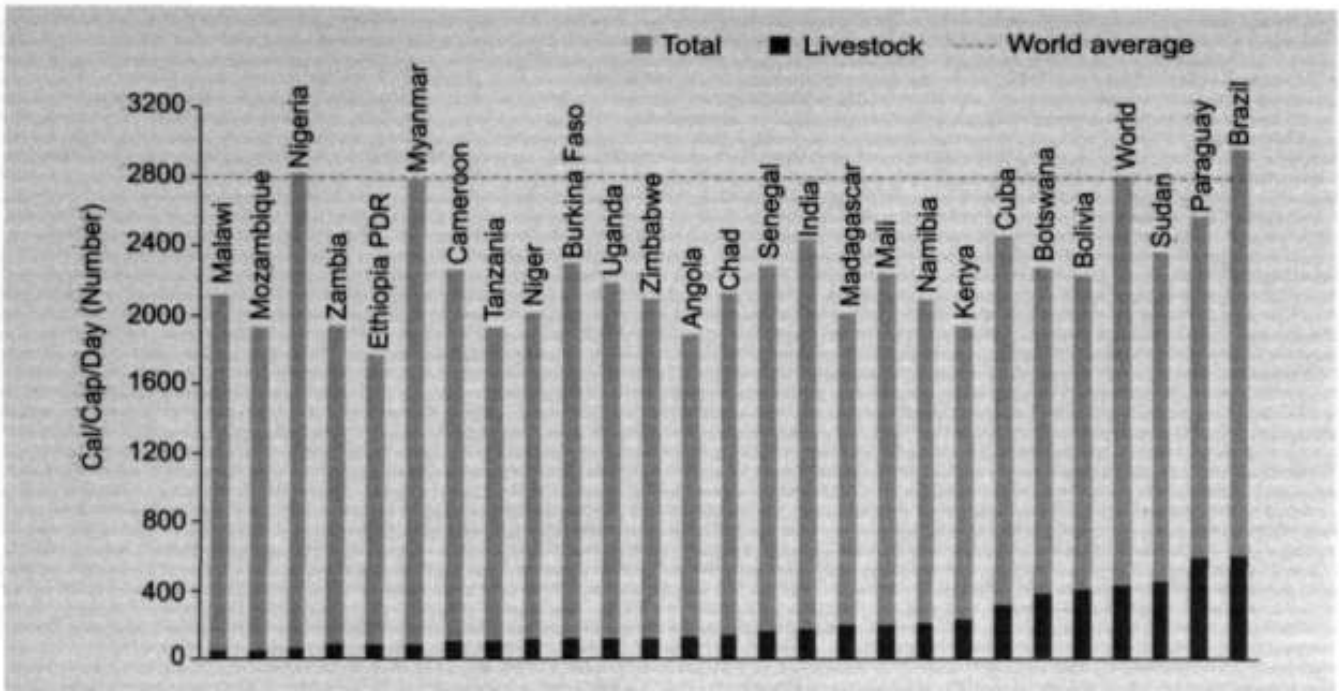

Figure 11. Contribution of livestock products in total calorie intake in SAT countries, 1997-99.

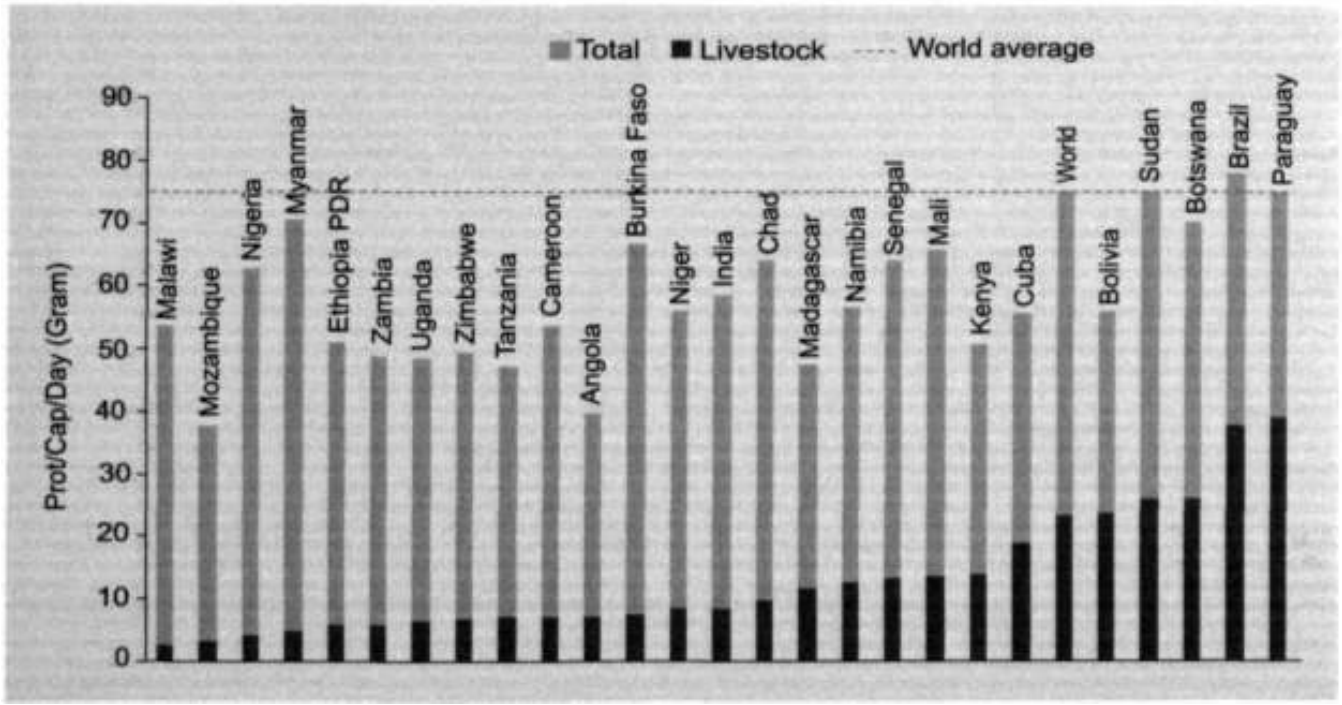

Figure 12. Contribution of livestock products in total protein intake in SAT countries, 1997-99.

Increased intake of animal protein helps brings down incidence of malnutrition (Delgado et al. 1999). Data on malnourished population and per capita consumption of animal protein for the SAT countries indicates a significant and negative relationship between malnourished population and consumption of animal protein (including sea food) (Figure 13).

International Trade in Livestock Products

Live animals and their products account for about one-sixth of global trade in agricultural commodities. Meat and meat products dominate livestock sector

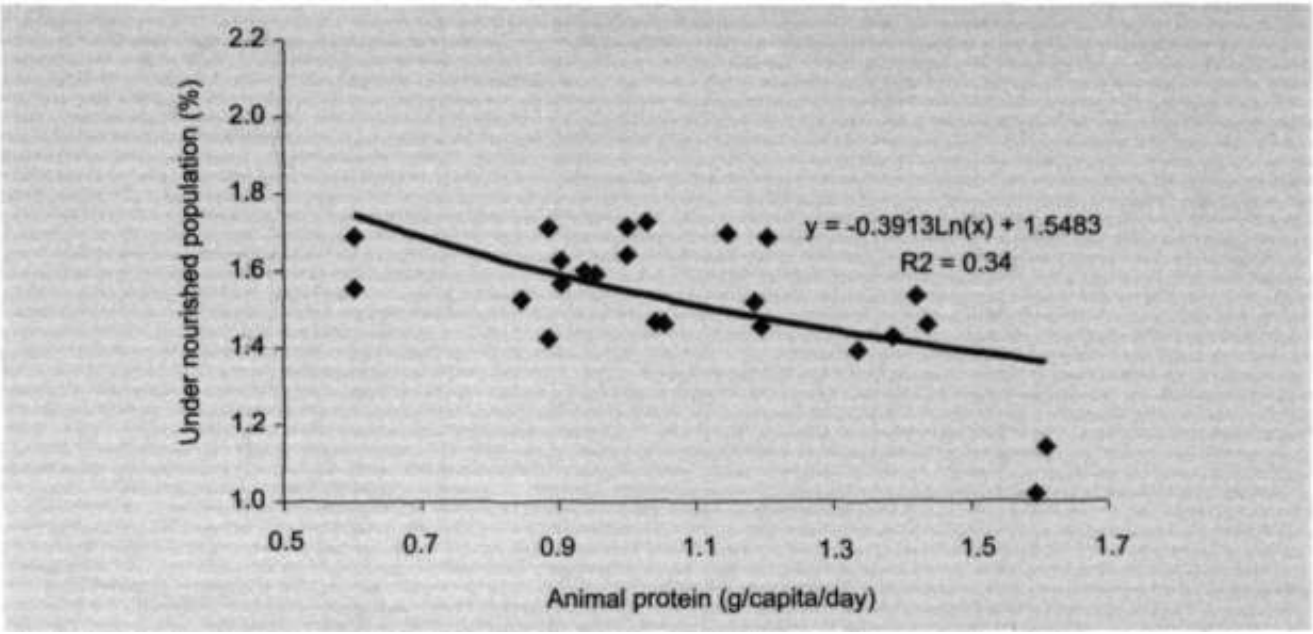

Figure 13. Relationship between animal protein intake and undernourished population, 2000 (log scale).

exports (50%), followed by milk and milk products (33%). Developing countries are net importers of livestock products, and dairy products account for a bigger share (Upton 2001).

Milk

The SAT accounts for less than 0.5% of global milk exports (milk equivalent). Nevertheless, exports have increased 10-fold during the last decade. Amongst SAT countries India, Zimbabwe and Brazil are the main exporters (Table 16).

SAT countries however account for about 5% of global milk imports with a net trade deficit of about 3 million t in TE 2001. Except for India, all SAT countries are net importers of milk. In TE 1982, Nigeria, India, Cuba, Brazil and Angola accounted for bulk of the imports. Over time imports by Brazil increased significantly while imports by India declined significantly. In the SSA imports increased significantly in Botswana and Mali. Staal (2002) observed that countries with a strong dairy tradition tend to import less milk due to preference for liquid milk that is traded in limited quantities. South Asia and East Africa fall in this category. Thus, in traditional milk consuming countries the premium for fresh milk will continue to support local producers.

Trends in the export and import of milk (in value terms) and SAT's share in global imports of milk are shown in Figure 14. There is considerable fluctuation in the share of SAT countries, but the value of imports remained stagnant at $0.8 billion between 1980 and 2000. However, during this period the global milk imports nearly doubled from $13 billion to $26 billion leading to a decline in SAT's share from 6% to 3% in total imports.

At the global level, cheese and dry whole milk (cow) account for the bulk of trade in dairy products. The main imports to SAT countries are dry skimmed and whole milk powder. Brazil accounts for the bulk of cheese exports. In 2000 the per unit value of milk imports to SAT countries was $270/t compared to the global average of $400/t. This implies imports of lower value milk products by SAT countries.

Meat

The SAT accounts for 8% of global meat exports, and between TE 1982 and 2001 exports increased four-fold from 0.55 million t to 1.9 million t. Brazil (82%) and India (12%) account for the bulk of exports.

The SAT accounts for about 1% of global imports down from 2% in early 1980s. The major importing countries are Brazil, Cuba and Angola. Thus, the SAT had a net trade surplus of 1.7 million t in 2000 compared to 0.36 million t in early 1980s. Brazil and India account for the bulk of this surplus. Sudan,

Table 16. Milk[1] exports and imports in SAT countries (000 t).

	Exports		Imports		Net	
Country/ Region	**1980-82**	**1999-01**	**1980-82**	**1999-01**	**1980-82**	**1999-01**
Ethiopia PDR	0.0	0.7	0.0	21.1	0.0	-20.5
Kenya	4.6	2.7	70.9	18.6	-66.3	-15.9
Madagascar	0.0	0.1	20.4	14.1	-20.4	-14.0
Sudan	0.0	0.0	57.1	33.2	-57.1	-33.2
Tanzania	0.3	1.5	41.2	20.9	-40.9	-19.4
Uganda	0.0	0.7	30.8	2.4	-30.8	-1.8
Angola	0.0	0.0	156.2	19.9	-156.2	-19.9
Botswana	0.3	0.6	26.4	133.3	-26.0	-132.7
Malawi	0.0	0.0	20.1	9.5	-20.1	-9.5
Mozambique	0.0	0.0	32.5	34.8	-32.5	-34.8
Namibia	0.0	3.2	0.0	27.7	0.0	-24.6
Zimbabwe	0.8	38.6	16.8	10.5	-16.1	28.1
Zambia	0.0	1.9	25.5	11.6	-25.5	-9.7
Cameroon	0.4	3.3	37.9	52.4	-37.5	-49.1
Chad	0.0	0.0	4.8	3.8	-4.8	-3.8
Mali	0.0	0.0	15.3	72.6	-15.3	-72.6
Niger	0.0	2.1	16.6	32.8	-16.6	-30.7
Nigeria	0.0	0.3	737.3	559.1	-737.3	-558.8
Senegal	2.8	5.8	99.4	123.7	-96.5	-117.9
Burkina Faso	0.0	1.5	73.0	42.5	-73.0	-41.0
Myanmar	0.0	0.0	32.7	116.3	-32.7	-116.3
India	2.9	139.3	517.0	104.8	-514.1	34.5
Cubs	0.1	0.0	479.4	328.8	-479.3	-328.8
Bolivia	0.0	15.1	.69.3	60.0	-69.3	-44.9
Brazil	16.5	27.9	221.0	1418.9	-204.6	-1391.0
Paraguay	0.0	1.5	6.5	29.9	-6.5	-28.3
SAT Total	28.7	246.7	2808.1	3303.3	-2779.4	-3056.6

1. Quantities in terms of milk equivalent.

Source: FAOSTAT 2003

Botswana, Namibia and Zimbabwe also have small surpluses (Table 17).

Trends in the value of exports and imports of meat for the SAT as a whole are shown in Figure 15. Exports have risen sharply from 1990 onwards, as has SAT's share in world meat exports. While the value of global meat exports doubled between 1980 and 2000 (from $21 billion to 44 billion), it increased three-fold for SAT countries from $0.9 billion to 2.7 billion. Bovine meat (33%), pig meat (31%) and poultry meat (22%) account for the bulk of trade at the global level. For SAT countries, bovine and poultry meat constitute the bulk of exports (90%), while imports include a large share of pig meat. Buffalo meat constitutes 90% of meat exports from India. The per unit value of meat exports from the SAT was $ 1280/t compared to world average of $1750/t.

Feed ingredients

Trade in coarse grains plays an important role in meeting feed requirements in several countries. In TE 2000, about 7.4 million t of sorghum and 82 million t of maize were traded globally (Table 18). Much of the trade however, takes place between developed countries and SAT's share is low.

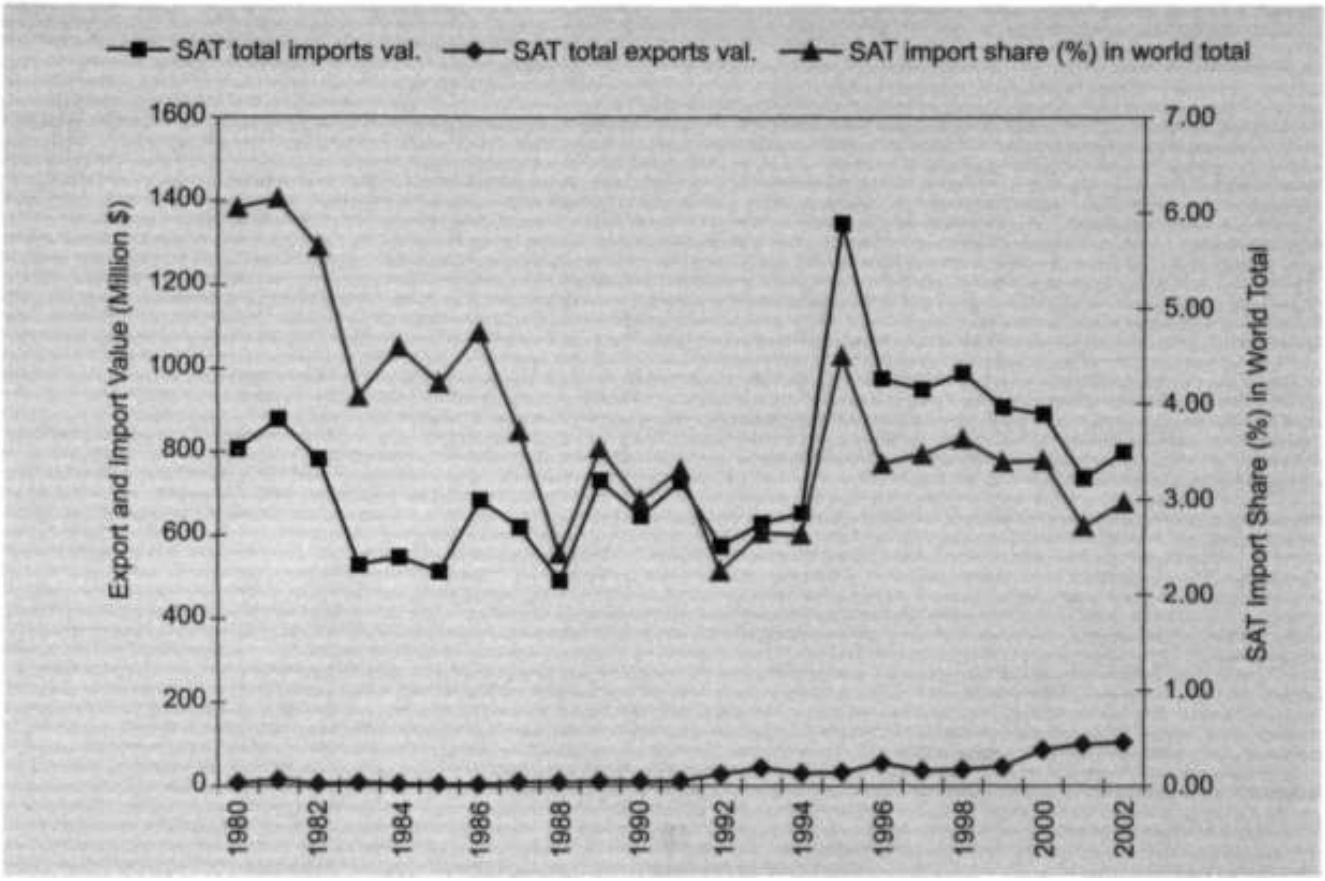

Figure 14. Export and import value of milk and milk equivalents, 1980-2002.

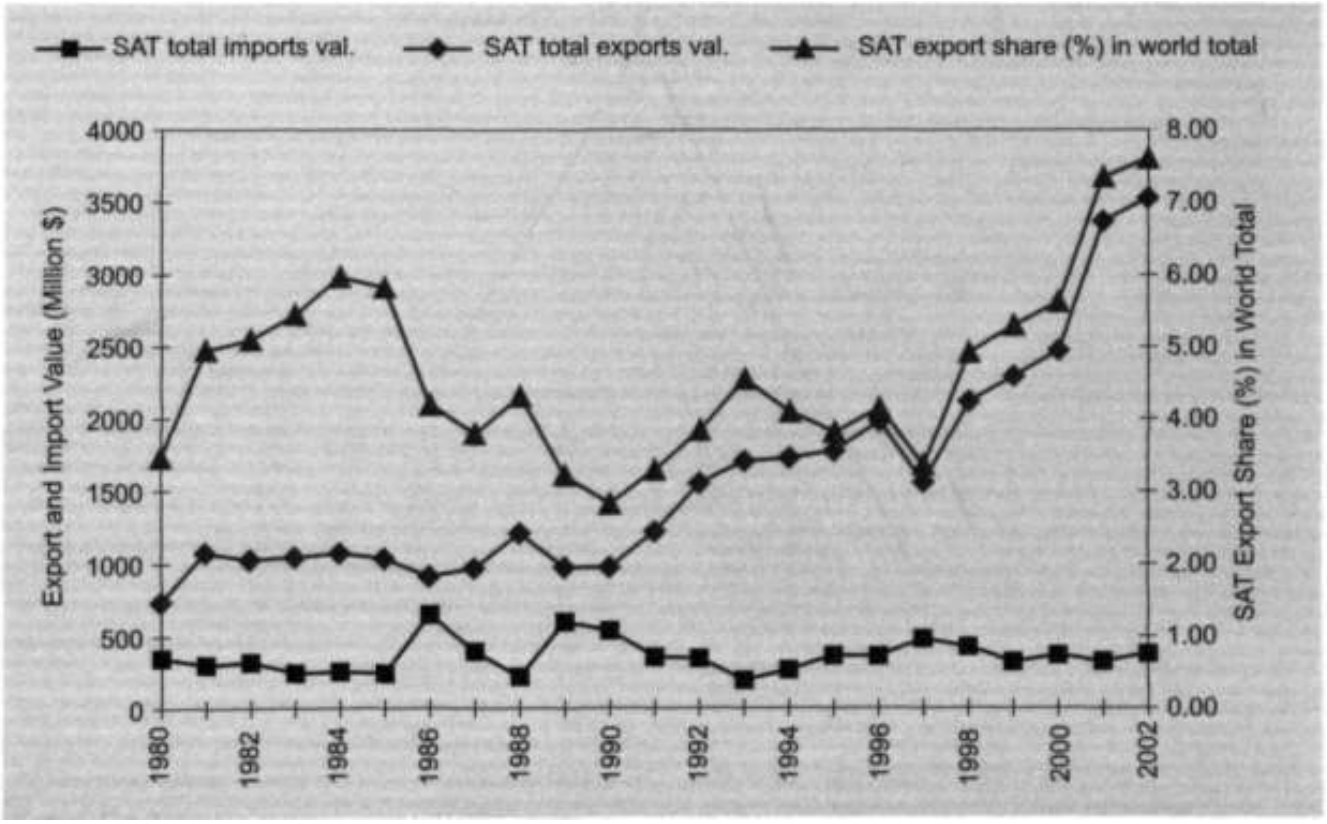

Figure 15. Export and import value of meat, 1980-2002.

Table 17. Meat exports and imports in SAT countries (000 t).

	Exports		Imports		Net	
Country/ Region	1980-82	1999-2001	1980-82	1999-2001	1980-82	1999-2001
Ethiopia PDR	0.0	1.1	0.0	0.1	0.0	1.0
Kenya	2.1	0.9	0.0	0.3	2.0	0.6
Madagascar	3.6	0.0	0.1	0.2	3.6	-0.1
Sudan	0.0	10.0	0.1	0.3	0.0	9.7
Tanzania	0.1	0.6	0.1	0.7	0.0	-0.1
Uganda	0.0	0.0	0.2	0.1	-0.2	-0.1
Angola	0.0	0.0	28.5	61.4	-28.5	-61.4
Botswana	27.2	17.4	1.2	3.1	25.9	14.3
Malawi	0.0	0.0	0.1	0.3	-0.1	-0.3
Mozambique	0.1	0.0	2.0	3.9	-1.9	-3.9
Namibia	16.8	25.1	0.0	19.3	16.8	5.9
Zimbabwe	8.9	11.1	1.9	0.5	7.0	10.6
Zambia	0.0	0.1	0.0	0.3	0.0	-0.2
Cameroon	0.0	0.0	1.9	12.4	-1.9	-12.4
Chad	0.0	0.3	0.1	0.1	-0.1	0.2
Mali	0.1	0.0	0.2	0.2	-0.1	-0.2
Niger	0.0	0.1	0.5	0.1	-0.5	0.0
Nigeria	0.0	0.0	40.8	1.8	-40.8	-1.8
Senegal	0.3	0.3	0.5	3.9	-0.2	-3.6
Burkina Faso	0.6	0.0	0.2	0.1	0.4	-0.1
Myanmar	0.0	0.0	0.0	0.1	0.0	-0.1
India	57.5	243.4	0.0	0.1	57.5	243.3
Cuba	0.3	0.0	61.9	67.3	-61.6	-67.3
Bolivia	0.1	0.8	0.1	1.8	0.0	-1.0
Brazil	437.2	1612.0	52.8	61.1	384.5	1550.8
Paraguay	0.8	38.2	0.2	1.6	0.6	36.6
SAT Total	555.8	1961.4	193.4	241.2	362.3	1720.2
Share of SAT in World (%)	5.6	8.1	2.0	1.1	_	_

Source: FAOSTAT 2003

The SAT accounts for 2% of global sorghum imports as well as exports. For maize, the SAT is a net importer of about 3 million t (4% of global trade). NCSA accounts for 50% of these imports, followed by southern and East Africa (Botswana and Kenya are the main importers). World trade in millets is only 0.25 million t, and SAT countries account for 15% of imports as also exports. Most of the imported millets in SAT countries are used for food, while in many developed countries millets are an important feed for birds/poultry.

The relative prices of feed grains and meat and milk products determine the volume of feed grain trade. The ratio of maize price to livestock product prices fluctuates considerably but was higher in the early 1990s and is coming down since then (Figure 16). Delgado et al. (1998) predict livestock product prices to rise faster relative to price of staple grains since the income elasticity of demand for livestock products is high compared to cereals. Despite this FAO (2000) has predicted a slower growth in cereals for use as feed mainly because of increasing substitution by oil cakes and meals.

About 50 million t of oilcakes was traded globally mainly for feed. Unlike grains the SAT accounted for about 28% of global oilcake exports in 2000. SAT countries in NCSA account for two-thirds of the exports, with India sharing the rest.

Table 18. Imports and exports of selected crops and oilcakes in SAT regions: 1998-00 (000 t).

	Bran		Sorghum		Maize		Millet		Total Oilcakes	
Region	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports
East Africa	3(0)	14(0)	92(1)	125(2)	508(1)	58(0.1)	1 (0.3)	13 (5)	16(0)	81(0)
Southern Africa	20(1)	22(0)	49 (1)	4 (0)	840(1)	235(0.3)	0(0.1)	0(0)	19(0)	46(0)
West Africa	20(1)	97(1)	10(0)	3(0)	137(0)	16(0.0)	31(12)	17(7)	23(0)	300(1)
South Asia	14(0)	9(0)	0 (0)	0 (0)	116(0)	111(0.1)	0 (0.0)	8 (3)	32(0)	2821(5)
NCSA	12 (0)	27 (0)	15(0)	' 0(0)	1472(2)	228(0.3)	6 (2)	0 (0)	133(0)	11148(22)
SAT Total	70(2)	169(2)	166(2)	132(2)	3073(4)	647(1)	38(15)	37(15)	223(0)	14396(28)
World	4092	7922	7788	7359	79706	81663	255	246	49773	51301

Figures in parentheses show % to world.

Source: FAOSTAT 2003

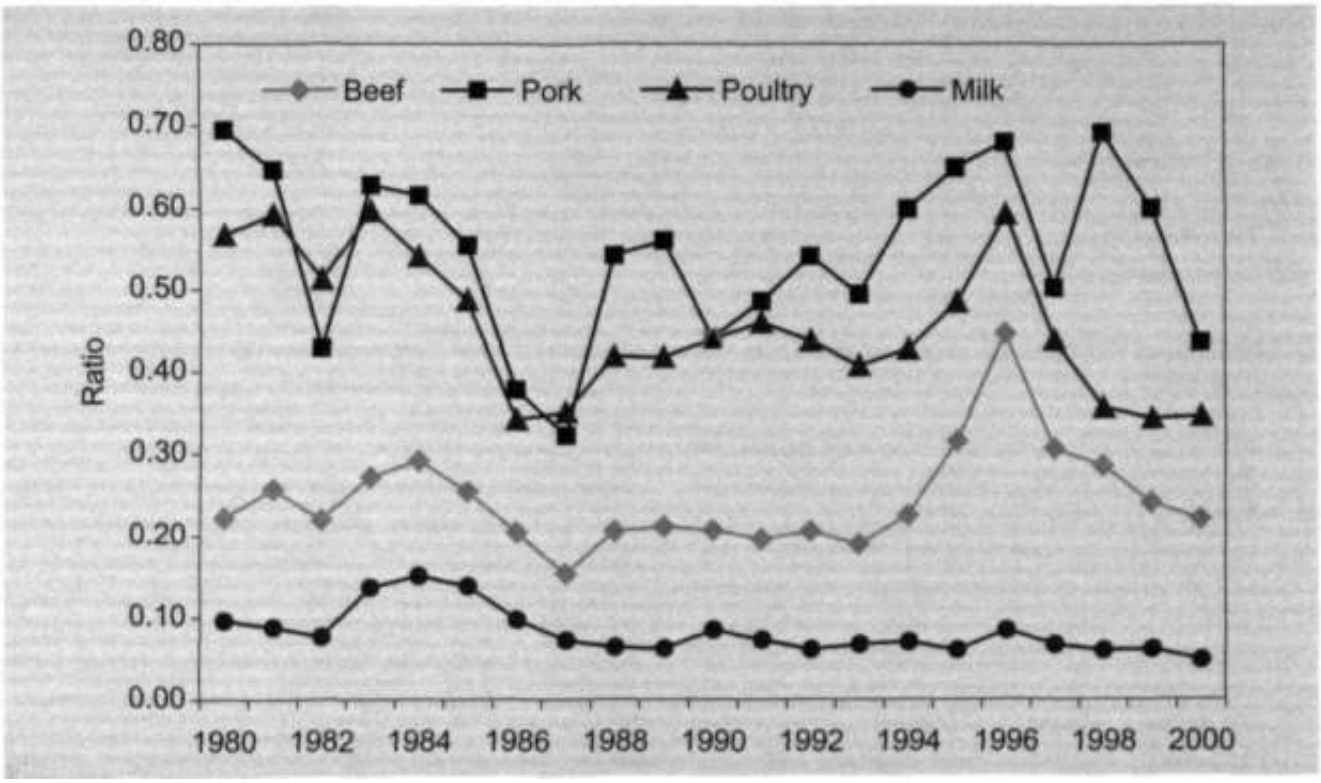

Figure 16. Ratio of maize to livestock product prices (Constant 1990 USD).

International prices

World prices of agricultural commodities are more volatile than domestic prices (Ramesh Chand 2002). Currently, the prices are at their historic low and the much-anticipated increase in world market prices due to reduction of support as per the Agreement on Agriculture (AOA) under the World Trade Organization did not materialize except in the initial years of implementation.

Between 1980 and 2000, real prices (1990 constant prices) of maize, beef and pork declined by 4% a year, and poultry meat prices by 2% a year. Only for milk (whole milk dry) was the overall decline in price less although the prices were more volatile with large year-to-year fluctuations (Figures 17 and 18). The decline in prices is attributed to agricultural policies and technological innovations in developed countries (Williams et al. 2004).

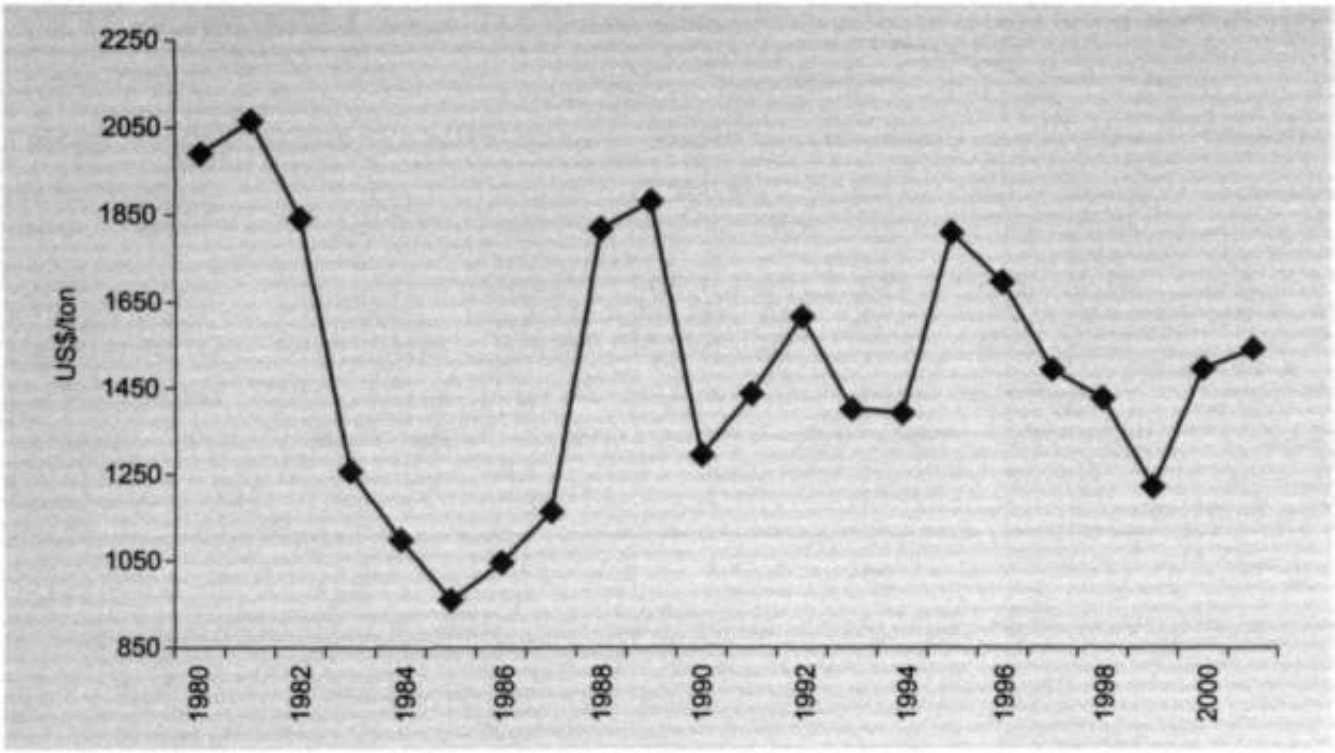

Figure 17. Trends in real prices of whole milk powder (Constant 1990 USD).

Milk: $/ton, whole milk powder, fob Western Europe. After 1994, midpoint of prices reported by NZ Dairy Board. Normal prices in USD are deflated by the US Consumer Price Index. Source: FAO Commodity Review and Outlook 1982-1991, FAO Commodity Market Review 1995-2000
Adapted from Delgado et al. 2003

Distortions in global trade and the role of WTO

Liberalization of international trade is an important element in the larger phenomenon known as globalization. Globalization in the livestock sector is manifested in increasing flows of livestock and livestock products as well as capital, exchange of information, technologies, increasing standards and change in sectoral structure towards concentration and integration (FAO 2005). In this section we address issues related to distortions in global livestock trade, and trade liberalization under the World Trade Organization (WTO).

Livestock trade is heavily distorted mainly due to subsidized production of livestock products in EU and USA that are exported at below true costs onto the world markets (Sharma et al. 1996; Williams et al. 1995, 2004). Additionally, trade barriers, restrictive trade policies and stringent health and sanitary standards also deny many producers in developing countries access to higher priced markets.

To deal with the global rules of trade and establish a fair and market oriented agricultural trading system, the WTO was created on 1 January 1995 as a successor to GATT. Among the various agreements under WTO, of direct relevance to the crop-livestock sector are the Agreement on Agriculture (AOA), and the Agreement on Application of sanitary and phytosanitary (SPS) measures among several others. Three basic pillars make up the AOA: market access (tariffication), domestic support, and export subsidies. All SAT countries (with the exception of two) are members of WTO and thereby are bound by WTO Riles under AOA and would be directly impacted by implementation of AOA commitments by other major trading partners or member countries. The current status of the implementation under AOA with particular relevance to the crop-livestock sector is briefly highlighted below.

Market access/tariffication

To improve market access, non-tariff barriers (quotas, licences, import levies etc), were converted to tariff equivalents as stipulated under AOA followed by a progressive decline in tariffs over time. Despite this, tariff escalation defined as high tariffs on processed products and tariff peaks, (ie, tariff rates greater than 15%) remain a problem for agriculture and livestock products. Many countries belonging to the Organisation for Economic Cooperation and

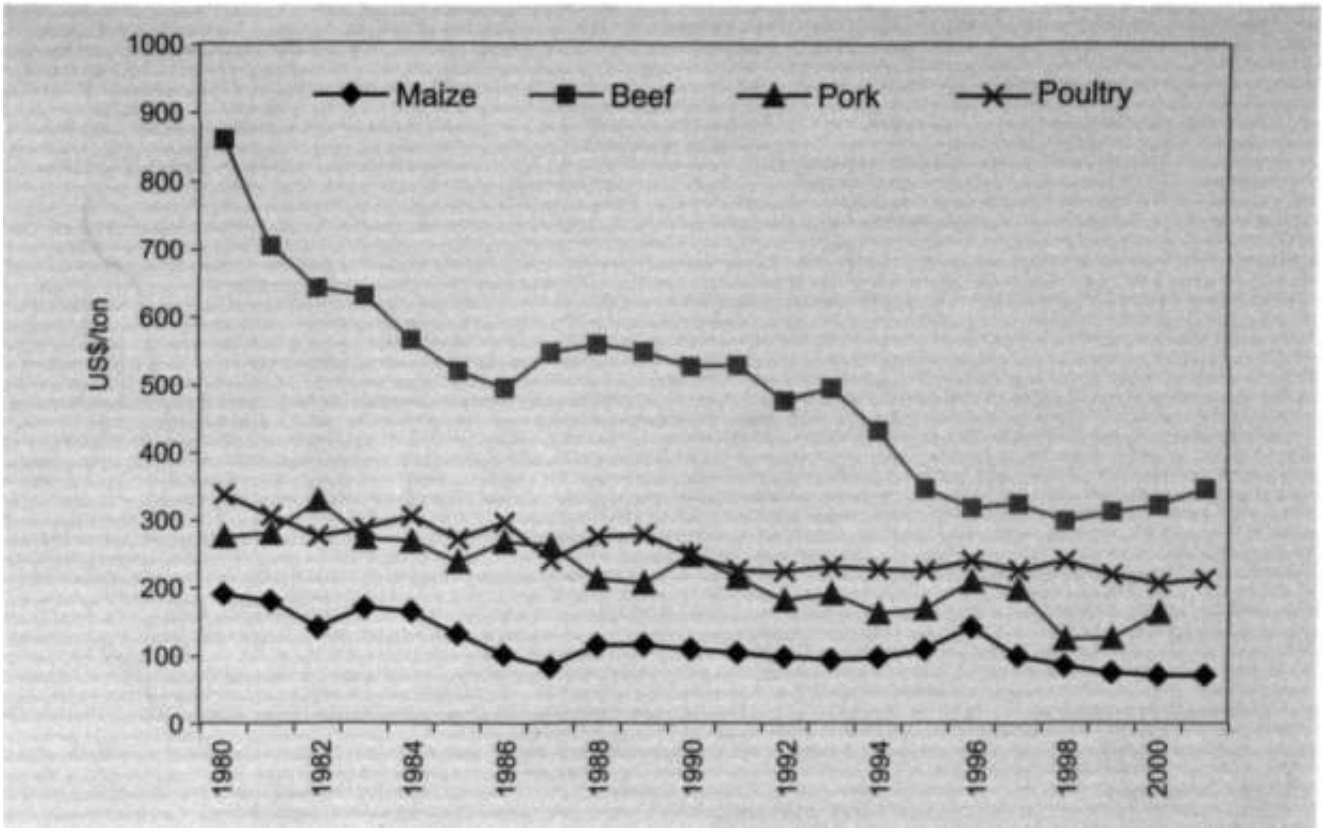

Figure 18. Trends in real prices of livestock feed and products (Constant 1990 US$).

Maize: $/ton, US #2 yellow, fob Gulf of Mexico. Source: IMF (http://www.imf.org/external/np/res/commod/index.asp)
Beef: $/ton, Australia/New Zealand frozen, US import price. Source: IMF, same as above.
Pork: $/ton, USDA 5-market average hog prices. Source: http://www.cattle-fax.com/data/files/hogs/b11.xls
Poultry: $/ton, USDA Avg. 12-City Broiler Price, Broiler Composite and Georgia Dock Price. Source: http://www.fattle-fBx.com/data/fiJes/poultry/priccs.xls
Adapted from Delgado et al. 2003

Development (OECD) have retained very high tariffs on agricultural products such as beef, wheat, sugar and milk ranging from 50% to 300%, denying market access to developing countries. Secondly, these countries opted for Tariff Rate Quotas (TRQ), which are meant to provide market access at a lower tariff to the extent of the quota. A significant share of world trade for a number of agricultural commodities falls under TRQs. Developed countries account for about 1350 TRQs, which include fruits and vegetables, cereals, dairy products, sugar, coffee and tea. However, lack of transparency in the implementation of TRQs, allocation of quotas to traditional suppliers ensured that market access under TRQs did not benefit imports from developing countries, or imports from countries outside a particular free trade block. Finally, higher tariffs on semi-processed and finished products are forcing developing countries out of the market for processed products whose share in agricultural trade is increasing (Bonilla and Reca 2000).

Domestic support and export subsidies

Agriculture has generally been characterized by high levels of governmental support in many developed countries. These were subject to reduction commitments under the AOA. However, taking advantage of several clauses in the AOA, domestic support continues to be high in several developed countries[8]. Support levels range from as high as 60% (in many developed countries) to negative (or below the de minimis level, ie, the minimum permissible level specified by WTO). Most SAT countries fall into the last category.

8. 'Ib meet WTO requirements, many developed countries reduced subsidies under the 'Amber Box', (product and non-product subsidies) which are subject to reduction commitment above the de minimis levels. However, support under the 'Green Box' policies have increased and most of these increases were concentrated in three countries - the United States, EU and Japan. These include shifting from price distorting subsidies to direct payments under the guise of decoupled incomes, loan rate guarantees in USA that permits refund of interest on fanners' loans when prices fall below a certain level, financing the eradication of cattle in EU due to outbreak of mad cow and foot and mouth disease etc.

Support to agriculture (crop and livestock) from OECD countries was $257 billion in 2003, and the average Producer Support Equivalent (PSE) to the agricultural sector was 32% (Table 19). Among OECD countries, the support was highest in EU (37%). Commodity specific PSEs for livestock products are high for milk (49%), followed by mutton, beef, pig and poultry meat. OECD countries are major exporters of dairy and meat products, and the high level of protection to these commodities has a large distortionary effect on world trade (Gulati and Narayanan 2003).

A similar story unfolds with respect to Export Subsidies. Twenty five developed countries resort to export subsidies and the European Union accounts for 88 percent of the total subsidies, followed by EFTA (European Free Trade Association) countries and the USA (Gulati and Narayanan 2003). Commodity wise dairy products (butter and butter oil, cheese and skim milk powder) beef and veal, sugar and coarse grains receive more than 50% of the total export subsidies (Figure 19). Exports of these subsidized products significantly depress world market prices for livestock products (Sharma et al. 1996, Williams et al. 1995, 2004).

Table 19. Support to agriculture and producer support equivalents for livestock products in OECD countries, 2003.

Commodity	US	EU	OECD
	Support to agriculture (US$ million)		
Total agriculture	38878	96549	257285
Livestock			
Milk	10992	17943	47396
Beef	1197	20389	33598
Pig meat	367	4736	11032
Poultry meat	677	3093	6632
Mutton	46	3820	5122
Eggs	166	105	1132
	Producer support equivalent (%)		
Total agriculture	18	37	32
Livestock			
Milk	45	51	49
Beef	3	77	35
Pig meat	4	24	21
Poultry meat	4	37	17
Mutton	12	58	42
Eggs	3	2	5

US - United States of America
EU - European Union
OECD - Organization for Economic Co-operation and 1 Vvelopment
Source: OECD.org

Many countries in SSA and India have opted for bound tariff rates" for crop and livestock products under AOA and since these rates are higher than the current applied rates there is no reduction commitment. The lower applied rates enable these countries to raise tariff rates under threat of cheap imports. Domestic support in SAT countries is below the de minimis level and they do not subsidize exports. A majority of SAT countries in SSA (12 out of 20) joined the WTO under the least developed country category and arc entitled to special privileges that protect them to some extent from distortions in the global market. For example, preferential access rates for crop and livestock products from QUAD (Canada, EU, Japan and USA) countries (Williams et al. 2004).

Regional trade blocks in recent years are increasingly becoming important with several concessions given to members in the group. Although such blocks are not compatible with the true sprit of multilateral trade agreement under WTO, the issue is not being raised for now. EU, EFTA, NAFTA, ASEAN and APEC are some examples. Several concessions are offered to members within the group at the expense of non-members.

If AOA commitments are truthfully implemented it should lead to capping and curtailing of support to agriculture in countries with high support levels. This should lead to contraction of production in those countries and expansion of production where the support levels are lower or negative. This in turn should lead to an increase in world market prices for primary commodities including livestock products (Diao et al. 2001).

Sanitary and phytosanitary measures

The agreement on SPS aims at ensuring safe food for human consumption. The safety is sought at three levels: human, plant and animal, by fixing certain hygienic standards of imported commodities. Uniform International standards are based on codex OIE, IIPC etc. However, many developed countries (and some developing countries) have been using SPS

9. Bound tariff rates are the rates negotiated with WTO prior to joining the organization. The bound tariffs represent the upper bound on the level of protection.

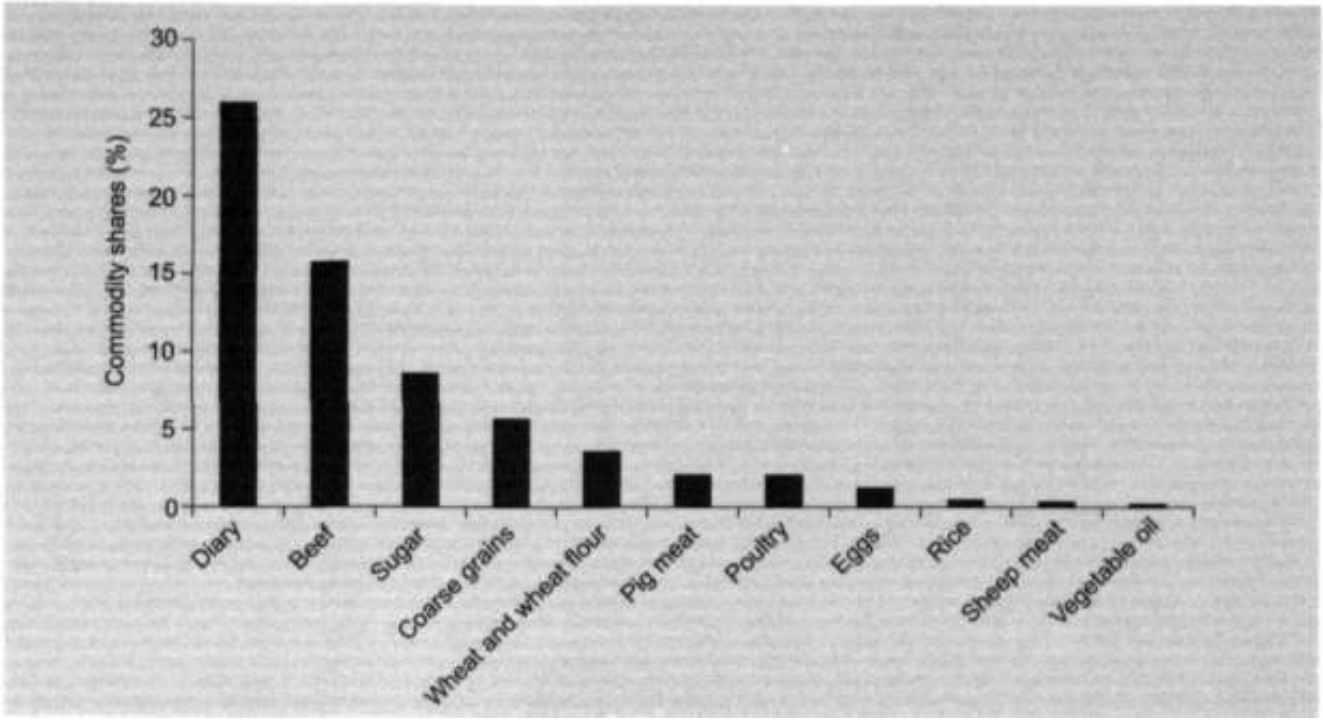

Figure 19. Commodity shares in total export subsidies: 1995-99.

Source: Gulati and Narayanan (2003)

as non-tariff barriers by arbitrarily raising standards on ground of health and environmental issues. Food safety hazards and their importance vary by product and form. Exports of fresh products such as meat, seafood, vegetables and fruits account for nearly half the total value of agricultural exports from less developed countries. Food safety issues are more stringent in fresh food trade than other agricultural trade (Unnevehr 2000). Microbial contamination, drug residues, parasites and zoonotic diseases are the major hazards for meat, poultry, fish and seafood products.

Management of food safety hazards is becoming increasingly common in several developed countries. The hazard analysis critical control point (HACCP) system is a subset of more general quality management systems to address food safety hazards at different points in the food chain (Unnevehr and Jenson 1999).

Thus non-tariff barriers still exist in the form of requirement and regulation related to animal health and food safety and perhaps animal welfare and environmental factors in the future. Developing countries (including SAT countries) do not have the necessary knowhow/technical expertise and capital to meet food safety standards. OECD (2000) has observed that the costs of meeting different standards and regulations could amount to 2 to 10% of total production cost. Thus, these countries need to negotiate for more transparency in SPS measures and extended periods for implementation. Secondly, they must opt to receive technical and financial assistance from developed countries as stipulated under the SPS agreement of WTO, to build and improve their own systems of safety and testing.

Projected Demand for Livestock Products

The demand for livestock products will be driven by population growth, urbanization and income growth[10]. The positive association between per

10. To predict future demand, projections of population and income growth (weighted by income elasticity of demand) have been used according to the following equations:

Dt = Do (1 +d) t

and d = p+ i * n

where, Dt is consumption/demand of livestock products at future tume t, Do is consumption at 1998-00 level, d is the compound growth rate, p is the population growth rate, i is the income growth rate and n is the income elasticity of demand. Income elasticity of demand was calculated using time series data from 1980 to 2000, on per capita income and per capita consumption of livestock products.

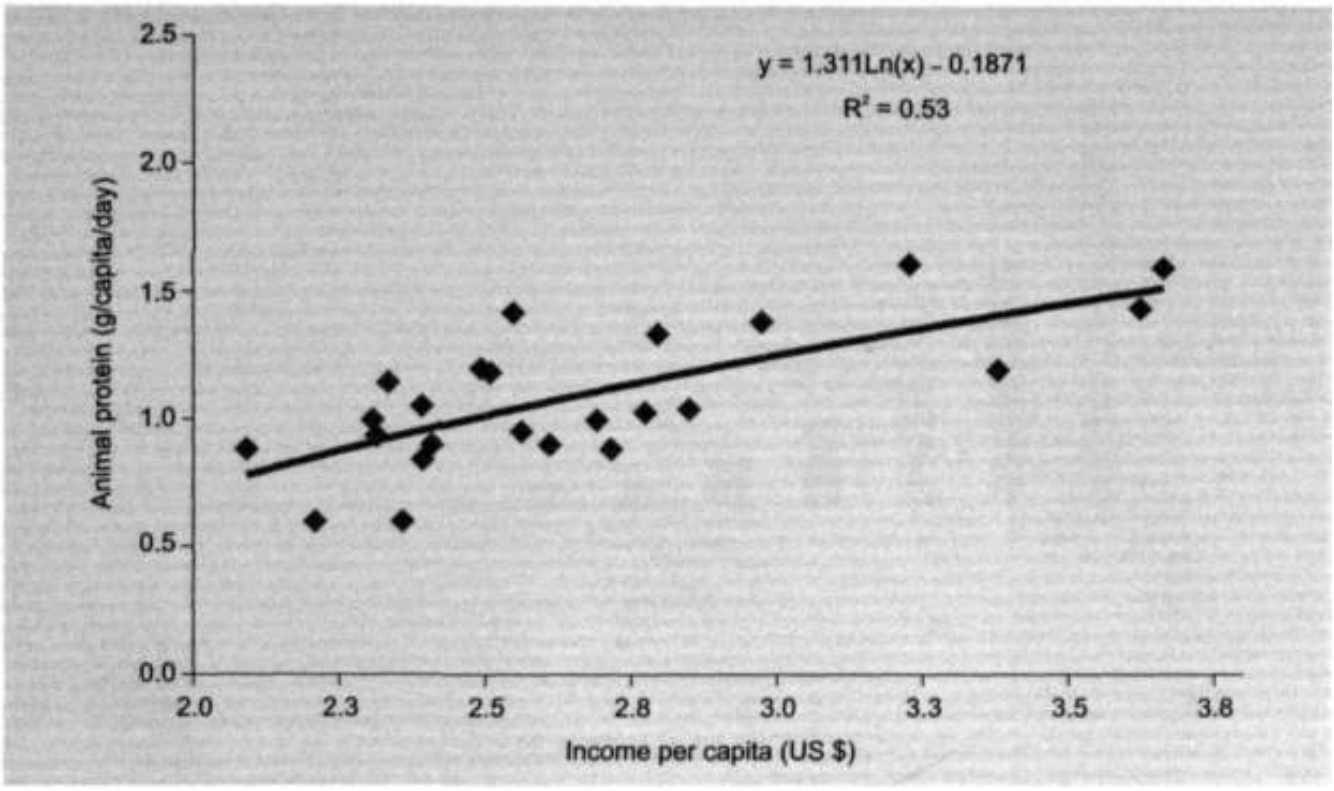

Figure 20. Relationship between animal protein intake and income per capita, 2000 (log scale).

capita income and animal protein consumption in Figure 20 suggests that demand for animal foods would increase with sustained rise in per capita income in SAT countries. Similarly, urbanization will be a key driver of growth in demand for animal food. For example, in India there has been a marked increase in demand for poultry meat due to urbanization, leading to a significant increase in production (Figure 21). Data on income growth and population growth for SAT countries is given in Appendix Table 8.

Milk

By 2020 demand for milk is projected to double in the SAT, from 112 million t to 210 million t (Table 20). The increase is expected to be faster in Sudan, Uganda, Chad, Mali Burkina Faso and India. In these countries both sustained rise in per capita income and population would drive the growth. The increase in demand would not be as high in other countries in SSA and NCSA due to slower growth in income.

Despite large increases in total demand, per capita consumption would decline or remain stagnant in SSA except in Sudan and Burkina Faso where it is expected to increase. The decline in per capita consumption however would be relatively less than that in the recent past. Per capita consumption is set to increase significantly in India and Brazil.

If the current production trends continue, many countries in SSA will not be able to meet the demand through domestic production. These countries will continue to rely on imports. In contrast, India and countries in NCSA will adequately meet the demand growth from domestic supplies.

Meat

Demand for meat is projected to increase from 22.6 million t in 2000 to 44 million t by 2020. Increases will be faster in Sudan, Uganda, Botswana, Chad, Mali, Burkina Faso, India and Brazil. Demand for meat will grow faster in Botswana mainly due to faster growth in per capita income and higher demand elasticity. In Brazil high-income elasticity for meat (particularly for poultry meat) is driving rapid growth in demand. Projected demand for different meats is given in Appendix Table 9. Demand for poultry meat is expected to grow faster than other meats. Similar trends are observed in other developing countries outside SAT (Delgado et al. 1999). In some countries in SSA, however, the growth in demand for ruminant meat would be higher than for poultry meat.

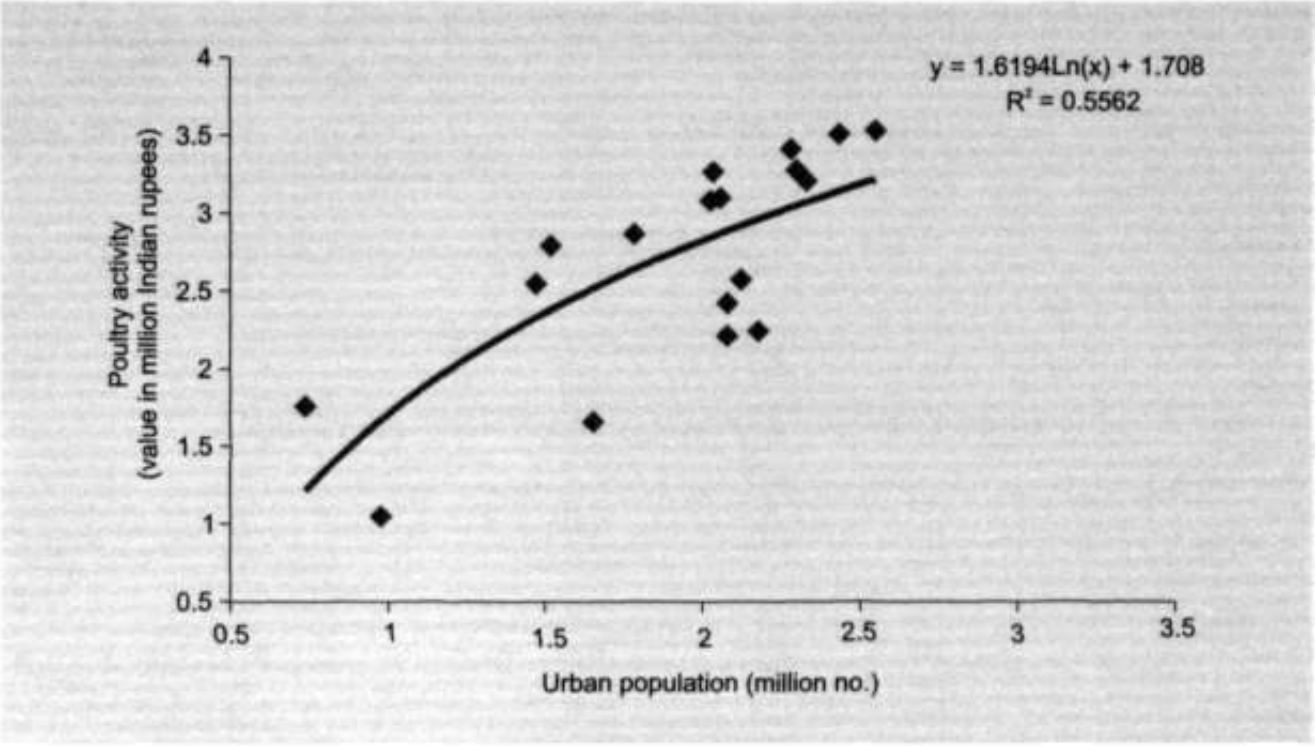

Figure 21. Relationship between poultry activity and urban population, India: 1998, zone level (log scale).

In SSA, significant increases in per capita meat consumption are expected in Namibia, Botswana, and Burkina Faso only. In the remaining countries consumption is likely to remain stagnant or increase only marginally. Similar conclusions were drawn by FAO (2000) for SSA wherein no significant increases in per capita consumption were observed over the last three decades. Elsewhere per capita consumption is likely to increase marginally in India, and significantly in Brazil.

About half of the SAT will be able to meet demand growth if recent production trends are sustained. Countries in NCSA may end up with some surpluses for export. For poultry meat, if past production trends continue, almost all countries will be self-sufficient.

Ruminant vs non-ruminant meats

During the last few decades globally the demand for non-ruminant meat (pig and poultry) has been increasing faster and the share of non-ruminant meat in total meat consumption increased from 58% in TE 1982 to 67% in TE 1999. This rapid growth in poultry meat production was due to both demand and supply side factors. Rapid technological progress occurred in genetic enhancement and animal health, spearheaded by the private sector. Large-scale operators began reaping significant economies of scale (Narrod and Pray 2001). Decline in per unit costs of production led to a decline in real prices of poultry products that stimulated demand. This was further fuelled by a change in tastes and preferences towards lean meats.

In many SAT countries the share of poultry meat in total consumption increased but the phenomenon was less widespread (Figure 22). In much of East and West Africa non-ruminant meat accounts for only 21 % in total meat consumption although their share increased marginally between TE 1982 and 1999. In contrast, in southern Africa, these meats account for 38% of total meat consumption and their share is projected to further increase by 2020. Similarly, substantial increases in the consumption of non-ruminant meat are expected in South Asia and NCSA.

Slower growth in per capita income, preference for ruminant meat, non-consumption of pig meat due to religious factors will ensure that meat of ruminants will continue to dominate in many countries of SSA. For instance in West Africa small ruminant meat accounts for 25% of consumption compared to the SAT average of 8%. In East Africa, large ruminant meat accounts for the bulk of consumption (except

Table 20. Demand for milk, meat and eggs in 2020 and percent change over 1998-2000.

	Milk	Meat	Eggs	Milk	Meat	Eggs
Country/ Region	**Demand in 2020[1] (000 t)**			**% Change over 1998-2000**		
Ethiopia PDR	1740	1058	106	62	60	59
Kenya	3192	585	52	45	40	38
Madagascar	882	460	22	73	58	65
Sudan	8670	1183	60	90	92	67
Tanzania	1209	500	83	63	58	63
Uganda	958	569	26	106	152	84
Angola	308	315	9	54	69	127
Botswana	201	115	6	2	172	166
Malawi	S3	84	30	52	70	68
Mozambique	101	140	17	41	54	47
Namibia	118	47	2	44	45	42
Zimbabwe	320	190	20	36	39	40
Zambia	89	142	57	40	32	51
Cameroon	341	325	14	61	51	35
Chad	365	240	6	81	111	77
Mali	997	364	13	86	80	73
Niger	490	186	10	63	51	59
Nigeria	1504	1422	541	67	61	62
Senegal	229	264	41	52	63	60
Burkina Faso	698	343	24	191	172	116
Myanmar	_[2]	-	-	_	-	-
India	155682	9556	3668	111	111	158
Cuba	-	-	-	-	-	-
Bolivia	488	606	81	56	58	41
Brazil	31021	24791	1673	63	111	43
Paraguay	728	586	65	63	60	55
SAT Total	210397	44070	6625	97	100	95

1. Data for the year 2020 based on projections. See footnote 10.
2. Not estimated.

Based on FAOSTAT 2003 data

Sudan). Additionally, in many countries of East and West Africa consumption of other minor meats (zebra, giraffe, camel etc) is relatively higher compared to average consumption globally and even within the SAT. For example, other meats account for only 3% of total consumption for all SAT, while it is more than 10% in several countries in SSA. The projected demand for these meats is also growing.

Meeting Challenges to Remain Competitive

There are a number of challenges facing the livestock sector in the SAT particularly under an era of trade liberalization and the larger phenomenon of globalization. These include: domestic reforms in markets, institutions and policies to remain competitive and at the same time to protect the interests of small producers; stricter regulations on animal health and improved veterinary services; meeting quality standards and food safety requirements of livestock products both for national and international consumers; and finally raising crop and livestock productivity through appropriate targeting of technology to reduce per unit costs of production.

Markets, institutions and policies

In both Asia and Africa net trade surpluses in commodities such as coffee, cocoa, fruits and

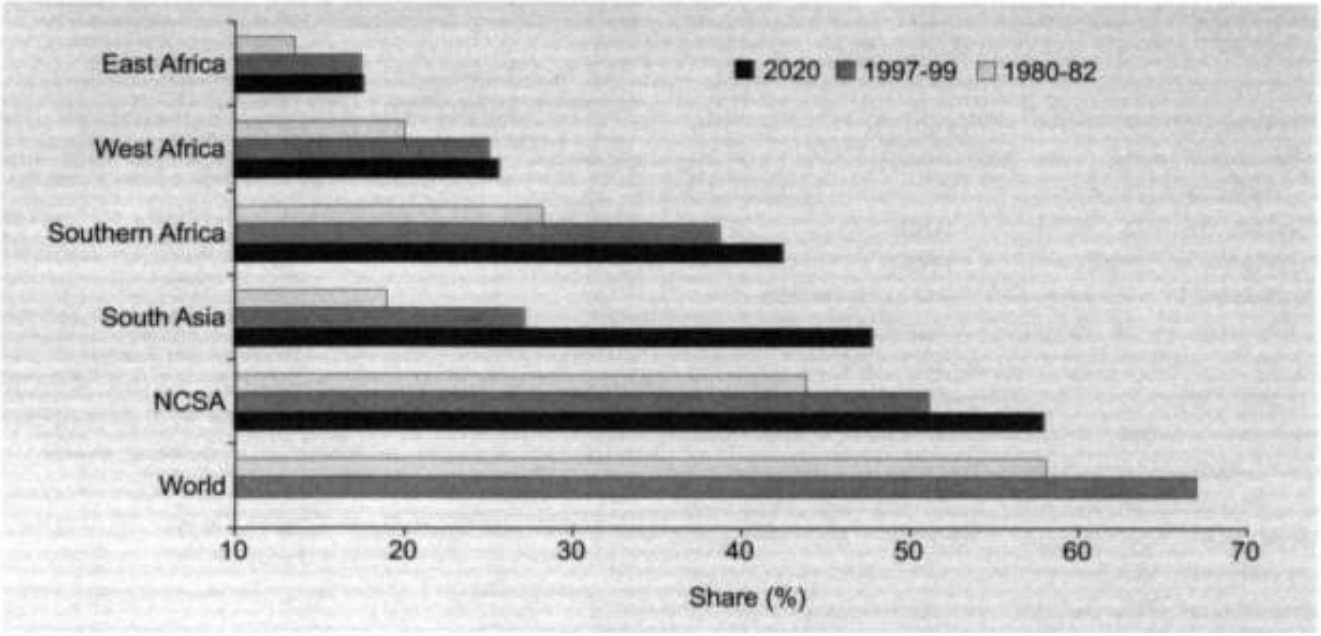

Figure 22. Share of non-ruminant meat to total meat consumption, SAT regions and World.

vegetables do not compensate for trade deficits in cereals, meat, dairy and other products. Developed countries dominate the world trade in these commodities (Bonilla and Reca 2000). Considering the importance of these sectors in developing economies (including SAT countries) trade distortions would stifle their growth, and prove detrimental to millions of producers whose livelihood depends on those sectors. Also, in a globalized market smallholder producers and small traders have limited scope and ability to insure themselves against risk or market failure that could occur due to reasons beyond their control.

Evidence indicates that agricultural production in developing countries will increase if trade distortions are reduced (Anderson and Strutt 1996; Sharma et al. 1996). Upton (2001) found that reduction in price support in Europe and USA should lead to increase in dairy exports from Oceania, South Asia and southern Africa. Beef and lamb exports may expand from Oceania and South America.

Notwithstanding trade distortions under the liberalized environment, domestic reforms can help improve competitiveness in the crop and livestock sectors. On the trade front, reforms should enable diversification to value added products for niche markets particularly in the face of secular decline in prices of primary products (Williams et al. 2004). Some examples of domestic reforms in selected SAT countries are briefly highlighted below.

In India, the dairy sector was delicensed in 1991, and more recently, the restrictions on new milk processing capacity were removed. This has helped the private sector enter the dairy industry in a big way. Reforms in the cooperative sector aimed at depoliticizing these institutions and making them more accountable to the members. The concept of producer companies was floated recently on an experimental basis to overcome the shortcomings of the cooperative system.

In Kenya, reforms in the dairy sector were aimed at reducing government support for the sector. The measures included: full cost recovery for veterinary drugs, transfer of management of cattle dips to community groups, privatization of artificial insemination services and liberalization of the dairy sector (Omiti 2002). However, the pace of reforms has been slow since the private sector and community groups needed time to take over responsibilities.

In WCA the correction in the overvalued exchange rate in 1994 restored the competitiveness of Sahelien exports of beef to coastal countries". The devaluation coincided with a favorable policy environment for Sahelian exporters, characterized by streamlining of export procedures, the reduction of export subsidies on European beef and the

11. Prior to the devaluation of the CFA, the livestock sub-sector in Sahelian countries (Burkina Faso, Mali, Niger) faced strong competition from international meat exports. This was primarily from heavily subsidized meat from EU in its traditional export market on the coast (Benin, Ghana. Nigeria, Togo etc).

establishment of compensatory import taxes to offset EU subsidies by coastal country governments (Yade et al. 1999). The competitiveness of Sahelian exports is however, still adversely affected by high export marketing costs, particularly transport cost.

Although the above reforms are aimed at improving competitiveness of the livestock sector they could have adverse effects on the domestic economy if not supported by adequate safety nets, particularly under a distorted world trading environment. For example in India, with the opening up of the dairy industry coupled with low import tariffs, imports of milk powder increased substantially between 1995 and 2000. India however, bounced back by renegotiating the bound tariff rates on milk and milk products thus halting the adverse affects of cheap imports on domestic producers. Sharma (2002) found that the Indian dairy industry is highly competitive if developed countries remove their export subsidies in line with current WTO rules.

The growth of the poultry sector in India is marked by an increase in the size of the poultry farms, since small-scale producers were unable to compete with large producers who have access to state-of-the-art technology and are able to withstand risks in production due diseases and fluctuating prices. To overcome these problems, vertical coordination between poultry industry and small-scale producers is considered a viable option, under which the industry supplies the latest technology and feed to the small-scale producers and bears the risk associated with price fluctuations (Birthal et al. 2002, Delgado et al. 2003). Mehta et al. (2002) found that the main factors for the inefficiencies on small farms relate to lack of information, marketing, transportation and storage facilities that lead to high transaction costs. Delgado et al. (2003) found that in a few selected Asian countries, vertical integration through contract farming, dairy cooperatives and other such institutional arrangements has the potential to reduce transaction costs. This would ensure the competitiveness of smallholders. Improvements in vertical coordination would also help improve quality of the output at the primary level of production.

Similarly in Brazil, two important technological changes in dairy marketing and processing led to the displacement of many small and medium size dairy producers by large producers as suppliers to the agribusiness firms (Delgado et al. 2003). Delgado et al. (2003) conclude that the smallholder livestock producer is least likely to survive in Brazil, at least as an independent producer.

Improving animal health

Animal diseases are a major constraint to increasing livestock productivity and thereby production and farm incomes, since it restricts market opportunities for the producers. Under trade liberalization, outbreaks of transboundry diseases and new diseases such as avian influenza can disrupt regional and national trade with adverse consequences for the small producers (FAO 2005). In sub-Saharan Africa, Trypanosomiasis (sleeping sickness) is an important disease (Mohammed Saleem 1995). However, with the control of the Tsetse fly (that transmits this disease), large areas are now free from Trypanosomiasis. Others major diseases affecting livestock include: New Castle disease, Gumbaro, fowl pox (poultry), African swine fever, pneumonia (porcine) FMD, CBPP, Anthrax (bovine) and PPR, Anthrax (ovine). As production systems intensify other infectious and non-infectious diseases are bound to emerge. The economic loss of diseases is manifold both at the household and national level. Government budgetary limitations, public sector domination of veterinary services and inputs and poor management are the main factors hindering effective delivery of livestock services (de Haan 1995, Blench et al. 2003). In this context the role of the private sector, in partnership with the public sector, is seen as a possible solution (Holden 1999, Mcdermott et al. 2004).

In South Asia, common diseases include rinderpest, foot and mouth diseases, haemorrhagic septicimia and black quarter. India has successfully eradicated rinderpest. Nevertheless, other diseases still prevail and cause huge losses to production. Preliminary estimates from an ongoing study in India show that over 20 percent of the attainable output is lost due to diseases (Birthal et al. 2005). The infrastructure for disease control has expanded, but the main limitations are inadequate focus on preventive measures, lack of medicines, and equipment in the clinics, and ignorance among the farmers about diseases and their preventive measures.

The public sector dominates veterinary services in most SAT countries. Currently much of the debate is centered on the public and private sector partnership in delivery services. It is agreed that there are a few services that come under the domain of public sector (quarantine, food inspection and quality control). The private sector can play an important role in clinical animal health care, animal breeding and credit. For others, the public sector

would take the major responsibility, sub-contracting a few responsibilities to the private sector (for instance vaccination campaigns). Demand studies in India revealed that even the poor are willing to pay for quality veterinary services (Ahuja et al. 2000).

Investing in animal science research

Domestic producers would gain from reforms only if they are able to produce more efficiently. Besides, international prices, exchange rate fluctuations (which are not under the control of domestic-producers), the competitiveness of the livestock sector would hinge on cost of domestic production, efficiency of processing plants, and meeting quality standards of the products. Reduction in per unit costs of production and processing through adoption of improved technology is the best option to remain competitive.

An important reason for stagnation or slow growth in animal productivity in the SAT, particularly in SSA countries, is the low rate of adoption of improved technologies. Much of the growth in production was achieved through increase in animal numbers. Number-driven growth cannot be sustained for long considering the pressure on feed resources and environmental degradation. Future growth in production will have to come from productivity increases via technological change. Animal science research has generated a number of technologies in the areas of breeding, nutrition and health that can improve efficiency of livestock production (see Box Pay offs from investment in livestock research). Yet, their adoption remains low. The reasons for low adoption are: lack of client orientation in research especially for small-scale production; a blanket approach to technology transfer that ignores the variations in the farming systems and land, labor and capital constraints that prevent farmers from adopting promising technologies.

Artificial insemination (AI) had a major impact on cattle, sheep, pig, goat and poultry production in the developed countries. However, a similar impact is lacking in most developing countries. The technology has not been widely adopted except in the poultry sector. For instance, in India, only 7.5% of the cattle population are crossbreeds, it is 5% for sheeps and 15% for pigs (Birthal 2002). Further, the success rate is also reported to be low (20%). Similarly in Kenya and Ethiopia, farmers are aware of dairy technologies but adoption is constrained by non-availability of capital and socioeconomic constraints (Oluoch and Ogutu 1998; Ade Freeman et al. 1998). The availability of credit might help in overcoming the liquidity constraint for use of improved technology, provided credit is used not only to increase herd size of improved cattle (capital expenses) but also to manage them better through better feeding etc (operational expenses).

Technologies are also available to improve feed quality. These include urea molasses mineral blocks

Pay offs from investment in livestock research

Despite livestock's potential to alleviate problems of poverty and food insecurity, it has not received adequate attention in research and development efforts. In the majority of semi-arid countries, animal productivity is low. Nevertheless, there is considerable scope to raise animal productivity through research and development interventions. Genetic enhancement technologies such as crossbreeding generate substantial economic benefits. In Kenya, the adoption of crossbreeding in cattle was found to increase milk production, reduce milk prices and unit cost of production and reduce milk imports (Karugia et al. 2001).

Animal health remains a gray area for research and development intervention. In Africa, the Trypanosomosis disease causes annual losses to producers and consumers worth $1.3 billion without including productivity losses of reduced manure production and traction (Kristjanson et al. 1999). Returns to investment in vaccine research are substantial. On the assumption of an adoption ceiling of 30 percent within 12 years, and 30 percent probability of research success, the internal rate of return is estimated to be 33 percent and the benefit: cost ratio 34:1.

Research on improving the quality of feed too yields considerable benefits. George (1998) estimated an internal rate of return of 13 percent and benefit : cost ratio of 2.15:1 for urea molasses block and bypass protein feed for Indian livestock.

(UMMB), urea treated fodder, bypass protein and mineral supplements. Their adoption, however, is not widespread. Other technologies that improve nutrition from feedstuffs and improve productivity include enzymes, feed additives and recombinant somtotropin.

Diseases are a major factor in reducing animal productivity. Improvements in diagnostic technology and its application can significantly contribute to reduction in losses due to diseases. Lack of awareness among farmers and non-availability of veterinary services within reachable distance are other factors constraining their adoption.

Conclusions

During the last two decades, there has been a rapid increase in the consumption of animal-based food in all SAT countries. The forces underlying the demand growth have been quite robust and are unlikely to subside in the near future. Demand for milk, meat and eggs in the SAT are expected to double by 2020. The drivers of growth however vary by region. Urbanization and income growth are likely to drive demand increases in India and NCSA, while rapid increase in population in many SSA countries will be the main driver. Growth in demand was accompanied by an increase in per capita consumption (with the exception of several countries in SSA); however, per capita consumption of milk and meat in a majority of SAT countries is significantly lower than the world average.

The growing demand for livestock products in the SAT was accompanied by an increase in domestic production, but the growth in production was largely driven by an increase in animal numbers rather than productivity. Only in India, did productivity improvements contribute significantly to milk production growth.

Further, livestock productivity in SAT countries remains abysmally low. Only in NCSA are cattle milk yields close to the global average; the figure is less than one-fourth the global average in SSA. Cattle meat yields are half to two-thirds the global average, while small ruminant meat yields are closer to the global average.

Rising demand for animal-based foods is likely to have several implications for livestock production systems (structure, production, productivity, intensification), environment, markets, institutions and trade policy and ultimately for livestock producers.

Currently, we are thus witnessing a dualistic mode of livestock development, ie, a fast growing commercial sector close to the demand centers/ peri-urban areas. Apart from dairy, the commercial sector is also dominated by the poultry sector, relying on imported technology and feed grains. These systems are fairly intensive and purchased inputs such as concentrate feed are common. At the same time, traditional semi-subsistence systems that rely mainly on feed and fodder available on-farm or grazing resources continue to be the lifeline of many small and poor livestock keepers. Here too, due to population pressure and the emergence of market economies the systems are evolving into mixed crop-livestock systems and moving from semi-subsistence production to market-oriented production. In the commercial sector, the non-food functions of livestock (draught, transport, asset etc) are on the decline. However, the multi-purpose functions of livestock will remain important particularly in the SAT countries of SSA and South Asia, where livestock development is a win-win strategy contributing to higher agricultural productivity, improved soil fertility and higher incomes.

Major changes are expected in meat production. Monogastrics, mainly poultry, will occupy a place of prominence. South Asia and NCSA countries are already witnessing this phenomenon. Even in SSA, poultry production has started showing signs of industrialization.

The growing demand for livestock products would lead to an increase in the derived demand for livestock feeds. As grazing systems evolve into mixed crop-livestock systems, the demand for crop residues for animal feed will increase in South Asia and sub-Saharan Africa. As systems intensify, the derived demand for agro-industrial by products (brans, oil meals and grains) would increase in all the regions. Cultivated fodder crops play a less important role in the drier areas of SSA and South Asia.

The rising demand for animal-based food is of course one of the causal factors for such a transformation. Other factors would be the intensification of crop production in SSA, declining land holding size and shrinking common grazing lands in South Asia, the quest for increasing exports from South Asia and NCSA, and domestic reforms to meet the challenges of trade liberalization.

The livestock sector is under pressure to adjust to the forces of trade liberalization and globalization. With challenges such as distortions in the world trading environment and stiff SPS standards, the competitiveness of domestic dairy and meat

production in SAT countries is under threat. The European Union and United States provide a high level of protection to the livestock producers through tariffs, production support and export subsidies. Reduction in protection to the livestock sector is likely to benefit livestock producers in SAT countries (perhaps at the cost of consumers) and needs further investigation.

In a majority of SAT countries, access to markets is a major constraint to the growth of the livestock sector. Producers operate on a small-scale with small marketed surpluses. While markets in rural areas are thin, sale in distant urban markets is costly due to high transportation costs. Improvements in infrastructure like roads, and economic reforms emphasizing private sector investment in food processing and institutional innovationsthatlinkproduction-processing-marketing (cooperatives, producers' associations and contract farming) would not only help improve production and productivity but also ensure the survival of small and marginal producers. Small-scale production partnered with large-scale processing would ensure the competitiveness of domestic producers.

Structural adjustments such as correction in overvalued exchange rates, and domestic reforms in marketing, processing, and public-private sector partnerships in service delivery has to some extent restored the competitiveness of the livestock sector. However, progress has generally been slow.

Nevertheless, a majority of SAT countries have increased their presence in world trade of livestock products. The SAT is a net exporter of meat, led by Brazil and India. Sudan, Botswana, Namibia and Zimbabwe are main exporters amongst SSA countries. India is emerging as an exporter of milk products and Kenya and Zimbabwe have the potential to enter the export market for milk products.

Poverty is high in all SAT countries of SSA and South Asia. For a majority of the rural poor, livestock rearing is an important means of livelihood. However, low and stagnant productivity of the livestock sector in SAT countries is a matter of concern as the number-driven growth observed in the past will come under pressure due to dwindling feed resources and cannot be sustained for long. Future growth in production therefore will have to come from productivity increases through accelerating the pace of adoption of improved technologies. Animal science research and extension would therefore be critical in improving productivity and should be accompanied by domestic reforms to make the sector internationally competitive.

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Appendices

Appendix Table 1. Developing countries with semi-arid tropical environments.

Country	Total area (000 km^2)	SAT area (000 km^2)	SAT area as a proportion to total area (%)
Asia			
India	3089.3	1289.7	42
Myanmar	669.8	86.2	13
Sri Lanka	66.6	7.9	12
Thailand	515.1	46.3	9
Yemen	425.5	38.3	9
Cambodia	182.6	9.8	5
Indonesia	1910.8	35.1	2
Laos	230.6	3.7	2
Viet Nam	327.1	5.1	2
Africa			
Gambia	10.7	10.7	100
Senegal	196.9	166.1	84
Burkina Faso	273.7	214.1	78
Zimbabwe	390.8	262.3	67
Mozambique	788.6	359.8	46
Nigeria	912.0	352.3	39
Haiti	37.2	12.9	35
Botswana	580.0	200.1	34
Zambia	754.8	258.5	34
Tanzania	945.0	308.2	33
Chad	1168.0	362.9	31
Benin	116.5	35.4	30
Mali	1256.7	377.1	30
Sudan	2490.4	742.3	30
Angola	1252.4	289.2	23
Eritrea	121.9	27.1	22
Jamaica	11.0	2.5	22
Madagascar	594.9	131.4	22
Namibia	825.6	181.5	22
Kenya	584.4	99.6	17
Ethiopia PDR	1132.3	186.1	16
Uganda	243.1	38.9	16
Malawi	119.0	17.5	15
Ecuador	256.9	35.4	14
Niger	1186.0	151.9	13
Cameroon	466.3	48.3	10
Swaziland	17.2	1.8	10
Mauritania	1041.6	63.7	6
Somalia	639.1	41.4	6
Central African Republic-	621.5	30.2	5
Ghana	240.0	10.2	4
Guinea	246.1	7.0	3
Guinea Bissau	33.6	1.1	3
Togo	57.3	1.1	2
America			
Cuba	110.4	83.9	76
Bahamas	12.9	4.6	36
Dominican Republic	48.4	16.6	34
Paraguay	400.1	127.3	32
Bolivia	1090.4	256.9	24
Puerto Rico	9.1	1.3	14
Venezuela	916.6	95.3	10
Brazil	8507.1	641.2	8
Mexico	1962.9	107.5	5
Colombia	1142.0	46.5	4
Peru	1296.9	15.4	1
Argentina	2781.0	5.6	0.2

Source: Ryan and Spencer 2001

Appendix Table 2. Selected developing countries with SAT area and SAT index.

Country	SAT area (000 km^2)	SAT area as a proportion to total area (%)	Share in total SAT area (%)	SAT-Index
India	1289.7	42	16.2	6.81
Sudan	742.3	30	9.3	2.80
Zimbabwe	262.3	67	3.3	2.21
Burkina Faso	214.1	78	2.7	2.10
Mozambique	359.8	46	4.5	2.08
Senegal	166.1	84	2.1	1.75
Nigeria	352.3	39	4.4	1.73
Mali	377.1	30	4.7	1.42
Chad	362.9	31	4.6	1.41
Tanzania	308.2	33	3.9	1.28
Zambia	258.5	34	3.3	1.11
Botswana	200.1	34	2.5	0.86
Angola	289.2	23	3.6	0.84
Cuba	83.9	76	1.1	0.80
Bolivia	256.9	24	3.2	0.78
Brazil	641.2	8	8.1	0.64
Paraguay	127.3	32	1.6	0.51
Namibia	181.5	22	2.3	0.50
Ethiopia PDR	186.1	16	2.3	0.37
Madagascar	131.4	22	1.7	0.36
Niger	151.9	13	1.9	0.25
Kenya	99.6	17	1.3	0.21
Myanmar	86.2	13	1.1	0.14
Uganda	38.9	16	0.5	0.08
Cameroon	48.3	10	0.6	0.06
Malawi	17.5	15	0.2	0.03
Total SAT area	7952.8		91.3	

Source: Compiled from Ryan and Spencer 2001

Appendix Table 3. Annual compound growth rates in milk yields by species in SAT countries, 1981-2001. (in%)

Country/ Region	Cow	Buffalo	Sheep	Goat
Ethiopia PDR	0.2	_[1]	0.0	0.0
Kenya	0.4	-	0.0	0.0
Madagascar	0.4	-		
Sudan	-0.2	-	-7.8	-3.2
Tanzania	1.3	-		0.0
Uganda	0.0	-		
Angola	-0.1	-		
Botswana	0.0	-		0.0
Malawi	-0.1	-		
Mozambique	0.0	-		0.0
Namibia	-0.2	-		
Zimbabwe	-2.0	-		
Zambia	0.0	-		
Cameroon	0.0	-	0.0	0.0
Chad	0.0	-	0.0	0.0
Mali	0.0	-	0.0	0.0
Niger	3.2	-	0.0	0.0
Nigeria	0.0	-		
Senegal	0.0	-	0.2	0.0
Burkina Faso	0.1	-		0.0
Myanmar	0.2	2.6	0.8	0.2
India	2.9	1.8		2.2
Cuba	-2.6	-		
Bolivia	0.5	-	0.0	0.0
Brazil	2.9	-		0.0
Paraguay	1.3	-		
World	0.3	1.7	-0.5	0.1

1. Buffalo not reared.

Based on FAOSTAT 2003 data

Appendix Table 4a. Annual compound growth rates in meat production by species in SAT countries, 1980-2000. (in %)

Country/ Region	Cattle	Buffalo	Sheep	Goat	Pig	Poultry	Total Meat	Eggs
Ethiopia PDR	1.9	_[1]	0.2	0.7	2.0	0.5	1.2	0.2
Kenya	2.2	-	1.8	3.6	6.1	2.8	2.4	3.2
Madagascar	0.6	-	2.0	-0.4	3.5	3.3	1.7	2.8
Sudan	0.8	-	4.3	8.7	0.0	2.8	2.5	2.6
Tanzania	2.7	-	1.2	2.3	4.1		2.8	3.3
Uganda	0.9	-	-1.8	4.1	13.7	3.4	3.4	3.0
Angola	2.8	-	4.5	5.3	2.8	0.7	2.7	0.7
Botswana	-0.2	-	5.1	5.1	4.3	11.3	1.6	6.4
Malawi	0.9	-	-0.8	3.5	2.3	2.9	1.9	3.0
Mozambique	0.2	-	0.8	0.9	1.8	2.9	1.4	2.1
Namibia	2.5	-	-1.4	1.5	-5.2	5.5	1.8	2.9
Zimbabwe	0.6	-	-1.7	6.4	1.8	6.2	2.0	4.3
Zambia	0.4	-	6.8	6.8	2.9	3.7	2.0	3.8
Cameroon	3.4	-	4.2	5.3	0.6	7.4	3.2	2.5
Chad	4.3	-	1.4	4.1	4.9	2.5	3.6	2.4
Mali	4.1	-	1.1	3.3	1.7	4.0	2.9	2.2
Niger	1.2	-	2.0	0.1	1.0	4.3	2.1	1.9
Nigeria	-1.4	-	6.0	4.5	1.8	1.8	0.8	3.8
Senegal	1.8	-	4.0	8.2	1.1	9.8	4.8	10.2
Burkina Faso	4.1	-	4.3	4.9	5.1	5.1	4.2	3.5
Myanmar	0.8	0.9	2.3	2.3	0.8	3.7	1.9	2.9
India	2.8	2.8	1.8	2.1	3.9	9.3	3.2	5.7
Cuba	-4.7	-	-1.6	2.5	2.5	-2.1	-1.8	-3.2
Bolivia	1.9	-	-0.8	1.3	1.9	11.2	3.6	4.2
Brazil	4.3	-	4.3	2.6	4.1	8.2	5.5	3.3
Paraguay	5.2	-	0.7	0.2	1.9	6.2	4.0	3.8
SAT Total	3.1	2.8	2.4	3.0	3.7	7.2	4.0	3.9
World	1.0	3.2	1.4	4.1	2.8	5.1	2.8	3.5

1. Buffalo not reared.

Based on FAOSTAT 2003 data

Appendix Table 4b. Annual compound growth rates in meat yields by species in SAT countries, 1980-2001. (in %)

Country	Cattle	Buffalo	Sheep	Goat	Pig	Poultry	Eggs
Ethiopia PDR	0.0	_[1]	0.0	0.0	0.0	0.0	0.0
Kenya	1.0	-	0.0	0.0	0.0	0.2	0.0
Madagascar	0.0	-	0.0	0.0	1.4	-0.1	0.0
Sudan	-2.5	-	-0.2	0.0	0.0	0.0	-0.9
Tanzania	0.2	-	0.0	0.0	0.0	-4.3	0.0
Uganda	0.0	-	0.0	0.0	0.0	0.0	0.0
Angola	-0.2	-	2.6	3.2	1.6	0.0	0.0
Botswana	-0.3	-	0.0	0.0	0.0	0.0	0.0
Malawi	0.5	-	0.0	0.0	0.0	0.0	0.0
Mozambique	0.0	-	0.0	0.0	0.0	0.0	0.0
Namibia	0.2	-	0.6	0.0	-0.8	1.6	0.0
Zimbabwe	1.7	-	0.0	0.0	0.0	0.0	0.0
Zambia	-0.1	-	0.0	0.0	0.0	0.0	0.0
Cameroon	0.4	-	0.0	0.0	0.0	0.0	0.0
Chad	0.2	-	0.9	0.0	0.0	0.0	0.0
Mali	0.0	-	-0.3	0.5	0.0	0.0	0.0
Niger	1,1	-	0.4	0.0	0.0	0.0	0.0
Nigeria	-1.3	-	0.0	0.0	0.0	0.0	-0.1
Senegal	0.0	-	0.1	1.0	0.0	0.0	-0.1
Burkina Faso	0.5	-	0.7	1.0	0.0	0.0	0.1
Myanmar	0.0	0.0	0.0	-0.8	0.0	0.3	0.1
India	0.9	0.0	0.0	0.0	0.0	0.0	1.8
Cuba	-0.5	-	0.0	0.0	-0.5	-0.2	-0.3
Bolivia	-0.2	-	-1.2	0.0	0.0	2.4	-2.5
Brazil	1.2	-	0.0	1.2	0.9	0.9	2.9
Paraguay	-0.6	-	0.0	0.0	0.0	0.0	1.7
World	0.2	0.1	0.3	0.5	0.5	0.7	0.7

1. Buffalo not reared.

Based on FAOSTAT 2003 data

Appendix Table 5. Structure of cereal production in SAT countries, 1999-2001.

Country/ Region	Rice, Paddy	Wheat	Maize	Millet	Sorghum	Total cereal production[1]	SS Index[2]
	- % share in total cereal production						
Ethiopia PDR	0.1	15.2	33.2	4.0	16.6	8.9	82.7
Kenya	1.7	7.7	83.6	1.7	3.6	2.9	68.6
Madagascar	93.3	0.4	6.3	0.0	0.0	2.8	86.4
Sudan	0.3	5.8	1.2	13.2	79.6	4.0	80.1
Tanzania	16.4	2.1	61.0	4.9	15.5	4.2	84.3
Uganda	4.8	0.6	50.4	26.1	18.1	2.2	93.8
Angola	2.9	0.7	75.1	21.3	0.0	0.6	51.0
Botswana	0.0	2.3	34.6	4.4	58.7	0.02	10.2
Malawi	3.7	0.1	93.7	0.9	1.6	2.3	108.7
Mozambique	10.6	0.1	67.0	3.6	18.6	1.6	73.3
Namibia	0.0	4.4	25.9	62.8	7.0	0.1	16.8
Zimbabwe	0.0	12.8	79.2	2.2	4.7	2.1	87.7
Zambia	1.4	8.0	82.3	5.5	2.6	0.9	55.4
Cameroon	4.8	0.0	57.5	9.9	27.7	1.3	71.8
Chad	9.9	0.3	7.6	29.2	38.6	1.2	90.6
Mali	31.0	0.3	14.6	30.4	22.7	2.6	92.8
Niger	2.4	0.4	0.2	78.5	18.5	2.7	90.0
Nigeria	*14.6*	0.4	22.2	27.5	34.9	21.3	86.4
Senegal	22.0	0.0	8.1	56.0	13.8	1.0	51.0
Burkina Faso	3.8	0.0	18.5	33.1	44.1	2.7	89.3
Myanmar	96.8	0.5	1.9	0.8	0.0	21.8	120.8
India	56.3	30.4	5.1	4.2	3.3	238.1	107.4
Cuba	67.9	0.0	32.1	0.0	0.0	0.8	22.2
Bolivia	23.3	9.9	49.7	0.0	9.5	1.2	73.3
Brazil	21.9	5.0	70.4	0.0	1.5	50.1	83.7
Paraguay	9.3	21.2	66.7	0.0	2.8	1.2	110.0
World	28.9	28.2	29.0	1.3	2.8	2085.1	

1. Quantity in million tons.
2. Self Sufficiency Index (SSI) is calculated as domestic production of cereals over domestic supply of cereals (availability)* 100.
Index value = 100 self sufficient; > 100 excess production or surplus for exports; < 100 not self sufficient or dependant on imports.
Source: FAOSTAT 2003

Appendix Table 6. Concentrate feed in SAT countries (000 t).

	Feed grain (Cereals + Pulses)		Brans		Oilcakes		Total Feed	
Country	1980-82	1998-00	1980-82	1998-00	1980-82	1998-00	1980-82	1998-00
Ethiopia PDR	107(2)	117(1)	339	581	82	113	528	810
Kenya	121 (4)	111(3)	178	314	25	61	324	487
Madagascar	197 (72)	72(3)	47	79	14	21	258	173
Sudan	103 (4)	130(2)	186	376	208	206	497	711
Tanzania	154(5)	140 (3)	104	209	69	92	326	441
Uganda	118(8)	206 (7)	71	138	16	38	205	382
Angola	14(2)	17(2)	31	31	16	18	60	67
Botswana	7(4)	4(2)	3	10	2	3	11	17
Malawi	92(6)	235(10)	85	133	15	36	192	404
Mozambique	6(1)	22(1)	87	165	81	112	174	299
Namibia	1(1)	14(3)	14	25	3	4	18	43
Zimbabwe	327(17)	332(13)	169	261	93	144	590	736
Zambia	64(5)	37(2)	97	126	19	44	181	208
Cameroon	17(1)	5(0)	70	133	41	66	128	205
Chad	11(1)	28(2)	54	113	14	70	79	211
Mali	0(0)	0(0)	75	150	51	138	126	288
Niger	75 (4)	127(4)	165	281	20	24	259	432
Nigeria	628 (6)	2204 (8)	752	1776	178	897	1558	4878
Senegal	13(1)	20(1)	129	197	4	57	146	274
Burkina Faso	0(0)	0(0)	114	245	9	57	124	302
Myanmar	474 (6)	1108(8)	821	1058	243	615	1538	2781
India	2150(2)	3009 (2)	9316	12557	4145	11498	15612	27064
Cuba	1132(42)	618 (28)	149	131	173	227	1454	975
Bolivia	260 (28)	340 (23)	108	178	41	216	409	735
Brazil	16549 (44)	27346 (50)	2149	2684	2687	7606	21385	37636
Paraguay	133(25)	406 (34)	37	49	76	248	247	703
SAT Total	22751 (10)	36648(11)	15352	22001	8325	22612	46428	81262
World	589191 (39)	666783 (35)	99351	134502	91347	161597	779889	962882

Figures in parenthesis show percent share to domestic supply of total food grains of the corresponding year.

Source: FAOSTAT 2003

***Appendix* Table 7. Calories and protein consumption in SAT countries, 1997-99.**

	Calories: Cap/Day/Number			Proteins: Cap/Day/Gram		
	Total	Animal[1]	Livestock	Total	Animal[1]	Livestock
Country/ Region		Share to total (%)			Share to total (%)	
Ethiopia PDR	1767	5	5	-51	11	11
Kenya	1934	12	12	51	30	27
Madagascar	2005	10	10	47	30	25
Sudan	2366	19	19	75	35	34
Tanzania	1926	6	6	47	21	15
Uganda	2184	6	5	48	19	13
Angola	1878	8	7	40	27	18
Botswana	2278	17	16	70	39	37
Malawi	2115	3	2	54	7	5
Mozambique	1923	3	3	38	11	8
Namibia	2091	11	10	57	28	22
Zimbabwe	2085	6	6	49	16	14
Zambia	1936	5	4	49	16	12
Cameroon	2259	6	5	54	20	13
Chad	2117	7	6	64	18	15
Mali	2238	9	9	66	24	21
Niger	2008	6	6	56	15	15
Nigeria	2813	3	2	63	11	7
Senegal	2284	9	7	64	34	21
Burkina Faso	2293	5	5	67	12	11
Myanmar	2787	4	3	71	13	7
India	2434	8	7	58	17	15
Cuba.	2453	14	13	56	40	34
Bolivia	2222	19	18	56	43	43
Brazil	2971	21	20	78	50	48
Paraguay	2574	23	23	75	54	52
World	2803	16	15	75	37	31

1. Animal includes fishery products besides livestock products.

Source: FAOSTAT 2003

Appendix Table 8. Income, population growth and urbanization in SAT countries.

	Per capita income growth[1]	Population Growth[1]		Urban population Growth[1]	Urban population (%)[2]	
Country	1981-2000	1981-2000	2001-2020	1981-2000	1981	2000
Ethiopia PDR	0.07	2.8	2.3	4.7	10.9	15.7
Kenya	0.07	3.0	1.6	6.6	16.8	33.4
Madagascar	-1.29	2.7	2.6	5.0	19.0	29.5
Sudan	1.60	2.2	1.9	5.2	20.3	36.1
Tanzania	0.30	3.0	2.1	6.9	15.4	32.3
Uganda	2.57	3.0	3.3	5.4	9.0	14.2
Angola	-1.87	3.0	3.0	5.4	21.6	34.2
Botswana	4.50	2.5	0.7	7.2	20.1	49.1
Malawi	0.54	2.9	2.1	5.3	9.3	14.7
Mozambique	1.81	2.1	1.6	6.5	13.8	32.1
Namibia	-0.07	2.8	1.8	4.3	23.1	30.8
Zimbabwe	0.03	2.7	1.6	5.0	22.8	35.3
Zambia	-2.10	2.8	1.3	2.7	40.1	39.6
Cameroon	-1.94	2.6	1.9	4.7	32.3	48.9
Chad	0.86	2.7	2.9	3.9	19.2	23.8
Mali	0.11	2.5	2.8	4.9	18.9	30.2
Niger	-2.08	3.2	3.4	5.6	12.9	20.6
Nigeria	0.10	2.7	2.3	5.2	27.6	44.1
Senegal	0.20	2.5	2.2	4.0	36.1	47.4
Burkina Faso	1.43	2.4	3.0	5.6	9.0	16.5
India	3.64	1.8	1.2	2.7	23.3	27.7
Bolivia	0.23	2.1	1.8	3.6	46.4	62.3
Brazil	0.74	1.6	1.0	2.5	67.7	81.2
Paraguay	0.07	2.7	2.1	4.2	42.3	56.0

1. Annual compound growth rates (%/annumJ.

2. Urban population as share to total population (%).

Source: World Development Indicators, World Bank

Appendix Table 9. Demand for meat by species and percent change over 1998-2000 in SAT countries.

	Bovine	Mutton	Pork	Poultry	Other Meat	Bovine	Mutton	Pork	Poultry	Other Meat
Country	Demand 2020[1] (000 t)					% Change over 1998-2000				
Ethiopia PDR	475	246	2	119	216	62	59	63	59	61
Kenya	357	85	12	83	49	40	42	39	41	40
Madagascar	180	11	165	98	6	22	13	128	73	47
Sudan	326	688	0	47	122	25	172		64	63
Tanzania	340	58	17	65	20	56	59	71	67	50
Uganda	324	61	87	71	26	229	147	64	89	158
Angola	140	21	71	72	12	52	119	76	92	56
Botswana	27	16	9	47	16	54	106	306	496	127
Malawi	26	9	23	26	0	50	91	95	68	62
Mozambique	65	4	16	54	0	67	60	26	51	0
Namibia	10	19	5	7	6	43	48	44	43	42
Zimbabwe	93	17	16	31	33	39	40	39	39	39
Zambia	32	9	13	47	40	12	151	23	49	22
Cameroon	127	59	20	53	67	42	89	5	80	44
Chad	177	45	1	8	10	125	75	106	77	112
Mali	161	106	5	49	44	77	87	79	75	80
Niger	47	42	3	60	33	21	13	102	160	50
Nigeria	476	391	116	278	161	60	63	60	62	61
Senegal	78	48	13	104	21	62	63	75	64	63
Burkina Faso	131	95	24	72	21	159	169	203	198	158
Myanmar	_[2]	-	-	-	-	-	-	-	-	-
India	3721	1043	1034	3531	228	42	53	90	552	73
Cuba	-	-	-	-	-	-	-	-	-	-
Bolivia	221	32	104	236	12	46	56	45	81	53
Brazil	10132	177	2362	12111	9	79	61	54	172	102
Paraguay	336	5	184	58	1	64	58	54	55	59
SAT Total	18002	3287	4303	17328	1152	66	77	65	191	62

1. Quantities in 2020 based on projections. See footnote 10.
2. Not estimated due to non availability of data.

Appendix Table 10. Per capita milk and meat consumption in SAT countries.

	Milk (Kg/capita/annum)			Meat (Kg/capita/annum)		
Country/Region	**1998-00**	**2020[1]**	**Change**	**1998-00**	**2020[1]**	**Change**
Ethiopia PDR	18	16	-2	10	10	0
Kenya	81	75	-6	14	14	0
Madagascar	34	32	-2	19	17	-2
Sudan	158	188	30	21	26	5
Tanzania	23	22	-1	9	9	0
Uganda	22	21	-1	10	12	2
Angola	16	13	-3	15	13	-2
Botswana	137	114	-23	28	65	37
Malawi	4	4	0	5	5	0
Mozambique	4	4	0	5	5	0
Namibia	52	47	-5	18	17	-1
Zimbabwe	19	18	-1	11	11	0
Zambia	7	5	-2	11	8	-3
Cameroon	15	15	0	15	15	0
Chad	28	26	-2	15	17	2
Mali	52	49	-3	19	18	-1
Niger	30	22	-8	12	8	-4
Nigeria	8	8	0	8	8	0
Senegal	17	15	-2	18	18	0
Burkina Faso	23	32	9	11	16	5
Myanmar	20	_[2]	-	8	-	-
India	79	121	42	5	7	2
Cuba	59	-	-	26	-	-
Bolivia	40	40	0	48	50	2
Brazil	116	147	31	71	118	47
Paraguay	77	85	8	70	68	-2
World	89	-	-	37	-	-

1. Figures on 2020 based on projections. See footnote 10.
2. Not estimated.

About ICRISAT

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a non-profit, non-political organization belonging to the Future Harvest Alliance of Centers supported by the Consultative Group on International Agricultural Research (CGIAR). Established in 1972, ICRISAT generates and shares cutting edge technologies that support the livelihoods of more than 300 million people - the poorest of the poor in semi-arid areas of the developing world.

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